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## Digestion and Absorption - Part 3

### Objectives

After going through this lesson, the learners will be able to understand the following:

- Absorption of Digested Products
- Disorders of Digestive System
- Constipation and Diarrhoea
- Effects of Ageing
- Homeostasis

### Content Outline

- Introduction to Absorption of Digested Products
- Disorders of Digestive System
- Constipation
- Diarrhea and Constipation
- Effects of Aging
- Homeostasis
- Summary

### Introduction to Absorption of Digested Products

Absorption is the process by which the end products of digestion pass through the intestinal mucosa into the blood or lymph. It is carried out by passive, active or facilitated transport mechanisms. Small amounts of monosaccharides like glucose, amino acids and some electrolytes like chloride ions are generally absorbed by simple diffusion. The passage of these substances into the blood depends upon the concentration gradients. However, some of the substances like fructose and some amino acids are absorbed with the help of the carrier ions like  $\text{Na}^+$ . This mechanism is called facilitated transport.

Transport of water depends upon the osmotic gradient. Active transport occurs against the concentration gradient and hence requires energy. Various nutrients like amino acids, monosaccharides like glucose, electrolytes like  $\text{Na}^+$  are absorbed into the blood by this mechanism. Fatty acids and glycerol being insoluble, cannot be absorbed into the blood. They are first incorporated into small droplets called micelles which move into the intestinal

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mucosa. They are re-formed into very small protein coated fat globules called the chylomicrons which are transported into the lymph vessels (lacteals) in the villi. These lymph vessels ultimately release the absorbed substances into the bloodstream. Absorption of substances takes place in different parts of the alimentary canal, like mouth, stomach, small intestine and large intestine. However, maximum absorption occurs in the small intestine. A summary of absorption (sites of absorption and substances absorbed) is given in Table 16.1. The absorbed substances finally reach the tissues which utilize them for their activities. This process is called assimilation. The digestive wastes, solidified into coherent faeces in the rectum initiate a neural reflex causing an urge or desire for its removal. The egestion of faeces to the outside through the anal opening (defaecation) is a voluntary process and is carried out by a mass peristaltic movement.

### **Disorders of Digestive System**

The inflammation of the intestinal tract is the most common ailment due to bacterial or viral infections. The infections are also caused by the parasites of the intestine like tapeworm, roundworm, threadworm, hookworm, pinworm, etc.

**Jaundice:** The liver is affected, skin and eyes turn yellow due to the deposit of bile pigments.

**Vomiting:** It is the ejection of stomach contents through the mouth. This reflex action is controlled by the vomit centre in the medulla. A feeling of nausea precedes vomiting.

**Diarrhoea:** The abnormal frequency of bowel movement and increased liquidity of the faecal discharge is known as diarrhoea. It reduces the absorption of food.

**Constipation:** In constipation, the faeces are retained within the rectum as the bowel movements occur irregularly.

**Indigestion:** In this condition, the food is not properly digested leading to a feeling of fullness. The causes of indigestion are inadequate enzyme secretion, anxiety, food poisoning, over eating, and spicy food.

### **Constipation**

The colon of the large intestine has four regions: the ascending colon, the transverse colon, the descending colon, and the sigmoid colon (see Fig. 15.9a). Water is removed from the nondigestible intestinal contents entering the ascending colon from the small intestine. At this

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point, bacteria begin their action; they use cellulose as an energy source as they produce fatty acids and vitamins that can also be used by their host. They also release hydrogen gas and sulfur-containing compounds that contribute to human flatulence (gas). Feces, which consist of undigested intestinal contents, bacteria, and sloughed-off intestinal cells, begin to form in the transverse colon. From there, they are propelled down the descending colon toward the rectum by periodic, firm contractions called peristalsis. When sufficient feces are in the rectum (130-200 grams), a defecatory urge is felt. The involuntary defecation reflex contracts the rectal muscles and relaxes the internal anal sphincter, a ring of muscle that closes off the rectum (Fig. 15B). Then, feces move toward the anus. A pushing motion, along with relaxation of the external anal sphincter, propels feces from the body. Since these activities are under voluntary control, it is possible to control defecation.

Defecation normally occurs from three times a week to three times a day; therefore, some variation in occurrence is nothing to worry about. However, if the frequency of defecation declines and if defecation becomes difficult, constipation is present. If constipation is a continuing problem, a physician can help record the movement of materials through the large intestine via several tests. The patient swallows about 20 small markers that will show up on an X ray. At intervals during the following week, X rays are taken, and the number and locations of the markers are noted. If muscle contraction of the intestinal wall is insufficient, the markers move slowly along their course. Injured nerves, certain drugs, dehydration, and prolonged overuse of stimulatory laxatives can bring about this difficulty. Some or all of these problems frequently occur in the elderly. On the other hand, markers may move normally at first and then slow down considerably in the descending colon and rectum. Habitual disregard of the defecatory urge may have caused this problem, or a cancerous polyp might be obstructing normal movement. If the former is the case, it is possible to retrain the rectum to work properly. Sitting on the toilet for about 20 minutes each morning can encourage a return of the reflexes that have disappeared, but straining is not recommended.

Temporary constipation due to traveling, pregnancy, or medication can sometimes be relieved by increasing dietary fiber, drinking plenty of water, and getting moderate amounts of exercise. The use of oral laxatives (agents that aid emptying of the intestine) is a last resort. Bulk-forming laxatives, such as those that contain bran, psyllium, and methyl cellulose, are

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considered best because they promote the defecation reflex. Laxatives that contain osmotic agents, such as carbohydrates or salts (lactulose, milk of magnesia, or Epsom salts), cause water to move into rather than out of the colon. Stool softeners (mineral oil or those that contain docusate) should be used sparingly. Mineral oil reduces the absorption of fat-soluble vitamins, and docusate can cause liver damage. Laxatives that contain chemical stimulants (such as phenolphthalein in Ex-Lax and Feen-A-Mint) can damage the defecation reflex and lead to a dependence on their use. Aside from laxatives, rectal suppositories are sometimes helpful in providing lubrication and stimulating the defecation reflex. Enemas introduce water into the colon and, therefore, also help stimulate defecation.

### **Diarrhea and Constipation**

Two common everyday complaints associated with the large intestine are **diarrhea** and **constipation**. The major causes of diarrhea are infection of the lower intestinal tract and nervous stimulation. In the case of infection, such as food poisoning caused by eating contaminated food, the intestinal wall becomes irritated, and peristalsis increases. Water is not absorbed, and the diarrhea that results rids the body of the infectious organisms. In nervous diarrhea, the nervous system stimulates the intestinal wall, and diarrhea results. Prolonged diarrhea can lead to dehydration because of water loss and to disturbances in the heart's contraction due to an imbalance of salts in the blood. When a person is constipated, the feces are dry and hard. The Medical Focus on this page discusses the causes of constipation and how it can be prevented. Chronic constipation is associated with the development of hemorrhoids, enlarged and inflamed blood vessels at the anus.

### **Polyps**

The colon is subject to the development of **polyps**, small growths arising from the epithelial lining. Polyps, whether benign or cancerous, can be removed surgically along with a portion of the colon if necessary. If colon cancer is detected while still confined to a polyp, the expected outcome is a complete cure. If the last portion of the rectum and the anal canal must be removed, then the intestine is sometimes attached to the abdominal wall through a procedure known as a **colostomy**, and the digestive remains are collected in a plastic bag fastened around the opening. Recently, the use of metal staples has permitted surgeons to join the colon to a piece of rectum that formerly was considered too short.

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Some investigators believe that dietary fat increases the likelihood of colon cancer because dietary fat causes an increase in bile secretion. It could be that intestinal bacteria convert bile salts to substances that promote the development of cancer. On the other hand, fiber in the diet seems to inhibit the development of colon cancer. Dietary fiber absorbs water and adds bulk, thereby diluting the concentration of bile salts and facilitating the movement of substances through the intestine. Regular elimination reduces the time that the colon wall is exposed to any cancer promoting agents in feces.

### **Other Disorders of the Large Intestine**

The appendix is a fingerlike projection from the cecum of the large intestine. Unfortunately, the appendix can become infected, resulting in **appendicitis**, a very painful condition in which the fluid content of the appendix can increase to the point that it bursts. The appendix should be removed before it bursts to avoid a generalized infection of the peritoneal membrane of the abdominal cavity.

**Diverticulosis** is characterized by the presence of diverticula, or saclike pouches, in the colon. Ordinarily, these pouches cause no problems. But about 15% of people with diverticulosis develop an inflammation known as diverticulitis. The symptoms of diverticulitis are similar to those of appendicitis — cramps or steady pain with local tenderness. Fever, loss of appetite, nausea, and vomiting may also occur. Today, high fiber diets are recommended to prevent the development of these conditions and of cancer of the colon.

### **Effects of Aging**

The incidence of gastrointestinal disorders increases with age. Periodontitis, which is common in elderly people, leads to the loss of teeth and the need for false teeth. The esophagus, which rarely causes any difficulties in younger people, is more prone to disorders in the elderly. A portion of the esophagus normally found inferior to the diaphragm can protrude into the thoracic cavity, causing an esophageal hiatal hernia. In some cases, the lower esophageal sphincter opens inappropriately and allows chyme to regurgitate into the esophagus, causing heartburn. Or in some older persons, chest pain may occur when this sphincter fails to open and a bolus cannot enter the stomach. Eventually, the esophagus may develop a diverticulum that allows food to collect abnormally.

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Peristalsis generally slows within the alimentary canal as the muscular wall loses tone. Peptic ulcers increase in frequency with age. The failure of older people to consume sufficient dietary fiber can result in diverticulosis and constipation. Constipation and hemorrhoids are frequent complaints among the elderly, as is fecal incontinence. The liver shrinks with age and receives a smaller blood supply than in younger years. Notably, it needs more time to metabolize drugs and alcohol. With age, gallbladder difficulties occur; there is an increased incidence of gallstones and cancer of the gallbladder. In fact, cancer of the various organs of the gastrointestinal tract is seen more often among the elderly. For example, most cases of pancreatic cancer occur in people over the age of 60.

### **Homeostasis**

Human Systems Work Together on page 313 tells how the digestive system works with other systems in the body to maintain homeostasis. Within the alimentary canal, the food we eat is broken down to nutrients small enough to be absorbed by the villi of the small intestine. Digestive enzymes are produced by the salivary glands, gastric glands, and intestinal glands. Three accessory organs of digestion (the pancreas, the liver, and the gallbladder) also contribute secretions that help break down food. The liver produces bile (stored by the gallbladder), which emulsifies fat. The pancreas produces enzymes for the digestion of carbohydrates, proteins, and fat. Secretions from these glands, which are sent by ducts into the small intestine, are regulated by hormones such as secretin produced by the alimentary canal. Therefore, the alimentary canal is also a part of the endocrine system. Other accessory organs, such as the salivary glands and teeth, are also essential to digestion.

The skeletal system assists the digestive system in that the teeth sockets are in the mandible and maxilla. The liver is the most important of the metabolic organs. The liver has a wide variety of functions and is chemically extremely active, which gives it an influence over all other organs. Some actions involve the breakdown of complex chemicals; other important ones involve synthesis, particularly the manufacture of protein molecules. The liver assists the urinary system, producing urea, the main nitrogenous end product of human beings. The liver acts as a cleansing station, inactivating hormones and drugs. The Kupffer cells that line the liver's sinusoids mop up unwanted substances and infectious pathogens reaching it from the small intestine. Because the liver is such an important organ, diseases affecting the liver, such as hepatitis and cirrhosis, are extremely dangerous.

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The liver and the cardiovascular system work together. A large amount of the body's blood reaches the liver constantly. Between meals, more than three-quarters of this supply comes to the liver by way of the hepatic portal vein, which drains the intestine. The remainder is from the body's main arterial system via the hepatic artery. When food is eaten, more blood is diverted to the intestine to cope with the tasks of digestion and absorption, and blood flow in the hepatic portal vein increases. The liver assists the cardiovascular system by aiding in the breakdown of red blood cells. It assists the urinary system by excreting bilirubin, a hemoglobin breakdown product. The nutrients absorbed by the alimentary canal are converted by the body into energy and used for physical activities and for the growth and repair of body tissue. As we shall see in section 15.6, carbohydrates and fats are used to fuel all the body's processes and functions, while protein is mainly used as a building material. Besides these three basic components, the body must also have vitamins and minerals. Vitamins are essential for normal growth and development, and because they cannot be manufactured in the body, they must be supplied ready-made in the diet or as supplements. Minerals assist in many body processes, such as normal nerve and muscle function, but are needed only in small quantities.

The muscular system and digestive system work together. The muscular system benefits from the nutrients absorbed by the alimentary canal, but mechanical digestion is in part dependent upon the muscular walls of the alimentary canal. Also, peristalsis pushes food along from organ to organ.

Peyer patches and Kupffer cells are examples that the digestive system and the lymphatic system work together. Peyer patches in the wall of the small intestine are lymphatic tissue. They are an important way for the small intestine to protect itself from invasion by bacteria. The patches contain large numbers of antibody-secreting lymphocytes. The endocrine system and the digestive system also work together. The secretion of digestive juices is dependent on hormones produced not by the endocrine glands but by the digestive organs themselves. Thus, these organs become a part of the endocrine system. Certainly, the pancreas is counted as an endocrine gland when it produces insulin, which causes cells, including the hepatic cells, to take up glucose. Thereafter, glucose is stored in the liver and muscles for future use.

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## Summary

The digestive system of humans consists of an alimentary canal and associated digestive glands. The alimentary canal consists of the mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine, large intestine, rectum and the anus. The accessory digestive glands include the salivary glands, the liver (with gallbladder) and the pancreas. Inside the mouth the teeth masticates the food, the tongue tastes the food and manipulates it for proper mastication by mixing with the saliva. Saliva contains a starch digestive enzyme, salivary amylase that digests the starch and converts it into maltose (disaccharide). The food then passes into the pharynx and enters the oesophagus in the form of bolus, which is further carried down through the oesophagus by peristalsis into the stomach. In the stomach mainly protein digestion takes place. Absorption of simple sugars, alcohol and medicines also takes place in the stomach. The chyme (food) enters into the duodenum portion of the small intestine and is acted on by the pancreatic juice, bile and finally by the enzymes in the succus entericus, so that the digestion of carbohydrates, proteins and fats is completed. The food then enters into the jejunum and ileum portions of the small intestine. Carbohydrates are digested and converted into monosaccharides like glucose. Proteins are finally broken down into amino acids. The fats are converted to fatty acids and glycerol. The digested end products are absorbed into the body through the epithelial lining of the intestinal villi. The undigested food (faeces) enters into the caecum of the large intestine through ileo-caecal valve, which prevents the backflow of the faecal matter. Most of the water is absorbed in the large intestine. The undigested food becomes semi-solid in nature and then enters into the rectum, anal canal and is finally egested out through the anus.