THE HUMAN BODY

THE DIGESTIVE SYSTEM

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Humans eat for many different reasons: because they are hungry, because they are bored, because they are stressed, or simply because the food smells and tastes good. The biological reason for eating, however, is to replenish nutrients and to provide energy to support the body’s functions. The task of the digestive system is to break down food into the elements that the body can use and to eliminate as waste whatever is left over.

One might believe that such a basic function would be well understood, with little left to learn. In fact, scientists are constantly discovering new things about how the digestive system does its job and how it interacts with other aspects of the body. Current research may help experts understand elements of health as diverse as how the digestive system affects immunity as well as its relationship to such important health concerns as heart disease, diabetes, and cancer. This book explores what happens to food in its journey through your body.

The entrance to the digestive tract is the mouth. Although little digestion of food actually takes place in the mouth, it contains important structures that aid in and begin the digestive process. These include the teeth, the tongue, and the salivary glands, which together reduce food into small particles and mix it with saliva in order to speed its progression through the digestive system. Human teeth are specifically designed for an omnivorous diet, with different shapes and surfaces for cutting and tearing meat and grinding grains and vegetables. The muscular tongue moves food around the mouth, pushing it toward the esophagus. The tongue is also covered with a mucous membrane, which contains taste buds, allowing humans to distinguish between different flavours, such as sweet, salty, sour, bitter, and umami (meaty). Saliva, which is secreted by the salivary glands,
both moistens food and starts to dissolve it through the action of the enzyme amylase. The salivary glands make saliva to keep the mouth moist, but their action increases whenever chewing occurs. Salivary glands also increase their output in reaction to a stimulus that has been associated with food in the past, such as succulent odours or even a specific sight or sound related to food. So, in fact, people’s mouths actually do water when expecting something tasty such as a sizzling grilled steak.

From the mouth, food passes through the esophagus, driven by the swallowing process. Swallowing is basically involuntary—once food reaches the back of the mouth the reflex to swallow takes over and cannot be retracted. Muscles in the esophagus then carry food to the stomach through a series of rhythmic contractions known as peristaltic waves. These waves continuously push the food down to the stomach. Amazingly, it takes only 10 seconds for food to move through the esophagus. When people eat in an upright position, liquids simply fall to the bottom of the esophagus and wait for the action of peristalsis to open the lower esophageal sphincter to allow their passage into the stomach.

The stomach is where the process of digestion begins in earnest. The stomach walls contain both a layer known as the gastric mucosa, which secretes gastric acid to dissolve food, and a layer of muscles, which contract to mix food and squeeze it through to the small intestine. Very few nutrients are actually absorbed into the body directly from the stomach, although it can absorb simple sugars. Liquids also pass easily between the stomach lining and the blood. Once the stomach has finished mashing and dissolving the food with digestive juices, the food exists as a semiliquid substance called chyme. At that point the duodenal bulb, where the stomach attaches to the small
intestine, relaxes and opens, allowing the stomach contents to progress on the next phase of their journey.

The lower digestive tract consists of the small and large intestines, where nutrients are absorbed into the body and waste is eliminated. These two long tubes have a combined length of up to 9 metres (30 feet). In the body, they are folded and coiled in order to fit in the abdominal cavity. The long length of the intestines as well as the unique folded inner surface of the small intestine provide a large surface area, estimated to be some 4,500 square metres (5,400 square yards). This large surface area facilitates the absorption of nutrients.

The small intestine is in fact the principal organ of the digestive tract, as this is where most of the processes occur for the breakdown of carbohydrates, proteins, and fats into organic compounds, vitamins, and minerals that the body can use. The large intestine, or colon, completes the digestive process by absorbing water back into the body and compacting the remaining waste for elimination. It also contributes bacteria that help to synthesize a variety of important vitamins.

Another organ of the lower digestive tract is the appendix, a small hollow pouch attached near to where the small and large intestines are joined. Whether or not the appendix serves any function is still being studied. Removal of the appendix does not appear to interfere with normal bodily function, but some scientists suspect that it may serve as a reservoir of useful bacteria or help stimulate and develop the immune system.

Digestion is regulated by a number of important hormones, which are secreted from the liver, the pancreas, and the gastrointestinal tract, as well as from fat cells. These hormones include leptin, which controls hunger sensations by acting on cells in the hypothalamus in the
brain; gastrin, which prompts the release of acid and increases muscle activity in the stomach; glucagon, which stimulates the release of glucose from the liver into the blood; and insulin, which stimulates the absorption of glucose from the blood into muscles and other tissues.

The transportation and uptake of glucose is the primary mechanism by which the body stores energy. Energy occurs in the form of glycogen in muscles and in the form of triglycerides in fat cells and is readily liberated when needed, such as during exercise or fasting. Inadequate production of insulin can lead to diabetes, in which the body is unable to effectively regulate the body’s use of glucose.

A substantial part of the gastrointestinal tract is also occupied by lymphoid tissue, part of the body’s immune defense system. The digestive system is one of the most critical points at which foreign and potentially dangerous substances can enter the body. The system’s immune function is found primarily in the small intestine. For example, lymphocytes, a type of white blood cell, are present in the small intestine in the basement membrane, in the epithelial cells of the inner mucous layer, and in large groups of nodules known as Peyer patches. When these lymphocytes encounter a foreign substance, they respond by destroying the foreign cell or by adhering to its surface, interfering with its ability to invade tissue and rendering it harmless. Lymphocytes from the Peyer patches are also transported from the intestine back through the lymphatic system to the thoracic duct and dispersed from there throughout the body. Thus, the digestive tract also helps to maintain a reservoir of defense against infection wherever it might occur.

When all the parts of the digestive system are working as they should, carbohydrates, fats, and proteins are
broken down and converted into energy for the body. This energy is used to support daily activities, to regulate body temperature, and to maintain the bodily systems that contribute to normal physiological function. In addition to the energy that food supplies, it also contains minerals and vitamins, which are dissolved and absorbed during the digestive process, and amino acids, which are necessary to the regeneration of cells. These are vital for the body's healthy functioning. A lack of vitamin D, for instance, which comes from egg yolks, fortified milk, and even sunlight, can cause rickets. A lack of iron, found in red meat, can cause anemia. Even the nondigestible dietary fibre in food plays an important role, providing roughage to stimulate bowel function and aiding in the elimination of potentially toxic or carcinogenic (cancer-causing) substances.

There are many diseases and disorders that may interfere with the proper functioning of the digestive system. Some of these conditions are congenital (present at birth). Others may be caused by infections or environmental factors or may be effects of nutritional deficiencies or of other diseases. In tropical countries, intestinal parasites such as pinworms are a frequent cause of digestive disorders. Many diseases of the digestive system are strongly linked to behavioral choices, such as alcohol and tobacco use. Among these are malignant diseases, such as cancer of the mouth, esophagus, stomach, or pancreas, and inflammatory conditions, such as pancreatitis. Worldwide, cirrhosis of the liver is one of the most frequent diseases occurring as a result of long-term, high-volume intake of alcohol.

Some diseases may also be caused by digestive malfunction. Two common examples are appendicitis and gallstones. Appendicitis is an inflammation of the appendix, usually
occurring when the opening between the appendix and the large intestine becomes blocked, often by fecal matter. This prevents the appendix from emptying its contents into the intestine and leads to swelling and bacterial infection. Treatment for appendicitis is usually removal of the appendix. Gallstones are hardened deposits that form in the gallbladder, composed primarily of calcium bilirubinate (a brown-pigmented substance) and cholesterol. These stones are formed when the proportion of cholesterol in bile exceeds the level necessary to contain it in solution. At that point crystalline particles of cholesterol are formed, which may range from as small as a grain of sand to as large as a golfball in some instances. Risk factors for the formation of gallstones include obesity and high-calorie or high-cholesterol diets.

Even healthy people have occasional digestive disturbances, such as heartburn, diarrhea, and nausea. Heartburn, more technically known as gastroesophageal reflux disease (GERD), is the result of content from the stomach moving back up into the esophagus. It may occur occasionally after a large meal, but it may be aggravated by obesity or pregnancy, both of which create cramped conditions in the abdomen and put pressure on the stomach. Persistent reflux symptoms can lead to more serious diseases of the esophagus. Gastritis is an inflammation of the stomach lining that may be caused by contaminated food or by excessive alcohol intake. Traveler’s diarrhea is almost always caused by ingestion of Escherichia coli bacteria, frequently on unwashed vegetables or in drinking water. Other types of indigestion may be the result of food sensitivities or allergies; of excessive intake of acidic foods such as coffee; of improper eating habits; or of stress. Indigestion resulting from these causes may range in severity from mild abdominal
discomfort and intestinal gas to the more severe symptoms of irritable bowel syndrome, such as pain, cramping, and vomiting.

Ulcers are a relatively common disease of the stomach and can also be aggravated by stress. An ulcer is caused when the stomach lining is unable to protect itself from the stomach’s own acidic gastric juices. The most common causes for erosion of the stomach lining are long-term overuse of anti-inflammatory drugs such as aspirin, known collectively as non-steroidal anti-inflammatory drugs or NSAIDS, and infection with the *Helicobacter pylori* bacterium. Globally, *H. pylori* is one of the most common causes of bacterial infection in humans, being particularly problematic in less-developed countries and even affecting roughly one-third of the U.S. population.

In this volume, readers will learn that many of the most serious diseases of the digestive system remain poorly understood and may often be difficult to diagnose. Because they all affect the digestive tract, a wide variety of diseases may manifest themselves in symptoms such as persistent diarrhea, blood in the stool, abdominal pain, nausea and vomiting, and loss of appetite. Many types of digestive disorders and cancers have been found to have some genetic component, although this may only cause a predisposition to the disease rather than being a direct cause.

Readers will also discover that, for most people, one of the most important keys to maintaining good overall health is treating the digestive system with respect. Eating a balanced diet that is high in fibre and low in fat, avoiding tobacco, using alcohol in moderation, and maintaining a healthy weight are all actions that will help to keep everything running smoothly—not just the digestive system.