

**BIOLOGY**

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**SHORT STUDY NOTES**

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**DIGESTIVE  
SYSTEM**

**CLASS 11**

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**BY LEARNINGMANTRAS.COM**

## Digestive System

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**.

**Digestion** is the complex process of turning the food you eat into nutrients, which the body uses for energy, growth and cell repair needed to survive. The digestion process also involves creating waste to be eliminated.

### Activities of Digestion

- **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.
- **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.
- **Mechanical Digestion:** Digestion is a purely physical process that does not change the chemical nature of the food. 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.
- **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.
- **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.
- **Defecation:** 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 pepsin 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 gallbladder 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 tripeptides, dipeptides, and amino acids.
- 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 semi solid 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.

## Functions of the Human Digestive System

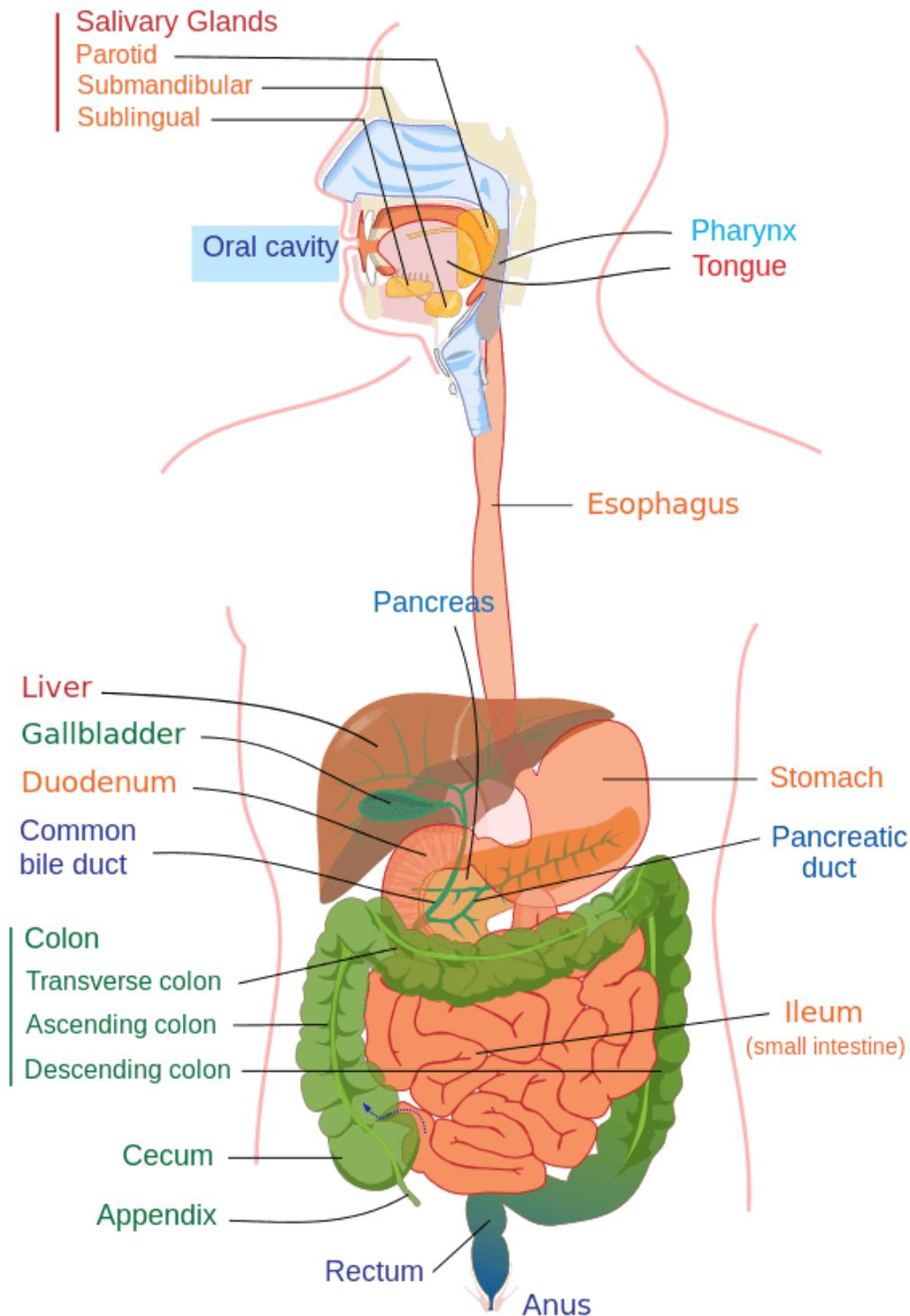
- Digestion is important for breaking down food into nutrients, which the body uses for energy, growth, and cell repair.
- The digestive system is not only uniquely constructed to perform its specialized function of turning food into energy but also responsible for packaging the residue for waste disposal.
- It is essential to good health because if the digestive system shuts down, the body cannot be nourished or rid itself of waste.

## Digestion and Absorption

- Process of conversion of complex food substances to simple absorbable forms is called digestion.
- When the process of digestion occurs within the cell in the food vacuole it is called intracellular digestion. E.g., protozoa, porifera, coelenterata and free living platyhelminthes.
- When the process of digestion occurs outside the cell it is called extracellular digestion. E.g., Coelenterates and phylum platyhelminthes to phylum chordata.

## Digestive System

Digestive system is made up of the gastrointestinal (GI) tract and your liver, pancreas and gallbladder. The GI tract is a series of hollow organs that are connected to each other from your mouth to your anus. The organs that make up your GI tract, in the order that they are connected, include your mouth, esophagus, stomach, small intestine, large intestine and anus.



- **What does the digestive system do?**

Digestive system is uniquely constructed to do its job of turning your food into the nutrients and energy you need to survive. And when it's done with that, it handily packages your solid waste, or stool, for disposal when you have a bowel movement.

- **Why is digestion important?**

Digestion is important because your body needs nutrients from the food you eat and the liquids you drink in order to stay healthy and function properly. Nutrients include carbohydrates, proteins, fats, vitamins, minerals and water. Your digestive system breaks down and absorbs nutrients from the food and liquids you consume to use for important things like energy, growth and repairing cells.

## **Alimentary Tract of The Human Digestive System**

The alimentary canal begins at the mouth, passes through the thorax, abdomen, and pelvis and ends at the anus. It is thus a long tube through which food passes. It has various parts that are structurally remarkably similar. The parts include:

### **Mouth**

- **The mouth or oral cavity is bounded by muscles and bones:**
  - anteriorly —by the lips
  - posteriorly — it is continuous with the oropharynx
  - laterally —by the muscles of the cheeks
  - superiorly —by the bony hard palate and muscular soft palate
  - inferiorly —by the muscular tongue and the soft tissues of the floor of the mouth.
- It is lined throughout with mucous membrane, consisting of stratified squamous epithelium containing small mucus-secreting glands.
- The palate forms the roof of the mouth and is divided into the anterior hard palate and the posterior soft palate. The soft palate is muscular, curves downwards from the posterior end of the hard palate, and blends with the walls of the pharynx at the sides.
- The uvula is a curved fold of muscle covered with mucous membrane, hanging down from the middle of the free border of the soft palate.
- **It consists of the following important parts:**
  - **The Tongue**
    - The tongue is a voluntary muscular structure that occupies the floor of the mouth.
    - It is attached by its base to the hyoid bone and by a fold of its mucous membrane covering, called the frenulum, to the floor of the mouth.
    - The superior surface consists of stratified squamous epithelium, with numerous papillae (little projections), containing nerve endings of the sense of taste, sometimes called the taste buds.
  - **The Teeth**
    - The teeth are embedded in the alveoli or sockets of the alveolar ridges of the mandible and the maxilla.
    - Each individual has two sets, the temporary or deciduous teeth, and the permanent teeth.
    - At birth, the teeth of both dentitions are present in an immature form in the mandible and maxilla.
    - There are 20 temporary teeth, 10 in each jaw. They begin to erupt when the child is about 6 months old, and should all be present after 24 months.
    - The permanent teeth begin to replace the deciduous teeth in the 6th year of age and this dentition, consisting of 32 teeth, is usually complete by the 24th year.

## Pharynx

Food passes from the oral cavity into the pharynx then to the esophagus below, with which it is continuous. The pharynx is divided for descriptive purposes into three parts, the nasopharynx, oropharynx, and laryngopharynx. The nasopharynx is important in respiration. The oropharynx and laryngopharynx are passages common to both the respiratory and the digestive systems.

## Oesophagus

The esophagus is about 25 cm long and about 2 cm in diameter and lies in the median plane in the thorax in front of the vertebral column behind the trachea and the heart. It is continuous with the pharynx above and just below the diaphragm it joins the stomach. The upper and lower ends of the esophagus are closed by sphincter muscles. The upper cricopharyngeal sphincter prevents air from passing into the esophagus during inspiration and the aspiration of oesophageal contents. The cardiac or lower oesophageal sphincter prevents the reflux of acid gastric contents into the esophagus.

## Stomach

The stomach is a hollow organ, or "container," that holds food while it is being mixed with stomach enzymes. These enzymes continue the process of breaking down food into a usable form. Cells in the lining of your stomach secrete a strong acid and powerful enzymes that are responsible for the breakdown process. When the contents of the stomach are processed enough, they're released into the small intestine.

- **Functions of the Stomach**

- Temporary storage allows time for the digestive enzymes, pepsins, to act.
- Chemical digestion — pepsins convert proteins to polypeptides.
- Mechanical breakdown — the three smooth muscle layers enable the stomach to act as a churn, gastric juice is added and the contents are liquefied to chyme.
- Performs limited absorption of water, alcohol and some lipid-soluble drugs
- Non-specific defense against microbes — provided by hydrochloric acid in gastric juice.
- Preparation of iron for absorption further along the track — the acid environment of the stomach solubilizes iron salts, which is required before iron can be absorbed
- Production of intrinsic factor needed for absorption of vitamin B<sub>12</sub> in the terminal ileum
- Regulation of the passage of gastric contents into the duodenum. When the chyme is sufficiently acidified and liquefied, the pyloric antrum forces small jets of gastric contents through the pyloric sphincter into the duodenum.

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## Small intestine

Made up of three segments — the duodenum, jejunum, and ileum — the small intestine is a 22-foot long muscular tube that breaks down food using enzymes released by the pancreas and bile from the liver. Peristalsis also works in this organ, moving food through and mixing it with digestive juices from the pancreas and liver.

The duodenum is the first segment of the small intestine. It's largely responsible for the continuous breaking-down process. The jejunum and ileum lower in the intestine are mainly responsible for the absorption of nutrients into the bloodstream.

Contents of the small intestine start out semi-solid and end in a liquid form after passing through the organ. Water, bile, enzymes and mucus contribute to the change in consistency. Once the nutrients have been absorbed and the leftover-food residue liquid has passed through the small intestine, it then moves on to the large intestine, or colon.

### **Pancreas**

The pancreas secretes digestive enzymes into the duodenum that break down protein, fats and carbohydrates. The pancreas also makes insulin, passing it directly into the bloodstream. Insulin is the chief hormone in your body for metabolizing sugar.

### **Liver**

The liver has many functions, but its main job within the digestive system is to process the nutrients absorbed from the small intestine. Bile from the liver secreted into the small intestine also plays an important role in digesting fat and some vitamins.

The liver is your body's chemical "factory." It takes the raw materials absorbed by the intestine and makes all the various chemicals your body needs to function.

The liver also detoxifies potentially harmful chemicals. It breaks down and secretes many drugs that can be toxic to your body.

### **Gallbladder**

The gallbladder stores and concentrates bile from the liver, and then releases it into the duodenum in the small intestine to help absorb and digest fats.

### **Colon (Large Intestine)**

The large intestine, or colon, is responsible for processing waste so that emptying the bowels is easy and convenient. It's a 6-foot long muscular tube that connects the small intestine to the rectum.

The large intestine is made up of the cecum, the ascending (right) colon, the transverse (across) colon, the descending (left) colon, and the sigmoid colon, which connects to the rectum.

Stool, or waste left over from the digestive process, is passed through the colon by means of peristalsis, first in a liquid state and ultimately in a solid form. As stool passes through the colon, water is removed. Stool is stored in the sigmoid (S-shaped) colon until a "mass movement" empties it into the rectum once or twice a day.

It normally takes about 36 hours for stool to get through the colon. The stool itself is mostly food debris and bacteria. These "good" bacteria perform several useful functions, such as synthesizing various vitamins, processing waste products and food particles and protecting against harmful bacteria. When the descending colon becomes

full of stool, or feces, it empties its contents into the rectum to begin the process of elimination (a bowel movement).

### **Rectum**

The rectum is a straight, 8-inch chamber that connects the colon to the anus. The rectum's job is to receive stool from the colon, let you know that there is stool to be evacuated (pooped out) and to hold the stool until evacuation happens. When anything (gas or stool) comes into the rectum, sensors send a message to the brain. The brain then decides if the rectal contents can be released or not.

If they can, the sphincters relax and the rectum contracts, disposing of its contents. If the contents cannot be disposed of, the sphincter contracts and the rectum accommodates so that the sensation temporarily goes away.

### **Anus**

The anus is the last part of the digestive tract. It is a 2-inch long canal consisting of the pelvic floor muscles and the two anal sphincters (internal and external). The lining of the upper anus is able to detect rectal contents. It lets you know whether the contents are liquid, gas or solid.

The anus is surrounded by sphincter muscles that are important in allowing control of stool. The pelvic floor muscle creates an angle between the rectum and the anus that stops stool from coming out when it's not supposed to. The internal sphincter is always tight, except when stool enters the rectum. This keeps us continents (prevents us from pooping involuntarily) when we are asleep or otherwise unaware of the presence of stool.

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