Human Digestive System

The human digestive system is a complex process that consists of breaking down large organic masses into smaller particles that the body can use as fuel. The breakdown of the nutrients requires the coordination of several enzymes secreted from specialized cells within the mouth, stomach, intestines, and liver. The major organs or structures that coordinate digestion within the human body include the mouth, esophagus, stomach, small and large intestine, and liver.

Mouth

In the human body, the mouth (oral cavity) is a specialized organ for receiving food and breaking up large organic masses. In the mouth, food is changed mechanically by biting and chewing. Humans have four kinds of teeth: *incisors* are chisel-shaped teeth in the front of the mouth for biting; *canines* are pointed teeth for tearing; and*premolars* and *molars* are flattened, ridged teeth for grinding, pounding, and crushing food.

In the mouth, food is moistened by saliva, a sticky fluid that binds food particles together into a soft mass. Three pairs of **salivary glands**—the parotid glands, the submaxillary glands, and the sublingual glands—secrete saliva into the mouth. The saliva contains an enzyme called *amylase*, which digests starch molecules into smaller molecules of the disaccharide maltose.

During chewing, the tongue moves food about and manipulates it into a mass called a *bolus*. The bolus is pushed back into the pharynx (throat) and is forced through the opening to the esophagus.

Esophagus

The **esophagus** is a thick-walled muscular tube located behind the windpipe that extends through the neck and chest to the stomach. The bolus of food moves through the esophagus

by **peristalsis:** a rhythmic series of muscular contractions that propels the bolus along. The contractions are assisted by the pull of gravity.

Stomach

The esophagus joins the stomach at a point just below the diaphragm. A valvelike ring of muscle called the *cardiac sphincter* surrounds the opening to the stomach. The sphincter relaxes as the bolus passes through and then quickly closes. The *stomach* is an expandable pouch located high in the abdominal cavity. Layers of stomach muscle contract and churn the bolus of food with gastric juices to form a soupy liquid called **chyme.**

The stomach stores food and prepares it for further digestion. In addition, the stomach plays a role in protein digestion. Gastric glands called *chief cells* secrete pepsinogen. Pepsinogen is converted to the enzyme pepsin in the presence of hydrochloric acid. Hydrochloric acid is secreted by *parietal cells* in the stomach lining. The pepsin then digests large proteins into smaller proteins called peptides. To protect the stomach lining from the acid, a third type of cell secretes mucus that lines the stomach cavity. An overabundance of acid due to mucus failure may lead to an ulcer.

Small intestine

The soupy mixture called chyme spurts from the stomach through a sphincter into the small intestine. An adult's small intestine is about 23 feet long and is divided into three sections: the first 10 to 12 inches form the **duodenum;** the next 10 feet form the **jejunum;** and the final 12 feet form the **ileum.** The inner surface of the small intestine contains numerous fingerlike projections called *villi*. Each villus has projections of cells called *microvilli* to increase the surface area.

Most chemical digestion takes place in the duodenum. In this region, enzymes digest nutrients into simpler forms that can be absorbed. Intestinal enzymes are supplemented by enzymes from

the **pancreas**, a large, glandular organ lying near the stomach. In addition, bile enters the small intestine from the gall bladder to assist in fat digestion.

The enzymes functioning in carbohydrate digestion include amylase (for starch), maltase (for maltose), sucrase (for sucrose) and lactase (for lactose). For fats, the principal enzyme is lipase. Before this enzyme can act, the large globules of fat must be broken into smaller droplets by bile. *Bile* is a mixture of salts, pigments, and cholesterol that is produced by the liver and stored in the gall bladder, a saclike structure underneath the liver.

Protein digestion is accomplished by several enzymes, including two pancreatic enzymes: trypsin and chymotrypsin. Peptides are broken into smaller peptides, and peptidases reduce the enzymes to amino acids. Nucleases digest nucleic acids into nucleotides in the small intestine also.

Most **absorption** in the small intestine occurs in the jejunum. The products of digestion enter cells of the villi, move across the cells, and enter blood vessels called capillaries. Diffusion accounts for the movement of many nutrients, but active transport is responsible for the movement of glucose and amino acids. The products of fat digestion pass as small droplets of fat into lacteals, which are branches of the lymphatic system.

Absorption is completed in the final part of the small intestine, the ileum. Substances that have not been digested or absorbed then pass into the large intestine.

Large intestine

The small intestine joins the large intestine in the lower right abdomen of the body. The two organs meet at a blind sac called the **cecum** and a small fingerlike process called the **appendix.** Evolutionary biologists believe the cecum and appendix are vestiges of larger organs that may have been functional in human ancestors.

The large intestine is also known as the *colon*. It is divided into ascending, transverse, and descending portions, each about one foot in length. The colon's chief functions are to absorb water and to store, process, and eliminate the residue following digestion and absorption. The intestinal matter remaining after water has been reclaimed is known as *feces*. Feces consist of nondigested food (such as cellulose), billions of mostly harmless bacteria, bile pigments, and

other materials. The feces are stored in the rectum and passed out through the anus to complete the digestion process.

Liver

The liver has an important function in processing the products of human digestion. For example, cells of the liver remove excess glucose from the bloodstream and convert the glucose to a polymer called **glycogen** for storage.

The liver also functions in amino acid metabolism. In a process called *deamination*, it converts some amino acids to compounds that can be used in energy metabolism. In doing so, the liver removes the amino groups from amino acids and uses the amino groups to produce urea. Urea is removed from the body in the urine. **Fats** are processed into two-carbon units that can enter the Krebs cycle for energy metabolism. The liver also stores vitamins and minerals, forms many blood proteins, synthesizes cholesterol, and produces bile for fat digestion.

Digestive System Glossary:

abdomen - the part of the body that contains the digestive organs. In human beings, this is between the diaphragm and the pelvis

alimentary canal - the passage through which food passes, including the mouth, esophagus, stomach, intestines, and anus.

anus - the opening at the end of the digestive system from which feces (waste) exits the body.

appendix - a small sac located on the cecum.

ascending colon - the part of the large intestine that run upwards; it is located after the cecum.

bile - a digestive chemical that is produced in the liver, stored in the gall bladder, and secreted into the small intestine.

cecum - the first part of the large intestine; the appendix is connected to the cecum.

chyme - food in the stomach that is partly digested and mixed with stomach acids. Chyme goes on to the small intestine for further digestion.

descending colon - the part of the large intestine that run downwards after the transverse colon and before the sigmoid colon.

digestive system - (also called the gastrointestinal tract or GI tract) the system of the body that

processes food and gets rid of waste.

duodenum - the first part of the small intestine; it is C-shaped and runs from the stomach to the jejunum.

epiglottis - the flap at the back of the tongue that keeps chewed food from going down the windpipe to the lungs. When you swallow, the epiglottis automatically closes. When you breathe, the epiglottis opens so that air can go in and out of the windpipe.

esophagus - the long tube between the mouth and the stomach. It uses rhythmic muscle movements (called peristalsis) to force food from the throat into the stomach.

gall bladder - a small, sac-like organ located by the duodenum. It stores and releases bile (a digestive chemical which is produced in the liver) into the small intestine.

gastrointestinal tract - (also called the GI tract or digestive system) the system of the body that processes food and gets rid of waste.

ileum - the last part of the small intestine before the large intestine begins.

intestines - the part of the alimentary canal located between the stomach and the anus.

jejunum - the long, coiled mid-section of the small intestine; it is between the duodenum and the ileum.

liver - a large organ located above and in front of the stomach. It filters toxins from the blood, and makes bile (which breaks down fats) and some blood proteins.

mouth - the first part of the digestive system, where food enters the body. Chewing and salivary enzymes in the mouth are the beginning of the digestive process (breaking down the food).

pancreas - an enzyme-producing gland located below the stomach and above the intestines. Enzymes from the pancreas help in the digestion of carbohydrates, fats and proteins in the small intestine.

peristalsis - rhythmic muscle movements that force food in the esophagus from the throat into the stomach. Peristalsis is involuntary - you cannot control it. It is also what allows you to eat and drink while upside-down.

rectum - the lower part of the large intestine, where feces are stored before they are excreted.

salivary glands - glands located in the mouth that produce saliva. Saliva contains enzymes that break down carbohydrates (starch) into smaller molecules.

sigmoid colon - the part of the large intestine between the descending colon and the rectum.

stomach - a sack-like, muscular organ that is attached to the esophagus. Both chemical and

mechanical digestion takes place in the stomach. When food enters the stomach, it is churned in a bath of acids and enzymes.

transverse colon - the part of the large intestine that runs horizontally across the abdomen.