12 The Gastrointestinal System

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Introduction

Which organ is the most important organ in the body? Most people would say the heart or the brain, completely overlooking the gastrointestinal tract (*GI tract*). Though definitely not the most attractive organs in the body, they are certainly among the most important. The 30+ foot long tube that goes from the mouth to the anus is responsible for the many different body functions which will be reviewed in this chapter. The GI tract is imperative for our well being and our life-long health. A non-functioning or poorly functioning GI tract can be the source of many chronic health problems that can interfere with your quality of life. In many instances the death of a person begins in the intestines.

The old saying "you are what you eat" perhaps would be more accurate if worded "you are what you absorb and digest". Here we will be looking at the importance of these two functions of the digestive system: absorption and digestion.

The **Gastrointestinal System** is responsible for the breakdown and absorption of various foods and liquids needed to sustain life. Many different organs have essential roles in the digestion of food, from the mechanical disrupting of the teeth to the creation of bile (an emulsifier) by the liver. Bile production of the liver plays a important role in digestion: from being stored and concentrated in the gallbladder during fasting stages to being discharged to the small intestine.

In order to understand the interactions of the different components we shall follow the food on its journey through the human body. During digestion two main processes occur at the same time.

- Mechanical digestion: larger pieces of food get broken down into smaller pieces while being prepared for chemical digestion. Mechanical digestion starts in the mouth and continues into the stomach.
- Chemical digestion: starts in the stomach and continues into the intestines. Several different enzymes break down macromolecules into smaller molecules that can be absorbed.

The GI tract starts with the mouth and proceeds to the esophagus, stomach, small intestine (duodenum, jejunum, ileum), and then to the large intestine (colon), rectum, and terminates at the anus. You could probably say the human body is just like a big donut. The GI tract is the donut hole. We will also be discussing the pancreas and liver, and accessory organs of the gastrointestinal system that contribute materials to the small intestine.

Layers of the GI Tract

The GI tract is composed of four layers, or tunics. Each layer has different tissues and functions. From the inside out they are called: mucosa, submucosa, muscularis, and serosa.

Mucosa: The mucosa is the absorptive and secretory layer. It is composed of simple epithelium cells and a thin connective tissue. There are specialized goblet cells that secrete mucus throughout the

GI tract located within the mucosa. On the mucosa layer there are Villi and micro villi.

Submucosa: The submucosa is relatively thick, is highly vascular and serves the mucosa. The absorbed elements that pass through the mucosa are picked up from the blood vessels of the submucosa. The submucosa also has glands and nerve plexuses.

Muscularis: The muscularis is responsible for segmental contractions and peristaltic movement in the GI tract. The muscularis is composed of two layers of muscle: an inner circular and outer longitudinal layer of smooth muscle. These muscles cause food to move and churn with digestive enzymes down the GI tract.

Serosa: The last layer is a protective layer. It is composed of avascular connective tissue and simple squamous epithelium. It secretes lubricating serous fluid. This is the visible layer on the outside of the organs.

Accessory Organs

1. Salivary glands

- a. Parotid gland
- b. Submandibular gland
- c. Sublingual gland

2. Tongue
3. Teeth

4. Liver

- Produces and excretes bile required for emulsifying fats. Some of the bile drains directly into the duodenum and some is stored in the gall bladder.
- Helps metabolize proteins, lipids, and carbohydrates.
- Urea, chief end product of mammalian metabolism, is formed in liver from amino acids and compounds of ammonia.
- Breaks down insulin and other hormones.
- Produces coagulation factors.

5. Gallbladder

- Bile storage.

6. Pancreas

- Endocrine functions: Digestive enzyme secretion.
    - Stores zymogens (inactive enzymes) that will be activated by the brush boarder membrane in the small intestine when a person eats protein (amino acids).
- Trypsinogen – Trypsin: digests protein.
- Chymotypsinogen – Chymotrypsin: digests proteins.
- Carboxypeptidases: digests proteins.

- Lipase-lipid: digests fats.
- Amylase: digests carbohydrates.
- Endocrine functions: Hormone secretion.
    - Somatostatin: inhibits the function of insulin. Produced if the body is getting too much glucose.
- Glucagon: stimulates the stored glycogen in the liver to convert to glucose. Produced if the body does not have enough glucose.
- Insulin: made in the beta cells of the Islets of Langerhans of the pancreas. Insulin is a hormone that regulates blood glucose.

7. Vermiform appendix

The Digestive System

The first step in the digestive system can actually begin before the food is even in your mouth. When you smell or see something that you just have to eat, you start to salivate in anticipation of eating, thus beginning the digestive process.

Food is the body's source of fuel. Nutrients in food give the body's cells the energy they need to operate. Before food can be used it has to be broken down into tiny little pieces so it can be absorbed and used by the body. In humans, proteins need to be broken down into amino acids, starches into sugars, and fats into fatty acids and glycerol.

During digestion two main processes occur at the same time.

- Mechanical digestion: larger pieces of food get broken down into smaller pieces while being prepared for chemical digestion. Mechanical digestion starts in the mouth and continues in to the stomach.
- Chemical digestion: several different enzymes break down macromolecules into smaller molecules that can be more efficiently absorbed. Chemical digestion starts with saliva and continues into the intestines.

The digestive system is made up by the alimentary canal, or the digestive tract, and other abdominal organs that play a part in digestion such as the liver and the pancreas. The alimentary canal is the long tube of organs that runs from the mouth (where the food enters) to the anus (where indigestible waste leaves). The organs in the alimentary canal include the esophagus, stomach and the intestines. The average adult digestive tract is about thirty feet (30') long. While in the digestive tract the food is really passing *through* the body rather than being *in* the body. The smooth muscles of the tubular digestive organs move the food efficiently along as it is broken down into absorbable atoms and molecules. During absorption, the nutrients that come from food (such as proteins, fats, carbohydrates, vitamins, and minerals) pass through the wall of the small intestine and into the bloodstream and lymph. In this way nutrients can be distributed throughout the rest of the body. In the large intestine there is reabsorption of water and absorption of some minerals as feces are formed. The parts of the food that the body passes out through the anus is known as feces.

Mastication

Digestion begins in the mouth. A brain reflex triggers the flow of saliva when we see or even think

about food. Saliva moistens the food while the teeth chew it up and make it easier to swallow. Amylase, which is the digestive enzyme found in saliva, starts to break down starch into simpler sugars before the food even leaves the mouth. The nervous pathway involved in salivary excretion requires stimulation of receptors in the mouth, sensory impulses to the brain stem, and parasympathetic impulses to salivary glands.

Swallowing your food happens when the muscles in your tongue and mouth move the food into your **pharynx**. The pharynx, which is the passageway for food and air, is about five inches (5") long. A small flap of skin called the epiglottis closes over the pharynx to prevent food from entering the trachea and thus choking. For swallowing to happen correctly a combination of 25 muscles must all work together at the same time. Salivary glands also produce an estimated three liters of saliva per day.

Esophageal Sphincter

After passing through the throat, the food moves down a muscular tube in the chest called the **esophagus**. *Peristalsis* (involuntary wavelike muscle contractions along the G.I. tract) moves the food from the esophagus and pushes it down into the stomach. At the end of the esophagus there is a sphincter that allows food into the stomach then closes back up so the food cannot travel back up into the esophagus.

Stomach

The stomach is a thick walled organ that lies of the left side of the diaphragm. It stores food and acid for digestion. Stomach muscles mix up the food with enzymes and acids to make smaller digestible pieces. Acid is needed for digestion in the stomach and is secreted by *chief cells*. The gastric glands begin secreting before food enters the stomach due to the parasympathetic impulses of the vagas nerve. The stomach lining has glands that produce up to three quarts of this digestive fluid daily. The secretion of gastric juices occurs in three phases: cephalic, gastric, and intestinal. The cephalic phase is activated by the smell and taste of food and swallowing. The gastric phase is activated by the chemical effects of food and the distension of the stomach. The intestinal phase blocks the effect of the cephalic and gastric phases. Gastric juice also contains an enzyme named **pepsin**, which digests proteins, hydrochloric acid and mucus. Hydrochloric acid causes the stomach to maintain a pH of about 2, which helps kill off bacteria that comes into the digestive system via food.

Water, alcohol, salt, and simple sugars can be absorbed directly through the stomach wall. However, most substances in our food need a little more digestion and must travel into the intestines before they can be absorbed. When the stomach is empty it is about the size of one fifth of a cup of fluid. When stretched and expanded, it can hold up to eight cups of food after a big meal.

Once mixed with digestive juices in the stomach the food is called *chyme*. The pyloric sphincter, a walnut shaped muscular tube at the stomach outlet, keeps chyme in the stomach until it reaches the right consistency to pass into the small intestine. The food leaves the stomach in small squirts rather than all at once.

Food that has not been digested then travels from the small intestine to the large intestine. When the food reaches the large intestine, the work to absorb the nutrients is nearly done. The main function of the large intestine is to excrete the fluid from the undigested food and produce solid waste and finally to be excreted through the anus.

Enzyme	Produced In	Site of Release	pH Level
Carbohydrate Digestion:			
Salivary amylase	Salivary glands	Mouth	Neutral
Pancreatic amylase	Pancreas	Small intestine	Basic
Maltase	Small intestine	Small intestine	Basic
Protein Digestion:			
Pepsin	Gastric glands	Stomach	Acidic
Trypsin	Pancreas	Small intestine	Basic
Peptidases	Small intestine	Small intestine	Basic
Nucleic Acid Digestion:			
Nuclease	Pancreas	Small intestine	Basic
Nucleosidases	Pancreas	Small intestine	Basic
Fat Digestion:			
Lipase	Pancreas	Small intestine	Basic

Esophagus

The **esophagus** (also spelled oesophagus/esophagus) or gullet is the muscular tube in vertebrates through which ingested food passes from the mouth area to the stomach. The esophagus is continuous with the laryngeal part of the pharynx at the level of the C6 vertebra.

Food is passed through the esophagus by using the process of *peristalsis*. It connects the pharynx, which is the body cavity that is common to both the digestive and respiratory systems behind the mouth, with the stomach, where the second stage of digestion is initiated (the first stage is in the mouth with teeth and tongue masticating food and mixing it with saliva).

Histology

The esophagus is lined with mucus membranes, and uses peristaltic action to move swallowed food down to the stomach.

The esophagus is lined by a *stratified squamous epithelium*, which is rapidly turned over, and serves a protective effect due to the high volume transit of food, saliva, and mucus into the stomach. The *lamina propria* of the esophagus is sparse. The mucus secreting glands are located in the submucosa, and are connective structures called *papillae*.

The muscularis propria of the esophagus consists of *straited muscle* in the upper third (superior) part of the esophagus. The middle third consists of a combination of *smooth muscle* and straited muscle, and the bottom (inferior) third is only smooth muscle. The distal end of the esophagus is slightly narrowed because of the thickened circular muscles. This part of the esophagus is called the lower esophageal sphincter. This aids in keeping food down and not being regurgitated.

The esophagus has a rich *lymphatic* drainage as well.

Stomach

The **stomach** lies between the esophagus and the first part of the small intestine (the duodenum). It is on the left side of the abdominal cavity; the fundus of the stomach lying against the diaphragm. Lying beneath the stomach is the pancreas. The greater omentum hangs from the greater curvature. A mucous membrane lines the stomach which contains glands that secrete gastric juices. When food is mixed and churned with gastric juices it forms a semi-liquid substance called **chyme**, which then, through peristalsis, is pushed to the stomach and on to the small intestine.

The stomach is divided into four sections, each of which has different cells and functions. The sections are: 1) Cardiac region, where the contents of the esophagus empty into the stomach, 2) Fundus, formed by the upper curvature of the organ, 3) Body, the main central region, and 4) Pylorus or atrium, the lower section of the organ that facilitates emptying the contents into the small intestine. Two smooth muscle valves, or sphincters, keep the contents of the stomach contained. They are the: 1) Cardiac or esophageal sphincter, dividing the tract above, and 2) Pyloric sphincter, dividing the stomach from the small intestine. The gastric juice, which is in the stomach, is highly acidic with a pH of 1-3. Gastric acid may cause or compound damage to the stomach wall or its layer of mucus, causing a peptic ulcer. On the inside of the stomach there are folds of skin call the gastric rugae. Gastric rugae make the stomach very extendable, especially after a very big meal.

Gastric Glands

There are many different gastric glands and they secret many different chemicals. Parietal cells secrete hydrochloric acid; chief cells secrete pepsinogen; goblet cells secrete mucus; argentaffin cells secrete serotonin and histamine; and G cells secrete the hormone gastrin.

Vessels and nerves

Arteries: The arteries supplying the stomach are the left gastric, the right gastric and right gastroepiploic branches of the hepatic, and the left gastroepiploic and short gastric branches of the lineal. They supply the muscular coat, ramify in the submucous coat, and are finally distributed to the mucous membrane.

Capillaries: The arteries break up at the base of the gastric tubules into a plexus of fine capillaries, which run upward between the tubules, anatomizing with each other, and ending in a plexus of larger capillaries, which surround the mouths of the tubes, and also form hexagonal meshes around the ducts.

Veins: From these the veins arise, and pursue a straight course downward, between the tubules, to the submucous tissue; they end either in the lineal and superior mesenteric veins, or directly in the portal vein.

Lymphatics: The lymphatics are numerous: They consist of a superficial and a deep set, and pass to the lymph glands found along the two curvatures of the organ.

Nerves: The nerves are the terminal branches of the right and left urethra and other parts, the former being distributed upon the back, and the latter upon the front part of the organ. A great number of branches from the celiac plexus of the sympathetic are also distributed to it. Nerve plexuses are found in the submucous coat and between the layers of the muscular coat as in the

intestine. From these plexuses fibrils are distributed to the muscular tissue and the mucous membrane.

Disorders of the Stomach

Disorders of the stomach are common. There can be a lot of different causes with a variety of symptoms. The strength of the inner lining of the stomach needs a careful balance of acid and mucus. If there is not enough mucus in the stomach, ulcers, abdominal pain, indigestion, heartburn, nausea and vomiting could all be caused by the extra acid.

Erosions, ulcers, and tumors can cause bleeding. When blood is in the stomach it starts the digestive process and turns black. When this happens, the person can have black stool or vomit. Some ulcers can bleed very slowly so the person won't recognize the loss of blood. Over time, the iron in your body will run out, which in turn, will cause anemia.

There isn't a known diet to prevent against getting ulcers. A balanced, healthy diet is always recommended. Smoking can also be a cause of problems in the stomach. Tobacco increases acid production and damages the lining of the stomach. It is not a proven fact that stress alone can cause an ulcer.

Histology of the human stomach

Like the other parts of the gastrointestinal tract, the stomach walls are made of a number of layers.

From the inside to the outside, the first main layer is the mucosa. This consists of an epithelium, the lamina propria underneath, and a thin bit of smooth muscle called the muscularis mucosa.

The submucosa lies under this and consists of fibrous connective tissue, separating the mucosa from the next layer, the muscularis externa. The muscularis in the stomach differs from that of other GI organs in that it has three layers of muscle instead of two. Under these muscle layers is the adventitia, layers of connective tissue continuous with the omenta.

The epithelium of the stomach forms deep pits, called fundic or oxyntic glands. Different types of cells are at different locations down the pits. The cells at the base of these pits are chief cells, responsible for production of pepsinogen, an inactive precursor of pepsin, which degrades proteins. The secretion of pepsinogen prevents self-digestion of the stomach cells.

Further up the pits, parietal cells produce gastric acid and a vital substance, intrinsic factor. The function of gastric acid is two fold 1) it kills most of the bacteria in food, stimulates hunger, and activates pepsinogen into pepsin, and 2) denatures the complex protein molecule as a precursor to protein digestion through enzyme action in the stomach and small intestines. Near the top of the pits, closest to the contents of the stomach, there are mucous-producing cells called goblet cells that help protect the stomach from self-digestion.

The muscularis externa is made up of three layers of smooth muscle. The innermost layer is obliquely-oriented: this is not seen in other parts of the digestive system: this layer is responsible for creating the motion that churns and physically breaks down the food. The next layers are the square and then the longitudinal, which are present as in other parts of the GI tract. The pyloric antrum which has thicker skin cells in its walls and performs more forceful contractions than the fundus. The pylorus is

surrounded by a thick circular muscular wall which is normally tonically constricted forming a functional (if not anatomically discrete) pyloric sphincter, which controls the movement of chyme.

Control of secretion and motility

The movement and the flow of chemicals into the stomach are controlled by both the nervous system and by the various digestive system hormones.

The hormone gastrin causes an increase in the secretion of HCL, pepsinogen and intrinsic factor from parietal cells in the stomach. It also causes increased motility in the stomach. Gastrin is released by G-cells into the stomach. It is inhibited by pH normally less than 4 (high acid), as well as the hormone somatostatin.

Cholecystokinin (CCK) has most effect on the gall bladder, but it also decreases gastric emptying. In a different and rare manner, secretin, produced in the small intestine, has most effects on the pancreas, but will also diminish acid secretion in the stomach.

Gastric inhibitory peptide (GIP) and enteroglucagon decrease both gastric motility and secretion of pepsin. Other than gastrin, these hormones act to turn off the stomach action. This is in response to food products in the liver and gall bladder, which have not yet been absorbed. The stomach needs only to push food into the small intestine when the intestine is not busy. While the intestine is full and still digesting food, the stomach acts as a storage for food.

Small Intestine

The small intestine is the site where most of the chemical and mechanical digestion is carried out. Tiny projections called **villi** line the small intestine which absorbs digested food into the capillaries. Most of the food absorption takes place in the jejunum and the ileum.

The functions of a small intestine is, the digestion of proteins into peptides and amino acids principally occurs in the stomach but some also occurs in the small intestine. Peptides are degraded into amino acids; lipids (fats) are degraded into fatty acids and glycerol; and carbohydrates are degraded into simple sugars.

The three main sections of the small intestine is *The Duodenum, The Jejunum, The Ileum.*

The Duodenum

In anatomy of the digestive system, the **duodenum** is a hollow jointed tube connecting the stomach to the jejunum. It is the first and shortest part of the small intestine. It begins with the duodenal bulb and ends at the ligament of Treitz. The duodenum is almost entirely retro peritoneal. The duodenum is also where the bile and pancreatic juices enter the intestine.

The Jejunum

The *Jejunum* is a part of the small bowel, located between the distal end of duodenum and the proximal part of ileum. The jejunum and the ileum are suspended by an extensive mesentery giving the bowel great mobility within the abdomen. The inner surface of the jejunum, its mucous membrane, is

covered in projections called villi, which increase the surface area of tissue available to absorb nutrients from the gut contents. It is different from the ileum due to fewer goblet cells and generally lacks Preyer's patches.

The Ileum

Its function is to absorb vitamin B12 and bile salts. Thee wall itself is made up of folds, each of which has many tiny finger-like projections known as villi, on its surface. In turn, the epithelial cells which line these villi possess even larger numbers of micro villi. The cells that line the ileum contain the protease and carbohydrate enzymes responsible for the final stages of protein and carbohydrate digestion. These enzymes are present in the cytoplasm of the epithelial cells. The villi contain large numbers of capillaries which take the amino acids and glucose produced by digestion to the hepatic portal vein and the liver.

Large Intestine

The large intestine (colon) extends from the end of the ileum to the anus. It is about 5 feet long, being one-fifth of the whole extent of the intestinal canal. It's caliber is largest at the commencement at the cecum, and gradually diminishes as far as the rectum, where there is a dilatation of considerable size just above the anal canal. It differs from the small intestine in by the greater caliber, more fixed position, sacculated form, and in possessing certain appendages to its external coat, the appendices epiploicæ. Further, its longitudinal muscular fibers do not form a continuous layer around the gut, but are arranged in three longitudinal bands or tæniæ.

The large intestine is divided into the cecum, colon, rectum, and anal canal. In its course, describes an arch which surrounds the convolutions of the small intestine. It commences in the right iliac region, in a dilated part, the cecum. It ascends through the right lumbar and hypochondriac regions to the under surface of the liver; here it takes a bend, the right colic flexure, to the left and passes transversely across the abdomen on the confines of the epigastric and umbilical regions, to the left hypochondriac region; it then bends again, the left colic flexure, and descends through the left lumbar and iliac regions to the pelvis, where it forms a bend called the sigmoid flexure; from this it is continued along the posterior wall of the pelvis to the anus.

There are trillions of bacteria, yeasts, and parasites living in our intestines, mostly in the colon. Over 400 species of organisms live in the colon. Most of these are very helpful to our health, while the minority are harmful. Helpful organisms *synthesize* vitamins, like *B12*, *biotin*, and *vitamin K*. They breakdown toxins and stop proliferation of harmful organisms. They stimulate the immune system and produce short chain fatty acids (SCFAs) that are required for the health of colon cells and help prevent colon cancer. There are many beneficial bacteria but some of the most common and important are *Lactobacillus Acidophilus* and various species of *Bifidobacterium*. These are available as "probiotics" from many sources.

Pancreas, Liver, and Gallbladder

The pancreas, liver, and gallbladder are essential for digestion. The pancreas produces enzymes that help digest proteins, fats, and carbohydrates, the liver produces bile that helps the body absorb fat,

and the gallbladder stores the bile until it is needed. The enzymes and bile travel through special channels called ducts and into the small intestine where they help break down the food.

Pancreas

The pancreas is located posterior to the stomach and in close association with the duodenum.

In humans, the pancreas is a 6-10 inch elongated organ in the abdomen located retro peritoneal. It is often described as having three regions: a head, body and tail. The pancreatic head abuts the second part of the duodenum while the tail extends towards the spleen. The pancreatic duct runs the length of the pancreas and empties into the second part of the duodenum at the ampulla of Vater. The common bile duct commonly joins the pancreatic duct at or near this point.

The pancreas is supplied arterially by the pancreaticoduodenal arteries, themselves branches of the superior mesenteric artery of the hepatic artery (branch of celiac trunk from the abdominal aorta). The superior mesenteric artery provides the inferior pancreaticoduodenal arteries while the gastroduodenal artery (one of the terminal branches of the hepatic artery) provides the superior pancreaticoduodenal artery. Venous drainage is via the pancreatic duodenal veins which end up in the portal vein. The splenic vein passed posterior to the pancreas but is said to not drain the pancreas itself. The portal vein is formed by the union of the superior mesenteric vein and splenic vein posterior to the body of the pancreas. In some people (as many as 40%) the inferior mesenteric vein also joins with the splenic vein behind the pancreas, in others it simply joins with the superior mesenteric vein instead.

The function of the pancreas is to produce enzymes that break down all categories of digestible foods (exocrine pancreas) and secrete hormones that affect carbohydrates metabolism (endocrine pancreas).

- **Exocrine**

The pancreas is composed of pancreatic exocrine cells, whose ducts are arranged in clusters called acini (singular acinus). The cells are filled with secretory granules containing the precursor digestive enzymes (mainly trypsinogen, chymotrypsinogen, pancreatic lipase, and amylase) that are secreted into the lumen of the acinus. These granules are termed zymogen granules (zymogen referring to the inactive precursor enzymes.) It is important to synthesize inactive enzymes in the pancreas to avoid auto degradation, which can lead to pancreatitis.

The pancreas is near the liver, and is the main source of enzymes for digesting fats (lipids) and proteins - the intestinal walls have enzymes that will digest polysaccharides. Pancreatic secretions from ductal cells contain bicarbonate ions and are alkaline in order to neutralize the acidic chyme that the stomach churns out. Control of the exocrine function of the pancreas are via the hormone gastrin, cholecystokinin and secretin, which are hormones secreted by cells in the stomach and duodenum, in response to distension and/or food and which causes secretion of pancreatic juices.

The two major proteases which the pancreas are trypsinogen and chymotrypsinogen. These zymogens are inactivated forms of trypsin and chymotrypsin. Once released in the intestine, the enzyme enterokinase present in the intestinal mucosa activates trypsinogen by cleaving it to form trypsin. The free trypsin then cleaves the rest of the trypsinogen and chymotrypsinogen to their active forms.

Pancreatic secretions accumulate in intralobular ducts that drain the main pancreatic duct, which drains directly into the duodenum.

Due to the importance of its enzyme contents, injuring the pancreas is a very dangerous situation. A puncture of the pancreas tends to require careful medical intervention.

- **Endocrine**

Scattered among the acini are the endocrine cells of the pancreas, in groups called the islets of Langerhans. They are:

- Insulin-producing beta cells (50-80% of the islet cells)
- Glucagon-releasing alpha cells (15-20%)
- Somatostatin-producing delta cells (3-10%)
- Pancreatic polypeptide-containing PP cells (remaining %)

The islets are a compact collection of endocrine cells arranged in clusters and cords and are crisscrossed by a dense network of capillaries. The capillaries of the islets are lined by layers of endocrine cells in direct contact with vessels, and most endocrine cells are in direct contact with blood vessels, by either cytoplasmic processes or by direct apposition.

Liver

The liver is an organ in vertebrates, including human. It plays a major role in metabolism and has a number of functions in the body including glycogen storage, plasma protein synthesis, and drug detoxification. It also produces bile, which is important in digestion. It performs and regulates a wide variety of high-volume biochemical reaction requiring specialized tissues.

The liver normally weighs between 1.3 - 3.0 kilograms and is a soft, pinkish-brown "boomerang shaped" organ. It is the second largest organ (the largest being the skin) and the largest gland within the human body. its anatomical position in the body is immediately under the diaphragm on the right side of the upper abdomen, The liver lies on the right side of the stomach and makes a kind of bed for the gallbladder.

The liver is supplied by two main blood vessels on its right lobe: the hepatic artery and the portal vein. The hepatic artery normally comes off the celiac trunk. The portal vein brings venous blood from the spleen, pancreas, and small intestine, so that the liver can process the nutrients and byproducts of food digestion. The hepatic veins drain directly into the inferior vena cava.

The bile produced in the liver is collected in bile canaliculi, which merge from bile ducts. These eventually drain into the right and left hepatic ducts, which in turn merge to form the common hepatic duct. The cystic duct (from the gallbladder) joins with the common hepatic duct to form the common bile duct. Bile can either drain directly into the duodenum via the common bile duct or be temporarily stored in the gallbladder via the cystic duct. The common bile duct and the pancreatic duct enter the duodenum together at the ampulla of Vater. The branching's of the bile ducts resemble those of a tree, and indeed term "biliary tree" is commonly used in this setting.

The liver is among the few internal human organs capable of natural regeneration of lost tissue: as little as 25% of remaining liver can regenerate into a whole liver again. This is predominantly due to

hepatocytes acting as unipotential stem cells. There is also some evidence of bio potential stem cells, called oval cell, which can differentiate into either hepatocytes or cholangiocytes (cells that line bile ducts).

The various functions of the liver are carried out by the liver cells or hepatocytes.

- The liver produces and excretes bile requires for dissolving fats. Some of the bile drains directly into the duodenum, and some is stored in the gallbladder
- The liver performs several roles in carbohydrate metabolism:
- gluconeogenesis (the formation of glucose from certain amino acids, lactate or glycerol)
- Glycogenolysis (the formation of glucose from glycogen)
- Glycogenesis (the formation of glycogen from glucose)
- The breakdown of insulin and other hormones
- The liver is responsible for the mainstay of protein metabolism.
- The liver also performs several roles in lipid metabolism:
- cholesterol synthesis
- The production of triglycerides (fats)
- The liver produces coagulation factors I (fibrinogen), II (prothrombin), V, VII, IX, X and XI, as well as protein C, Protein S and antithrombin.
- The liver breaks down hemoglobin, creating metabolites that are added to bile as pigment
- The liver breaks down toxic substances and most medicinal products in a process called drug metabolism. This sometimes results in toxication, when the metabolite is more toxic than its precursor.
- The liver converts ammonia to urea.
- The liver stores a multitude of substances, including glucose in the form of glycogen, vitamin B12, iron, and copper
- In the first trimester fetus, the liver is the main site of red blood cell production. By the 32nd weeks of gestation, the bone marrow has almost completely taken over that task.
- The liver is responsible for immunological effects the reticuloendothelial system if the liver contains many immunologically active cells, acting as a 'sieve' for antigens carried to it via the portal system.

Gallbladder

The gallbladder is a pear shaped organ that stores about 50 ml of bile (or "gall") until the body needs it for digestion. The gallbladder is about 7-10cm long in humans and is dark green in appearance due to its contents (bile), not its tissue. It is connected to the liver and the duodenum by biliary tract.

The gallbladder is connected to the main bile duct through the gallbladder duct (cystic duct). The main biliary tract runs from the liver to the duodenum, and the cystic duct is effectively a "cul de sac", serving as entrance and exit to the gallbladder. The surface marking of the gallbladder is the intersection of the midclavicular line (MCL) and the trans pyloric plane, at the tip of the ninth rib. The blood supply is by the cystic artery and vein, which runs parallel to the cystic duct. The cystic artery is highly variable, and this is of clinical relevance since it must be clipped and cut during a cholecystectomy.

The gallbladder has a epithelial lining characterized by recesses called Aschoff's recesses, which are pouches inside the lining. Under epithelium there is a layer of connective tissue, followed by a muscular wall that contracts in response to cholecystokinin, a peptide hormone by the duodenum.

The gallbladder stores bile, which is released when food containing fat enters the digestive tract, stimulating the secretion of cholecystokinin (CCK). The bile emulsifies fats and neutralizes acids in partly digested food. After being stored in the gallbladder, the bile becomes more concentrated than when it left the liver, increasing its potency and intensifying its effect in fats.

Anus

The human anus is situated between the buttocks, posterior to the perineum. It has two anal sphincters, one internal, the other external. These hold the anus closed until defecation occurs. One sphincter consists of smooth muscle and its action is involuntary; the other consists of striated muscle and its action is voluntary. In many animals, the anus is surrounded by anal sacs. Role of the anus is when the rectum is full, the increase in intra-rectal pressure forces the walls of the anal canal apart allowing the fecal matter to enter the canal. The rectum shortens as material is forced into the anal canal and peristaltic waves propel the feces out of the rectum. The internal and external sphincters of the anus allow the feces to be passed by muscles pulling the anus up over the exiting feces.

Conditions Affecting the Esophagus

There are two different types of conditions that may affect the esophagus. The first type is called congenital: meaning a person is born with it. The second type is called non-congenital: meaning the person develops it after birth. Some examples of these are:

Tracheoesophageal fistula and esophageal atresia

Both of these conditions are congenital. In *Tracheoesophageal fistula* there is a connection between the esophagus and the wind pipe (trachea) where there shouldn't be one. In *Esophageal atresia* the esophagus of a newborn does not connect to the stomach but comes to a dead end right before the stomach. Both conditions require corrective surgery and are usually detected right after the baby is born. In some cases, it can be detected before the baby is born.

Esophagitis

Esophagitis is inflammation of the esophagus and is a non-congenital condition. Esophagitis can be caused by certain medications or by infections. It can also be caused by gastroesophageal reflux disease (gerd), a condition where the esophageal sphincter allows the acidic contents of the stomach to move back up into the esophagus. Gastroesophageal reflux disease can be treated with medications, but it can also be corrected by changing what you eat.

Conditions Affecting the Stomach and Intestines

Everybody has experienced constipation or diarrhea in their lifetime. With constipation, the contents of the large intestines don't move along fast enough and waste material stays in the large intestines so long. All water is extracted out of the waste and it becomes hard. With diarrhea you get the exact opposite reaction. Waste moves along too fast and the large intestines can't absorb the water before the waste is pushed through. Common flora bacteria assists in the prevention of many serious

problems. Here are some more examples of common stomach and intestinal disorders:

Appendicitis

Appendicitis is the inflammation of the appendix, the finger-like pouch that extends from the cecum. The most common symptoms are abdominal pain, loss of appetite, fever, and vomiting. Kids and teenagers are the most common victims of appendicitis and must be corrected by surgery. While mild cases may resolve without treatment, most require removal of the inflamed appendix, either by laparotomy or laparoscopy. Untreated, mortality is high, mainly due to peritonitis and shock.

Celiac Disease

Celiac disease is a disorder in which a person's digestive system is damaged by the response of the immune system to a protein called gluten, which is found in rye, wheat, and barley, and also in foods like breakfast cereal and pizza crust. People that have celiac disease experience abdominal pain, diarrhea, bloating, exhaustion, and depression when they eat foods with gluten in them. They also have difficulty digesting their food. Celiac disease runs in families and becomes active after some sort of stress, like viral infections or surgery. The symptoms can be managed by following a gluten free diet. Doctors can diagnose this condition by taking a full medical history or with a blood test.

Diverticulitis

Diverticulitis is a common disease of the bowel, in particular the large intestine. Diverticulitis develops from diverticulosis, which involves the formation of pouches (diverticula) on the outside of the colon. Diverticulitis results if one of these diverticula becomes inflamed. In complicated diverticulitis, bacteria may subsequently infect the outside of the colon if an inflamed diverticula bursts open. If the infection spreads to the lining of the abdominal cavity (peritoneum), this can cause a potentially fatal peritonitis. Sometimes inflamed diverticula can cause narrowing of the bowel, leading to an obstruction. Also, the affected part of the colon could adhere to the bladder or other organ in the pelvic cavity, causing a fistula, or abnormal communication between the colon and an adjacent organ.

Gastritis and Peptic ulcers

Usually the stomach and the duodenum are resistant to irritation because of the strong acids produced by the stomach. But sometimes a bacteria called Helicobacter pylori or the chronic use of drugs or certain medications, weakens the mucous layer that coats the stomach and the duodenum, allowing acid to get through the sensitive lining beneath. This can cause irritation and inflammation of the lining of the stomach, which is called gastritis, or cause peptic ulcers, which are holes or sores that form in the lining of the stomach and duodenum and cause pain and bleeding. Medications are the best way to treat this condition.

Gastrointestinal Infections

Gastrointestinal infections can be caused by bacteria such as Campylobacter, Salmonella, E. coli, or Shigella. They can also be caused by viruses or by intestinal parasites like amebiasis and Giardiasis. The most common symptoms of gastrointestinal infections Abdominal pain and cramps, Diarrhea, and vomiting. These conditions usually go away on there own and don't need medical attention.

Inflammatory Bowel Disease

Inflammatory bowel disease is the chronic inflammation of the intestines, which usually affect older kids, teens and adults. There are two major types, *ulcerative colitis* and *Crohn's disease* and indeterminate colitis, which occurs in 10-15% of patients. Ulcerative colitis usually affects just the rectum and small intestine, while Crohn's disease can affect the whole gastrointestinal tract from mouth to anus along with some other parts of the body. Patients with these diseases also suffer from extraintestinal symptoms including joint pain and red eye, which can signal a flare of the disease. These diseases are treated with medications and if necessary, Intravenous or IV feeding, or in the more serious cases, surgery to remove the damaged areas of the intestines.

Polyp

A polyp is an abnormal growth of tissue (tumor) projecting from a mucous membrane. If it is attached to the surface by a narrow elongated stalk it is said to be pedunculated. If no stalk is present it is said to be sessile. Polyps are commonly found in the colon, stomach, nose, urinary bladder and uterus. They may also occur elsewhere in the body where mucous membranes exist like the cervix and small intestine.

Disorders of the Pancreas, Liver, and Gallbladder

Disorders of the pancreas, liver, and gallbladder affect the ability to produce enzymes and acids that aid in digestion. examples of these disorders are.

Cystic Fibrosis

Cystic fibrosis is a chronic, inherited illness where the production of abnormally thick mucous blocks the duct or passageways in the pancreas and prevents the digestive fluids from entering the intestines, making it difficult for the person with the disorder to digest protein and fats which cause important nutrients to pass through without being digested. People with this disorder take supplements and digestive enzymes to help manage their digestive problems.

Hepatitis

Hepatitis is a viral condition that inflames a person's liver which can cause it to lose it's ability to function. Viral hepatitis, like hepatitis A, B, and C, is extremely contagious. Hepatitis A, which is a mild form of hepatitis, can be treated at home, but more serious cases that involve liver damage, might require hospitalization.

Cholecystitis

Acute or chronic inflammation if the gallbladder causes abdominal pain. 90% of cases of acute cholecystitis are caused by the presence of gallstones. The actual inflammation is due to secondary infection with bacteria of an obstructed gallbladder, with the obstruction caused by the gallstones. Gallbladder conditions are very rare in kids and teenagers but can occur when the kid or teenager has sickle cell anemia or in kids being treated with long term medications.

Cholestasis

Cholestasis is the blockage in the supply of bile into the digestive tract. It can be "intrahepatic" (the

obstruction is in the liver) or "extrahepatic" (outside the liver). It can lead to jaundice, and is identified by the presence of elevated bilirubin level that is mainly conjugated.

Biliary colic

This is when a gallstone blocks either the common bile duct or the duct leading into it from the gallbladder. This condition causes severe pain in the right upper abdomen and sometimes through to the upper back. It is described by many doctors as the most severe pain in existence, between childbirth and a heart attack. Other symptoms are nausea and vomiting and diarrhea, bleeding caused by continual vomiting, and dehydration caused by the nausea and diarrhea. Another more serious complication is total blockage of the bile duct which leads to jaundice, which if it is not corrected naturally or by surgical procedure can be fatal as it causes liver damage. The only long term solution is the removal of the gallbladder.

Gastrointestinal Dysfunctions

As we age, the amount of digestive enzymes produced by the body drops way down. This leads to decreased and slower digestion, slower absorption of nutrients and increased accumulation of fecal mater in the intestinal tract. Undigested food material and metabolic waste can also build up due to slow elimination, starting of a series of health problems.

When digestion slows, it turns the intestines into a toxic environment. Helpful organisms cannot live in toxic environments. When the beneficial organisms die they are replaced by harmful organisms, such as yeasts and parasites, the most common being *Candida albicans*. This leads to changes in the intestinal wall which produces *leaky gut syndrome* which allows many toxic chemicals to be introduced into the blood stream. As a result the entire toxic load of the body is increased, which causes a bigger burden on the liver, kidneys and other body organs. When this happens the organs that are normally used for eliminating waste and supplying nutrients the GI tract becomes into a large dump for waste. This problem is made worse by the use of junk food, prescriptions, over the counter medications, antibiotics and a diet that is too low in fiber.

Most people never even think about their GI tract. We are all concerned about what the outside of our body look like, but we completely ignore the inside. Because our bodies a very resilient. deterioration of the digestive system can go on for years with no symptoms or side-effect. When symptoms finally do appear they are usually very non-specific, they include: decreased energy, headaches, diarrhea, constipation, heartburn, and acid reflux. Over the years these symptoms become more serious, they include: asthma, food allergies, arthritis, and cancer.

Poor digestion, poor absorption, and bacterial imbalance can be traced to a lot of chronic conditions. Every organ in the body receives nutrients for the GI tract. I if the GI tract is malfunctioning then the whole body suffers.

It is possible to return good health to your GI tract by improving digestion, consuming the right amount of fiber, cutting out junk food and refined sugars.

You can improve the function of the intestines by taking fiber supplements and vitamins (especially B12 and vitamin K). Some doctors suggest herbal or vitamin enema's to cleanse and relieve constipation and to help stimulate *peristaltic movement* which will help to move the bowels.

Irritable Bowel Syndrome

Irritable Bowel Syndrome (IBS) is a disorder with symptoms that are most commonly bloating, abdominal pain, cramping, constipation, and diarrhea. IBS causes a lot of pain and discomfort. It does not cause permanent damage to the intestines and does not lead to serious diseases such as cancer. Most of the people affected with IBS can control their symptoms with stress management, diet, and prescription medication. For others IBS can be debilitating, they may be unable to go to work, travel, attend social events or leave home for even short periods of time.

About 20 percent of the adult population has some symptoms of IBS, making it one of the most common intestinal disorders diagnosed by physicians. It is more common in men than women and in about 50 percent of people affected it starts at about age 35.

Researchers have not found out what exactly causes IBS. One idea is that people with IBS have a large intestine (colon) that is sensitive to certain foods and stress. The immune system may also be involved. It has also been reported that *serotonin* is linked with normal GI functioning. 95 percent of the body's serotonin is located in the GI tract (the other 5 percent is in the brain). People with IBS have diminished receptor activity, causing abnormal levels of serotonin in the GI tract. Because of this IBS patients experience problems with bowel movement, mobility, and sensation having more sensitive pain receptors in their GI tract. Many IBS patients suffer from depression and anxiety which can make symptoms worse.

There is no cure for IBS, but medications are an important part of relieving symptoms. Fiber supplements or laxatives are helpful for constipation. Anti diuretics such as Imodium can help with diarrhea. An antispasmodic is commonly prescribed for colon muscle spasms. Antidepressants and pain medication are also commonly prescribed. [12]

Gastrointestinal Stromal Tumor

Gastrointestinal Stromal Tumors or GIST is an uncommon type of cancer in the GI tract (esophagus, stomach, small intestine, and colon). These types of cancers begin in the connective tissue like fat, muscles, nerves , cartilage, etc.

GIST originates in the stroma cells. Stroma cells are strung along the GI tract and are part of the system that helps the body to know when to move food through the digestive system. Over half of Gist's occur in the stomach. Most cases occur in people between the ages of forty and eighty, but can also show up in a person of any age.

All GIST's of any size or location have the ability to spread. Even if a GIST is removed, it can reappear in the same area, or may even spread outside of the GI tract.

In the early stages, GIST is hard to diagnose because in the early stages symptoms cannot be recognized. In the later stages a person can have vague abdominal pain, vomiting, abdominal bleeding that shows up in stool or vomit, low blood counts causing anemia, and having an early feeling of being full causing a decrease in appetite.

GIST is now recognized as an aggressive cancer that is able to spread to other parts of the body. People who have been diagnosed with GIST should get treatment as soon as possible.

Food Allergies

Food allergies occur when the immune system thinks that a certain protein in any kind of food is a foreign object and will try to fight against it.

Only about eight percent of children and two percent of adults actually have a food allergy. A person can be allergic to any kind of food, but the most common food allergies are from nuts, cow's milk, eggs, soy, fish, and shellfish. Most people who have a food allergy are allergic to less than four different foods.

The most common signs of food allergies are hives, swelling, itchy skin, itchiness, tingling or swelling in the mouth, coughing, trouble breathing, diarrhea, and vomiting. The two most common chronic illness that are associated with food allergies are eczema and asthma.

Food allergies can be fatal if it causes the reaction called anaphylaxis. This reaction makes it hard for the person to breathe. This can be treated by an epinephrine injection.

GERD, Heartburn, Acid Reflux

GERD, or Gastroesophageal Reflux Disease occurs when the lower esophageal sphincter is not able to close properly. When this happens, contents from the stomach called reflux leak back into the esophagus and the stomach.

When the stomach refluxes, stomach acid touches the lining of the esophagus and causes it to have a burning feeling in the throat or the chest. This is what heartburn is. When you taste the fluid in the back of your throat, it is called acid indigestion. It is common for a person to get occasional heartburn, but when it occurs more than twice a week it can be considered as GERD. GERD can occur in people of all ages including infants.

Some symptoms of GERD include having a pain in your chest, hoarseness, having trouble swallowing, or having the feeling of food being stuck in your throat. The main symptoms are having persistent heartburn and acid regurgitation. GERD can also cause bad breath and a dry cough.

No one knows why people get GERD. Some things that could contribute to GERD are alcohol use, pregnancy, being overweight and smoking. Certain foods night also contribute like citrus fruits, caffeine, spicy, fatty, and dried foods, and also mint flavorings.

Over-the-counter antacids or medications that help stop acid production and help the muscles empty the stomach are commonly used to treat GERD.

Constipation

Not everyone is on the same schedule for having a bowel movement. Depending on the person, a "normal" schedule can range anywhere from three times a day to three times a week. If you start having bowel movements less than your own personal schedule, then you might be getting the signs of constipation.

Constipation is when you have trouble having bowel movements. The stool is very hard making it hard to pass and causing a person to strain. You may even feel like you have to have a bowel

movement even after you have already had one.

When you digest food, the waste products go through your intestines by the muscles contracting. When in the large intestine, most of the water and salt from the waste products are reabsorbed because they are needed by the body for our everyday functions. You can become constipated if too much water is absorbed, or if waste products move too slowly.

Not getting enough fluids, a low fiber diet, age, not being physically active, depression, stress and pregnancy can all be causes of constipation. Medications and narcotics can also cause a person to get constipated. Chronic constipation may be a symptom of a liver problem such as a urea cycle disorder.

The best way for a person to treat constipation is to make sure that you are getting enough fluids as well as fiber in your diet. By doing this, the bulk of your stool is increased and also makes the stool softer so that it can move through your intestines more easily. Being more active and increasing your daily exercise also helps keep you regulated.

Hemorrhoids Hemorrhoids (also known as haemorrhoids, emerods, or piles) are varicosities or swelling and inflammation of veins in the rectum and anus.

Two of the most common types of hemorrhoids are external and internal hemorrhoids.

- **External hemorrhoids** are those that occur outside of the anal verge (the distal end of the anal canal). They are sometimes painful, and can be accompanied by swelling and irritation. Itching, although often thought to be a symptom from external hemorrhoids, is more commonly due to skin irritation.
    - If the vein ruptures and a blood clot develops, the hemorrhoid becomes a **thrombosed hemorrhoid**.

- **Internal hemorrhoids** are those that occur inside the rectum. As this area lacks pain sensory receptor|receptors, internal hemorrhoids are usually not painful and most people are not aware that they have them. Internal hemorrhoids, however, may bleed when irritated.

- Untreated internal hemorrhoids can lead to two severe forms of hemorrhoids: prolapsed and strangulated hemorrhoids.
    - **Prolapsed hemorrhoids** are internal hemorrhoids that are so distended that they are pushed outside of the anus.
- If the anal sphincter muscle goes into spasm and traps a prolapsed hemorrhoid outside of the anal opening, the supply of blood is cut off, and the hemorrhoid becomes a **strangulated hemorrhoid**.

Bleeding in the Gastrointestinal tract

Bleeding in the gastrointestinal tract doesn't always mean you have a disease, it's usually a symptom of a digestive problem. The cause of the bleeding may not be that serious, it could be something that can be cured or controlled such as hemorrhoids. However, locating the source of the bleeding is very important. The gastrointestinal tract contains many important organs like the esophagus, stomach, small intestine, large intestine or colon, rectum, and anus. Bleeding can come from one or more of these area from a small ulcer in the stomach, or a large surface like the

inflammation of the colon. Sometimes a person doesn't even know they are bleeding. When this happens, it is called hidden, or occult bleeding. Simple tests can detect hidden blood in the stool.

What Causes Bleeding in the Digestive Tract

Esophageal bleeding may be caused by Mallory-Weiss syndrome which is a tear in the esophagus. Mallory-Weiss syndrome is usually caused by excessive vomiting or may be caused by childbirth, a hiatal hernia, or increased pressure in the abdomen caused by coughing. Various medications can cause stomach ulcers or inflammations. Medications containing aspirin or alcohol, and various other medications(mainly those used for arthritis) are some examples of these.

Benign tumors or cancer of the stomach may also cause bleeding. These disorders don't usually produce massive bleeding. The most common source of bleeding usually occurs from ulcers in the duodenum. Researchers believe that these ulcers are caused by excessive stomach acid and a bacteria called Helicobacter Pylori.

In the lower digestive tract, the most common source of bleeding is in the large intestine, and the rectum. Hemorrhoids are the most common cause of bleeding in the digestive tract. Hemorrhoids are enlarged veins in the anal area which produces bright red blood that you see in the toilet or on the toilet paper.

How do you Recognize Bleeding in the Digestive Tract

The signs of bleeding in the digestive tract vary depending on the site and severity of the bleeding. If the blood is coming from the rectum, it would be bright red blood. If it was coming from higher up in the colon or from the small intestine, the blood would be darker. When the blood is coming from the stomach, esophagus, or the duodenum, the stool would be black and tarry.

If the bleeding is hidden, or occult, a person may not notice changes in the stool color. If extensive bleeding occurs, a person may feel dizzy, faint, weak, short of breath, have diarrhea or cramp abdominal pain. Shock can also occur along with rapid pulse, drop in blood pressure, and difficulty urinating. Fatigue, lethargy, and pallor from anemia will settle in if the bleeding is slow. Anemia is when the bloods iron-rich substance, hemoglobin, is diminished.

Common Causes of Bleeding in the Digestive Tract

- Hemorrhoids
- Gastritis (inflammation)
- Inflammation (ulceratice colitis)
- Colo rectal Polyps
- Colo rectal Cancer
- Duodenal Ulcer
- Enlarged Veins
- Esophagitis (inflammation of the esophagus)
- Mallory-Weiss Syndrome
- Ulcers

Iron and beets can also turn the blood red or black giving a false indication of blood in the stool.

How Bleeding in the Digestive Tract is Diagnosed

To diagnose bleeding in the digestive tract the bleeding must be located and a complete history and physical are very important. Here are some of the procedures that diagnose the cause of bleeding.

Endoscopy

An endoscopy is a common diagnostic technique that allows direct viewing of the bleeding site. Since the endoscope can detect lesions and confirm the absence or presence of bleeding, doctors often use this method to diagnose acute bleeding, the endoscope can also be used to treat the cause of bleeding as well.

The endoscope is a flexible instrument that can be inserted through the mouth or rectum. The instrument allows the doctors to see inside the esophagus, stomach, duodenum(esophagoduodenoscopy), sigmoid colon(sigmoidoscopy), and rectum(rectoscopy, to collect small samples of tissues, take pictures, and stop the bleeding. There is a new procedure out using a long endoscope that can be inserted during surgery to locate a source of bleeding in the small intestine.

Capsule Endoscopy

Capsule endoscopy helps doctors to see and examine the lining of the middle part of the gastrointestinal tract, which includes the three parts of the small intestine (duodenum, jejunum, ileum). The capsule is a small pill sized video camera called an endoscope. It has its own lens and light that transfers the images to a monitor so the doctor can view them outside of the body. This process is also referred to as small bowel endoscopy, capsule endoscopy, or wireless endoscopy.

The most common reason for doing a capsule endoscopy is to look for the causes of bleeding that is coming from the small intestine. It is also able to help detect ulcers, tumors, and Crohn's disease.

Angiography

Angiography is a technique that uses dye to highlight blood vessels. This procedure is used when the patient is bleeding badly enough that it allows the dye to leak out of the blood vessels and identifies the bleeding site. In some situations, Angiography allows the patient to have medication injections that may stop the bleeding.

Radionuclide Scanning

Radionuclide scanning is a non-invasive screening technique used for locating sites of acute bleeding, especially in the lower GI tract. This procedure injects small amounts of radioactive material that either attach to the persons red blood cells or are suspended in the blood. Special pictures are taken that allows doctors to see the blood escaping. Barium x-rays, angiography, and radionuclide scans can be used to locate sites of chronic occult bleeding.

How to Recognize Blood in the Stool and Vomit

- Bright red blood coating the stool
- Dark blood mixed with the stool
- Black or tarry stool

- Bright red blood in the vomit
- Grainy appearance in vomit

Symptoms of Acute Bleeding

- Weakness
- Shortness of breath
- Dizziness
- Cramp abdominal pain
- Feeling light headed
- Diarrhea

Symptoms of Chronic Bleeding

- Fatigue
- Shortness of breath
- Lethargy
- Pallor

Colonoscopy

A colonoscopy is a test to look at the inside of your colon. Everyone should have a colonoscopy by the time they are 50 to check for diseases of the colon. Colonoscopy is best known for its use in early detection of colorectal cancer, the second leading cause of cancer deaths in the United States. Colon cancer develops from growths like polyps within the intestinal wall. These growths often take 5-10 years to develop usually without symptoms. You are at a higher risk to have this disease if you have a close relative who has had it. If you are going to develop a polyp, you will probably do so after age 50. So the American College of Gastroenterology (the digestive specialists) recommends screening examinations every 5 years for early detection and removal of these cancer-causing growths after that age. Don't make excuses! It's not so bad and it may save your life!

Case Study

Bob had a history of chronic pain in his intestinal area. He wasn't so sure what it was. The doctor suspected what it was and gave Bob antibiotics. It helped. It so happened that whenever Bob ate popcorn or nuts he would get this pain. Sometimes it would just go away... other times he had to go on antibiotics. The doctor ordered some tests. Bob would have to stay away from nuts, popcorn, tomatoes, strawberries, and anything else with seeds or hard parts. Seems something in his bowels couldn't tolerate those foods. Bob ate a pretty healthy diet so he couldn't understand what was happening. A few years later, Bob had another series of painful episodes. The pain was so great Bob could hardly stand let alone go to work. This time the doctor did more tests and found out that his lower intestine was almost blocked. Surgery was ordered. What did Bob have?

Glossary

Amebiasis
: An inflammation if the intestines caused by infestation with Entameba histolytica (a type of ameba) and characterized by frequent loose stools flecked with blood and mucus

Amylase
: An enzyme produces in the pancreas and salivary glands that help in the digestions of starches.

Bile
: A bitter, alkaline, brownish-yellow or greenish-yellow fluid that is secreted by the liver, stored in the gallbladder, and discharged into the duodenum and aids in the emulsification, digestion, and absorption of fats. Also called gall.

Biotin
: Biotin is used in cell growth, the production of fatty acids, metabolism of fats, and amino acids. It plays a role in the Krebs Cycle. Biotin is also helpful in maintaining a steady blood sugar level. It is often recommended for strengthening hair and nails.

B12
: A vitamin important for the normal formation of red blood cells and the health of the nerve tissues. Undetected and untreated B12 deficiency can lead to anemia and permanent nerve and brain damage

Candida Albicans
: Found in animals and in man. Has been isolated from the skin and mucosa of man, but has also been recovered from leaves, flowers, water, and soil. Reported to be allergenic. A common cause of superficial infection, oral and vaginal infection, sepsis, and disseminated disease. Cells from the organism are usually not airborne and are considered to be normal component of the flora of the mouth and other mucous membranes on the body.

Chemical digestion
: Is a chemical breakdown of food when being in the mouth (oral cavity). Is the digestive secretions of saliva that moistens food and introduces gastric juices and enzymes that are produced in the stimulation to certain macronutrients, such as, carbohydrates. In this, the mouth saliva carries an enzyme called amylase for breaking down carbohydrates.

Cholecystokinin (CCK)
: Cholecystokinin (also called pancreozymin), this is a hormone in the small intestinal cells (intestinal mucosa) that is produced in response to food. This hormone regulates the release of secretions of many organs that aid digestion, such as, bicarbonate from the pancreas to reduce the acidity of digestive juices like the chyme that enters the small intestine form the stomach that contains hydrochloric acid (HCL).

Chylomicrons
: The lipoproteins first formed after absorption of lipids form food.

Chyme
: The thick semi fluid mass of partly digested food that is passed from the stomach to the

duodenum.

Crohn's Disease
: Described as skip lessions in the large and small bowel it is a malabsorption disorder that can affect the gastrointestinal tract for the mouth to the anus.

Deamination
: When an amino acid group breaks off an amino acid that makes a molecule of ammonia and keto acid.

Emulsifier
: A mixture of two immiscible (unblendable) substances.

Gastrin
: The stomach mucosa secretes a hormone gastrin that increases the release of gastric juices.

GI tract
: Gastrointestinal Tract, The tube that extends from the mouth to the anus in which the movement of muscles and release of hormones and enzymes digest food.

Hydrochloric
: The chemical substance hydrochloric acid is the water-based solution of hydrogen chloride (HCI) gas. It is a strong acid, the major component of stomach acid and of wide industrial use.

Lactobacillus Acidophilus
: Important resident inhabitant of the human small and large intestines, mouth, and vagina. Secretes natural antibiotic substances which strengthen the body against various disease-causing microbes

Leaky gut syndrome
: Abnormal level of intestinal permeability

Lingual lipase
: An enzyme produced only in infancy to aid digestion of long-chain fatty acids.

Lipase
: An enzyme produced by microorganisms that split the fat molecules into fatty acids which create flavor

Mechanical digestion
: The crushing of the teeth and rhythms made by the movement of the tongue, the teeth aid in tearing and pulverizing food, while the tongue helps with peristalsis (movement), of food down the esophagus.

Micelles
: A product of lipids and bile assist in lipid absorption.

Microvilli
: On the villi in the small intestine is mivrovilli, these projections called brush border microvilli

secrete specific enzymes for disaccharide hydrolysis, these further aid the absorption of the carbohydrate by yielding a monosaccharide that then can go through portal circulation to liver circulation to be further processed into immediate use for energy or glycogen storage.

Peristalsis
: The wavelike muscular contractions of the intestine or other tubular structure that propel the contents onward by alternate contraction and relaxation.

Proliferation

: The process of reproduction or division of cells

Proteases
: Protein enzyme

Rennin
: Only produced during infancy and is a gastric protease and functions with calcium to clot with milk proteins casein, to slow the movement of milk so that digestion is prolonged.

Serotonin
: chemical messenger in the brain that affects emotions, behavior, and thought

Synthesize
: To create something, such as chemicals in the body, from simpler, raw materials

Ulcerative Colitis

Villi
: A minute projection arising from a mucous membrane, especially one of the vascular projections of the small intestine.

Vitamin K
: A substance that promotes the clotting of blood

Case Study Answer Bob has diverticulitis. The doctor was afraid that if he had another bad infection that scar tissue would eventually block his colon completely and burst, which would necessitate a colostomy. Bob ended up having to have surgery to remove the damaged part of his colon. The doctor removed almost 18 inches of Bob's large intestine. Bob is doing fine now and most importantly, he can now eat his favorite food - nuts! Note: Sometimes a diet rich in fiber can help you avoid this dread problem. Sometimes, like in Bob's case, the predisposition to have this problem runs in the family. All of his siblings and his father suffered from this same ailment. Stress is another factor that can exacerbate this disease. So.. don't worry, be happy and eat fiber!

Review Questions

1. This is released in the duodenum in response to acidic chyme

: A) Cholecystokinin

B) Gastrin
C) Secretin
D) Peptide

2. In the GI tract, this layer is responsible for absorption and secretions

A) Mucosa
B) Sub mucosa
C) Muscularis
D) Serosa

3. This digestive enzyme is produced in the salivary glands and the pancreas

A) Maltase
B) Amylase
C) Pepsin
D) Nuclease
E) Lipase

4. This keeps the chyme in the stomach until it reaches the right consistency to pass into the small intestine

A) Esophageal sphincter
B) Intrinsic sphincter
C) Cardiac sphincter
D) pyloric sphincter

5. The site where most of the chemical and mechanical digestion is carried out

A) Pylorus
B) Fundus
C) Stomach
D) Large intestine
E) Small intestine

6. Parietal cells secret

A) Serotonin
B) Mucus
C) Pepsinogen
D) Hydrochloric Acid
E) Gastrin

7. The cells at the base of fundic or oxyntic glands

A) Chief cells
B) G cells
C) Argentaffin cells
D) Goblet cells

E) Parietal cells

8. The movement and the flow of chemicals into the stomach is controlled by

A) Nervous system
B) Pancreas
C) Various digestive system hormones
D) Liver
E) Both the nervous system and various digestive system hormones

9. The function of the Ileum is

A) Absorb nutrients
B) Absorb vitamin B12 and bile salts
C) To introduce bile and pancreatic juices
D) Absorb alcohol and aspirin

10. The liver does this

A) Glycogen storage
B) Plasma protein synthesis
C) Bile production
D) Drug detoxification
E) All of the above

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