The Long Hollow Tube: A Primer on the Digestive System

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Wise men, poets and philosophers have long honored the process of digestion as the basis of good health, sound sleep and a happy attitude. "I am convinced digestion is the great secret of life," said the prolific and quotable Reverend Sydney Smith. "Now good digestion wait on appetite, and health on both!" toasts Shakespeare's Macbeth. Milton wrote, "His sleep was very light, from pure digestion bred."

Rudolf Steiner, the Austrian philosopher and mystic, placed the highest importance on complete and thorough digestion. He described digestion as the annihilation or breaking down of the outer world, which is food, into nothingness or chaos. A primary task of the human ego, according to Steiner, was the building up of that pregnant chaos into compounds that bear our own imprint.

But let's begin more prosaically with *Gray's Anatomy*, which describes the digestive tract as a "musculo-membranous tube, about thirty feet in length, extending from the mouth to the anus, and lined throughout its entire extent by mucous membrane."

Mucous membranes are soft and velvety tissues, plentifully supplied with blood; their entire surface is coated over by the secretion of mucus, which serves to protect them from foreign substances with which they are brought into contact--in the case of the digestive tract, with the food we eat and our digestive secretions. Note also the word "musculo." The muscles that encase the digestive tract work autonomously, without our conscious involvement, in a series of peristaltic (wavelike) contractions to mix our food with digestive juices and move it along as digestion occurs.

The Incredible Journey

Digestion begins in the mouth as food is chewed and mixed with saliva. Saliva keeps the mouth moist and usually contains a starch-digesting enzyme, ptyalin, which breaks down starches into the simple sugar, glucose. Place a bit of cracker on the tongue and in a moment it will taste sweet, due to the action of this enzyme. The introduction of food into the mouth--or even the smell of food--stimulates increased production of saliva and also signals to the stomach and small intestine that food is on the way.

Chewing is an important first step in the digestive process, especially for fruits and vegetables, as it breaks down membranes of cellulose (indigestible for humans) and liberates the nutrients they surround. Chewing also breaks food into small pieces, creating a large amount of surface area--digestive enzymes can only work on the surface of our food. When we wolf down our food, it takes much longer to digest.

When we swallow, chewed food is forced into the pharynx, a muscular apparatus that moves the food into the esophagus, the tube from the mouth to the stomach.

The esophagus is also a muscular organ, which propels the food down to the stomach by a series of wavelike contractions. Small glands located in the mucous membrane of the esophagus secrete alkaline compounds that further lubricate the food. The esophagus is the narrowest part of the digestive tract and esophageal secretions ensure a smooth passage.

Food enters the stomach via the cardiac opening, so called because of its proximity to the heart, via a circular muscle or sphincter that opens to allow food to pass through. When empty or contracted, the interior walls of the stomach form numerous folds. These disappear when the stomach contains food and is distended. The stomach must begin to open up as food enters; this process of relaxation begins with the sphincter muscle at the cardiac opening in response to commencement of eating.

The stomach has two main functions--the storage of food until it can pass into the intestines and the mixing of food with digestive enzymes, a process that turns the bits and chunks of food that enter the stomach into a relatively smooth and thick fluid mixture called chyme. Mixing occurs due to the action of muscles that encase the stomach. Periodic contractions churn and knead the food into chyme and rhythmical pumping moves the food toward the pylorus, the opening at the lower end of the stomach.

The mucous membrane of the stomach is densely packed with glands that secrete hydrochloric acid and pepsin, a protein-digesting enzyme. The role of hydrochloric acid is to create a sufficiently acid environment for pepsin to be activated. If we do not produce enough hydrochloric acid, then we cannot fully digest protein. The parietal cells that create hydrochloric acid also produce a large protein called the intrinsic factor, necessary for the assimilation of vitamin B12.

The pumping action of the stomach moves the chyme through the pyloric valve into the duodenum, the first section of the small intestine. The small intestine is about 25 feet long and one inch in diameter; it fits in coiled fashion in the abdominal cavity. It has three parts: the first twelve inches is called the duodenum (which means "twelve" in Latin), the jejunum, which is about 10 feet long, and the ileum, the last portion of the small intestine, which is about 15 feet long. While the environment in the stomach, especially the lower part of the stomach, is highly acidic, the environment in the small intestine is alkaline.

The entrance of food into the duodenum stimulates the production of two hormones, secretin and cholecystokinin, which communicate important messages to the stomach, the pancreas and the gall bladder. They tell the stomach to moderate its contractions so that the chyme does not arrive too quickly, but in measured amounts; and they signal the release of digestive secretions from the pancreas and gall bladder.

It is in the first two sections of the small intestine that most digestion and assimilation occur. Absorption takes place via the villi, small projections in the mucous membrane. Each villus has a network of capillaries through which the broken-down components of the food are absorbed. The nutrients then pass through the epithelial cells in the inner lining of the villi, at which point they enter the capillaries. The small intestine is attached to the rear abdominal wall by a thin sheet of membrane called the mesentery, which carries blood vessels to nourish the small intestine and carries absorbed nutrients to the liver and other parts of the body.

Once again, muscular contractions move the chyme along. Whenever a section of the small intestine becomes stretched, peristaltic movements (waves of contractions) occur at spaced intervals. These not only move the chyme along but also mix it with digestive secretions. At the end of the small intestine is the ileocecal valve. As with the connection between the stomach and the small intestine, various hormones and feedback mechanisms regulate the passage of chyme through the ileocecal valve into the large intestine. When the ileum becomes stretched and full, the valve opens to allow the passage of chyme and if the large intestine is too full, the valve remains closed until the bowel empties.

The small intestine actually meets the large intestine at a kind of T junction. To the left is the cecum, a kind of holding tank, and to the right the bowel. Attached to the cecum is the appendix, once considered a non-functioning or "vestigial" organ but now recognized as serving an important immunological function. The appendix contains a high concentration of lymphoid follicles that produce antibodies to help keep the bacteria of the colon from infecting other areas of the body, such as the small intestine and the bloodstream, particularly in early life.

The large intestine or colon is five to six feet long with a diameter of about two inches and is divided by sharp turns into three major parts--the ascending colon on the right hand side of the body, the transverse colon which runs from right to left across the upper abdomen, and the descending colon which carries the mass of digested food downward to the rectum. The purpose of the large intestine is threefold: storage of waste materials and undigested food from the small intestine--not just the breakdown products of what we take in but the residue of secretions, sloughed-off cells and dead bacteria that accumulate during the digestive process; the absorption of water and electrolytes from the food residue; and the further decomposition of solid materials by the action of millions of bacteria. Combined contractions of circular and lengthwise muscles surrounding the colon roll over the fecal materials to ensure that all of it is exposed to the intestinal wall, so that all the fluid can be absorbed. Special cells called goblet cells lining the large intestine secrete mucus that protects the walls of the intestine, helps maintain alkalinity and provides a medium to hold the fecal matter together.

The final stage of this incredible journey is the movement of the now solid fecal matter from the transverse colon via strong contractions down the descending colon and into the rectum, a process that occurs only a few times each day--usually upon arising in the morning or immediately after breakfast. When these movements force a mass of fecal matter into the rectum, the desire to evacuate is felt.

The Second Brain

"Have you ever wondered why people get butterflies in the stomach before going on stage? Or why an impending job interview can cause an attack of intestinal cramps? And why do antidepressants targeted for the brain cause nausea or abdominal upset in millions of people who take such drugs? The reason for these common experiences is because each of us literally has two brains--the familiar one encased in our skulls and a lesser-known but vitally important one found in the human gut. Like Siamese twins, the two brains are interconnected; when one gets upset, the other does, too." So writes science journalist Sandra Blakeslee for the *New York Times*. Indeed, the human digestive tract contains over one million nerve cells, about the same number found in the spinal cord. There are actually more nerve cells in the overall digestive system than in the peripheral nervous system. Furthermore, major neurotransmitters found in the brain--including serotonin, dopamine, glutamate, norepinephrine and nitric oxide--occur plentifully in the gut as well. Enkephalins--described as the body's natural opiates--also occur in the intestinal tract, as do benzodiazepines, psychoactive chemicals similar to mood-controlling drugs like Valium and Xanax.

Jordan Rubin describes the "brain-gut" connection very well in his book *The Maker's Diet*:

"Early in our embryogenesis, a collection of tissue called the 'neural crest' appears and divides during fetal development. One part turns into the central nervous system, and the

other migrates to become the enteric nervous system. Both ‘thinking machines’ form simultaneously and independently of one another until a later stage of development.

"Then the two nervous systems link through a neural cable called the "vagus nerve," the longest of all cranial nerves. . . The vagus nerve "wanders" from the brain stem through the organs in the neck and thorax and finally terminates in the abdomen. This is your vital brain-gut connection."

Serotonin in the gut is thought to initiate peristalsis, the rhythmic movement of food through the digestive tract. Drugs like Prozac actually divert serotonin from the intestinal tract to the brain, leading to digestive problems including constipation in many patients.

The gut produces the same pain-alleviating chemicals as those in antianxiety drugs. Says Rubin, "If you overeat because you feel anxious, your body may be trying to use the extra food to produce more benzodiazepines. We are not sure whether the gut synthesizes benzodiazepine from chemicals in our foods, from bacterial actions or from both. We do know that extreme pain appears to put the gut into overdrive in order to send benzodiazepine directly to the brain for immediate pain management."

An Ecosystem

The digestive system is far more than a collection of pipes, wiring and membranes. It is actually an ecosystem, populated by billions of organisms that produce substances necessary for digestion to occur--enzymes, vitamins and beneficial acids (especially lactic acid). In the young, gut bacteria interact with intestinal cells, called paneth cells, to promote the development of blood vessels in the intestinal lining. In the large intestine, fermentation processes produce butyric acid and other short-chain fatty acids that nourish the intestinal wall.

But fermentation is undesirable in the small intestine. When the intestinal ecosystem is healthy, beneficial bacteria keep yeasts and other fermentation microorganisms at bay in this part of the digestive tract. An imbalance of microorganisms, called dysbiosis, results in overgrowth of fungus and other pathogens, resulting in numerous digestive disorders.

Even today, textbooks typically describe the environment of the small intestine as "sterile." Scientists thought that beneficial organisms could not survive the highly acid milieu of the stomach to pass into the small intestine. This view is no longer tenable. Good health depends on the right mix of microorganisms in both the small and large intestine.

Like all ecosystems, the delicate balance of the digestive tract can be altered by various toxins including antibiotics and other drugs, chemicals like chlorine and fluoride in our water, food additives and preservatives, stimulants like coffee, and an overabundance of difficult-to-digest foods like improperly prepared whole grains.

Digestion of Carbohydrates

Digestion of sugars and starches begins in the mouth as amylases (starch-digesting enzymes) begin the breakdown of starches into simple sugars such as maltose, fructose and glucose. This process continues, but at a lesser rate, in the upper portion of the stomach where the enzymes provided by the saliva continue their work. Once the food moves into

the lower portion of the stomach, which is highly acidic, carbohydrate digestion temporarily ceases.

In the small intestine, the breakdown of starches and sugars renews. Amylases produced by the pancreas split sugars and starches into disaccharides (such as lactose, sucrose and maltose) and enzymes from the cells lining the small intestine (called the brush border) reduce these into the monosaccharides galactose, glucose and fructose. About 80 percent of the final product of carbohydrate digestion is glucose. These various simple sugars are selectively absorbed through the intestinal membrane.

Digestion of Protein

Digestion of proteins begins in the highly acidic medium of the lower stomach. Hydrochloric acid activates pepsin, an enzyme that breaks down proteins into shorter strings of amino acids. These products then move into the alkaline environment of the small intestine where pancreatic enzymes break down these strings into individual amino acids. The proteolytic or breakdown enzymes are very specific for the amino-acid linkages--a specific enzyme is required for each type of amino-acid linkage. The proteins are then rapidly absorbed, usually as single amino acids but occasionally as combinations of two or three amino acids.

Digestion of Fat

Digestion of fats is more complex than that of proteins or carbohydrates. Some digestion occurs in the mouth and the upper stomach due to the action of lipases (fat-digesting enzymes) on the surface of the fat globules. But most fat digestion takes place in the small intestine. For full digestion to occur the fat globules must be broken down; the substance that accomplishes this process (called emulsification) is bile, which is a secretion of the liver. The soap-like action of bile on fat globules increases the surface area an estimated 10,000-fold, thus allowing the lipases to liberate the fatty acids. Stable compounds called micelles are formed, small spherical globules consisting of long chain fatty acids, monoglycerides (a glycerol molecule attached to a single fatty acid) and bile salts. The micelles are absorbed at the surface of the intestinal mucous membrane. Once in the intestinal mucosa the various fatty compounds are joined with small amounts of protein and formed into compounds called chylomicrons, which enter the lymph system and eventually the blood as lipoproteins--compounds with a lipid core and a protein coating that makes them soluble in water.

Bile is produced by the liver out of cholesterol and stored in the gall bladder. The gall bladder releases bile into the small intestine through the action of a hormone, cholecystokinin. When the meal contains sufficient amounts of fat, the gall bladder empties completely in about one hour. Then the gall bladder slowly fills up again, getting ready for the next meal.

Bile not only serves to break down fats but also carries a lot of waste products away from the liver and into the intestine so that they can be eliminated.

The Role of the Liver

The liver performs a multitude of wide-ranging tasks. These include the destruction of old red blood cells, the manufacture of proteins and of blood-clotting agents, the manufacture of cholesterol, the storage of carbohydrates in the form of glycogen, some storage of fats and proteins, the conversion of fats and proteins to carbohydrate, the transformation of galactose (milk sugar) into glucose, the extraction of ammonia from amino acids, the conversion of ammonia into urea, the production of bile salts, the storage of fat-soluble vitamins and the conversion of adipose fat into more combustible ketone bodies. The liver also neutralizes various drugs and poisons--everything from alcohol to bartitrurates.

Unlike other organs in the body, the liver can regenerate its tissues, a trait that has led to its title of "the immortal organ" and "the seat of life." It sorts, organizes and stores the simple breakdown products of digestion, sent to it from the small intestine via the portal vein, and then uses these basic components to construct the complex substances the body needs; it also *deconstructs* a wide range of toxins and sends them away for elimination.

Lending a Helping Hand

The exquisite and finely tuned digestive system requires our utmost respect. From the first bite of food to the elimination of wastes, membranes, glands, muscles, hormones, secretions, enzymes, blood, nerves and microorganisms work in concert to extract nourishment from our food and deliver it to our cells.

The wrong diet can disrupt this system in two ways--by failing to provide nourishment and by delivering food that is difficult to digest.

While the medical profession turns to drugs as a solution to digestive problems, the basic remedy should be nutrient-dense foods, especially the animal foods that provide fat-soluble nutrients, combined with wise preparation methods.

Many modern foods, such as processed milk products, breads and soy foods are extremely difficult to digest; but traditional preparation methods made food easy to digest and facilitated assimilation of nutrients. They include:

- Preparation of grains by soaking and sour leavening to neutralize difficult-to-digest components and nutrient blockers.
- Long soaking and cooking, or even fermentation, of legumes.
- Fermentation of many types of tubers, such as casava.
- Lacto-fermentation of condiments and beverages to provide beneficial bacteria for the digestive tract.
- Consumption of protein foods (meat, eggs, fish and milk products) with plenty of fat.
- Use of gelatin-rich bone broths. Gelatin acts not only to bring food into contact with digestive juices, it also soothes the intestinal wall.
- Cooking of most vegetables (and even some fruits) to neutralize toxins and break down cell walls.
- Proper aging of meat to initiate the breakdown of protein. With proper aging and/or fermentation, meat is quite digestible either raw or carefully cooked at low temperature.
- Soaking and/or roasting of nuts to remove irritants and toxins.

Happy Meals

Our journey through the digestive tract teaches us that digestion is more than just a biochemical process--it is a rhythmical alchemy that is highly influenced by our emotional state. The digestive system needs to alternate between periods of activity and rest, and that rhythm is best served by three meals per day, with nothing to eat in between. This allows the stomach to rest, the gall bladder to refill, the intestines to move at their proper pace.

Delicious smells and attractive presentation make meals a pleasurable experience, stimulating the production of feel-good chemicals in the gut; a moment of silence or prayer before the first bite allows the brain and the stomach to communicate to the body that nourishment is on its way. Slow eating and careful chewing let your digestive tract know that it doesn't need to rush. Above all, pleasant surroundings and conversation provide support to the entire digestive process. No arguments at dinner, please--to paraphrase the great Satchell Page, they angers the stomach.

Sidebar Articles

Strange Facts about the Digestive System

Hydrochloric acid produced by the stomach is extremely corrosive; yet it does not harm the lining of the stomach.

The surface area of the small intestine, with its thousands of villi and microvilli projections, is approximately 300 square yards, larger than a tennis court.

The contents of the stomach enter the small intestine at different rates--carbohydrates first, then proteins and then fats.

The digestive tract is populated by about 10,000 different kinds of microbes, which manufacture enzymes, vitamins and other substances that aid the digestive process.

There are more nerve cells in the digestive system than in the peripheral nervous system.

The lining of the large intestine is as smooth as the inside of the mouth. Except in very high fiber diets, the bulk of the feces is made up not of fiber but dead bacteria.

A Medicine Chest for the Digestive Tract

Aloe Vera has soothing, anti-inflammatory effects on the digestive system and is a source of proteolytic enzymes.

Artichoke powder had traditionally been used to treat IBS, and liver, gall bladder and pancreatic problems. Herbalists classify artichoke as a "cholagogue," a substance that can help these organs make and release bile, thus assisting in fat metabolism. It also works wonders for constipation. Some formulations of bitters contain extract of artichoke.

Bitters; that is, tinctures of a combination of bitter herbs, is an excellent digestive aid, especially for those who have trouble digesting fats.

Cabbage Juice has been found to be extremely effective in treating peptic ulcers. We actually recommend the juice of fermented cabbage; that is, sauerkraut juice, because raw cabbage can depress thyroid function.

Digestive Enzymes taken with meals can be very helpful for those with digestive problems.

Flaxseed ground to a powder and mixed with food or water is an excellent remedy for constipation.

Ginger has a calming effect on the digestive system and also helps increase peristaltic action, to help move food through the intestine.

Mint Tea is a popular remedy for indigestion and stomach aches.

Ox Bile tablets can help with digestion of proteins or any case of insufficient hydrochloric acid, including the removal of the gall bladder.

Raw Cream and **raw butter** are said to be excellent remedies for gallstones. For bladder and gall stones, said Paracelsus, "There is nothing so much to recommend as butter and olives."

Slippery Elm provides mucilage which soothes the digestive tract and fights inflammation. Slippery elm is the herb of choice for gastritis, ulcers, inflammation, lack of appetite and diarrhea.

Anger and the Stomach

Credit for our understanding of how the stomach works goes to a French-Canadian named Alexis St. Martin who was shot in the stomach on June 6, 1822, leaving a hole that never healed. When he ate, the contents of his stomach spilled out unless he wore a special bandage. A US Army surgeon, William Beaumont, recognized the opportunity that St. Martin's unfortunate accident presented and devised a number of experiments that would provide enlightenment on man's inner workings. He weighed morsels of food, tied them with silk and observed what happened when the stomach did its work on them. He took specimens of gastric secretions and identified the major component as hydrochloric acid. He noted that a fasting stomach was empty and contracted. Most importantly, he observed that the stomach became flushed with blood when Mr. St. Martin was angry. It also moved about with anger.

Years later, a woman in St. Louis had a stomach that could also be inspected. When she was made angry, her stomach grew pale and motionless.

These two examples clearly show that emotions affect our digestions--perhaps in different ways but the effect is definitely physiological. The moral: never eat when you are angry!

Nutrients for the Digestive Tract

Vitamin A, our favorite vitamin, is absolutely critical to the health of the intestinal mucosa. Without sufficient vitamin A, the mucous membranes become hardened and, paradoxically, more easily penetrated, leading to "leaky gut, " ulceration and irritable bowel syndrome. Vitamin A is also necessary for the assimilation of minerals and protein and plays an important role in the repair process. It has been used successfully to treat gastritis. Best sources are cod liver oil followed by liver and other organ meats, and butterfat and egg yolks from grassfed animals.

Vitamin B Complex is important for fat metabolism and liver health; B vitamins play a role in the production of bile. They are necessary to maintain muscle tone, stimulate digestive secretions, support the nervous system and ensure normal carbohydrate metabolism. We recommend Frontier brand nutritional yeast as a supplement along with a diet of whole foods to ensure adequate B vitamins.

Vitamin C complex contributes to the health of all the epithelial cells as well as the integrity of the blood vessels that nourish the intestinal tract. Vitamin C is necessary for biochemical repair. Lacto-fermented fruits and vegetables are especially good sources.

Vitamin D plays a role in fighting inflammation and strengthening the immune system, as well as in the assimilation of calcium and other important minerals. Crohn's disease is associated with vitamin D deficiency. Best sources are cod liver oil, lard from pastured pigs, oily fish, fish eggs, shellfish, and butterfat and egg yolks from grassfed animals.

Vitamin E is needed for muscle tone and a healthy nervous system. Deficiency has been linked to digestive problems such as peptic ulcers, colitis, constipation and cancer of the colon. Best sources are small amounts cold-pressed oils (too much polyunsaturated oil can deplete vitamin E), whole grains, butter and other animal fats and a supplement of wheat germ oil.

Protein is necessary for the maintenance of the mucous membrane in the stomach, particularly the amino acids cystine, lysine and arginine. Deficiency leads to muscular weakness and many other problems. Bone broths are an excellent source of arginine, and cystine and lysine occur in meat, milk and eggs.

Phosphatidylcholine (PC) has been studied by German researchers who found that PC is highly beneficial to the mucosal lining of the digestive tract, preventing or healing lesions and reducing the incidence of stomach ache. They found that PC was more effective than nonsteroidal anti-inflammatory drugs (NSAID) in reducing gastric mucosal lesions. The researchers used PC derived from soy, but the best dietary sources are egg yolks and butter.

CoEnzyme Q10 is critical for healthy muscles. The importance of good muscle tone is often overlooked in discussions about digestion. The best source is meat, especially heart.

Cholesterol plays a role in intestinal health. The cells lining the digestive tract are particularly rich in cholesterol. Cholesterol is also the precursor to bile. It is provided only by animal foods.

Salt is key to digestion. Salt provides chloride for hydrochloride, necessary for the digestion of protein; and salt activates an enzyme needed for the digestion of carbohydrates.

Calcium prevents cramps and spasms, protects against inflammation and supports both the muscles and the nervous system. Best sources are raw dairy products and bone broths.

Potassium supports the nervous system and connective tissue, as well as the production of hydrochloric acid. Best sources are meats, whole grains and vegetables.

Zinc deficiencies have been associated with problems of fat metabolism, inflammatory bowel disease and Crohn's disease. Best sources are red meat and oysters.

Beneficial Bacteria help maintain a healthy ecosystem in the gut. Best dietary sources are natural yoghurt and lacto-fermented condiments and beverages. Supplements such as Primal Defense from Garden of Life can help repopulate the digestive tract very quickly in cases of digestive disorders.

When Things Go Wrong

Gastritis is an inflammation of the mucous membrane lining of the stomach, leading to burning pain in the stomach area, often with belching or burping. Symptoms can inlcude coated tongue, mild fever, loss of appetite, nausea, vomiting, headache, dizziness, weakness and exhaustion.

Peptic Ulcer is a "hole" in the mucous membrane of the stomach. The current theory is that the bacterium Heliobacter pilori is the cause, but obviously the health of the mucous membrane is key to prevention of ulcers.

Heartburn sometimes occurs when the sphincter muscle connecting the esophagus to the stomach opens and allows chyme to reenter the esophagus, which is not resistant to the acidic stomach juices. Antacids are commonly prescribed but most cases of stomach distress are due to *low* levels of hydrochloric acid, not too much.

Dyspepsia is the term for imperfect or painful digestion, usually brought on by low levels of hydrochloric acid. Symptoms include sour belching, discomfort, nausea and vomiting. Supplements of hydrochloric acid can be helpful in these conditions--not antacids, which only make matters worse.

Celiac Disease is a hypersensitivity to gluten, a protein in grains, leading to inflammation and malabsorption in the small intestine. The sufferer must avoid all gluten-containing grains during the healing process, and then consume only grains that have been properly prepared by sour leavening once healing has occurred.

Gastroenteritis in an inflammation of the mucous membrane lining of the stomach or small intestine, leading to nausea, vomiting and diarrhea.

Duodenal Ulcer is an ulcer in the small intestine.

Leaky Gut is a condition wherein the integrity of the intestinal wall has been compromised so that compounds only partially digested pass through, provoking allergic reactions.

Gall bladder problems include inflammation and stones, often leading to acute pain. The wrong fats (trans fats and polyunsaturated oils) can cause inflammation and lowfat diets often lead to stones.

Irritable Bowel Syndrome is often brought on by insufficient hydrochloric acid in the stomach or insufficient digestive enzymes or bile salts in the small intestine. Trans fats, polyunsaturated oils and a poor diet can lead to inflammation.

Diverticulitis describes the presence of small protrusions or sacs that occur on the side of the colon. They are like tiny pouches that can trap fecal matter leading to constipation, pain and even ruptures. Chronic constipation and difficulty passing stools is said to be the cause, but the integrity of the muscles surrounding the bowel is obviously a key factor.

Diarrhea in healthy people is simply the body's way of quickly ridding itself of contaminants--including pathogenic bacteria, chemicals and pesticides. But chronic diarrhea can be the result of irritable bowel syndrome, colitis, or any condition of intestinal inflammation.

Colitis is an inflammation of the colon, often leading to sores or lesions and bloody stools, constant diarrhea, fluid loss and weight loss. Stress can trigger attacks, but poor diet is also a culprit.

Crohn's disease is an enlargement, hardening and scarring of the mucous membrane lining the ileum, the last part of the small intestine. The intestine narrows so that passage of chyme is difficult, leading to bloating and pain about an hour after a meal. Crohn's is usually treated with prednisone or some other synthetic cortisol, which can produce dramatic short-term results. Unfortunately, in the long-term, many serious side effects ensue.

Hemorrhoids are actually varicosities of the veins in the anal canal, leading to inflammation, protrusion, bleeding and pain on elimination. They are typically treated with stool softener but long term treatment must address the weakness in the veins and muscles surrounding the rectum.

Fiber

Fiber is a catchall term defined as that portion of the diet that is not enzymatically digested by our digestive enzymes and thus does not directly serve as a source of nourishment. (Fiber is broken down by a process of bacterial fermentation in the digestive tracts of animals, and to a much lesser extent in the human colon.) The word is misleading because dietary fiber is not fibrous nor long and stringy, and can even be soluble in water. In general, the various types of fiber are polysaccharides; that is, complex chains of sugars. The definition includes cellulose and hemicelluloses from plant walls, pectins (part of the "ground" substance of fruits) and mucilages and gums, which are non-structural components of plant cells (especially abundant in apples and the white portions of citrus). Cellulose is composed of glucose molecules joined in a chain-like structure (as opposed to

starch where the glucose molecules are more loosely joined and can be broken by enzymatic action); hemicellulose, a component of many vegetables, is composed of sugar units; pectin, a polysaccharide made mainly of chains of galacturonic acid (a derivative of galactose) units, forms a gel in the presence of sugar and acid, hence its use in making jams and jellies; and gums and mucilages have a variety of structures and uses, mainly as food additives like guar gum, agar and carrageenan.

Until fairly recently, the medical profession warned against overconsumption of fiber, especially for those suffering from digestive problems. Fiber's reputation rose with the work of Dennis Burkitt in Africa, who proposed that the excellent intestinal health of Africans was due to a diet rich in fibrous grains and tubers. Oat bran became popular and the medical community hopped on the bandwagon, recommending high fiber diets as a way to avoid modern diseases--cancer, heart disease and constipation.

Results of research on the benefits of fiber have been mixed; many studies do show a correlation between diets rich in fiber with low rates of cancer and heart disease, although these results may simply mean that those who can afford to eat a lot of fruits and vegetables, or who make a conscious choice to consume whole grains, have lower rates of disease than those consuming processed food. Those who eat more fiber also tend to smoke less, drink less alcohol and consume more nutrients than the general population. On the other hand, the Harvard Nurses Study, which studied 89,000 female nurses for 16 years, reported no association between fiber intake and the risk of colorectal cancer, a finding that set off ripples of head-scratching in the medical community.

It is always difficult to draw conclusions from epidemiological data, but there is one study that should serve as a warning to the fiber brigade. Researchers fed four groups of rats on diets high in alfalfa, wheat bran, cellulose and pectin for six weeks and then examined the jejunum and the mid-colon using electron microscopy. All groups suffered from mucosal surface changes that could interfere with nutritional absorption. Bran provoked the least severe changes, followed by cellulose followed by pectin, followed by alfalfa. Those consuming pectin and alfalfa suffered from severe degeneration of the intestinal villi (*Am J Clin Nutr* 1981 Feb;34(2):218-28).

Humans do not eat alfalfa, but they commonly eat lots of pectin from fresh fruit and cellulose in whole grains. This study raises a red flag, especially for those with digestive difficulties. Common whole grain foods and even fresh fruit may have a real downside. The rat study findings point to the wisdom of traditional food preparation methods. Throughout the world, indigenous groups took great care with the preparation of grains, by soaking or sour leavening them for a long period of time. In Africa, grains are made into a sour porridge or a fermented beverage called sorghum beer, processes that take several days and in which cellulose is partially broken down. They also prepare tubers like cassava by throwing them in a hole to ferment.

As for fresh fruit, perhaps we should take a cue from Asian cultures who typically cook high-pectin fruits like apples, pears, peaches and plums. Stewed fruit is an old-fashioned dish--who makes stewed fruit anymore? Here is another traditional food way that should be resurrected.

Coconut Oil for Digestion

Coconut oil is rich in medium-chain fatty acids that provide unique benefits for the digestive process. They have anti-microbial properties; that is, they fight against pathogenic viruses, yeasts, bacteria and parasites in the gut. These special fats are also the preferred food for beneficial bacteria in the colon.

For those who have gall bladder problems and difficulty in digesting fats, coconut oil can be very useful because the medium-chain fatty acids do not need to be acted on by the bile salts. And for those who have trouble digesting milk and cream, coconut milk and coconut cream can serve as substitutes.

Best of all, the body uses the medium-chain fatty acids for energy and rarely stores them as fat. Coconut oil aids digestion and boosts metabolism--wonderful benefits that come in a delicious package.

An Interesting Theory

In a fascinating book called *Salt Deficiency: The Cause of All Serious Diseases*, author Martin J. Lara describes the importance of unrefined salt in providing all the trace minerals the body needs. Lara contends that the result of trace mineral deficiencies is constipation because the body holds the fiber-rich waste in the colon so that it can ferment, a process that releases trace minerals the body needs. While fermentation is taking place, the body continues to remove water from the feces, resulting in hard and impacted stools. Most textbooks now recognize that some fiber is broken down by fermentation in the colon.

Lara explains that when a person is deficient in minerals, particularly trace minerals, he does not retain enough of the liquids he drinks--instead of hydrating the body, water is quickly eliminated via the kidneys. This is another reason the body retains feces in the bowel, in order to extract as much water as possible.

Lara describes a condition he calls partial constipation, which is often unrecognized because an individual with this condition may still have regular bowel movements. However, waste material can remain in the colon several days before it is eliminated, undergoing fermentation and compaction due to the removal of water. One sign of partial constipation is strong smelling urine, especially in the morning. Colonic irrigations can provide temporary relief from this condition, but they do not solve the problem.

A strong sphincter muscle (called the inner sphincter) separates the lower part of the colon (called the sigmoid colon) from the rectum. Under normal conditions, feces pass through the rectum only during bowel movements. When the sigmoid colon enlarges after years of carrying large amounts of feces undergoing fermentation, the inner sphincter becomes weak due to the pressure and the feces normally stored in the colon descend into the rectum, a condition that leads to autointoxication. The colon absorbs only water and small compounds like mineral ions, but the rectum is very absorptive, which is why medicines work when given as suppositories. Furthermore, the blood that absorbs nutrients from the small and large intestines goes into the liver where toxins can be neutralized. However, since the rectum is not designed to store waste, the blood that leaves this organ does not go into the liver; thus toxins enter the blood stream and are carried to other organs, including the head, heart and lungs. Lara's solution: always use unrefined sea salt on your food plus take

2 grams of sea salt in a mug of warm water every morning for complete and easy elimination.