

# The Digestive System

Written by W.J.Pais

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Digestion starts in the mouth where food is broken down to enable its absorption and assimilation into the body. Saliva helps to swallow and gulp it, as it enters the esophagus (the pipe connecting the mouth and the stomach).

Saliva contains an enzyme which acts on food while it is in the mouth. Mastication of food by the teeth softens the food to prepare the work, to be carried out in the stomach. Gastric juice in the stomach is essential for the production of mucus in the stomach. Thus people who eat in a hurry, do not masticate their food, are laying the foundation stone for their future problems.

A rhythmic involuntary contraction of muscles that begin in the esophagus, continue along the wall of the stomach and the rest of the organs that follow. This results in the production of chyme, (more of which is discussed later) which gets absorbed into the blood as it passes through the small intestine where most of the digestion of food takes place.

The waste products of digestion are defecated from the anus via the rectum.

There are several organs involved in the digestion of food and the largest structure of the digestive system is the gastrointestinal tract.

Thus what starts at the mouth and ends at the anus, covers a distance of about nine ) metres.

## **Mouth:**

The salivary glands, teeth and the tongue are in the mouth, which consists of two regions: the vestibule and the oral cavity proper.

The vestibule is the area between the teeth, lips and cheeks and the rest is the oral cavity proper is lined with a mucous membrane that produces a lubrication.

The roof of the mouth is called the palate and it separates the oral cavity from the nasal cavity. The palate is hard at the front of the mouth since the overlying mucosa is covering a plate of bone; it is softer and more pliable at the back being made of muscle and connective tissue, and it can move to swallow food and liquids. The surface of the hard palate allows for the pressure needed in eating food, to leave the nasal passage clear.

The lips are the mouth's front boundary. At either side of the soft palate are the muscles which also reach into regions of the tongue. Muscles in the mouth, raise the back of the tongue and also close both sides to enable food to be swallowed.

## **Salivary glands**

These mainly serve the digestive process and play an important role in the keeping the teeth healthy. Without the lubrication from these glands, speech would be impossible.

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There are other glands on the surface of the tongue that encircle taste buds on the back part of the tongue. They produce a serous fluid which contains lipase (lingual lipase). Lipase offers an early defense (outside of the immune system) against microbes in food, when it makes contact with these glands on the tongue tissue.

Our sense of smell and taste, and visual stimulus that food on the table provides, can stimulate the secretion of saliva providing the necessary fluid for the tongue to work with and also to ease swallowing of the food. That is why Chefs spend a lot of effort on decorating the food laid on the table.

## Tongue

The tongue is a sensory organ, and the sensory information is received via the taste buds on its surface. If the taste is agreeable the tongue will go into action, manipulating the food in the mouth which stimulates the secretion of saliva from the salivary glands. The first part of the food to be broken down is the starch of carbohydrates.

Taste is formed by specialised receptors of taste cells, contained in structures called taste buds in the mouth. Taste buds are mainly on the upper surface of the tongue. Taste perception is vital to help prevent harmful or rotten foods from being consumed. The brain can distinguish between the chemical qualities of the food.

The five basic tastes are referred to as those of saltiness, sourness, bitterness and sweetness. Pungency is a component of main Indian dishes. These tastes are what the ingredients in a recipe provide. The detection of saltiness and sourness enables the control of salt and acid balance. The detection of bitterness warns of poisons – many of a plant's defences are of poisonous compounds that are bitter. Sweetness guides to those foods that will supply energy. Sour tastes are acidic which is often found in bad food, the brain has to decide very quickly whether to eat the food or not. Acid like vinegar is added for the digestion of meat and fish, and tamarind is used for vegetables in Indian recipes. All the ingredients in Indian cooking have come down from the knowledge of Ayurveda, in the historical development of the civilization of India. They are closely linked with our digestive system. The olfactory receptors are located on cell surfaces in the nose which bind to chemicals enabling the detection of smells. It is assumed that signals from taste receptors work together with the signals from those in the nose, to form an idea of complex food flavours.

## Teeth

Teeth are complex structures made of materials specific to them. They are made of a bone-like dentin, which is covered by the hardest tissue in the body—enamel. Teeth have different shapes to deal with different aspects of mastication employed in tearing and chewing pieces of food into smaller and smaller pieces. Incisors are used for cutting or biting off pieces of food; canines, are used for tearing, premolars and molars for chewing and grinding. Mastication of the food with the help of saliva and mucus results in the formation of a soft bolus which can then be swallowed to make its way down the upper gastrointestinal tract to the

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stomach. Dental health is maintained by the salivary secretion of gingival crevical fluid. The digestive enzymes in saliva also help in keeping the teeth clean by breaking down any lodged food particles. Dental hygiene is often neglected and can cause great harm to the body through irregular digestion of food.

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## **Epiglottis**

The epiglottis is a flap that is made of elastic cartilage and attached to the entrance of the larynx. It is covered with a mucous membrane and there are taste buds on its lingual surface which faces into the mouth. Its laryngeal surface faces into the larynx. The epiglottis functions to guard the entrance of the glottis, the opening between the vocal folds. It is normally pointed upward during breathing with its underside functioning as part of the pharynx, but during swallowing, the epiglottis folds down to a more horizontal position, with its upper side functioning as part of the pharynx. In this manner it prevents food from going into the trachea and instead directs it to the esophagus, which is posterior. During swallowing, the backward motion of the tongue forces the epiglottis over the glottis' opening to prevent any food from entering the larynx which leads to the lungs; the larynx is also pulled upwards to assist this process. Stimulation of the larynx by ingested matter produces a strong cough reflex in order to protect the lungs.

## **Pharynx**

The pharynx is a part of the digestive system and also a part of the conducting zone of the respiratory system. It is the part of the throat immediately behind the nasal cavity at the back of the mouth and superior to the esophagus and larynx. The pharynx is made up of three parts. The lower two parts—the oropharynx and the laryngopharynx are involved in the digestive system. The laryngopharynx connects to the esophagus and it serves as a passageway for both air and food. Air enters the larynx anteriorly but anything swallowed has priority and the passage of air is temporarily blocked. Muscles in the pharynx push the food into the esophagus.

## **Esophagus**

The esophagus commonly known as the gullet, is an organ which consists of a muscular tube through which food passes from the pharynx to the stomach. The esophagus is continuous with the laryngeal part of the pharynx. Its length averages 25 cm, varying with height. It is divided into cervical, thoracic and abdominal parts. The pharynx joins the esophagus at the esophageal inlet. Generally the esophagus is closed at both ends, by the upper and lower esophageal sphincters. The opening of the upper sphincter is triggered by the swallowing reflex so that food is allowed through. The sphincter also serves to prevent back flow from the esophagus into the

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pharynx.

The esophagus has a mucous membrane having a protective function which is continuously replaced due to the volume of food that passes inside the esophagus. Once in the esophagus, the bolus travels down to the stomach via rhythmic contraction and relaxation of muscles known as peristalsis. The lower esophageal sphincter is a muscular sphincter which remains constricted at all times other than during swallowing and vomiting to prevent the contents of the stomach from entering the esophagus. Any failure of this sphincter can lead to heartburn.

## **Diaphragm**

The diaphragm is an important part of the body's digestive system. The diaphragm separates the thoracic cavity from the abdominal cavity where most of the digestive organs are located. The suspensory muscle attached helps the digestive system in the easier passage of digesting material. The diaphragm also attaches to the bare area of the liver, which it anchors.

## **Stomach**

Gastric acid (informally gastric juice), produced in the stomach plays a vital role in the digestive process, it mainly contains hydrochloric acid and sodium chloride. A peptide hormone gastrin produced by G cells in the stomach, stimulates the production of gastric juice which activates the digestive enzymes. Pepsinogen is produced by the gastric cells and gastric acid activates the enzyme pepsin which begins the digestion of proteins. As these two chemicals would damage the stomach wall, mucus is secreted by the stomach, to provide a slimy protective layer against the damaging effects of the chemicals. At the same time that protein is being digested, mechanical churning occurs through the action of peristalsis, waves of muscular contractions that move along the stomach wall. This allows the mass of food to further mix with the digestive enzymes. Gastric lipase secreted by the glands in the gastric mucosa of the stomach, is an acidic lipase, in contrast with the alkaline pancreatic lipase. This breaks down fats to some degree though is not as efficient as the pancreatic lipase.

The lowest section of the stomach which attaches to the duodenum via the pyloric canal, contains countless glands which secrete digestive enzymes including gastrin. After an hour or two, a thick semi-liquid called chyme is produced. When the pyloric sphincter, or valve opens, chyme enters the duodenum where it mixes further with digestive enzymes from the pancreas, and then passes through the small intestine, where digestion continues. When the chyme is fully digested, it is absorbed into the blood. 95% of absorption of nutrients occurs in the small intestine. Water and minerals are re-absorbed back into the blood in the colon of the large intestine, where the environment is slightly acidic. Some vitamins, such as biotin and vitamin K produced by bacteria in the colon are also absorbed.

The cells in the pit of the stomach, produce a glycoprotein which is essential for the absorption of vitamin B12. Vitamin B12 (cobalamin), is carried to, and through the stomach, bound to a glycoprotein secreted by the salivary glands - transcobalamin I also called haptocorrin, which protects the acid-sensitive vitamin from the acidic stomach contents. Once in the more neutral duodenum, pancreatic enzymes break down the protective glycoprotein. The freed vitamin B12

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is then absorbed by the enterocytes in the ileum.

The stomach is a distensible organ and can normally expand to hold about one litre of food. The stomach of a newborn baby will only be able to expand to retain about 30 ml.

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## **Spleen**

The spleen breaks down both red and white blood cells that are spent. This is why it is sometimes known as the 'graveyard of red blood cells'. A product of this digestion is the pigment bilirubin which is sent to the liver and secreted in the bile. Another product is iron which is used in the formation of new blood cells in the bone marrow.

Western medicine treats the spleen solely as belonging to the lymphatic system, though it is acknowledged that the full range of its important functions is not yet understood.

In contrast to this view, traditional Chinese medicine sees the spleen to be of central importance in the digestive system. The role of the spleen is seen to affect the health and vitality of the body in its turning of digested material from the stomach into usable nutrients and energy.

Symptoms that include poor appetite, indigestion, bloating and jaundice, are seen to be indications of an imbalance in the spleen. The spleen is further seen to play a part in the metabolism of water, in ridding the body of excess fluid.

In the west, the spleen is seen to be paired with the stomach but in Chinese medicine, reference is made to the spleen system, which involves the pancreas. Fluids in the body are seen in traditional Chinese medicine to be under the control of the spleen.

Fluids include digestive enzymes, saliva, mucus, fluid in the joints, tears, sweat and urine. They are categorised as thin and thick and together they are seen as nourishing all tissues and organs. In acupuncture two widely used acupuncture points - the stomach, (close to the knee) and the spleen, (halfway down from the knee) have long been seen to be connected and involved in digestive issues.

## **Liver**

The liver is the largest organ and is an accessory digestive gland which plays a role in the body's metabolism. The liver has many functions some of which are important to digestion. The liver can detoxify various metabolites; synthesise proteins and produce biochemicals needed for digestion. It regulates the storage of glycogen which it can form from glucose (glycogenesis). The liver can also synthesise glucose from certain amino acids. Its digestive functions are

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largely involved with the breaking down of carbohydrates. It also maintains protein metabolism in its synthesis and degradation. In lipid metabolism it synthesises cholesterol. Fats are also produced in the process of lipogenesis. The liver synthesises the bulk of lipoproteins. The liver is located in the upper right quadrant of the abdomen and below the diaphragm to which it is attached at one part, This is to the right of the stomach and it overlies the gall bladder. The liver produces bile, an important alkaline compound which aids digestion. Liver failure in people addicted to heavy drinking have often lost their lives, due the fact that they did not take the trouble to know their digestive system.

## **Bile**

Bile produced by the liver is made up of water (85%), bile salts, mucus and pigments, 1% fats and inorganic salts. Bilirubin is its major pigment. Bile acts partly as a surfactant which lowers the surface tension between either two liquids or a solid and a liquid and helps to emulsify the fats in the chyme. Food fat is dispersed by the action of bile into smaller units called micelles. This creates a much larger surface area for the pancreatic enzyme, lipase to work on. Lipase digests the tryglycerides which are broken down into two fatty acids and a monoglyceride. These are then absorbed by cells on the intestinal wall. If fats are not absorbed in this way in the small intestine problems can arise later in the large intestine which is not equipped to absorb fats. Bile also helps in the absorption of vitamin K from the diet. Bile is collected and delivered through the common hepatic duct which joins with the cystic duct to connect in a common bile duct with the gallbladder. Bile is stored in the gallbladder for release when food is discharged into the duodenum and also after a few hours.

## **Gallbladder**

The gallbladder is a hollow part of the biliary system that sits just beneath the liver. It is a small organ where the bile produced by the liver is stored, before it is released into the small intestine. The bile flows from the liver through the bile ducts and into the gall bladder for storage. The bile is released in response to cholecystokinin (CKK) a hormone released from the small intestine. At the neck of the gallbladder is a mucosal fold called Hartmann's pouch, where gallstones commonly get stuck. The angle of the gallbladder is located between the costal margin and the lateral margin of the rectus abdominis muscle. The gallbladder needs to store bile in a natural, semi-liquid form at all times. Hydrogen ions secreted from the inner lining of the gallbladder keep the bile acidic enough to prevent hardening. To dilute the bile, water and electrolytes from the digestion system are added. Also, salts attach themselves to cholesterol molecules in the bile to keep them from crystallising. If there is too much cholesterol or bilirubin in the bile, or the gallbladder doesn't empty properly the systems can fail. This is how gallstones form when a small piece of calcium gets coated with either cholesterol or bilirubin and the bile crystallises and forms a gallstone. The main purpose of the gallbladder is to store and release bile, or gall. The liver produces the bile and then it flows through the bile ducts into the gallbladder. When the bile is released, it is released into the small intestine and its purpose is to break down large fat molecules into smaller ones. After the fat is absorbed, the bile is also absorbed and transported back to the liver for reuse.

## **Pancreas**

The pancreas is a major organ functioning as an accessory digestive gland in the digestive system. It is both an endocrine gland and an exocrine gland. The endocrine part secretes insulin when the blood sugar becomes high; insulin moves glucose from the blood into the muscles and other tissues for use as energy. The exocrine part releases glucagon when the blood sugar is low; glucagon allows stored sugar to be broken down into glucose by the liver in order to re-balance the sugar levels. Digestive enzymes are also produced. The pancreas lies below and at the back of the stomach. It connects to the duodenum via the pancreatic duct where it can act on the chyme that is released from the stomach into the duodenum. There is a nearby connection of the common bile duct to the duodenum. Aqueous pancreatic secretions from duct cells contain bicarbonate ions which are alkaline and help to neutralise the acidic chyme that is churned out by the stomach. The pancreas is also the main source of enzymes for the digestion of fats (lipids) and proteins. The cells are filled with secretory granules containing the precursor digestive enzymes. The major proteases, the pancreatic enzymes which work on proteins, are trypsinogen and chymotrypsinogen. Elastase is also produced. Smaller amounts of lipase and amylase are secreted.

## **GI: The lower gastrointestinal Tract;**

The lower gastrointestinal tract, includes the small intestine and all of the large intestine. It is also called the bowel or the gut. It starts at the pyloric sphincter of the stomach and finishes at the anus.

The small intestine is subdivided into the duodenum, the jejunum and the ileum. The caecum marks the division between the small and large intestine.

The large intestine includes the rectum and anal canal.

Food once eaten, starts to arrive in the small intestine after one hour, and after two hours the stomach has emptied. Until this time the food is termed a bolus. It then becomes the partially digested semi-liquid termed chyme.

In the small intestine, the pH becomes crucial; it needs to be finely balanced in order to activate digestive enzymes. The chyme is very acidic, with a low pH, having been released from the stomach and needs to be made much more alkaline. This is achieved in the duodenum by the addition of bile from the gall bladder combined with the bicarbonate secretions from the pancreatic duct and also from secretions of mucus-rich bicarbonate from duodenal glands known as Brunner's glands.

The chyme arrives in the intestines having been released from the stomach through the opening of the pyloric sphincter. The resulting alkaline fluid mix, neutralises the gastric acid which would damage the lining of the intestine. The mucus component lubricates the walls of the intestine. When the digested food particles are reduced enough in size and composition, they can be absorbed by the intestinal wall and carried to the bloodstream. The first receptacle

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for this chyme is the duodenal bulb. From here it passes into the first of the three sections of the small intestine, the duodenum.

(The next section is the jejunum and the third is the ileum).

A milky fluid called chyle consisting mainly of the emulsified fats of the chylomicrons results from the absorbed mix with the lymph in the lacteals. Chyle is then transported through the lymphatic system to the rest of the body.

The last part of the small intestine is the ileum. This also contains villi and vitamin B12; bile acids and any residue nutrients are absorbed here. When the chyme is exhausted of its nutrients the remaining waste material changes into the semi solids called faeces, which pass to the large intestine, where bacteria in the gut flora further break down residual proteins and starches.

## **Caecum**

The caecum is a pouch marking the division between the small intestine and the large intestine. The caecum receives chyme from the last part of the small intestine, the terminal ileum, and connects to the ascending colon of the large intestine. At this junction there is a sphincter or valve, which slows the passage of chyme from the ileum, allowing further digestion. It is also the site of the appendix attachment.

## **Large intestine**

In the large intestine, the passage of the digesting food in the colon is a lot slower, taking from 12 to 50 hours until it is removed by defecation. The colon mainly serves as a site for the fermentation of digestible matter by the gut flora. The time taken varies considerably between individuals. The remaining semi-solid waste is termed faeces and is removed by the coordinated contractions of the intestinal walls, termed peristalsis, which propels the excreta forward to reach the rectum and exit via defecation from the anus. The wall has an outer layer of longitudinal muscles, the taeniae coli, and an inner layer of circular muscles. The circular muscle keeps the material moving forward and also prevents any back flow of waste. Also of help in the action of peristalsis is the basal electrical rhythm that determines the frequency of contractions. Most parts of the Gastro intestinal tract are covered with serous membranes and have a mesentery. Other more muscular parts are lined with adventitia.

## **Clinical significance**

Each part of the digestive system is subject to a wide range of disorders. In the esophagus Schatzki rings can restrict the passageway, causing difficulties in swallowing. They can also completely block the esophagus.

A common disorder of the bowel is diverticulitis. Diverticula are small pouches that can form inside the bowel wall, which can become inflamed to give diverticulitis. This disease can have complications if an inflamed diverticulum bursts and infection sets in. Any infection can spread



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further to the lining of the abdomen (peritoneum) and cause potentially fatal peritonitis.

Crohn's disease is a common chronic inflammatory bowel disease (IBD), which can affect any part of the GI tract, but it mostly starts in the terminal ileum.

Ulcerative colitis an ulcerative form of colitis, is the other major inflammatory bowel disease which is restricted to the colon and rectum. Both of these IBDs can give an increased risk of the development of colorectal cancer. Ulcerative colitis is the most common of the IBDs

There are several idiopathic disorders known as functional gastrointestinal disorders that the Rome process has helped to define. The most common of these is irritable bowel syndrome (IBS).

Giardiasis is a disease of the small intestine caused by a protist parasite *Giardia lamblia*. This does not spread but remains confined to the lumen of the small intestine.[33]It can often be asymptomatic, but as often can be indicated by a variety of symptoms. Giardiasis is the most common pathogenic parasitic infection in humans.

## **Conclusion:**

It is surprising that we humans pay so little attention to the main system what makes us what we are, and dwell on the exterior, enhancing our skin and facial appearance to please others, and get their attention, while we leave our personal health to the care of the doctors to attend to when needed. All our exterior features are given for our survival, and often it becomes a cause of our extinction. Just see how much thought has gone into designing our inner parts of our body, and this has been done, so that we can contribute to a society that allows us the live. How often do we raise our thoughts to the Creator who was instrumental in making such a marvellous system of existence. How often we brush it under the carpet, saying it is all a matter of &quot;evolution&quot;; and leave our thinking powers in the dust bin of ignorance.

## **SOURCE OF INFORMATION:**

[http://en.wikipedia.org/wiki/Human\\_digestive\\_system](http://en.wikipedia.org/wiki/Human_digestive_system)