# DIGESTION

In our model of health, we like to perceive the map of the physical body from a macro perspective as 3 fluid/colloidal/gel compartments (blood, interstitial, intracellular) separated by membrane material. It is in these areas and the divisions between each which are and do create the environment for all that happens at the micro level inside those compartments. It is the epigenetic dynamic.

This is the thrust of the Flow component of our work, to show how to measure as simply as possible and manage as effectively as possible the health dynamics inherent in our map which in reality is all about balancing a body's internal biological terrain for optimal function. In doing so it is paramount that the map always be kept in mind for it is the knowledge of the map and how things interconnect that leads to inductive and deductive reasoning and logic to master the art of supporting the body appropriately. When done right, it allows the body to fix itself when things go wrong.

If we looked at a map of a nation in a book, you would see the body of the nation, the boundaries separating the states like membranes, the states themselves like cells, the interconnecting rivers, tributaries, highways and byways through which commerce moves and makes things happen.

If you took a microscope and zoomed in on the map and looked at those pathways of commerce, you would see that they have to be clean and free of obstruction for traffic to move. If they aren't, things stop working. One key, which you might not see in your microscopic review, are the workers from the Department of Streets and Sanitation. If they stopped working, the highways and byways would fall into dis-repair, things would clog up, and commerce would slow down.

And so it is in the human body as reflected in the osteopathic maxim *the rule of the artery reigns supreme*. Inherent in this phrase is the operation of certain principles of physics that apply to the body's own internal streets and sanitation department so to speak. The blood as one compartment on our map touches everything. Its flow and how it moves and traverses elements to and fro and keeps things clean is best understood by always keeping in mind that the blood is a colloidal suspension under the control of zeta potential.

Toxins, in that system, which need to be kept out of the highways and byways, are best defined as; *anything with which the body does not have an inherently high enough zeta potential to either overcome or utilize.*

Note: At any given time when we ourselves traverse the study of the human health condition, it presupposes that any given reference made in our study of any given concept is fully understood. Of course upon first hearing such a reference, how could we possibly understand it when we've never heard it before? And so it is that our study is forever circular with vectors to certain knowledge shooting off and then returning again. Hearing the words colloids and zeta potential and suspension may put you in that position as there has generally been no formal course of study in the health care arena that covers these most important of foundational principles as they relate to biology. Even though many things such as this were well discussed and laid out by

others long ago, the information has often been dropped or has never appeared in formal course work in the health arts. Alas, when working with the Biomedx knowledge map, you will vector off at times to study these and other areas that have relevance, often again and again, and then return to pick up your current study with deeper understanding. And so it is with the topic at hand.

Blood, interstitial and intracellular compartments, separated by membranes, composing the cells of the body, need to be fed. Blood is the highway, the interstitial space is the front yard, some might call it the demilitarized zone, the membranes are the fence or the border, the cell is the target.

Digestion events, in no less than three places, need to be understood.

First is our body's own digestive system. This is one long tube of sorts, with certain diversions and stops along the way, fed into by certain organs and glands, beginning at our lips and ending at our anus. This is the discussion of this report.

Second is our cells mitochondrial digestive system. Incredibly important, it is covered in other reports.

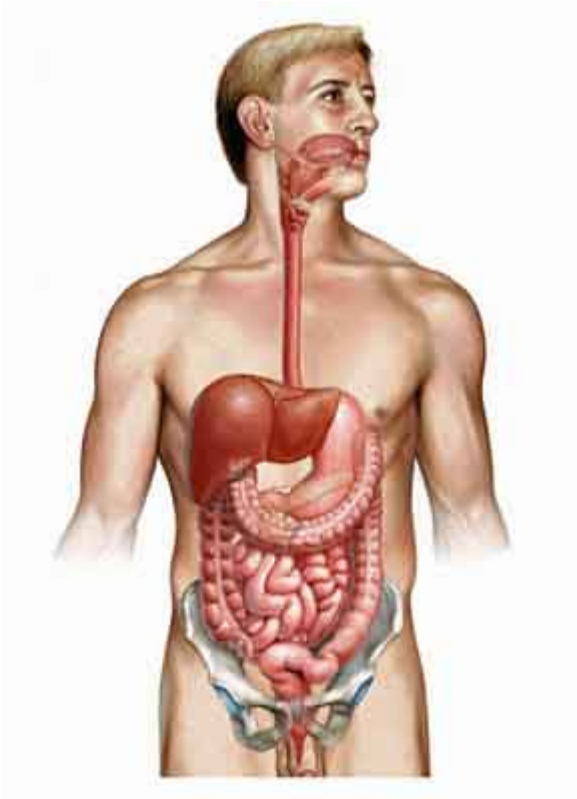
Third, is not something we will dissect as we do the above, but simply keep an awareness of - that there are other entities living within us that also have digestive processes the output of which can greatly impact our internal environment, either positively or negatively. This is the digestive activity of the trillions of bacteria that live within us, preferably of a pro-biotic nature, but sometimes anti-biotic. And occasionally, though research indicates it unknowingly affects the majority of us, is the activity of parasites with their own digestive systems.

But no more about them, let's talk about us.

*The following review of digestion is from the newsletters of Jon Barron, publically available and found on line at jonbarron.org, © by Baseline of Health Foundation. Jon has been writing about health and formulating nutrition based products for many companies for many years. This content was in a series of his newsletters and it concisely reviews much of what you need to know to understand digestion as it relates to health concepts that are not normally discussed or reviewed with clients in a typical physician's office. Yet these things should be discussed as it is of critical importance to everyone's health, yet the average individual knows next to nothing about how this system works.*

*Digestion Discussion follows on Page 3 to 97, special reference to HCl Therapy, Page 98-102.*

## Digestive system overview



The digestive system is also known as the gastrointestinal (GI) tract and the alimentary canal and covers everything from the digestive tract itself to the organs that support it. It is a continuous tube-like structure that develops outpouchings, which in turn evolve into those aforementioned attached digestive organs such as the pancreas, liver, and gallbladder. The entire system is about 30 feet in length from the mouth to the anus and is designed to transport food and water, modify it, and make it suitable for absorption and excretion. There are storage sites, excretion sites, and detoxifying sites along the way. And, according to the medical community, it has six primary functions.

1. Ingesting food.
2. Preparing food for digestion by physically grinding it and breaking it down into small pieces and unwinding proteins so they can be separated into their component amino acids.
3. Actually breaking the food into molecular pieces that your body can use as nourishment.
4. Transporting the food during its various stages of breakdown along the digestive tract in a measured, "manageable" flow.
5. Absorbing the nutrients into the body. Absorption is the movement of broken-down nutrients across the digestive tract wall and into the bloodstream for use by the cells of the body. Only water and alcohol are absorbed through the mucosa of the stomach – and only in special circumstances such as severe dehydration. All the rest of absorption happens in the small intestine.
6. Eliminating the unused waste products of digestion and absorption from the body.
    1. Digested waste products go to the kidneys
    2. Undigested waste products pass out through the colon and rectum.
    3. Ingested material that might otherwise be toxic is rendered harmless, primarily by the liver, and excreted from the body.

But that said, I now have my first disagreement with the medical community. I submit to you that the above list is incomplete, and that these omissions are not unimportant. For example, medicine has no understanding of the role your digestive system plays in maintaining an optimal environment for beneficial bacteria and why that's essential. Therefore, they both allow and, in fact, encourage by their treatments many diseases to manifest that should never appear -- and have no idea how to treat them when they do. And that's just one example that we'll explore in more detail later on. So, from a holistic point of view, the digestive system, in addition to the functions listed above, also performs the following functions:

- It is the first line of defense in the body's immune system. It both identifies and eliminates viruses and unhealthy bacteria ingested with our food and water.
- It plays a key role in helping remove, not just food waste from the body, but also metabolic waste, heavy metals, and drug residues.
- It also serves as a drain for toxic substances absorbed through the skin and lungs.
- And, of course, as mentioned above, it is designed to serve as a hospitable breeding ground for trillions of beneficial bacteria that do everything from aiding in digestion, waste elimination, and immune function. In fact, as much of 60% of your immune function comes from beneficial bacteria living in your intestinal tract.

## Getting food into the digestive tract -- the mouth and esophagus

Let's begin our exploration of the digestive system by examining the structures that play a key role in getting the food into the stomach. And since this is not an actual anatomy course, but a series of newsletters about how anatomy and physiology relate to alternative health, we will focus our discussion on the specific parts of the system relevant to our discussion and brush lightly over the rest.

### *Mouth*

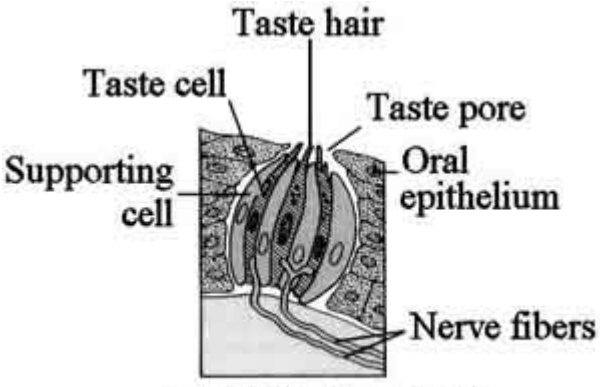
The mouth is the portal to the digestive system. Food enters the body through the mouth, where it is cut and ground by the teeth and moistened by saliva for ease in swallowing and to start the digestive process. The tongue assists in moving food around during chewing and swallowing and also contains the taste buds.

### *Teeth*

Most medical texts suggest that our teeth are designed to eat all kinds of food from meat to fruit, thus proving that man is an omnivore. But as I mentioned earlier, the facts do not bear this out.

### *Tongue*

The tongue is the largest muscle in the mouth. It functions in chewing, swallowing, and forming words. The extrinsic muscles of the tongue (those muscles that originate outside the tongue itself) attach to the skull and neck, and they move from side to side and in and out. The intrinsic muscles attach to the tongue itself, and they alter the tongue's shape (for swallowing and speech). The most interesting parts of the tongue in terms of our discussion are the papillae, the bumps on the tongue that contain the taste buds.



Seeley, Rod R.; T.D. Stephens, and P. Tate. (1996). Essentials of Anatomy & Physiology, 2nd ed.. Mosby, NY. pg.240.

Taste buds are composed of groups of about 40 column shaped epithelial cells bundled together along their long axes. Taste cells within a bud are arranged such that their tips form a small taste

pore. Minute, hair-like threads called microvilli extend through this pore from the actual taste cells. The microvilli of the taste cells bear the actual taste receptors, and it appears that most taste buds contain cells that bear receptors for two or three of the basic tastes.

There are four tastes we normally associate with taste buds: sweet, salty, sour, and bitter. However, research has identified a fifth taste our buds can identify. The fifth taste is umami, the taste of monosodium glutamate (no kidding), and has recently been recognized as a unique taste, as it cannot be elicited by any combination of the other four taste types. Glutamate is present in a variety of protein-rich foods, and particularly abundant in aged cheese.

Unless artificially disrupted, our sense of taste will guide us to the foods necessary for our survival. And, in fact, our taste preferences change according to our body's needs. Just ask the husband of any pregnant woman. Or more scientifically:

- Removal of the adrenal glands without replacement of mineralocorticoids leads rapidly to death due to massive loss of sodium from the body. Adrenalectomized animals (animals whose adrenal glands have been surgically removed) show a clear preference for salty water over pure water, and if provided with salt water, can actually survive.
- If the parathyroid glands are removed, animals lose calcium and cannot maintain blood calcium levels appropriately due to deficiency in parathyroid hormone. Following parathyroidectomy (removal of the parathyroid glands), animals choose drinking water that contains calcium chloride over pure water or water containing equivalent concentrations of sodium chloride.
- Injection of excessive doses of insulin results in hypoglycemia (low blood sugar). Following such treatment, animals will preferentially pick out and consume the sweetest among a group of foods.

Now, there are three tastes I want to focus on.

**Sweet**

The sweet taste was designed to cause us to desire natural carbohydrates essential for our survival. Our teeth match those of the frugivores, largely fruit eaters. However, technology has allowed food manufacturers to exploit our desire for sweet things -- to our detriment. For the most part, concentrated sugars, other than honey, are not naturally available for us to consume. Table sugar is a manufactured creation, as is maple syrup, agave syrup, not to mention high fructose corn syrup, glucose, dextrose and all of the other concentrated sweeteners added to our food. If living in nature, our desire for sweets would lead us to low concentrations of sugar bound to fiber, not 32 oz Big Gulp sodas containing almost a cup of concentrated sugar. The bottom line is that these concentrated sweeteners feed an addiction because, based on evolution, our taste buds never expected to find concentrated sweeteners -- only natural foods, with a far less concentrated character. And to make matters even worse, the more concentrated sweeteners we eat, the more we crave.

**Umami**

A similar situation exists with umami, also known as "savory." In nature, this taste is never

concentrated, and exists only in very small amounts in selected foods. Concentrating it as a food additive, confuses the system and allows us to consume glutamate in far higher levels than our bodies were ever designed to handle -- with highly disruptive health effects for sensitive people.

**Bitter**
And then there's bitter! Bitterness is the most sensitive of the five tastes. It has been suggested that the evolutionary purpose of "bitter" is to warn us against ingesting toxic substances, many of which have a bitter character. Unfortunately, this association between bitter and unhealthy is not entirely true, and our current culinary desire to avoid bitter tastes causes us to miss the health benefits associated with many bitters. Common bitter foods and beverages include coffee, unsweetened chocolate, bitter melon, beer, bitters, olives, citrus peel. But how many people eat them in their unadulterated form any more. Bitters are almost always masked by added sugar. In any case, whereas at one time people regularly consumed bitters as part of their diet, we pretty much completely avoid them now. When's the last time you saw a fast food or soda pop based on bitter?

This has major health consequences for your liver. The body has a number of built-in feedback loops, a number of which we'll cover as we move through the digestive system, such as the triggers that both stimulate and shut off the production of stomach acid. But the simple fact is that the taste of bitter in the mouth is stimulating to the liver. There is a direct feedback loop from the tongue to the liver. Every time you taste something bitter, your liver gets a positive jolt that stimulates it to put out more essential bio-chemicals and expel accumulated toxic waste. If you never taste any bitter, your liver tends to become sluggish over time and retain toxic build-up. This is one of the key reasons that the Liver Tincture and Blood Support™ formulas I use during detoxing have such a pronounced bitter taste. In fact, all of the great liver herbs, milk thistle, dandelion root, and Picrorhiza Kurrooa are decidedly bitter.

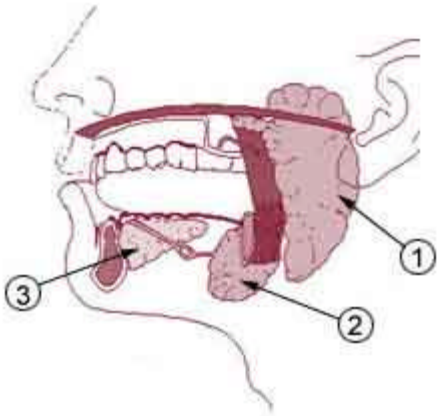
### *Nose/Smell*

Although not usually considered, anatomically, as part of the digestive system, the nose really does qualify. After all, up to 75% of what we perceive as taste is due to smell. And the mere smell of certain foods can stimulate hunger and the production of digestive juices. Thus, simple nasal maintenance, such as daily nasal cleansing, is an important part of good intestinal health -- not to mention the fact that it washes out vast quantities of bacteria and viruses, thus preventing them from entering the digestive tract. Incidentally, the primary role of the uvula, the fleshy piece that hangs from the back of the throat, is to detect food that passes over it, and rise up during swallowing to close off the nose from the food so it can't back up into the nose.

### *Salivary glands*

There are three pairs of salivary glands that secrete saliva, the first of the digestive juices to contact the food in the mouth. They are:

1. The parotid glands, which are located high up in each cheek, just below the ears. Incidentally, these are the glands that get infected and swell up when you have the mumps.
2. The submandibular glands, which are located in the floor of the mouth just below the parotid glands.
3. And the sublingual glands, which are located on the floor of the mouth, upfront.




Saliva performs several key functions. It moistens the mucous membrane, moistens food for easy swallowing, lubricates the esophagus for swallowing, washes the mouth, kills bacteria, dilutes poisonous substances, and contains enzymes that begin the digestion process. Your body produces from 1-1.5 liters of saliva per day (about a quart). More than 99% of that saliva is water, and almost all of it is reabsorbed in the digestive tract. The tiny bit of saliva that is not water contains about 0.05% enzymes:

- Lysozyme kills bacteria in the mouth. Incidentally, your mouth is remarkably dirty and infested with bacteria -- some good, but most not so much. It is really true that the mouth of a dog that drinks from the toilet is cleaner than yours. And if you must be bitten, better to be bitten by a dog than a person.
- Lingual lipase breaks triglycerides down into far healthier and more easily digested fatty acids and monoglycerides.
- And then there's salivary amylase

### *Salivary amylase begins the breakdown of carbohydrates*

Your digestive system is remarkably adaptable; after all, it can handle pepperoni pizza, beer, and Ding Dongs. But there are consequences if you abuse it. There are two forms of abuse. First, there's eating a diet high in cooked and processed food that has destroyed all of the enzymes naturally present in the food. In this particular case, we're talking about amylase. All natural carbohydrates contain the amylase needed to digest them. In fact, the amylase found in wheat and other grains will actually work in the stomach at high acid pH levels of 3 to 4. If natural amylase is present, it will handle a great deal of the digestive process required to break down the carbohydrates you eat. Second, you need to chew your food thoroughly. If you chew your food well enough, it slows down the entire eating process, which spreads out the glycemic response. It also allows the amylase in the saliva to effectively start breaking down the carbohydrates, which takes a huge burden off your pancreas. And it allows time for your stomach to signal your brain that you're full (it normally takes twenty minutes for your brain to catch up with your stomach), so you end up eating less.

So, how much do you need to chew your food? There's an old saying: "You should drink your solids and chew your liquids." What that means is that you should chew the dry food you eat until it turns to liquid in your mouth (about forty chews per mouthful), and that you should swish

liquids back and forth in your mouth (chew them as it were) an equal number of times. This helps mix enzymes into the food or liquid and begins the digestive process.

The more you chew, the more effective these enzymes are.

And if you don't do these things, how much does the body have to compensate? Amylase levels in the saliva of people eating the typical western cooked/processed diet are as much as 40 times higher than that found in people eating a more natural diet!

Note: During dehydration, the brain signals the mouth to stop the flow of saliva to impel us to drink more water and to conserve fluids.

## Swallowing (deglutition)

Once you start chewing your food and mixing it with saliva, it picks up a technical name; the wad of chewed food is called a bolus. During the voluntary stage of swallowing, the tongue moves the bolus of food upward and backward. Once the bolus reaches the back of the throat, all actions become involuntary -- they happen outside of your conscious control. During the first of these involuntary phases, the muscles move the food down and back into the esophagus. And finally, the food is actively moved through the esophagus to the stomach. By actively, I'm referring to the fact that movement through the esophagus is the result of series of active, coordinated movements by constrictor muscles lining the esophagus -- not the result of gravity. Specifically, longitudinal muscles pull the esophagus up and relax lower portions so that the circular bands of muscle lining the esophagus can constrict and move the bolus down into the stomach. In fact, although it is not advisable, you can easily swallow when hanging upside down. As we discussed in our series on breathing, aspiration (entry of food or water) into the lungs and nasopharynx is prevented in a series of involuntary actions.

- The uvula and soft palate move upward to close off the nasopharynx.
- The larynx is pulled forward and upward under the protection of the tongue.
- The epiglottis moves back and down to close the opening of the trachea and airway.
- Food slides over the epiglottis into the esophagus.
- Vocal cords close to further block the airway.
- Breathing ceases for about 2 seconds while this process takes place, then resumes.

## Esophagus ("carries food")

Although there are a number of things that can go wrong with the esophagus, they are mostly medical and fall outside the scope of our discussion. For our purposes, the only function of the esophagus is to carry food from the mouth to the stomach. No digestion or absorption of nutrients takes place in the esophagus. Liquids pass through quickly -- in about a second. A food bolus, on the other hand will take about five to nine seconds to make its way through the esophagus.

In fact, there is little to interest us from an alternative health point of view until we reach the lower esophageal sphincter, which is located at the end of the esophagus just above the

diaphragm. The sphincter is not actually an anatomical structure. It's just an area at the end of the esophagus that is capable of constricting to effectively separate the stomach from the esophagus. When functioning properly, it allows food to enter the stomach while at the same time preventing stomach acids and bile from refluxing back into the esophagus.

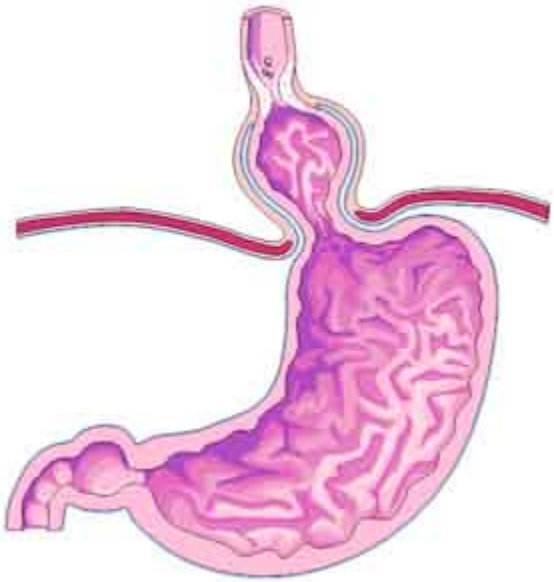
From a medical point of view, there are a number of things that can go wrong with the lower esophageal sphincter, such as achalasia (inability to relax), which prevents food from entering the stomach. But for the purposes of our discussion, two conditions stand out: GERD and hiatal hernia. These conditions used to be handled surgically, but with rather poor results. Antacids provided temporary relief, but as we will learn when we discuss the stomach, actually aggravated the problems. Now, new drugs called proton pump inhibitors are the treatment of choice. They work by cutting the ability of the body to produce stomach acid and are more effective, from a medical point of view, than either surgery or antacids.

## GERD

GERD (Gastro esophageal reflux disease) is also known as acid reflux disease. It is a condition in which the sphincter fails to prevent acid from backing up into the esophagus. This causes inflammation, scarring, and can lead to esophageal cancer. We will talk more about GERD when we talk about acid production in the stomach, which is the primary contributing factor in this disease. We will also discuss why Prilosec, Prevacid, and Nexium may not be the best answers to this problem. One other note on acid reflux at this time is that hiatal hernia is often a contributing factor.

## Hiatal hernia

Hiatal hernia is a condition in which part of the stomach moves above the diaphragm, into the chest. They are much more common than generally recognized and can produce a wide variety of symptoms that make diagnosis difficult. Hiatal hernias can manifest as severe chest pains that mimic a heart attack, pressure in the chest, or severe stomach pain. And most notably, as mentioned above, a hiatal hernia can significantly aggravate acid reflux as it pushes the esophageal sphincter out of position, thereby seriously compromising its ability to prevent stomach acid from moving into the esophagus.



There are very few medical options for treating a hiatal hernia. As I mentioned earlier, surgical intervention is only marginally effective. The common medical approach today is to reduce the amount of acid the stomach produces with proton pump inhibitor drugs. But the use of these drugs is even more questionable for a hiatal hernia than for standard

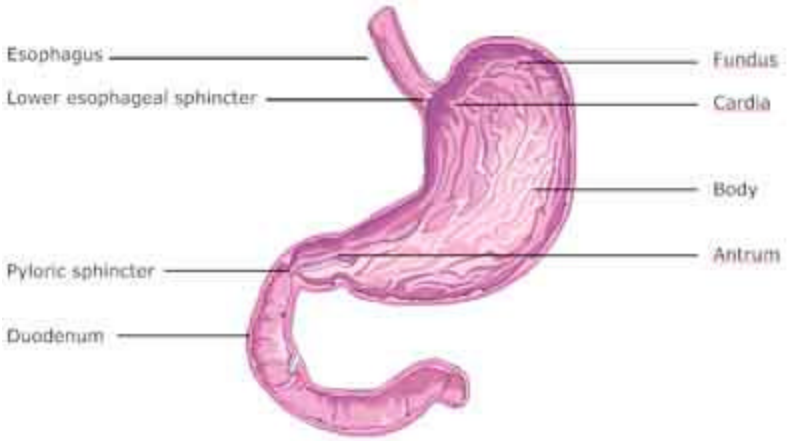
GERD as it does nothing at all to alleviate the underlying condition -- the fact that part of your stomach is now up in your chest cavity. It merely helps control one symptom.
Fortunately, there are alternatives.

- Self massage
- Chiropractic adjustment
- Then, once you've corrected the initial hiatal hernia you might want to do some yoga exercises to strengthen your diaphragm so that your stomach won't slip back up through the opening again. For example:
    - Kapalabhati
    - Uddyiana Bandha

## Your Stomach

**The divisions of the stomach**

Anatomically, the stomach is not so much a separate organ as it is an enlargement (like the esophagus) of the intestinal tract that sits just below the diaphragm. In fact, the only thing that separates it from the rest of the GI tract are areas at its top and bottom that use muscles to constrict and close it off from the esophagus and the duodenum on either end respectively. Its functions are very simple: to grind, mix, digest, and parcel out its contents to the intestinal tract in a slow, controlled manner.




Although it is a single cavity (again, just part of the GI tract), it has four main "functional" divisions. Physiologically speaking, they are:

- The **cardia**, which is a small space at the very entrance to the stomach that sits just under the diaphragm and the heart. In fact, the cardia is named for its proximity to the heart. It is the landing area for the bolus (clump of chewed food) that you swallow and

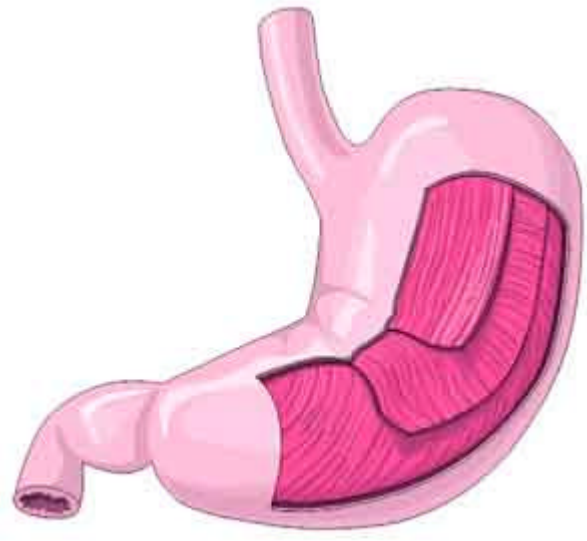
that drops down from the esophagus. Note: once the stomach starts working on the bolus, grinding it down and mixing it with enzymes and acids, it acquires a new name. This semi-digested glop (a non-medical term) is called chyme. You would be familiar with chyme if you've ever vomited.

- The **fundus**, which is the main upper portion of the stomach. Fundus means "enlargement" and refers to the rounded enlarged area at the top of the stomach. Food gets ground, mixed, and held in the fundus. It is in the fundus that enzymatic digestion takes place, assuming there are live enzymes present with your meals (or if you are using digestive enzyme supplements). Although stomach acid will be released into the fundus, it is only at about 30% concentration and will not affect enzymatic digestion. After about 40-60 minutes in the fundus, the chyme will move on into the body of the stomach.
- The **body**, which is the large middle section of the stomach. It is a primary area of digestion, and it is here that hydrochloric acid and pepsin begin to work full bore, and **at levels sufficient to stop most enzymatic digestion**.
- The **antrum**, which is the last part of the stomach before the pylorus, the gate which prevents food from entering the intestine before its time. Actually, the major portion of digestion takes place in the antrum as food is held a long time and parceled out to the duodenum in a very slow, methodical manner. Incidentally, antrum means cave and pylorus means gatekeeper.

The chyme moves through these divisions sequentially, rather than just dumping into one great cavity. This distinction is crucial to understanding the digestive process. Unfortunately, although medical doctors understand the sequential nature of digestion in the stomach, they do not fully understand what it means. And once again, that's because they base their assumptions on observation; and when it comes to observation, 99.9% of the people they see eat the typical highly processed, cooked food "modern" diet -- not the more natural diet our bodies were designed to handle. In other words, doctors' assumptions about digestion are based on observing people who eat badly, consume food totally devoid of live enzymes, and gulp their food down so quickly it barely has any time to mix with salivary enzymes. This gives a very distorted view of how the digestive process "should" work. And it has profound implications for our understanding of the digestive process and the things that can go wrong with it -- all of which, we will talk more about later.

For now, just understand that food moves through the divisions of the stomach sequentially. Among other things, this allows us to consume more than the intestines are ready for at one time. The divisions allow us to process the food slowly and prepare it for entry into the intestines in a controlled and measured manner.

**The layers of the stomach**



The outer covering of the stomach is called the serosa. Its primary purpose is to carry blood vessels and to protect the stomach. The stomach is supplied by an extremely rich supply of blood vessels. Just under the serosa are the layers of muscle -- longitudinal, circular, and oblique.

As you can see from the illustration to the right, these muscles allow the stomach to bend, twist, and fold in almost any direction. Combine all of that motion with the folds (rugae) in the interior of the stomach (as shown in our previous illustration of the stomach's divisions) and it's easy to see how the stomach can easily "grind" food down and totally mix it up with any digestive enzymes and juices that are present.

One final layer that we need to talk about is the thick, plush layer of mucosa cells that line the stomach cavity. It has deep clefts that increase the stomach's surface area considerably. There are four different types of mucosa cells.

- Epithelial cells cover the surface of the stomach and also line the gastric pits. Specifically, mucosal neck cells are the most numerous cells in the stomach. They function as glands and produce a thick glycoprotein (sugar and protein together) mucous that is greasy to the touch and coats everything it touches. It protects the stomach wall from autodigestion by keeping the stomach juices from actually touching any tissue and digesting the stomach (most of the time). Any defects in the glycoprotein covering will lead to erosions, ulcers, and even autodigestion of the stomach wall.
- Parietal cells produce stomach acid (HCL) and intrinsic factor, which helps absorb vitamin B-12. They are located only in the fundus and body of the stomach. Along with "chief cells," these cells lie in deep tubules; their secretions reach the surface through "gastric pits." (see illustration)
- Chief cells produce pepsinogen (the precursor to pepsin) and gastric lipase (a fat-digesting enzyme).
- And finally, there are the enteroendocrine cells (G-cells) located in the antrum that produce the hormone gastrin. Gastrin is secreted directly into the bloodstream and makes its way back to the fundus and body of the stomach to stimulate parietal cells to produce more hydrochloric acid. (Hormones are signalers.) The triggers for gastrin production are the physical distension of the antrum (as "too much" food presses its way in) and any rise in pH, which signals receptors in the antrum that the acid levels of the chyme have become too diluted.

**Digestion**

There are two main kinds of digestion processes in the stomach:

- Mechanical
- Chemical

Mechanical digestion is defined by the stomach's mixing of the chyme, whereas chemical digestion is defined by the action of various acids, hormones, and enzymes on the chyme.

**Mechanical digestion**

After the bolus drops into the cardia, it is pushed up into the fundus, where it is held for upwards of 40-60 minutes with minimal stomach acid being produced -- about 30% of full levels and not enough to render digestive enzymes inactive. It is while in the fundus that enzymatic digestion (from live enzymes present in the food, salivary enzymes introduced while chewing, or supplemental digestive enzymes taken with your meal) takes place. Up to 75% of digestion can take place during this phase -- or none at all if there are no enzymes present. Since any sustained heat of approximately 118-129 degrees F destroys virtually all enzymes, it's easy to see why the modern diet is pretty much devoid of live enzymes. Add to this the fact that the vast majority of people don't really chew their food but, rather, gulp it down -- thus missing out on salivary enzymes as well -- and you have the very real potential for zero enzymatic digestion taking place in the fundus.

Once again, enzymatic digestion is almost never accounted for in medical texts because doctors rarely see it. Again, ninety-nine percent of their patients eat cooked/processed food that is devoid of digestive enzymes and chew their food minimally so there is very little salivary action on the food. In any case, when doctors look at the cardia and fundus, they primarily see holding areas where virtually no enzymatic digestion takes place.

One nod the medical texts do give to the fundus is that it's where ghrelin is manufactured. Ghrelin is a hormone produced mainly by the P/D1 cells lining the fundus. The key role ghrelin plays is that it stimulates hunger. It is considered the counterpart of the hormone leptin, produced by fatty tissue, which induces satiation when present at higher levels.

In any case, at the end of "fundal" cycle, whether any enzymatic digestion has taken place or not, the chyme is moved down into the body of the stomach, where stomach acid is introduced at full levels, thus neutralizing all enzyme activity. Very little mixing takes place in the cardia or the fundus (again, these areas are reserved primarily for enzymatic digestion) but commences full force once the chyme is in the body of the stomach. In fact, waves of peristalsis (muscle contractions) grind and mix the food once in the body. This action is aided by the rugae, or folds, in the interior of the stomach, which force the chyme to roll over and churn as the muscular contractions squeeze the chyme over the folds.

After a period of intense mixing and digestion, the chyme moves from the body of the stomach into the antrum, where it is held up. The body knows that the duodenum is very small. Therefore,

only a small amount of chyme is allowed into the duodenum at any given time; the rest remains in the antrum for additional mixing and grinding and additional chemical digestion. In fact, the major chemical processes take place, not in the body of the stomach, but in the antrum while chyme is waiting its turn to pass through the pyloric valve.

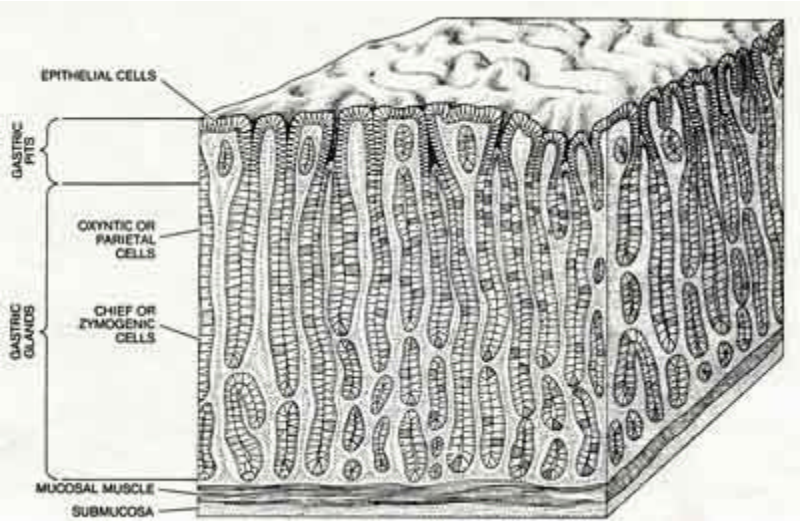
And with that stated, now let us take a closer look at these chemical processes.

**Chemical digestion**

When we refer to chemical digestion, we're talking about the action of hydrochloric acid and pepsin (or parietal cells and chief cells) on the chyme. At its most basic level, chemical digestion is about taking big molecules and breaking them down into smaller molecules. Note: enteroendocrine cells are also active in the stomach, but (as we will discuss later) they play a regulatory role, rather than a digestive role. Let us now look at the different cells in the stomach that play the major roles in chemical digestion.

**Parietal cells**

There are some parietal cells in the fundus, but most are in the body of the stomach and the antrum. The parietal cells are extremely important as they secrete hydrochloric acid (HCL) in very high concentrations.




HCL performs the following functions.

- It denatures (unfolds) proteins so that they can actually be broken down by pepsin during digestion. Without being unfolded, they resist digestion. Understand, proteins are chains of amino acids that are folded in on themselves -- and can only function when they are geometrically correct in these folds. Denaturing means they are made inactive in the physiological sense by breaking the bonds that hold their geometric shape and allowing the proteins to unfold into long chains -- which can then be broken apart into component amino acids. It should be noted that denaturing proteins can have two

entirely different effects depending on how complete the denaturing is; and if not complete, what variation of the protein is left. A major factor in determining that outcome is how the denaturing is accomplished (heat VS acid) and on which protein it is effected (e.g., meat VS dairy).

  - As a rule of thumb, acid denaturing as takes place in the stomach is beneficial and assists in the digestion of the protein.
  - Denaturing as caused by heat applied to food before digestion takes place can often produce versions of a particular protein that are highly indigestible and highly allergenic. This is the primary reason that pasteurized dairy is so much more allergenic than raw dairy.

- HCL kills many micro-organisms, such as the ones that travel into the digestive tract from the human mouth or come breeding in the food itself -- as with contaminated meat or produce. (Note: the human mouth is so dirty, you'd rather be bitten by a dog than another person.)
- HCL stimulates the flow of hormones, bile juices, and pancreatic juices in preparation for release into the small intestine. In other words, it is a key trigger for all aspects of the digestive process. Note: this is where live food makes a difference. The more enzymatic digestion that takes place before this point, the less HCL is required to finish the process. The less HCL produced, the less pancreatic juices are signaled for -- thus sparing the pancreas a great deal of work.
- HCL inhibits the activity of the hormone gastrin in a negative feedback loop. We will talk more later about how gastrin is released into the bloodstream and stimulates the flow of HCL. But, for now, as HCL builds up, the increase in HCL signals that less gastrin be produced -- thus leading to the lessening and stopping of HCL production. This makes perfect sense as it's a simple way for the body to prevent over production of stomach acid. Unfortunately, this loop is easily disrupted. This fact will become particularly important when we talk about antacids such as Tums and proton pump inhibitors such as Prilosec, Prevacid, and Nexium a little later.
- And finally, when the chyme passes into the duodenum, the HCL stimulates the release of secretin (which regulates pH in the intestinal tract) and cholecystokinin (CCK), which regulates the flow of bile and pancreatic enzymes and prepares the small intestine for the chyme headed its way. And here again we can see a primary problem with not having sufficient enzymatic digestion take place higher up in the stomach. The less digestion that takes place in the cardia and fundus, the more acid will be required to make up the difference in the body of the stomach and the antrum. The higher the levels of HCL in the chyme that passes into the duodenum, the higher the levels of CCK that will be called forth. And the higher the levels of CCK called forth, the more pancreatic enzymes your body will be forced to produce in anticipation of what's coming down the chute and the more bile your liver will have to produce to compensate. This is the reason virtually everyone consuming a modern diet has an enlarged pancreas by the time they are 40. In fact, it is so common that an asymptomatic enlarged pancreas is now considered "normal" as people age. Normal???

### *Chief cells*

Pepsinogen is secreted by the chief cells. By itself, pepsinogen is inactive and will digest nothing until it is converted into pepsin when it comes in contact with the hydrochloric acid in the stomach. Pepsin is an extremely powerful protein digestive enzyme that thrives in a high acid environment. Pepsinogen converts to active pepsin only at low (high acid) pH. This is actually a remarkably elegant maneuver by your digestive system. Since pepsin literally digests protein, you don't want pepsin active in the mucosal/chief cells or it would digest them. Thus the mucosal cells release pepsinogen, pepsin's precursor -- which is converted into pepsin only after the pepsinogen has made its way out of the chief cells and into the stomach itself, where it is converted in the presence of stomach acid. Since the wall of the stomach is coated with a glycoprotein mucous, the pepsin can only digest your meal and not your stomach.

As we discussed already, stomach acid doesn't actually digest protein; it merely unfolds the proteins. That's where pepsin comes in. Pepsin is what actually breaks bonds between amino acids that make up proteins; thus, it is the pepsin that literally digests proteins. (Actually, it breaks them into "peptides," which are smaller chains of amino acids.) And once again, if your body is getting the benefit of full enzymatic digestion in the cardia and fundus, it will digest up to 75% of the proteins in your meal before HCL and pepsin ever come into play. This means that in proper digestion, HCL and pepsin should only be required to do clean up duty. But without enzymatic digestion, your body is required to increase HCL and pepsinogen production by some 400% to make up the difference. Once again, this is a major body stressor with profound long term consequences.

Pepsinogen serves one other key function in the stomach: it plays a significant role in moving chyme through the digestive tract. Or in "medicalese," it increases gastric motility. It accomplishes this in two ways. First, it is the arrival of pepsinogen that plays a key role in telling the esophageal sphincter to close down so that food and stomach acid can't back up into the esophagus. Pepsinogen then works at the other end of the stomach by telling the pyloric sphincter to open, thus allowing food to exit the stomach and make its way into the duodenum.

The chief cells also secrete gastric lipase, which breaks triglycerides into fatty acids and monoglycerides. Unlike triglycerides, fatty acids and monoglycerides are usable by your body and do not promote heart disease. It should also be noted that because gastric lipase is active at a pH of 3-6, its role is somewhat limited until it enters the duodenum, where stomach acid is neutralized and pH is raised. Another note is that although salivary lipase and gastric lipase are overshadowed by the later action of pancreatic lipase in the intestinal tract, if allowed to do their job, the action of salivary and gastric lipase can significantly reduce the burden of pancreatic lipase in the intestinal tract. Once again, we pay a price for our modern diets -- unless we supplement with digestive enzymes.

### *Enteroendocrine cells*

Enteroendocrine cells, which are also known as G-cells, are located primarily in the antrum and release gastrin which stimulates the production of both HCL and pepsinogen in the antrum and higher up in the body of the stomach. It is able to signal higher up in the stomach because the

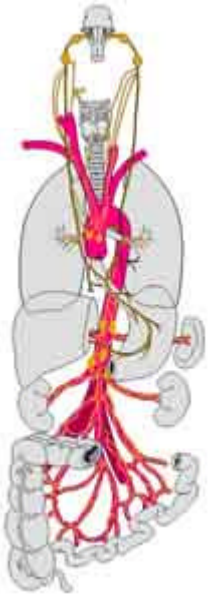
gastrin is released into the bloodstream and circulates around until it can enter the blood vessels that feed the stomach all the way from the esophageal sphincter to the pyloric valve. In addition to promoting digestive juices, gastrin causes the lower esophageal sphincter to relax; thus, high levels of gastrin are thought to play a role in the development of acid reflux disease since they cause the valve to relax too much and at inappropriate times. This will become significant when we talk about using antacids and proton pump inhibitors since by dramatically lowering HCL levels during digestion they cause a concomitant jump in gastrin levels in an attempt to ramp HCL levels back up. The net effect is a much "looser" esophageal valve thus allowing chyme to back up into the esophagus more easily. Taking this into consideration, high levels of gastrin may play a significant role in the development of acid reflux disease.

It probably should be mentioned that G-cells produce these higher levels of gastrin in response to antacids and proton inhibitors by proliferating wildly so that there are more of them to produce gastrin. So once again, artificially forcing symptoms back in line with pharmaceutical drugs has consequences. Although, to be fair, there is no evidence yet that this proliferation of cells leads to a malignant transformation in patients using the drugs. Then again, is that a risk you want to take?

## Gastric secretion and the regulation of food moving through the stomach goes through <u>three phases</u>

The three phases of digestion (cephalic, gastric, and intestinal) are regulated by both neural, blood, and hormonal factors, and there is much overlap and redundancy.

### *Cephalic phase*



The first phase is called the cephalic or neural phase. This phase actually occurs before food even enters the stomach and involves preparation of the body for eating and digestion. In fact, forget food entering the stomach. It can be triggered by the mere smell of food, or for that matter, just the thought of food. Sight, smell, and thought stimulate your cerebral cortex. Just think for a moment how the smell of your favorite dinner can make your mouth water, or how just thinking of eating can make your stomach growl and gurgle. Once your brain has picked up on the taste and/or smell of food, the stimulus is sent to the hypothalamus and the medulla oblongata (the reptilian part of the brain located in the brain stem). From there, it runs down the vagus nerve, which connects to every major organ in the body (except the adrenal glands) and specifically controls the cephalic phase of digestion in the stomach. The word vagus has the same root as the word vagrant and means much the same thing in the body – wanderer. As you can see in the illustration on the right, the vagus nerve (in yellow) starts in the brain stem and runs down through your torso, playing a role in regulating everything from your heart and lungs to your stomach and intestines. In the stomach, the vagus nerve controls muscular contraction, telling the stomach to “grind” harder. It also stimulates secretion of HCL and pepsinogen and stimulates mucous production to protect against autodigestion of your stomach wall. And finally, it stimulates the release of gastrin from the antrum, providing yet another signal for the stomach to

produce HCL. Gastric secretion during the cephalic phase rises to only 30% of maximum. Acidity in the stomach is not buffered by food at this point and thus acts to inhibit any further production of digestive juices.

As a side note, it is the vagus nerve that is triggered when we smell food or think about it (or hear a bell ring if you're one of Pavlov's dogs). It is that stimulus of the vagus nerve that starts us salivating in anticipation of food.

### *Gastric phase*

The second phase of stomach digestion/secretion is the gastric phase, which is both neural and humeral (humeral means things circulating in the blood). This phase is initiated by the presence of the bolus (the chewed up food when it is first swallowed) in the stomach. In fact, the gastric phase is activated by the stretching of the stomach wall as more and more food enters the stomach. Distention activates nerve reflexes in the stomach wall, which in turn activate the release of acetylcholine (a neurotransmitter) which stimulates the release of yet more gastric juices.

In addition, as protein enters the stomach, it binds to hydrogen ions, which raises the pH of the stomach from around pH 2.0-3.5 to pH 4.0 or higher. (Note: acids are defined by the number of H+ ions they hold in a solution. Thus, binding H+ ions makes a solution more alkaline.) As the pH climbs, inhibition of gastrin and HCL secretion is lifted. This triggers G cells to release more gastrin, which in turn stimulates parietal cells to secrete more HCL.

Everyone wants to know how strong stomach acid is. As released by the parietal cells in your stomach, stomach acid has a pH of about 0.8-1.0. Stunningly that's about the same strength as battery acid! However, as soon as it starts mixing with food, it will quickly rise to a pH of about 2.0-3.5 – a pH your stomach will try and maintain for proper digestion. As more and more food enters the stomach, however, it continues to dilute the acid in the stomach, thus causing the pH to rise. Chemoreceptors in the stomach detect the rise in pH and signal the brain to produce more acid. In addition, as described above, protein in particular enters the stomach and binds to hydrogen ions, thus neutralizing some of the acid and raising the pH of the stomach. This rising and falling of pH in the stomach continues throughout the gastric phase, which lasts about three to four hours.

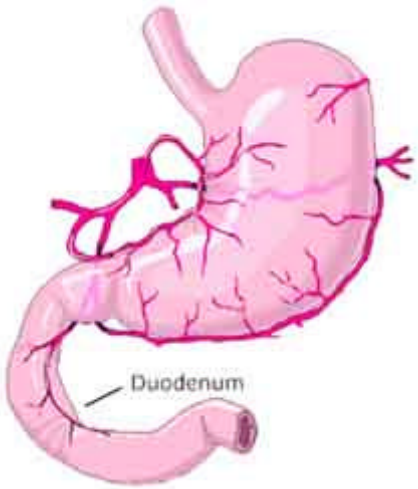
Once you understand the mechanisms of HCL production involved in the gastric phase, you can instantly understand the problem with using antacids such as Tums. Although they effectively can neutralize excess stomach acid short term, the very act of raising pH in the stomach while food is present tells the body to produce more acid to compensate. Thus, you get short term relief, followed immediately after by another round of excess stomach acid. On the other hand, moving chyme on through the stomach lessens the distension of the stomach, which signals that less acid is needed. In addition, eating live foods or using digestive enzymes with your meal allows for up to 75% of the meal to be digested by enzymatic action, cutting the time needed for gastric digestion by three-quarters – thus moving chyme through the stomach that much faster. This cuts stomach acid levels in two ways:

- Less acid is needed in the first place since the meal is 75% digested before acid levels reach 100%.
- Being largely pre-digested, food moves through the body and antrum of the stomach more quickly, thus cutting off the feedback loop calling for more acid.

Incidentally, the gastrin produced by the enteroendocrine cells in the antrum is not released directly into the stomach, where it would be unable to trigger HCL production in the body of the stomach because cells in the stomach wall are protected by a layer of mucous. Instead, it is released into the bloodstream, where it then circulates back to the blood vessels that feed the stomach, where it can then trigger the parietal cells in the body and antrum of the stomach. As stated earlier, gastrin circulating in the bloodstream also shuts the esophageal sphincter and opens the pylorus – leading into the duodenum and the small intestine. The total effect is to force a small amount of chyme across the pylorus into the duodenum. As one might imagine, this has implications for acid reflux disease, which we'll talk more about in our next newsletter.

### *Intestinal phase*

The intestinal phase refers to that part of digestion/secretion triggered when chyme reaches the duodenum. The high acid chyme triggers three events that affect the stomach.




1. First, the distension caused by the chyme entering the duodenum sends impulses to the brain that then sends signals down the vagus nerve telling the stomach to stop producing stomach acid.
2. Distension also causes direct nerve stimulation of the stomach telling it to stop producing gastric juices.
3. And finally, the distension and the high acid content of the chyme cause the pyloric sphincter to tighten – thus preventing any more food from entering the duodenum. In effect, the intestines slow down gastric digestion and emptying to give themselves more time to prepare for food. The more chyme that goes into the intestines, the more the intestines try to say, “Slow things down. I need more time.”

At this point, it's worth taking a look at some “numbers” involved here. The pyloric region of the stomach holds about 30 ml of chyme (about 1 oz). It allows only liquids and small particles of chyme, about 3 ml at a time, to pass through the valve with each peristaltic wave (when the valve is open). The contractions of the pylorus decrease the opening of the valve – as does the action of gastrin. This results in the majority of the chyme remaining in the stomach getting remixed again and again. Since the rate of peristaltic waves is a constant three per minute, that means the stomach only passes about one-third of an ounce of chyme into the duodenum per minute – again, when the pyloric valve is open. Thus it takes approximately three to four hours for an “average” meal to fully pass from the stomach. During that time, as each tiny wave of food enters the duodenum, the duodenum sends out its excitatory and inhibitory signals. Larger than average meals can take many hours longer to clear the stomach.

**Duodenum**

Although the duodenum is more anatomically aligned with the small intestine than the stomach, physiologically it is more oriented to digestion than absorption. Anatomically, the duodenum is defined as the first 12 inches of the small intestine. Very little absorption takes place in the duodenum -- mostly just transport and mixing. Its primary roles are to signal the stomach when to stop producing stomach acid, to regulate the flow of chyme into the intestinal tract, neutralize the hydrochloric acid in the chyme, and to start the digestive juices and insulin flowing from the pancreas and gallbladder. Also, as we discussed earlier, the duodenum releases three hormones when chyme (especially fatty acids and glucose) enter the duodenum. These are:

- GIP, the gastric inhibitory peptide hormone (GIP), was once thought to primarily inhibit gastric secretion (thus its name) and the movement of chyme through the system, which, in fact, it does at high enough levels. However, medical researchers now believe that the primary role of GIP is to trigger an increase in insulin secretion from the pancreas in preparation for handling the ingestion of high glycemic carbohydrates.
- Secretin targets the pancreas and causes it to secrete a bicarbonate-rich fluid that flows into the duodenum. Bicarbonate, of course, is highly alkaline and thus neutralizes the stomach acid in the chyme, establishing a more alkaline pH favorable to the action of digestive enzymes – both those temporarily rendered inactive by the HCL in the chyme and those produced by the pancreas and released into the intestines, which will soon begin finishing off the digestion of the chyme. And finally, secretin inhibits the release of gastrin, which thereby reduces acid secretion in the stomach.
- Cholecystokinin (CCK) inhibits gastric emptying, thus regulating the flow of chyme from the stomach into the duodenum. As we discussed earlier, CCK is released as partially digested food enters the duodenum. In addition to regulating flow, its other primary role is to trigger the pancreas and gallbladder to respectively release digestive enzymes and bile, thereby assisting in the digestion down the line of the proteins and fats entering the duodenum.

## Gastric emptying

Gastric emptying is promoted by the distension of the antrum, partially digested protein fragments (amino acids), and drugs such as alcohol and caffeine.

- All of the above tend to increase gastrin secretion and stimulation of the vagus nerve.
- All of the above tend to close the lower esophageal sphincter, open the pylorus, and increase gastric peristaltic contractions.

That's why having a cup of coffee in the morning or a drink before dinner stimulates hunger, because it causes the stomach to empty, decreases distension, which triggers hunger.

On the other hand, as we just discussed above, gastric emptying is inhibited by distension of the duodenum as food enters and by the presence fatty acids, glucose, and protein fragments in the duodenum. These are all triggers to slow the emptying of the stomach's contents. In addition,

increased secretion of CCK (cholecystokinin), secretin, and GIP (gastric inhibitory peptide (hormone) slow down gastric emptying.

As we discussed earlier, it takes about three to four hours for an average meal to completely empty from the stomach. However, that said, different types of food move through at different rates. Fatty foods remain in the stomach for the longest time; proteins remain an intermediate time; and carbohydrates remain for the shortest time. Although proponents of proper food combining would have a heart attack to hear this, combining all three elements (proteins, fats, and carbohydrates) at a meal provides the longest lasting sense of satiety. Quick signals from carbohydrates tell the brain you're full, followed by protein signals, and finally by fat signals. All telling your brain that you're still working on the meal and that you're still satiated. Diets that concentrate on only one element do not prolong satiety.

That said, proper food combining addresses an entirely different issue. By combining proteins fats and carbohydrates in the proper manner and not mixing bad matches in any given meal, you optimize the digestive process for those particular foods. Now it is certainly true, as many medical experts have stated, that much nonsense has been spouted in the name of food combining. And it is also true that it does not produce the same levels of satiety as seen when mixing foods. However, proper food combining absolutely minimizes gas and intestinal distress and leaves you feeling more energized after eating.

On a related note, it should be mentioned that your stomach has the capacity to stretch significantly. In fact, not only can the stomach stretch quite a bit, but it tends to collapse quickly when stretched, causing hunger to return quite soon after a large meal. How far can it stretch? After a Thanksgiving dinner, it can stretch almost down to your pelvis. Then it empties and you feel hungry again.

Grazing on the other hand does not overstretch the stomach, and keeps some food in there most of the day, which means you are constantly sending satiety signals to the brain. In other words, 6 small snack/meals will keep you feeling more satiated than 3 large meals – or any large meals, for that matter.

## Your Stomach, Part 3

Things that can go wrong with your stomach. Amusingly, the common stomach ache is not one of them. When most people complain of a stomach ache, they put their hands over their transverse colons -- the source of the problem -- and an area we will cover in great detail later in our series on the digestive system. But for now, our focus will be on stomach/duodenal specific problems. These include:

- Peptic ulcers
- Acid reflux
    - Mineral absorption
    - B12 absorption

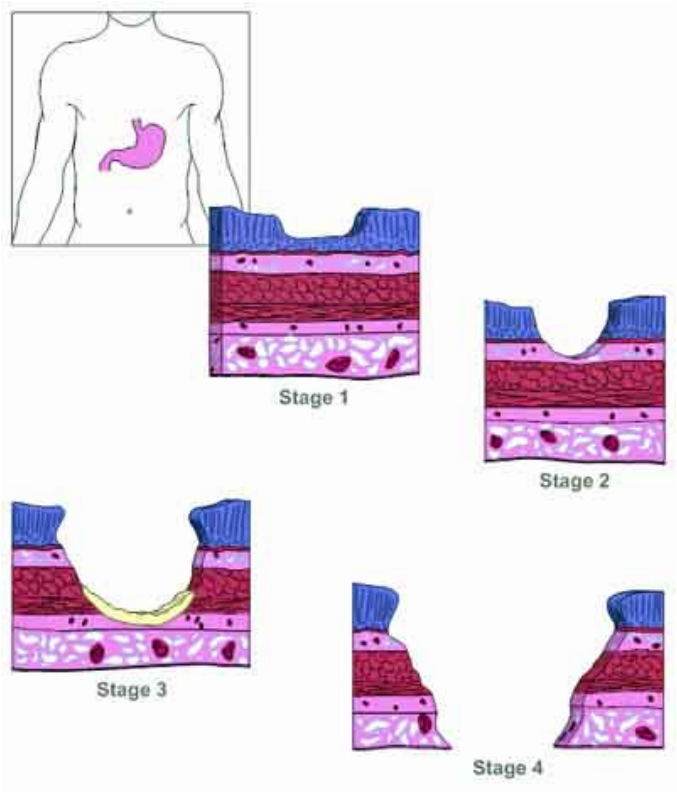
    - Incomplete digestion
- Satiety and weight gain
- Hiatal hernias would also be an issue, but we covered those two issues ago)

So, without further ado…

## Peptic ulcers

Most people do not understand ulcers. They think they are either caused by too much stomach acid (not true) or caused by the bacteria H. pylori (only partially true). They also think most ulcers occur in the stomach (gastric ulcers), which again is not true. In fact, about 60% of all peptic ulcers occur in the duodenum, where stomach acid is actually neutralized shortly after making its appearance -- which surprisingly contributes to the problem.

Quite simply, a peptic ulcer is **any ulceration in acid-exposed areas in the duodenum or stomach**. Stomach acid itself is not the culprit here. After all, strong stomach acid is a normal part of digestion. In fact the key to understanding peptic ulcers lies in two words found in the definition above: "**acid-exposed**." The bottom line is that peptic ulcers occur when the mucous that lines every square inch of the stomach and duodenum and that protects them from the corrosive effects of stomach acid is somehow worn away from an area of tissue -- exposing that tissue to the burning effects of the acid. Peptic ulcers, then, are caused not by stomach acid, but by damage to the body's protective mucosal lining.




This can have several causes:

Helicobacter pylori (H. pylori) is considered the primary culprit. Although somewhat resistant to stomach acid, H. pylori bacteria cannot really withstand a full onslaught of undiluted acid. Therefore, it lives under the mucosal layer lining the stomach, but does not actually invade it. It thus protects itself from the gastric juices, which can destroy it. H. pylori further protects itself by secreting urease, an enzyme that breaks down urea into ammonia and carbon dioxide; the ammonia in turn neutralizes stomach acid. This helps it survive short bursts of exposure to less than full strength stomach acid as it makes its way through the stomach and on into the duodenum. As the organism thrives and expands its colony under the mucosal lining, it causes the lining to inflame. This causes a thinning and breakdown of the mucous layer that protects the lining. The lining of the duodenum or stomach is now exposed to acid and pepsin, and ulcers may develop.

So again, stomach acid does not directly cause the stomach ulcer, and -- here's an important point -- can actually kill the bacteria if it is strong enough and is present before the bacteria can establish itself under the mucosa. If stomach acid is diminished for any reason (such as regular use of proton pump inhibitors, excessive use of antacids, or regular consumption of large amounts of liquids with meals), this can allow the bacteria the opportunity to survive long enough to establish itself in the mucosal lining protected from stomach acid. This can lead to a very interesting paradox.

Currently, proton pump inhibitor drugs are your physician's primary option for treating ulcers (along with antibiotics to kill the H. pylori) since they prevent your stomach from producing the stomach acid that is eating away at the exposed tissue. But without sufficient stomach acid, the bacteria can resist lower levels of stomach acid. That's why the standard medical treatment for H. pylori requires antibiotics to kill the bacteria. The problem with this form of treatment, however, is that it may actually make the condition worse. What a quandary! In addition, when discussing H. pylori, it should be mentioned that only a small minority of people (5-10%) who have *H. pylori* in their system ever develop a peptic ulcer. Not just a quandary -- but a paradox too!

The other two primary causes of peptic ulcers are non-steroidal inflammatory drugs (NSAIDS) and "social" drugs such as nicotine from smoking, alcohol, and caffeine. Many NSAIDS (especially aspirin) and corticosteroids irritate the stomach lining and can also cause ulcers. As for smoking, people who smoke are more likely to develop a peptic ulcer than people who do not smoke, and their ulcers heal more slowly. As for spicy foods and being stressed, they can make your ulcer "feel" worse, but there is no established link between them and the actual formation of peptic ulcers.

### *An alternative approach to ulcers*

Supplemental digestive enzymes help digest so much of your meal during the 40-60 minutes of pre-digestion that your body requires a less sustained release of acid in the actual digestion phase. (Note: the strength of the stomach acid released is undiminished, only the time of exposure is reduced.) This means that taking digestive enzymes will lessen the amount of time that your stomach and duodenum are exposed to acid -- but without raising pH when the acid is actually present. Those who suffer from chronic low levels of acid need not worry. Digestive enzyme supplements help here too by breaking down so much food in the pre-digestion phase

that less acid is actually required overall. And over time, decreased demand results in increased reserve capability.

In addition, protease released with the stomach acid or present in the supplemental enzymes will begin breaking down the protective coating of the H. pylori bacteria. In other words, the protease will actually begin to digest the bacteria, rendering it vulnerable to stomach acid. However, for those with a severe existing ulcer, the protease may begin to digest damaged mucosal tissue because its protective coating is missing. This can cause noticeable discomfort for several days. To avoid this, when using digestive enzyme supplements, start with very small amounts of the supplement with your meals and build up slowly.

And then there's mastic!

Mastic, which is widely used in Mediterranean cooking as a sweetening agent, offers a couple of interesting health benefits. First, studies now indicate that in addition to having direct antimicrobial activity, mastic renders H. pylori vulnerable to your body's immune system. Mastic also enhances your body's ability to regenerate the epithelial cells of your gastrointestinal lining. The net result is that mastic can help prevent and relieve a number of digestive disorders, including heartburn, gas, bloating, dyspepsia, nausea, and of course, peptic ulcers.

## Acid reflux

Acid reflux disease, also known as Gastroesophageal reflux disease or GERD, is defined as chronic symptoms or mucosal damage produced by the abnormal reflux of food and digestive juices (chyme) back up into the esophagus. This is commonly due to malfunctions in the lower esophageal sphincter that is supposed to prevent reflux from the stomach, back up into the esophagus -- and to loss of control of acid production during the digestive process. Surprisingly, most treatments deal only with the second factor, not the first.

Before we can actually cover the causes of acid reflux and what you can do about it, we need to quickly review the phases of acid release, the regulating mechanisms that govern its release, and the triggers your body uses to signal for increased production of stomach acid. Understanding these triggers becomes the key to managing them and also exposes the flaws in the basic medical approach.

As we discussed earlier, there are three phases of stomach acid release. To quickly review:

### *Cephalic phase*

Thirty percent of stomach acid is released by the anticipation of eating and the smell or taste of food. This is known as the cephalic phase, and as we will discuss in a bit, this is both governed and triggered by the vagus nerve. The vagus nerve starts in the medulla oblongata of the brain, runs down through the neck and then connects to virtually every organ in the body except the

adrenal glands. As such it plays a major role in the digestive process -- both sensing what's happening in the stomach and signaling the stomach to prepare for the ingestion of food.

### *Gastric phase*

Sixty percent of all stomach acid is released during the second phase of digestion, the gastric phase. This phase is triggered by the distention of the stomach -- primarily the lower part of the stomach (the antrum) as chyme (the mixture of food and digestive juices) makes its way through the digestive process -- and by the presence of proteins in the stomach. It is also triggered by a sudden rise in pH as stomach acid is diluted and if there is too little calcium in the blood. These four triggers cause gastrin, the primary regulator of stomach acid production, to be released. As we discussed earlier, gastrin is released into the bloodstream by the G cells located in the antrum of the stomach. Once in the bloodstream, gastrin circulates around body -- ultimately reaching the cells of the stomach wall via the rich blood network that supports the stomach and bathes all of the cells in the stomach wall. Once there, gastrin works by stimulating the pariatel cells and the gastric chief cells to produce stomach acid and pepsinogen respectively as needed for digestion. **In addition, gastrin causes the lower esophageal sphincter to constrict, thus inhibiting the backup of chyme and stomach acid into the esophagus**. Disrupting this signaling mechanism causes the sphincter to relax, thus making it more prone to reflux.

Since these triggers for the release of stomach acid are so important, let's review them in a little more detail.

- The first trigger is the anticipation of food -- triggered either by the smell, sight, or imagining of food. This releases about 5-10% of the acid your stomach will produce for digestion. At this point, the esophageal sphincter is somewhat relaxed to allow food to more easily enter the stomach upon swallowing. However, since the acid content is so low and there is no food pressing up against the sphincter, this is not usually a problem phase when it comes to acid reflux.
- The next trigger is the distension of the stomach in the fundus and the main body of the stomach that happens when you eat your meal and food enters the stomach. As might be expected, the larger the meal, the greater the distension, and the stronger the signal telling the stomach to produce stomach acid. Two things are important to understand about this trigger. First, this is a weak trigger and is responsible for only about 5-20% of the acid your stomach produces. (In fact, only in abnormal circumstances does the total acidity in the stomach caused by the first two triggers combined climb much above 30% to 50% maximum. And second, as food passes out of the stomach and the distension lessens, the trigger also abates. An important point concerning acid reflux is that **if you overeat, thus significantly stretching the stomach, you create huge backpressure on the esophageal sphincter -- in effect, forcing food back up into the esophagus. The more you overeat, the greater the tendency to have acid reflux.**
- Low acidity (high pH) while chyme is present in the stomach is the primary trigger for acid production in the stomach. In other words, if your body senses the presence of food that needs to be digested in the stomach and your stomach's gastric mucosal chemoreceptors show too little acid to digest it, that will trigger the production of more

stomach acid. Another way of looking at it is that **the more you eat or drink (thus diluting your stomach juices), the higher the pH will climb and the more acid your stomach will be triggered to produce in order to lower that pH.**

- Protein in particular is a trigger for acid production. As protein enters the stomach, it binds to hydrogen ions, thus neutralizing some of the acid and raising the pH of the stomach. As the pH rises, it lifts the inhibition of gastrin and HCl secretion. This triggers G cells to release gastrin, which in turn stimulates parietal cells to secrete more HCl. **Low acidity in the stomach, whether the result of straight dilution or protein neutralization accounts for upwards of 60% of all stomach acid produced during digestion.**
- Too little calcium in the blood (a condition called hypocalcemia) can trigger the production of additional stomach acid, beyond that required for ordinary digestion. It can certainly be caused by medical conditions such as deficient or ineffective parathyroid hormone (PTH). For our purposes, we are more concerned about the diet and lifestyle choices you make that might cause the condition and lead to the production of too much stomach acid. These include:
    - Too much magnesium in the diet or through supplementation.
    - Too little calcium in the diet.
    - Too little vitamin D in the diet and/or too little exposure to sunlight. Vitamin D is required for calcium utilization by the body.
    - Excessive use of magnesium based laxatives.
    - The body going too alkaline, a condition called alkalosis. This can easily happen when people become obsessive about raising their body pH such as by drinking too much high pH water. The body hates extremes, and it's possible to become too alkaline, which can lead to hypocalcemia and too much acid in the stomach.

### *Intestinal phase*

And finally, ten percent of stomach acid is released during the last phase of digestion, the intestinal phase. This is triggered when chyme begins leaving the stomach and causes distension of the duodenum. More importantly though, the presence of chyme in the duodenum starts triggering the inhibition of gastrin release -- and **ultimately** the inhibition of stomach acid production. This is regulated by the fact that the presence of chyme in the duodenum triggers the release of a number of hormones, including somatostatin, secretin, VIP, glucagon, calcitonin, and, of course, the appropriately named gastro inhibitory peptide.

## Solutions to excess stomach acid

So now that we know the mechanisms that regulate the production of stomach acid and the triggers that lead to excess production in the stomach, we should be able to look at the alternatives for alleviating the condition -- and what problems they might present.

### *Antacids*

As we discussed previously, once you understand the triggers involved in the production of stomach acid, you can instantly understand the problem with using antacids such as Tums and Rolaids. Although they effectively can neutralize excess stomach acid short term, the very act of raising pH in the stomach while food is present tells the body to produce more acid to compensate for the reduced acid levels. **Thus, although you may get short term release from antacids, it is likely to be followed by another round of excess stomach acid.**

### *Drinking water*

Drinking water to dilute excess stomach acid presents pretty much the same problem as using antacids. It will neutralize excess stomach acid short term, but **by raising pH while the stomach is still distended, it will merely trigger the subsequent production of even more stomach acid.**

Which brings up another issue associated with drinking water (or other liquids) while eating.

Drinking too much liquid while eating will dilute stomach juices from the get go. Not only does that interfere with digestion, it also immediately triggers the stomach to produce more stomach acid and is a primary factor in the onset of acid reflux disease. A little bit of water, wine, tea, whatever with your meal does not present a problem. Once you go beyond 8 ounces, however, problems start to develop. The more you drink, the greater the problems. Or to put it another way, three slices of pepperoni pizza sluiced down with an entire pitcher of root beer is a prescription for disaster.

### *Proton pump inhibitors*

"Proton pump inhibitors" is the name of class of drugs that includes familiar names such as Nexium, Prilosec, and Prevacid. Right now, within the medical community -- and within the public at large -- proton pump inhibitors are among the hottest drugs in use. This is a testament both to the extent of digestive problems in the developed world and in the ability of these drugs to effectively stop production of excess stomach acid. How do they accomplish this miracle?

Without going into technical details, suffice it to say that proton pump inhibitors act by blocking an enzyme system that controls the final stage of the release of stomach acid from the parietal cells. Block the enzyme system, and you stop the release of stomach acid. How effective are proton pump inhibitors in stopping the release of stomach acid?

Quite simply, proton pump inhibitors can reduce gastric acid secretion by up to 99%.

Problem solved! If you had acid reflux before, you do not now. Even if some chyme is still backing up into the esophagus, it's not a problem since there's no stomach acid present. For doctors, it's the perfect solution. It works like a charm, and their patients are happy.

However, since it doesn't address the actual problem behind acid reflux and merely suppresses a symptom (which is in fact what most drugs do), it should not be surprising that there is a physical cost to regular use of these drugs.

But even more significantly, there is a fundamental problem with suppressing the production of stomach acid. Hydrochloric acid is not just "something" in the stomach; it is an essential component of the digestive process. Suppressing the symptoms of acid reflux by eliminating 99% of all stomach acid production presents a fundamental disruption of the digestive process. Hydrochloric acid is **required** for the digestion of proteins; it unwinds them so that pepsin can break them down. It is also required for the absorption of nutrients, particularly of vitamin B12. And it is required for the utilization and absorption of minerals such as calcium. Specifically, suppressing the production of stomach acid through the long term use of proton pump inhibitor drugs will lead to:

**Incomplete digestion**
Stomach acid denatures (unfolds) proteins so that they can actually be broken down by pepsin during digestion. Without being unfolded, they resist digestion. Without sufficient stomach acid present, this process won't happen and the digestion of your food -- particularly proteins -- will be incomplete. This can result in long term deficiencies. In addition, since proteins now enter the intestinal tract not fully digested, this puts incredible stress on your pancreas (the digestive organ last resort, as it were) to produce vast quantities of protein digesting enzymes to try and compensate. And of course, the incomplete digestion of complex proteins (particularly those found in wheat, corn, and dairy) is a major factor in the onset of food allergies.

In addition, HCL kills many micro-organisms, such as the ones that travel into the digestive tract from the human mouth or come breeding in the food itself -- as with contaminated meat or produce. Without sufficient stomach acid present, you are that much more likely to succumb to food poisoning and stomach flus -- not to mention H. pylori and peptic ulcers, as we discussed earlier.

It is the presence of HCL in both the stomach and the duodenum that stimulates the flow of hormones, bile juices, and pancreatic juices in preparation for release into the small intestine. The less HCL produced, the less pancreatic juices are signaled for. Combine low HCL with no digestive enzymes being consumed with your food, and you have guaranteed lack of proper digestion (not just for proteins, but for fats too since the trigger for the release of bile has been disrupted).

**Poor B12 absorption**
Intrinsic factor is a protein made by the parietal cells in the stomach. It is made and released concurrently as the parietal cells make and release stomach acid. Effectively, the same things that trigger the release of stomach acid trigger the release of intrinsic factor -- and more to the point,

the same things that inhibit the release of stomach acid, such as proton pump inhibitors, inhibit the release of intrinsic factor.

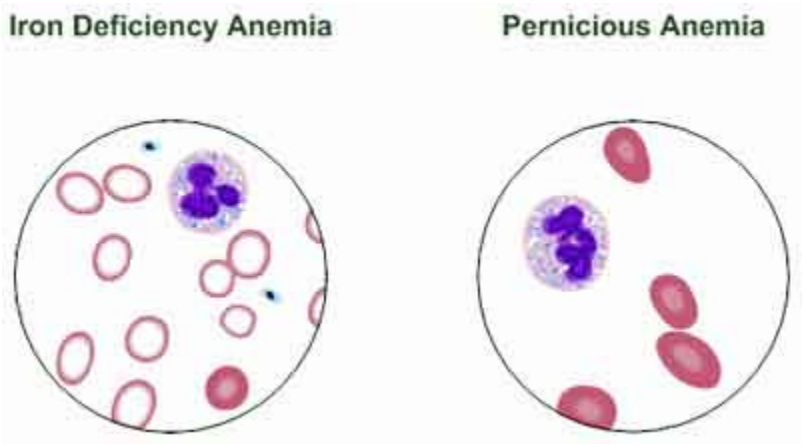
Why is this important?

Because intrinsic factor is essential if your body is to absorb and utilize vitamin B12. The mechanism is simple. Intrinsic factor, if it's present, binds with vitamin B12 in your food and/or supplements. This happens in the duodenum, and it accomplishes two things:

- First, it protects the B12 from bacteria that line the intestinal tract and that would "consume" it before your body could utilize it as it makes its way down to the ileum (the final section of the small intestine) where vitamin B12 is actually absorbed.
- Second, it plays a key role as part of an exchange mechanism that takes place in your ileum. In the ileum, the intrinsic factor bound to the B12 is swapped out for another protein, transcobalamin II (which is produced by epithelial cells that line the ileum). And it is this new complex that can pass through the walls of your intestine and travel to your liver, which ultimately regulates the utilization of B12 in your body.

Without intrinsic factor, most B12 could never reach the ileum, and even that which made it there could not be swapped out with transcobalamin II and thus utilized by the body. This means that if there is an intrinsic factor shortage, you will suffer from a B12 shortage, no matter how much you supplement.

The primary symptom of B12 shortage is pernicious anemia, a decrease in red blood cells that occurs when the body cannot properly absorb vitamin B12 from the gastrointestinal tract.




Symptoms of anemia can include:

- In people with anemia, the heart has to work harder to pump blood to get enough oxygen to the body's organs and tissues. This stress on the heart can cause heart murmurs (an extra or unusual sound heard during the heartbeat), fast or irregular heartbeats, an enlarged heart, or even heart failure. Related symptoms include:
    - Tiredness

    - Paleness
    - Dizziness when changing to standing position
    - Rapid heart rate
- A lack of vitamin B12 can cause extra problems for the heart because it raises homocysteine levels. High levels of homocysteine add to the buildup of fatty deposits in blood vessels, which in turn can lead to heart attacks and strokes.
- A lack of vitamin B12 can damage nerve cells and cause problems such as tingling and numbness in hands and feet and problems with walking and balance. A vitamin B12 deficiency can cause changes in taste, smell, vision, and ringing in the ears. Finally, it can cause mental changes, including memory loss, confusion, and depression.
- Digestive tract. A lack of vitamin B12 may change the surface of the tongue and shrink or thin the stomach lining. Any changes that occur in the stomach can put a person at risk for stomach cancer. Related symptoms include:
    - Stinging sensation on the tongue or smooth red tongue
    - Cracked lips
    - Yellow skin

Not surprisingly, pernicious anemia is a known side effect of the long term usage of proton pump inhibitors. And in fact, the problem is even worse than described above. In addition to causing B12 shortages, long term use of proton pump inhibitors leads to iron deficiency, which further exacerbates the problem by causing iron deficiency anemia -- as we will now discuss.

**Poor mineral absorption**

Hydrochloric acid is essential for separating minerals from the foods that bind them. Or, if the minerals are already separated, as in supplements, low HCL levels in the stomach allow the minerals to recombine with the chyme into compounds that are difficult to absorb. Some minerals are more prone to this problem than others. Of the major minerals, **iron,** zinc, and calcium absorption in particular are directly affected by low acid levels.

In addition, if the stomach produces too little stomach acid, minerals such as calcium remain insoluble and cannot be ionized, which is necessary for assimilation in the intestines. Ionization is the process whereby an atom changes its structure so that it can combine with other elements. This is why chelated calcium, like many other chelates, is much more absorbable than raw calcium. The bottom line is that proper stomach acid levels are essential for ionic bonding which is necessary for intestinal uptake. The proper level of hydrochloric acid in the stomach is so important that its lack in the digestive process can account for as much as an 80% loss of available calcium absorption.

That means that regular users of proton pump inhibitor drugs are prone to be deficient in these minerals. In addition, sufficient stomach acid is essential for the absorption of most trace minerals. And considering that most people get almost none of these essential micronutrients in their diets to begin with, deficiencies of trace minerals is epidemic among people who suppress stomach acid production.

**There's more**
In addition to the problems we've already discussed relative to B12 and minerals, the symptoms of HCL deficiency include:

- Bloating, belching, and flatulence immediately after meals
- Indigestion, diarrhea, or constipation
- Food allergies
- Candida overgrowth
- Acne
- Weak, peeling and cracked fingernails.
- And, surprisingly, heartburn

**The bottom line is that despite the fact that proton pump inhibitor drugs can help eliminate the short term "symptoms" of acid reflux disease, they create a whole range of problems of their own associated with reduced stomach acid production and should not be used long term.**

One final note on low stomach acid is that this is not just a concern for people who use antacids or proton pump inhibitor drugs. It is a major problem for the elderly. After a lifetime of eating enzyme deficient foods and forcing the stomach to overcompensate with extra high acid production, eventually the body's capacity to produce stomach acid breaks down. At that point, no matter what you do, the body can no longer produce enough stomach acid to properly digest foods or negotiate the absorption of vitamin B12 and minerals. That's one of the major reasons that so many of the elderly suffer from low blood counts and nutritional deficiencies -- particularly mineral deficiencies.

## *Natural Health Alternatives*

Fortunately, proton pump inhibitor drugs are not the only solution to acid reflux disease. There are natural alternatives. These include:

- Supplementing with digestive enzymes to reduce the need for stomach acid -- thereby giving the body a chance to rest and recover its ability to produce sufficient stomach acid.
- Mixing one teaspoon of apple cider vinegar with water and a little honey and drinking this with each meal. You may gradually increase the vinegar up to 3-4 tablespoons in water if needed.
- And for the elderly who no longer produce enough stomach acid, supplementing with betaine hydrochloride (HCL) tablets can help, but anything beyond minimal doses as found in most health food store supplements should only be administered under the supervision of a health practitioner to avoid damage to the stomach lining.

## Stomach Acid

Something must be going on with stomach acid. We've received over 50 emails in the last 30 days on stomach acid. Yes, we get 10,000 emails a month, but getting 50 on one topic is highly unusual. The questions on stomach acid were of all kinds mind you, but surprisingly, not one on what I would consider the most important issue: low stomach acid.

Here's a recap - covering all aspects:

- Stomach acid and digestion
- Too much stomach acid
- Too little stomach acid
- Stomach acid and proteolytic enzymes
- Stomach acid and probiotics

### Stomach acid and digestion

Before we can even talk about stomach acid, we need to spend a little time talking about how it fits in the digestive process. Most people believe that when you eat a meal it drops into a pool of stomach acid, where it's broken down, then goes into the small intestine to have nutrients taken out, and then into the colon to be passed out of the body -- if you're lucky. Not quite.

What nature intended is that you eat enzyme rich foods and chew your food properly. If you did that, the food would enter the stomach laced with digestive enzymes. These enzymes would then "predigest" your food for about an hour -- actually breaking down as much as 75% of your meal.

Only after this period of "pre-digestion" are hydrochloric acid and pepsin introduced. The acid inactivates all of the food-based enzymes, but begins its own function of breaking down what is left of the meal in combination with the acid energized enzyme pepsin. Eventually, this nutrient-rich food concentrate moves on into the small intestine. Once this concentrate enters the small intestine, the acid is neutralized and the pancreas reintroduces digestive enzymes to the process. As digestion is completed, nutrients are passed through the intestinal wall and into the bloodstream.

That's what nature intended. Unfortunately, most of us don't live our lives as nature intended!

Processing and cooking destroy enzymes in food. (Any sustained heat of approximately $118^0$ - $129^0$ F destroys virtually all enzymes.) This means that, for most of us, the food entering our stomach is severely enzyme deficient. The food then sits there for an hour, like a heavy lump, with very little pre-digestion taking place. This forces the body to produce large amounts of stomach acid in an attempt to overcompensate. In addition to failing in this attempt (much of the meal still enters the small intestine largely undigested), there are two major consequences.

1. Too much stomach acid.
2. Too little stomach acid.

## Too much stomach acid

This is obvious. In an attempt to overcompensate for lack of enzymes in the food, the stomach produces an inordinate amount of stomach acid to compensate, leading to acid indigestion. Taking antacids or purple pills doesn't actually solve the problem; it merely eliminates one of the symptoms. Ultimately, though, it passes even more quantities of poorly digested food into the intestinal tract where it leads to gas, bloating, bad digestion, chronic digestive disorders, in addition to blowing out your pancreas, which tries to compensate by producing huge amounts of digestive enzymes for use in the small intestine. All of this is exacerbated by foods and beverages such as alcohol (especially beer), high sugar foods, and caffeinated foods (coffee and tea, etc.) that can actually double acid production.

The simple solution for most people with excess stomach acid is to supplement with digestive enzymes which can digest up to 70% of the meal in the pre-acid phase, thus eliminating the need for large amounts of stomach acid and also taking tremendous stress off the digestive system and the pancreas.

One other factor which may be contributing to the problem is a hiatal hernia, in which part of the stomach can protrude through the diaphragm into the chest cavity allowing food and stomach acid to back up into the esophagus. Combine a hiatal hernia with excess stomach acid and you have the potential for great distress. The standard treatment for severe hiatal hernias is laparoscopic surgery -- with mixed results. Fortunately, there are chiropractic alternatives that can be quite effective.

In either case, dietary changes and supplemental digestive enzymes are likely to produce significant results, without creating problems further down the digestive tract.

Drinking 2-4 ounces of organic, stabilized, aloe vera juice every day can also help soothe irritated tissue in the esophagus and help balance out digestive juices in the stomach.

## Too little stomach acid

Follow the logic here for just a moment.

If you spend years forcing your body to massively overproduce stomach acid to compensate for the lack of enzymes in your diet, what do you think the long-term consequences might be in terms of your ability to produce stomach acid?

Bingo!

Eventually, your body's capacity to produce stomach acid begins to fade, with a concomitant loss in your body's ability to sufficiently process food in the stomach. The health consequences can be profound. Low production of stomach acid is quite common and becomes more prevalent with age. By age forty, 40% of the population is affected, and by age sixty, 50%. A person over age 40 who visits a doctor's office has about a 90% probability of having low stomach acid. Consequences can include:

- Poor digestion. Not only is there insufficient stomach acid to break down food, there is insufficient acidity to optimize the digestive enzyme pepsin, which requires a pH of around 2.0. This results in partial digestion of food, leading to gas, bloating, belching, diarrhea/constipation, autoimmune disorders, skin diseases, rheumatoid arthritis, and a host of intestinal disorders such as Crohn's and IBS.
- It is estimated that 80% of people with food allergies suffer from some degree of low acid production in the stomach.
- Many vitamins and minerals require proper stomach acid in order to be properly absorbed, including: calcium, iron, vitamin B12, and folic acid. Vitamin B12 in particular requires sufficient stomach acid for proper utilization. Without that acid, severe B12 deficiency can result. (Note: ionic delivery systems can bypass this problem.)
- With low acidity and the presence of undigested food, harmful bacteria are more likely to colonize the stomach and interfere with digestion. Normal levels of stomach acid help to keep the digestive system free of harmful bacteria and parasites.

It's worth noting that symptoms of low acidity include:

- Bloating, belching, and flatulence immediately after meals.
- Indigestion, diarrhea, or constipation.
- Heartburn.

Is it just me, or doesn't this list sound very similar to the symptoms associated with **too much** stomach acid? In fact, up to 95% of people who think they are suffering from too much stomach acid are actually suffering from the exact opposite condition. The use of antacids and purple pills then become exactly the wrong treatment to use since they exacerbate the underlying condition while temporarily masking the symptoms.

### *Options*

- Supplementing with digestive enzymes to reduce the need for stomach acid -- giving the body a chance to rest and recover its ability to produce sufficient stomach acid.
- Mix one teaspoon of apple cider vinegar with water and a little honey and drink this with each meal. You may gradually increase the vinegar up to 3-4 tablespoons in water if needed.
- Supplementing with betaine hydrochloride (HCL) tablets can also help, but anything beyond minimal doses as found in most health food store supplements should only be administered under the supervision of a health practitioner to avoid damage to the stomach lining.

## Stomach acid and proteolytic enzymes

As I previously mentioned, we received a number of questions on stomach acid in the last 30 days. Most of them had nothing to do with high or low stomach acid, but rather with the effect of stomach acid on supplements. In fact, the bulk of the questions we received were concerned with

how stomach acid affects proteolytic enzymes, and they all pretty much ran along the following lines.

Since enzymes are made from proteins and proteolytic enzyme formulas are taken orally:

- How do they survive the digestion of proteins that takes place in the stomach? Wouldn't they be broken down by stomach acid into amino acids?
- If they do make it through the stomach, since they are so large, wouldn't they be unable to pass through the intestinal wall?

### *Surviving the stomach*

Not all proteins (enzymes are proteins) are broken down by stomach acid. Rather than get technical, let me just point out pepsin. Pepsin is an enzyme secreted by the stomach to aid in digesting the proteins in your food. Not only is it NOT broken down by stomach acid, its optimum pH environment is about 2.0 (very, very acidic). Bottom line:

- Although some enzymes such as serapeptase are destroyed by stomach acid, most are not -- just temporarily rendered inactive. (Note: that's one of the reasons I do not use serapeptase in my own proteolytic enzyme formulation.)
- Different enzymes function differently in different pH environments, which is why I formulated my proteolytic enzyme formula, pHi-Zymes™, to function in a wide range of pH's.

### *Passing through the intestinal wall - absorption*

Enzyme absorption absolutely occurs and manifests through two main avenues:

- Pinocytosis
- Peristalsis

**Pinocytosis**. Enzyme molecules are bound to, and encapsulated, by other substances such as water. Since they are encapsulated, the intestinal wall cannot recognize them as enzymes and thinks they are "water," thus readily passing them through the intestinal wall. Once the enzymes are in the bloodstream they attach to lymphocytes and travel easily throughout the vascular and lymphatic systems.

**Peristalsis** not only forces food (and enzymes) down through the intestinal tract, it also forces transit through the intestinal wall.

## Stomach acid and probiotics

The questions related to probiotics are essentially the same as those for proteolytic enzymes: aren't they broken down and destroyed by stomach acid -- thus requiring special, acid-proof capsules? And the answer, for most probiotics, is absolutely not. (I think this is primarily a

marketing pitch for companies selling probiotics in enteric coated capsules, but the logic is flawed.)

The reason we're supposed to take probiotic supplements is to replace the probiotics that we used to get in a wide range of unprocessed fermented foods such as homemade yogurt, sauerkraut, buttermilk, pickled foods, kimchi, real soy sauce, raw vinegar, tempeh, etc. -- foods that are no longer a significant part of our diet. But think about this for a moment. These foods are not enteric coated. How could these foods provide probiotic value if the beneficial bacteria were destroyed by stomach acid? The simple truth is that beneficial bacteria, for the most part, easily survive stomach acid. Also, if you take your probiotic supplements with water on an empty stomach (as we've already discussed), they encounter almost no stomach acid anyway.

## Conclusion

The bottom line here is that most people are very confused about the role stomach acid plays in health. Most people:

- Think they have too much, when in fact they have too little.
- Treat the symptom and suppress stomach acid production, ultimately leading to long-term health problems.
- Ultimately lose the capacity to produce sufficient stomach acid as a result of dietary abuse and continual use of medications to suppress the body's ability to produce it.

Don't get into that trap.

- Use digestive enzymes with all your meals.
- Drink aloe vera juice.
- Use probiotic supplements with confidence.
- Use proteolytic enzyme supplements with confidence.
- And, if needed, use apple cider vinegar or betaine hydrochloride supplements to make up for stomach acid insufficiency.

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While discussing acid reflux disease, it's important not to forget the physical contributors to the problem

- Hiatal hernia
- Poorly functioning lower esophageal sphincter

As we previously reviewed above, there are steps you can take to help alleviate hiatal hernias.

As for the esophageal sphincter, getting the release of stomach acid back into proper alignment and timing, can go a long way to helping the sphincter close properly -- as can avoiding overeating.

# Pancreas - Liver - Gallbladder

Let’s move on to discuss those organs just outside the alimentary canal that play key roles in the digestive process, including the:

- Pancreas
- Liver
- Gallbladder

In some ways, these are three of the most fascinating organs in the body -- and three organs that are highly amenable to improvement through detoxing and flushing. Doctors absolutely do not understand the concept of detoxing when it comes to these organs, but we will explore the detox protocol using medical terminology and points of reference so that it will finally be understandable to them -- as well as to you.

## Pancreas and Digestion

As we work our way down the digestive tract, we encounter two major "outpouchings" -- the pancreas and the liver. Like the mouth and the stomach, these outpouchings represent evolutionary adaptations of the GI tract from its original straight line tube construction as found in more primitive animals such as worms. In today's newsletter, we are going to focus on the pancreas, both its anatomy and physiology. The pancreas actually plays two major roles in the body. It both produces hormones and digestive juices that dump into the duodenum, and it produces sugar and growth regulating biochemicals that empty directly into the bloodstream. In this newsletter, we will focus on the digestive functions (and the problems associated with those functions) and save the sugar and growth regulating functions for a later discussion when we explore the body's endocrine system. We will also explore how abuse of this commonly ignored organ (through poor diet, inadequate supplementation, and lack of regular cleansing) can lead to serious -- even fatal -- health problems.

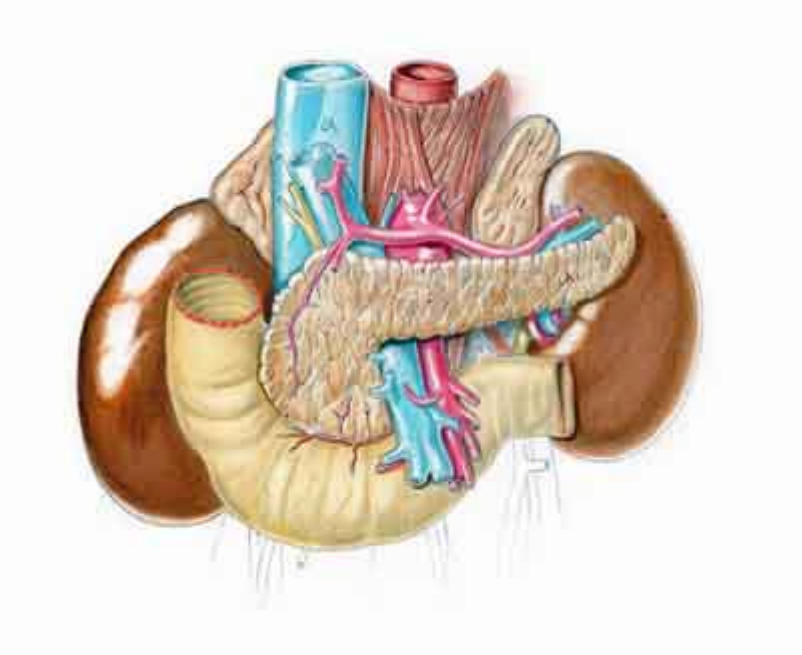
There is one important note/perspective before we begin. The word pancreas actually means something. Translated from the original Greek, it reads as "all flesh" (pan -- all, kreas -- flesh), which refers to its ability to digest virtually all flesh (protein based tissue), including itself.

## Physical facts about the pancreas

Most organs in the abdomen, such as the intestines, stomach, and liver are located in the peritoneal cavity. Just like we see with the heart, which is located in the pericardial cavity, the peritoneal cavity is lined with a sac like membrane called the parietal peritoneum. Also, as with the heart, the organs inside the peritoneal cavity are covered with a visceral membrane.

The pancreas, however, does not fit this description. Like the kidneys, the rectum, and most of the duodenum, the pancreas is what is called a retroperitoneal organ. That means it lies within the peritoneal cavity but outside (behind) the visceral peritoneum or membrane. From a natural health perspective, as we explore the anatomy and physiology of the pancreas, this distinction has little meaning. On the other hand, to the surgeon, it matters a great deal.

Physically, the pancreas is located in the middle to upper abdominal cavity, towards the back or posterior. It is about 12 inches long and tapers from right to left. (Remember, as with our discussion of the heart, anatomically speaking, left and right are referenced from behind the body so they are actually reversed in most diagrams that view the body from the front.) The thick part, the head, comprises almost 50% of the mass of the pancreas and lies to the right, nestled in the curve of the duodenum. This location, as we will learn in a bit, is key to the functioning of the pancreas. As for the body of the pancreas, it moves up and to the left, tapering into what is known as the tail of the pancreas, which terminates at the junction of the spleen.

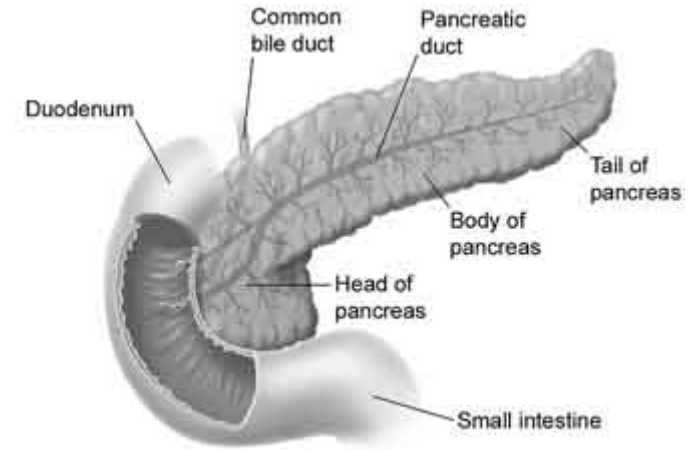


This locates the pancreas in terms of its head and tail. As for the front surface of the pancreas, it rests mostly against the back (posterior) wall of the stomach. The rest of it nestles against the first portion of the duodenum. This can be important in the case of duodenal ulcers that actually penetrate the duodenum -- as the ulcer will now begin to spread to the pancreas, leading to severe, often fatal, pancreatitis.

As might be suspected for such an important organ, the pancreas is richly supplied with arteries and veins. It is served by branches from the hepatic artery, the gastroduodenal artery, the pancreaticoduodenal artery, the superior mesenteric artery, and the splenic artery.

## Pancreatic duct system

The pancreas shares a duct system with the liver in what is known as the biliary tree. We will discuss the complete tree in more detail when we talk about the liver in our next issue of the newsletter. When it comes to natural health, a complete understanding of the biliary tree and how to keeps its functioning optimized is essential to maintaining optimal health. For now, though, we will focus on that




National Cancer Institute

part of the tree that resides in the pancreas.

The pancreas is served by a major pancreatic duct (the duct of Wirsung) that runs down the middle of the pancreas and empties into the duodenum at the head of the pancreas through a valve called the ampulla of Vater. (Some people have a secondary duct (the duct of Santorini) that splits off from the main duct and empties into the duodenum just above the ampulla of Vater -- but this duct is usually non-functional.) It is important to note that the main duct joins the common bile duct (through which the liver and gallbladder empty) at the point it enters the duodenum. This is important as stones from the gallbladder can find their way down into the pancreatic duct, blocking it at the ampulla of Vater and leading to pancreatitis.

Secretory cells that release pancreatic juice are arranged in acini (clusters of cells that resemble many-lobed "berries") around small ducts that feed into progressively larger ducts and ultimately into the main duct -- virtually identical to the tracheal-bronchi tree we saw in the lungs.

## Pancreatic function

Endocrine and exocrine functions coexist in the pancreas. By definition, endocrine organs secrete hormones directly into the bloodstream, whereas exocrine organs secrete hormones directly into the cavity (lumen) of another organ. The pancreas does both. The exocrine pancreas comprises 99% of pancreatic tissue. It secretes digestive juices into the duct system that carry them on into the cavity of the duodenum. The endocrine pancreas, on the other hand, secretes hormones (insulin, glucagon, and somatostatin) directly into the bloodstream. Simple math tells us that if 99% of pancreatic tissue serves the exocrine function of the pancreas, only 1% of pancreatic tissue is available for its endocrine function. Oh, but how important that 1% is. It is so important (and complex) that we will save our discussion of it for a separate newsletter when we explore the body's endocrine system. Once again, our focus on this issue is on the digestive system; therefore, our focus in this newsletter is on the exocrine function of the pancreas.

Finally, it should be noted that the major stimulation of the pancreas is primarily parasympathetic (originating in the brain stem), through the vagus nerve, and promotes secretion of digestive juices. Parasympathetic stimulation to the pancreas occurs in response to the digestive processes of the stomach. Food in the stomach stimulates the secretion of all pancreatic enzymes. And in fact, we covered the pancreatic triggering mechanisms in great detail in our exploration of the stomach.

Conversely, inhibition of pancreatic secretion of digestive juices is controlled by triggers and nerves outside of the central nervous system -- the sympathetic nervous system. Specifically, when acid chyme enters the duodenum, along with partially digested fats, proteins, and carbohydrates, enteroendocrine cells in the duodenum and small intestine release cholecystokinin (CCK) and secretin. Secretin decreases gastric secretion and CCK inhibits gastric emptying. These two enzymes circulate into the bloodstream. In addition, they stimulate further secretion of pancreatic enzymes and sodium bicarbonate into the small intestine, thus further raising the pH in the duodenum.

## Pancreatic digestion

As we've discussed previously, the primary processes of digestion occur in the stomach, and the primary processes of absorption occur in the small intestine. However, both these functions depend heavily on the digestive juices secreted by the pancreas -- specifically, the exocrine secretions of the pancreas that dump into the duodenum. The exocrine pancreas has the following components and functions.

### *Pancreatic juice*

The pancreas produces 1,000-1,500 mL (1-1.5 qts) of digestive juices per day. These juices consist primarily of water, NaCl (salt), and NaHCO3 (sodium bicarbonate). The purpose of the sodium bicarbonate is to neutralize the high acidity of the chyme (food plus stomach acid) raising it to an alkaline pH of 7.1-8.2. This both stops the action of gastric pepsins and stomach acid and prepares chyme for the process of nutrient absorption, which takes place in the small intestine.

### *Pancreatic enzymes*

In addition to containing sodium bicarbonate to neutralize the action of the digestive juices, pancreatic juice also contains a number of digestive enzymes (optimized to function in an alkaline environment) that help finish off the digestive process started in the stomach. (Obviously, and we will talk more about this later), the more complete the digestive process that took place in the stomach, the fewer digestive enzymes will be needed from the pancreas to finish the process. And in fact, the more complete will be the process of absorption in the small intestine.) These pancreatic enzymes include:

- **Amylase** digests the remaining complex carbohydrates into sugars -- mostly complex. Complex sugars are then further broken down into their individual component sugars in the small intestine:
    - Maltose (glucose + glucose) is acted on by maltase and broken down into two molecules of glucose.
    - Sucrose (glucose + fructose) is acted on by sucrase and broken down into glucose and fructose.
    - Lactose (glucose + galactose) is acted on by lactase and broken down into glucose and galactose.
- **Trypsin**, **chymotrypsin**, and **elastase** all digest proteins.
- **Lipase** digests triglycerides into fatty acids and monoglycerides.

Almost all pancreatic enzymes are secreted in an inactive form to prevent autodigestion. (Remember, pancreas literally means "eats all flesh.") Inactive forms of enzymes end in "gen", e.g. trypsinogen. If the pancreatic enzymes were in the active form inside the pancreas, they would literally digest the pancreas itself. This is, of course, identical to what we saw in the stomach, in which the mucosal cells of the stomach lining release pepsinogen, pepsin's precursor -- which is converted into pepsin only after the pepsinogen has made its way out of the chief cells and into the stomach itself, where it is converted in the presence of stomach acid. Since the

wall of the stomach is coated with mucous, the pepsin can only digest your meal and not your stomach. This would not be the case, of course, if the pepsinogen converted to pepsin while still in the stomach lining. And the same is true for the pancreatic enzymes, which only convert to their active form once they are fully clear of the pancreas itself. Incidentally, it is enterokinase (produced in the small intestine) that activates the pancreatic enzymes once they are in the safe confines of the small intestine. In the small intestine, the mucosal lining protects the tissue of the small intestine from autodigestion -- as in the stomach.

In severe pancreatitis, however, activated enzymes may travel back into the pancreas and digest it. We will talk more about pancreatitis in a little bit, but for now, consider alcohol. Regular consumption of alcohol inflames the pancreas. When the inflammation is severe, the smaller ducts of the pancreas are squeezed shut. Thus, the pancreatic enzymes do not readily flow through the duct system, but rather are released into the blood of the pancreas, where they become active and start digesting the pancreas itself. (Blockage of the biliary tree is also a major problem and can cause enzymes to back up and autodigest pancreatic tissue. We will explore this in more detail in a couple of newsletters when we focus on the biliary tree.)

It should be noted that the pancreas has self-defense mechanisms that can help prevent auto digestion -- at least in minor cases of back up. For example, the acinar cells (mentioned earlier) contain a trypsin inhibitor that inactivates any active trypsin accidentally released into the pancreatic tissues.

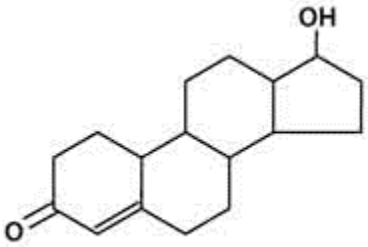
## The role of the pancreas in digestion

We've assumed a basic understanding of what the purpose of digestion is in all of our discussions of the digestive process so far, but never really defined it in specific detail. Now would be a good time. The purpose of digestion -- with the contribution of the pancreas -- is to take the generally complex molecules of the food you eat and break them down into simple molecules and reassemble those molecules into necessary compounds. That's it, in a nutshell. For example, by eating foods with proteins containing the essential amino acids, the body can break those proteins down into their component amino acids through the efforts of the stomach and the pancreas, then send those amino acids to the liver, which then reassembles them to produce the full complement of non-essential amino acids the body needs. Essential amino acids are those which the body cannot assemble in the liver. Non-essential amino acids are those which can be manufactured in the liver -- as long as the right mix of essential amino acids is present in the diet. Essentially the same process is involved in digesting carbohydrates and fats -- breaking down complex molecules of great variety into smaller molecules of limited variety.

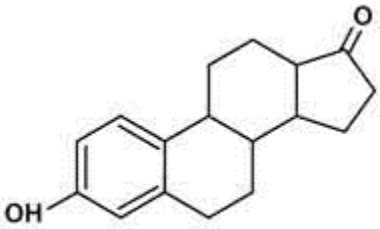
That's the simple description. If we take it one level deeper, it becomes even more interesting.

As it turns out, the body has evolved to favor molecules with similar structures. This presents the body with two major advantages. First, it makes the digestive process easier, since the body has only a limited number of end products it is trying to produce. But even more importantly, it makes reassembling molecules into more complex structures that much simpler since they all have fundamental similarities no matter what their function. For example, the four ring cyclopentanophenanthrene structure is common to all of the steroid hormones including:

cholesterol, estradiol, testosterone, and cortisol. The only differences between these compounds are one or two groups attached to the outside of the common ring structure. I discussed this in detail in *Lessons from the Miracle Doctors* when exploring the make-up of hormones in the body. (Search “free e-book lessons from the miracle doctors” for a copy of this text.) They all look remarkably similar because they share the same basic ring structure, but with tiny variations. Look at how remarkably similar the testosterone and estrone molecules are -- and yet how remarkably different they are in function. One makes men; the other makes women.




1. Testosterone




2. Estrone

The bottom line is that because they are remarkably similar, it is that much easier for the body to assemble the basic building blocks after digestion into whatever is needed: testosterone, DHEA, estrogen, cortisol, cholesterol. You name it. Thus, the body can easily replace any particular missing compound by modifying the creation process of a similar compound. And in fact, we see this all the time in the body. For example, if you remove the ovaries to drop estrogen production to combat breast cancer, it only provides temporary relief. Estrogen levels will miraculously start to rise again eventually. How? The adrenals take over and start producing estrogen from the almost identical cortisol building block. Miraculous!

Incidentally, that's why doctors now prefer tamoxifen to removing ovaries. Instead of eliminating the body's ability to produce estrogen (which always shifts over to another organ), tamoxifen works to block estrogen receptor sites so that vulnerable tissue cannot "take up" any estrogen circulating in the bloodstream. Of course, this can also be done using natural health resources without the side effects and cost, but that's a topic for another newsletter.

## What can go wrong with your pancreas?

Problems with the pancreas usually come down to two things -- pancreatitis and pancreatic cancer.

### *Pancreatitis*

Quite simply, pancreatitis refers to inflammation of the pancreas; usually marked by abdominal pain. The primary causes are identified in the medical community as alcohol, gallstones (by virtue of the shared biliary tree), infection, and certain medications such as diuretics. It is estimated that some 50,000 to 80,000 cases of acute pancreatitis occur in the United States each year. But that's just the tip of the iceberg. Acute pancreatitis only documents those cases accompanied by abdominal pain or threat of death. But what

about asymptomatic non-acute pancreatitis? How prevalent is that?

Unfortunately, doctors and hospitals do not document the incidence of non-acute pancreatitis since they offer no treatment for it. But researchers such as Edmund Howell in his book *Enzyme Nutrition* declared that virtually 100% of all Americans have an enlarged pancreas by the time they are 40! Is this possible? In fact, yes! There are strong indications that a major factor in chronic non-acute pancreatitis is the stress put on the pancreas through a diet high in cooked and processed foods -- a diet deficient in natural or supplemented enzymes.

Research done on rats and chickens that were fed cooked foods revealed that the pancreas enlarged to handle the extra burden of the enzyme-deficient diet. In other words, the pancreas will enlarge over time when called upon to compensate for a diet high in enzyme deficient foods. Ruminant animals such as cattle, goats, deer, and sheep get along with a pancreas about a third as large as the human pancreas because of their raw food diet. However, when these animals are fed heat-processed, enzyme-free food, their **pancreas enlarges up to three times the normal size** than when fed on a raw plant diet. Grossman, M. Greengard, H, Ivy, A. American Journal of Physiology. 141:38-41, 1944. Make no mistake; long-term, non-acute pancreatitis is a condition that affects virtually every person living on a modern diet -- given enough time. And just because doctors ignore it because it appears to be asymptomatic (at least in the short term), does not mean that you should be so cavalier about it. Over time, it has a profound impact on your health.

### *Pancreatic cancer*

Just like pancreatitis, the incidence of pancreatic cancer is rising dramatically in the developed world. At one time virtually unknown, there are now some 25,000 cases a year in just the US -- with a 95% mortality rate. In fact, the overall 5-year survival rate from pancreatic cancer is only about 2%. The first symptoms usually noticed are caused by the pancreatic tumor blocking the bile duct and causing a bile reflux into the bloodstream, resulting in jaundice as the first indicator. Even worse, though, are cancers of the tail and body of the pancreas, which produce no symptoms until they are far advanced. In the whole history of pancreatic cancer (millions of cases), there are only 5 known survivors of body and tail pancreatic cancer -- patients whose cancer was discovered early on, by pure accident.

Surgical treatment of pancreatic cancer involves removing the pancreas, duodenum, the bile ducts, and half the stomach and reconnecting the remaining organs (the Whipple procedure). This is one of the biggest surgeries known, requiring from 6-14 hours to complete. It has a five year survival rate of just 2%, and in fact, almost half of all patients die on the operating table. Treatment of pancreatic cancer is especially difficult because the location of the pancreas means that tumors tend to spread rapidly to highly innervated (rich in nerves) regions of the back and spine.

The causes of the rising incidence are unknown within the "medical community," although one link that has definitely been established is smoking. The bottom line is that if you get pancreatic cancer, there is very little the medical community can do for you. When the medical community accuses the natural health community of diverting people away from effective treatments for cancer, there is no way they could be looking in a mirror if they are talking about pancreatic cancer. All the medical community can offer in the case of pancreatic cancer is great pain and suffering -- and at huge cost. On the other hand, within the natural health community, we can once again make some educated assumptions that may allow you to better your odds of never getting pancreatic cancer in the first place.

## Using natural health to optimize your pancreas

The steps for taking care of your pancreas are fairly simple.

### *Basic concepts of pancreatic health*

- **Chronic pancreatitis:** Long-term inflammation of the pancreas (pancreatitis) has been linked to cancer of the pancreas. In fact, long-term, non-acute inflammation of the pancreas may be the single leading cause of pancreatic cancer. Reducing inflammation of the pancreas, both acute and non-acute is fundamental to pancreatic health.
- **Diabetes:** Diabetes is not only a symptom of pancreatic cancer, but long-standing Type 1 diabetes significantly increases the risk of pancreatic cancer.
- **Obesity:** Obesity also significantly increases the risk of pancreatic cancer.
- **Alcohol**: Consume alcohol only in moderation as even small quantities of alcohol inflame the pancreas, not to mention the liver.
- **And quit smoking**: Statistically, smoking doubles the risk of pancreatic cancer. It has been estimated that as many as one in four cases of pancreatic cancer are the direct result of smoking cigarettes. Conversely, the risk of pancreatic cancer drops close to normal in people who quit smoking.

### *Diet*

Diets high in meats, cholesterol, fried foods, and nitrosamines increase the risk of both pancreatic cancer and pancreatitis, while diets high in raw fruits and vegetables reduce risk. The bottom line is that a Mediterranean diet is pancreas friendly.

### *Supplemental digestive enzymes*

Unless you're living on an all raw food diet, you need to be supplementing with digestive enzymes. Insufficient live digestive enzymes in the diet force the pancreas to overwork and overstress resulting in long-term, non-acute enlargement of the pancreas. Using digestive enzymes with every meal is one of the simplest things you can do to improve the health of your pancreas.

### *Kidney, gallbladder, liver flushes*

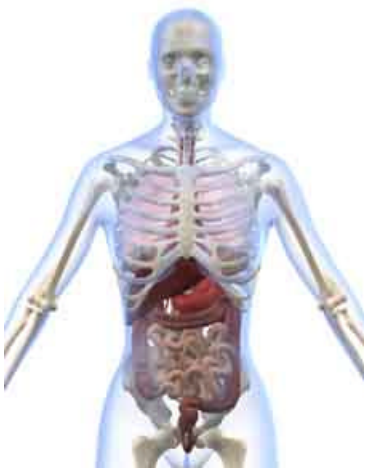
We will cover this issue in more detail when we focus on the liver and biliary tree. However, there can be no question but that regularly softening and flushing of gallstones that can block both the gallbladder and the pancreatic ducts is fundamental to preventing pancreatitis and pancreatic cancer.

### *Endocrine function*

All of the above steps will help with maintaining the health of the endocrine pancreas, but there is more that you can do to support that 1% of pancreatic function. However, we need to save that for our discussion of the body's endocrine system, when we will have time to explore that function in detail. In the meantime, for a heads up on additional steps you can take, check out http://www.jonbarron.org/article/diabetes-echo-effect

## Understanding The Liver and Cholesterol

And now we come to the liver, one of my favorite organs. Certainly the heart, the brain, and the immune system get more play in the popular imagination than the liver, but that's only because the liver is so misunderstood. Next to the skin, the liver is the largest organ in the body. In many ways, it is the most important organ, and the last to be considered when it comes to health. In addition to being large, the liver is also a complicated organ involved in at least 200 separate functions. Generally speaking, the liver performs a vital role in regulating, synthesizing, storing, secreting, transforming, and breaking down many different substances in the body. In this issue, we explore the anatomy and physiology of the liver in detail from a natural health perspective, and conclude with a discussion of how the body regulates cholesterol and why statin drugs may not be all that doctors promote.



## Physical facts about the liver

As I mentioned above, the liver is the heaviest and largest gland inside the body, weighing in at about 3 pounds. Only your skin (also a single functioning organ) is larger. Your liver occupies almost the entire right upper quadrant of the abdominal cavity. (Remember that in virtually all medical diagrams, right and left are reversed.) It nestles up against the diaphragm on the top and against the ribs on the right -- stretching across the body, almost touching ribs on the left. Thus, barring extreme trauma such as bullet wounds and automobile accidents (or if it is not enlarged), it is fully protected -- a testament to how important the body considers the organ.

Physically, it is divided into four lobes, a large right and a small left lobe. Nestled between those two lobes are two less easily visible lobes, the quadrate lobe sitting on top and the caudate lobe sitting just underneath and extending to the bottom of the liver.

Obviously, a three pound organ cannot just "hang" in the abdominal cavity. It needs to be secured. And in fact, it is suspended from the back of the diaphragm by two ligaments, the falciform and the suspensory ligaments. The falciform ligament in particular runs up through the entire liver, dividing the left and right lobes before attaching to the diaphragm. There is one other interesting note about the falciform ligament. The umbilical vein, when you are inside the womb, runs from the umbilical cord up between the left and right lobes of the liver. Within a week of birth, that vein is completely obliterated and replaced by the fibrous cord known as the falciform ligament.

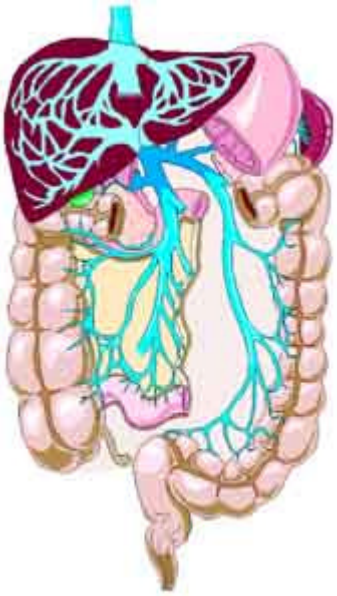
The liver has a reserve capacity of some 50-80%. That means you can destroy up to 80 percent (and in some cases possibly even more) of the liver's function and have no demonstrable negative symptoms. And as amazing as that is, it's not the most amazing part. As I have mentioned frequently over the years when talking about detoxing the liver, the liver is one of the few human organs that can regenerate itself. It can actually regenerate (in a matter of weeks) up to an 80% loss of tissue. Once regenerated, it will fill the same space it occupied before, and will take roughly the same shape as before. And when it's done regenerating, it stops! Though it grows faster than any cancer known to man, its regeneration does not become malignant, and the liver will stop growth at approximately its normal size. This is particularly useful after trauma such as an automobile accident that has damaged part of the liver. The damaged or diseased tissue can be removed by the surgeon with no loss of liver function, and in a matter of a few weeks, the liver will have regenerated all of its lost tissue. You've gotta love this stuff!

## Your liver's blood supply

Before we begin discussing the liver's blood supply, which is unique in the body, it should be noted that everything in the liver begins with the three letters "hep", as in hepatic or hepatitis.

### *Your liver's vascular system*

The right lobe of the liver is served by the right branch of the hepatic artery (a branch of the celiac trunk). The left branch serves the left lobe. Venous drainage occurs through the inferior vena cava, which cuts across the liver from top to bottom and receives venous drainage from the hepatic veins.



So far, nothing very interesting. But dig a little deeper and we find that the liver is unique in the entire body. In fact, the liver has an entirely separate circulation system to accommodate its special needs and functions. This is called the portal system.

### *Hepatic portal circulation*

As it turns out, all the physiology and pathology of the liver depend on this specialized circulation system. Functionally, the hepatic system is a venous system, ultimately returning used blood to the heart for reoxygenation. But unlike every other part of the venous system, it

serves a second, even more important function. The portal system actually takes all of the veins that drain the organs of digestion and instead of returning their blood directly to the heart passes it through the liver.

Why?

Effectively, the portal venous system is responsible for directing blood from parts of the intestinal tract to the liver. All of the substances that you process and absorb in your small intestine must first travel to the liver for a final processing before continuing to the heart. In addition to the small intestine, the portal system also includes venous drainage from the spleen and pancreas.

So what is being processed in the liver?

Ultimately, we are talking about all of the protein, fat, and sugar molecules broken down in your digestive tract -- and all of the vitamins and antioxidants. Every nutrient you consume flows from the intestinal tract, through the portal system, and into the liver for processing and extraction. The liver thus plays a primary role in the digestive process. Specifically, the portal vein drains the inferior mesenteric vein, the superior mesenteric vein, the splenic vein, the gastric veins, and the esophageal veins. As you can see from the diagram, all of these veins dump into one vein, the inferior vena cava, just before it enters the lower part of the liver. From there it splits into many progressively smaller veins that ultimately reach every single cell of the liver before reversing the flow and reassembling, once again, as the inferior vena cava that exits through the top of the liver on its way back to the heart.

As a side note, many drugs that are absorbed through the intestinal tract are substantially metabolized by the liver before being parceled out for general circulation. This is the primary reason that so many drugs list liver damage as a notable side effect. On the flip side of the coin, processing by the liver "inactivates" some drugs, thus they cannot be taken orally. Nitroglycerin, for example, cannot be swallowed as it would be neutralized by the liver. Thus, it is taken under the tongue and absorbed sublingually, totally bypassing the portal system and the liver. Other drugs are administered through skin patches so they can be absorbed transdermally, once again bypassing the portal system and the liver.

As mentioned above, and as befits the special function of the portal system, the inferior vena cava does not continue as an uninterrupted thoroughfare through the liver. In fact, the portal system divides into a capillary bed of ever smaller venous capillaries in the liver sinusoids (see diagram below) formed by the cells of liver. It re-forms on the other side of the sinusoids as the hepatic capillaries and veins, which drain into the vena cava. Effectively, it is a venous-capillary-to venous-capillary system.

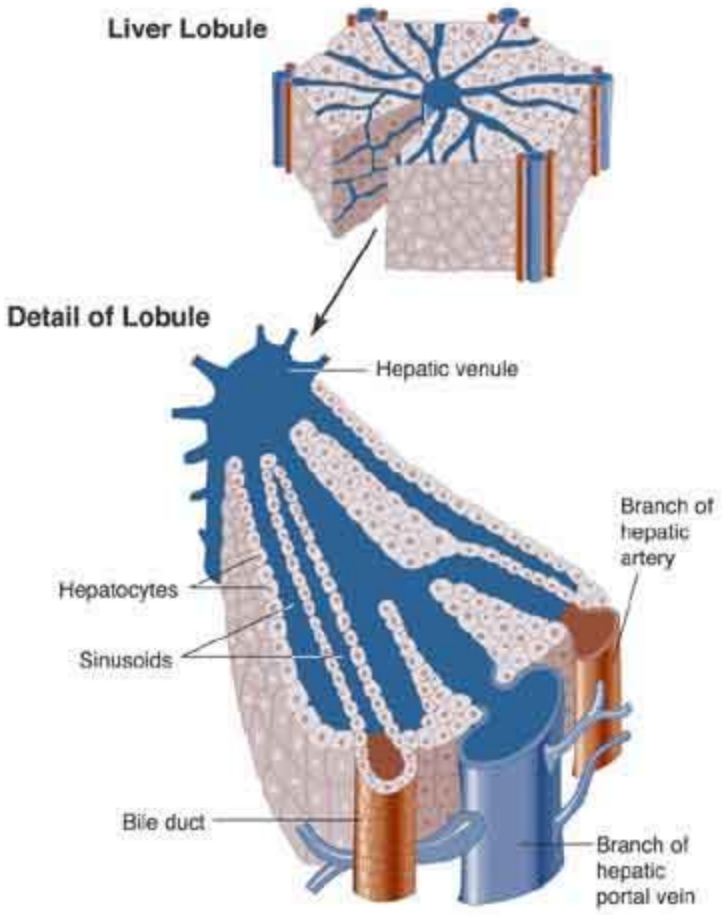
## What happens inside the liver

Okay, we've laid out the location of the liver and the unique blood supply that supports it. Now let's talk about the structures inside the liver that do the actual work.

- Liver lobules (aka hepatic lobules) are the microscopic working factories located inside the lobes of the liver.
- Sinusoids are small swellings or "plates" between hepatocytes that act like small capillaries.
- Hepatocytes are the liver cells that do all the actual work of the liver.

### *Liver lobules*

The hepatic lobule is the structural unit of the liver. It consists of a roughly hexagonal arrangement of plates of liver cells radiating outward from a central vein in the center. Each lobule is approximately one to two millimeters in diameter, with tens of thousands of lobules per liver. At the vertices of the lobule are regularly distributed "portal triads," containing a bile duct and a terminal branch of the hepatic artery and portal vein.




The lobule is composed of multiple smaller units, called acini (which are just the grouping of cells at the end of each sinusoid) and is artificially defined into three zones, with Zone I closest to the portal vein and Zone 3 closest to the hepatic venule in the center of the lobule. Organization of the functional parts of the liver into lobules and acini between the portal vein

and the hepatic vein allows for an easy exchange between the blood and the liver cells and a gradual filtration of blood as it moves through the sinusoids from Zone I to Zone 3. Contrary to blood flow, bile flows in the exact opposite direction, from Zone 3 to Zone I via a separate route to the portal bile ducts.

To summarize, nutrient-rich blood enters the liver via the hepatic artery and portal vein (remember, portal venous blood is rich in nutrients.) The blood from these two sources merges as it enters the sinusoids. Blood reaches the hepatocytes by detouring through capillaries at the sinusoids, where exchanges take place. The exchanges are made as the liver requires according to what zone the blood is in -- nutrients in, waste out, alcohol removed, etc. Blood then exits the lobule via the central hepatic vein, ultimately reentering circulation through the inferior vena cava that exits through the top of the liver. Note: the depleted blood returning from the legs and lower body is not involved in this exchange. It does not enter the liver. It is not altered in any way. Only the rich venous blood from the portal system is involved with the liver exchange before returning to the heart.

### *Sinusoids*

Sinusoids are vascular channels lined by hepatocytes. As blood flows out of the hepatic arteries and portal veins, it flows through the sinusoids for "processing" by hepatocytes before it ultimately empties out through the central vein of each lobule, the hepatic venule, from where it ultimately makes its way to the heart. In addition to normal processing by hepatocytes, liver sinusoids are equipped with Kupffer cells that literally devour foreign pathogens such as bacteria that enter the sinusoids. As a side note, Kupffer cells are particularly vulnerable to damage from alcohol.

### *Hepatocytes - liver cells*

Liver cells do the primary work in the liver -- everything from extracting oxygen and blood, to synthesizing cholesterol, to breaking down fats and sugars, to neutralizing toxins. That said, it's a little more complicated than that. In fact, although virtually all liver cells are fundamentally similar, their function varies according to their location in the liver lobule. Zone 1 cells, for example, are located near the blood vessels that bring oxygen rich blood and nutrients into the lobule and are adept at oxidative liver functions such as cholesterol synthesis, the oxidation of fatty acids, glycolysis (the process that breaks down sugar for energy), gluconeogenesis (the formation of glucose), and lipogenesis. Zone 3 cells, on the other hand, specialize in detoxification.

### *What the liver cells actually do*

The liver actually performs several hundred functions in the body. I can't cover them all in detail in this newsletter, but to summarize:

- First, and probably foremost, there's protein synthesis. The liver synthesizes proteins from amino acids. It takes amino acids and assembles them as needed into complex proteins. It makes almost all prothrombin and fibrinogen (clotting factors), as well as

albumin, the major blood protein. It also converts forms of amino acids from one to the other when needed for specific proteins.

- It converts toxic ammonia (from amino acid conversions) into less toxic urea (which is excreted).
- It uses amino acids and proteins for energy production or storage as fats and carbohydrates.
- It metabolizes carbohydrates (CHO).
- The liver is the storehouse of carbohydrates as glycogen (glycogenesis) and lipids (lipogenesis).
- It can rapidly break down large amounts of CHO (glycogenesis) and release it as glucose into the bloodstream.
- It can create glucose from lactic acid (gluconeogenesis).
- It metabolizes lipids (fat).
- The liver can store fats in various forms.
- It can break down and release stored fat for extraordinary needs.
- It cleanses the blood and discharges waste products.
- The liver also excretes bilirubin, the broken-down pigments from dead red blood cells, by metabolizing it with bile salts and excreting it through the feces. Bilirubin is what makes our feces brown. If for some reason, bilirubin is not excreted (as in obstructive jaundice) the feces will turn clay-colored.
- It neutralizes and destroys poisons and metabolizes alcohol.
- The liver also detoxifies drugs and chemicals and virtually any toxin that enters the body. It excretes those toxins in two ways.
    - It neutralizes them and releases them into the blood, where they make their way to the kidneys and on out through the urine.
    - It dumps the toxins directly into the bile and, thence into the intestines for excretion.
- It aids the digestive process by the production of bile, which is used for the breakdown of fats in the intestinal tract.
- It helps the body resist infections by producing immune factors and by removing bacteria from the bloodstream.
- It converts (conjugates) vitamin isolates as found in your vitamin pills into non-toxic forms your body can actually use -- and can then store some of those vitamins and minerals (iron and copper, for example) to be used as needed. In fact, the liver stores all the fat-soluble vitamins (A, B12, D, E, and K, for example). Water soluble vitamins such as vitamin C, on the other hand, are not stored in the liver and need to be taken daily, as any excess is expelled in the urine.
    - In addition, the liver is responsible for "activating" vitamin D so that your body can utilize it.
- It helps maintain the body's hormonal balance.
- It regenerates its own damaged tissue.
- And it synthesizes cholesterol from fatty acids and removes excess cholesterol from the bloodstream as required.

## Cholesterol

In previous newsletters and in *Lessons from the Miracle Doctors*, I've covered the range of misinformation relating to cholesterol and heart disease. In this newsletter, I want to cover a different aspect of cholesterol -- how the body regulates it and, therefore, what we can do to optimize that process.

### *Cholesterol defined*

Cholesterol is a fat soluble steroid. In fact, it is the most abundant steroid in the body. Far from being harmful, when properly regulated, it is a critically important molecule, essential in the formation of a number of key compounds, including:

- Vitamin D
- Progesterone
- Estrogen
- Testosterone
- And adrenaline

It is also essential in the formation of every cell membrane in your body, not to mention the fact that your brain is mostly made up of cholesterol -- much of it in the myelin sheaths that insulate nerve cells and in the synapses that transmit nerve impulses.

As a fat soluble molecule, cholesterol cannot easily be carried in the blood -- a water based medium. Therefore, the body converts cholesterol into water-soluble molecules known as lipoproteins so it can be transported. Lipoproteins are composed of an outer shell made from a phospholipid which renders the particle soluble in water, a core of fats (lipids) including cholesterol, and a surface protein molecule (apolipoprotein) that allows tissues to recognize and take up the particle. Lipoproteins are characterized by their density: high density lipoprotein (HDL), low density lipoprotein (LDL), very low density lipoprotein (VLDL).

In simple terms, HDL lipoproteins are good for you. LDL lipoproteins "theoretically" promote arterial build up and are bad for you.

## Where cholesterol comes from

Diet accounts for about 25% of the cholesterol levels in your body. Your liver synthesizes about the same amount, and the rest is synthesized in organs such as the intestines, the adrenals, and the

reproductive organs. Obviously, trying to control cholesterol levels by solely changing diet will be effective only if levels are slightly out of whack. Although keep in mind, controlling diet is not just a question of regulating the cholesterol or fats that you eat; it is also a question of the soluble fiber (such as oat bran and psyllium husks) that you eat and which absorbs cholesterol and carries it out with your feces so that it never enters your bloodstream.

Unlike dietary changes, statin drugs seek to stop cholesterol formation in the liver by inhibiting a biochemical called 3-hydroxy-3-methylglutaryl coenzyme A reductase, which is required for cholesterol synthesis. Unfortunately, the reason for high cholesterol levels is only rarely due to over production in the liver; it is primarily the result of inadequate removal from the body. That means that statin drugs are not going to be the cause of the problem, but are addressing a symptom by artificially suppressing a properly functioning mechanism in the body. In scientific terms: that can't be good. We'll talk more about that later. But for now, let's talk about how your body actually regulates cholesterol levels.

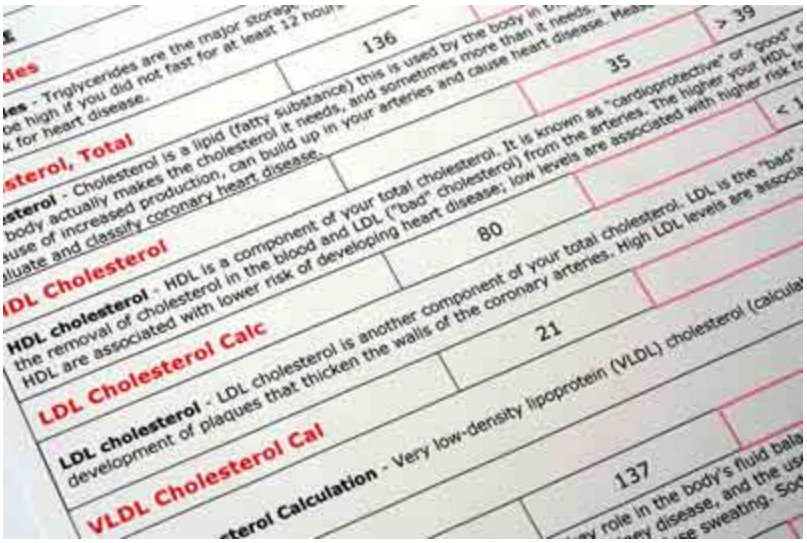
As it turns out, your liver not only manufactures and secretes LDL cholesterol into the bloodstream; it also "down regulates" or removes LDL cholesterol from the bloodstream. In general terms, your liver oxidizes the cholesterol into a variety of bile acids which are then "pulled into the liver," carried into the bile ducts, and then on out through the intestines. As a side note, if the cholesterol becomes **too concentrated** in the bile and sits **too long** in the gallbladder, it can crystallize and form gallstones. (We'll talk more about gallstones in the next issue of the newsletter.) In any case, that's the general description of the cholesterol removal process. To understand exactly what's going on here, we need to examine it in a little more detail.

As it turns out, a healthy liver has a large number of active LDL receptor sites sitting on the surface of all the liver cells. When present and functioning properly, these receptor sites are associated with the rapid removal of LDL cholesterol from the blood -- and consequentially low blood LDL cholesterol levels. So why do these sites sometimes not perform as advertised?

- Some people have an inherited genetic disorder (familial hypercholesterolemia) that causes them to be born with either a diminished number, or even zero, LDL receptors. For those people, statin drugs are a necessity. If the liver can never clear excess cholesterol, you have to stop production of cholesterol at its source.
- Some people, on the other hand have normal receptor sites but as the result of bad diet literally clog up their livers so that the cholesterol cannot clear the receptors -- thus stopping the process of LDL removal. For these people, statin drugs are probably not the best "first" option.

How many of each are we talking about? The genetic condition affects maybe one in 500 people. For everybody else, we're talking about a self-inflicted condition. In other words, the vast majority of cases of high LDL cholesterol are caused by a dietary inflicted blockage of the liver's LDL clearing mechanism. In fact, blockage occurs in two distinct places in the liver. First, fatty deposits can build up in the sinusoids, which prevents the bile from entering the bile ducts and physically clearing the liver -- essentially clogging the liver. Second, and more importantly, excess dietary fats can actually cause ingested cholesterol to build up in the membranes of liver

cells, thus crushing the ability of those cells to process Sterol Regulatory Binding Protein (SREBP), which as its name implies, activates the gene in the LDL receptor site to tell it to take up cholesterol from the bloodstream. This literally stops the receptor sites from functioning as receptors -- totally shutting down the flow of cholesterol through the liver and on out through the bile ducts and colon. Depending on how many liver cells are blocked, this can lead to anything from a minor rise in cholesterol levels on up to a "your doctor is screaming at you" level. In any case, the use of statin drugs does nothing to change this underlying problem. They merely force your body to work around it.




Fortunately, there are options. If you can flush the excess fats and cholesterol that are unnaturally stored in the liver, your body's mechanism for regulating excess LDL cholesterol in the bloodstream will once again function properly -- automatically lowering your cholesterol levels. This is actually not that hard to do, although medical doctors have no idea how to accomplish it. It's called a liver detox/flush, and we will explore it in detail in the next newsletter.

## Conclusion

Before we go, a couple of notes on statin drugs. I'm not very big of them for a number of reasons, including the fact that they have all kinds of side effects. But more to the point, they do nothing to address the underlying cause of high cholesterol levels for the vast majority of people who have the problem -- the clogging of your body's self-regulating mechanism. Oh, and as a minor point, the connection between cholesterol and heart disease is not necessarily as automatic as you have been led to believe. But most significantly of all, one of the side effects of statin drugs is liver failure. Now, given the understanding you now have of what has caused the problem in the first place, how much sense does it make to take a drug that potentially destroys the one mechanism in your body that actually down-regulates cholesterol?

Absolutely none! The bottom line is that unless you are one of the 1 in 500 who has a genetic problem, statin drugs should only be used as a last resort. Far better to address the source of the problem -- which we will do next issue. Specifically, we will cover:

- Liver function tests -- what they are and how to understand them
- Things that can go wrong with the liver
- The biliary tree, with emphasis on the gallbladder
- The liver/gallbladder flush

## Healing the Liver and Gallbladder

Here we will cover what can go wrong with the liver, how doctors test for it, and what you can do about it -- again from a natural health perspective. In addition, we will spend some time on the gallbladder and biliary tree, the bile ductwork that ties everything together. Considering that gallbladder removal (cholecystectomy) is now one of the most common surgeries in the world, with over a half million performed each year in the U.S. alone, that should be of interest to a number of people. In fact, roughly 20 million Americans suffer from gallstones, and 750,000 of them undergo cholecystectomies each year. There are 800,000 hospitalizations and $2 billion spent annually on gallbladder disease in the U.S. The bottom line is that gallbladder surgery pays for many boats for many doctors every year -- and there are far better, less expensive ways to deal with the problem.

### What can go wrong with the liver

The liver is amazingly resilient and, at the macroscopic level, not much goes wrong with it. Because it is so well protected, it is rarely affected by trauma, but when it is (automobile accidents, war, etc.), it is often fatal because of the large blood supply that serves it. Likewise, although primary liver cell cancer is common in Africa and Asia (related to a very specific combination of "insults" to the liver's cells), it is very rare in the United States and the rest of the developed world where those insults tend not to exist. Although hepatitis (particularly hepatitis B) and cirrhosis can be contributing factors, the primary cause of hepatocellular carcinoma is aflatoxin B1.

#### *Liver cancer*

Aflatoxin B1 is the most potent liver cancer-forming chemical known. It is a product of a mold called Aspergillus flavus, which is found in food that has been stored in a hot and humid environment (common storage conditions in much of the third world, especially Southern China and Sub-Saharan Africa). This mold is found in such foods as peanuts, rice, soybeans, corn, and wheat (all staples in the third world). It is thought to cause cancer by producing changes (mutations) in the p53 gene. These mutations work by interfering with the gene's important tumor suppressing (inhibiting) functions. Generally, both hepatitis B and aflatoxin B1 are required for hepatocellular cancer.

That said, metastatic cancer, which is carried to the liver from other organs (think back on how the portal system feeds blood from the intestinal tract, pancreas, and spleen through the liver) is very common.

### *Hepatitis A*

Hepatitis A is a viral disease that affects the liver. Transmission can occur through:

- Direct person-to-person contact
- Exposure to contaminated water or ice
- Contaminated shellfish (think oysters on the half shell)
- Fruits, vegetables, or other foods that are eaten uncooked and that were contaminated during harvesting or subsequent handling.

The symptoms of hepatitis A are fever, lack of appetite, nausea, and fatigue, and then jaundice. Jaundice is a yellow or orange tint to the skin or whites of the eyes. Some persons with hepatitis A will have no symptoms at all -- especially children. The symptoms of hepatitis A, if you have them, usually last about one or two weeks, and, in most cases, no specific treatment is required in order to get better. Infected persons shed the virus in their stools from a week or two before symptoms begin until a few days after jaundice begins. Because of this, persons who are ill with hepatitis A should not work in restaurants, child care centers, or nursing homes until their symptoms have resolved.

The hepatitis A IgM test is used to screen for early detection of infection and is used to diagnose the disease in patients with evidence of acute hepatitis. Hepatitis A IgM is the first antibody produced by the body when it is exposed to hepatitis A. On the other hand, hepatitis A IgG antibodies develop later and remain present for many years, usually for life, and protect you against further infection by the same virus. There is no test specifically for hepatitis A IgG antibodies, although a total antibody test (which detects both IgM and IgG antibodies) detects both current and former infection with hepatitis A and will remain positive even after receiving the hepatitis A vaccine.

### *Hepatitis B*

The hepatitis B virus results from exposure to infectious blood or body fluids containing infected blood. Possible forms of transmission include (but are not limited to) unprotected sexual contact, blood transfusions, re-use of contaminated needles & syringes (which explains why the incidence of hepatitis B among drug users is so high), and transmission from mother to child during childbirth. It should also be noted that if you are into the latest fashion trends centered around body piercing and tattooing, you have to be extremely careful with the equipment that is used on you. Make sure the equipment is totally sterile. Using non-sterile equipment can transfer the hepatitis B virus or other blood born diseases to your body.

Also, be careful when eating out. Eating uncooked, raw food or eating from outside vendors can infect you with hepatitis B. This is of particular note when visiting third world countries, but can still be a problem in any developed country.

Symptoms of hepatitis B include:

- Loss of appetite
- Fatigue
- Nausea and vomiting
- Itching all over the body
- Pain over the liver (on the right side of the abdomen, under the lower rib cage)
- Jaundice
- Urine becomes dark in color -- not yellow, but dark like tea
- Stools are pale in color (grayish or clay colored)

The danger of hepatitis B is that it can become acute, and then chronic -- ultimately leading to severe liver damage. Unfortunately, there is no treatment that can prevent acute HBV infection from becoming chronic once you get it. The degree of liver damage is related to the amount of active, replicating (multiplying) virus in the blood and liver. Antiviral agents, the medical treatment of choice for chronic hepatitis B, do not work in all individuals with the disease, and may not even be required as in many cases the infection may resolve itself over time.

Although, it's difficult to prevent hepatitis B from progressing if you get it, it is possible to protect yourself from getting it in the first place through immunization. The primary test for hepatitis B is for HBsAg (the hepatitis B surface antigen). Its presence indicates either acute or chronic hepatitis B infection.

### *Hepatitis C*

Hepatitis C (HCV) is the most dangerous of the hepatitis viral infections, and it is the most common cause of chronic liver disease in North America. It is difficult for the human immune system to eliminate the virus from the body once infected, and infection with HCV usually becomes chronic. Over time (often decades), hepatitis C damages the liver and can lead to liver failure. As mentioned, it is difficult for the immune system to clear the virus -- with up to 85% of newly infected people failing to clear it -- and thus most people become chronically infected. It is

estimated that in the U.S. alone more than three million people are chronically infected with hepatitis C, with between 8,000 to 10,000 people dying each year. In the U.S., hepatitis C is the leading cause of liver transplant surgery.

Treatment usually involves a combination of an antiviral (most often ribavirin) and alpha interferon. Alpha interferon is an antiviral protein normally made in the body in response to viral infections. The alpha interferon used in treating hepatitis C, however, is not natural. It is a recombinant form that usually involves the addition of a large molecule of polyethylene glycol to "improve" uptake, distribution, and excretion of the interferon, not to mention prolonging shelf life -- and of course, increasing profits for the companies holding patents.

Peginterferon (owned by Roche), the current alpha interferon of choice, can be given once weekly and provides a constant level of interferon in the blood, whereas standard interferon must be given several times weekly and provides intermittent and fluctuating levels. In addition, peginterferon is more active than standard interferon in inhibiting HCV and yields higher sustained response rates with similar side effects. Because of its ease of administration and better efficacy, peginterferon has replaced standard interferon both when used alone and as part of a combination therapy for hepatitis C.

Combination therapy can indeed lead to rapid improvements in up to 70 percent of patients, but it often doesn't last. Long-term improvement only occurs in 35-55 percent of patients. And unfortunately, there are side effects, which frequently include profound fatigue, headache, fever, muscle pain and chills. In fact, that's just the tip of the iceberg.

Fortunately, there are natural alternatives. Ten years ago, I was introduced to someone who had hepatitis C and who reacted badly (extremely so) to his interferon treatments. By the time I met him, he had reached the point that he had stopped his interferon treatments, as death was preferable to the side effects associated with his treatment. As I said, those side effects can be profound. Fortunately, using a different approach, which we'll talk more about at the end of this report, he was able to drop his numbers to undetectable levels -- and maintain those for years. When I last spoke to him about two years ago, he was still symptom free after eight years -- and that's despite never giving up many bad habits including heavy, daily cigarette smoking. Since then, I have personally seen that experience duplicated several more times with other HCV patients.

Testing for hepatitis C, usually involves a series of five tests -- each filling in a piece of the puzzle.

- **Anti-HCV** tests detect the presence of antibodies to the virus, indicating exposure to HCV. These tests cannot tell if you still have an active viral infection, only that you were exposed to the virus at some point in the past.
- **HCV RIBA** testing confirms the presence of antibodies to the virus. It is used to verify the results of the Anti-HCV test.
- **HCV-RNA** testing identifies whether your infection is active.
- **Viral Load or Quantitative HCV** tests determine the level of infection and are used to determine if treatment is working.

- **Viral genotyping** is used to determine exactly which type of hepatitis C is present. As it turns out, there are 6 major types of HCV, and they all respond differently to treatment. This test is often ordered before treatment to give your doctor an idea of the likelihood of success and how long treatment may be needed.

### *Cirrhosis of the liver*

Cirrhosis is a degenerative disease of the liver that is often caused by alcoholism, but also may result from hepatitis and even parasites. It is characterized by formation of fibrous tissue, nodules, and scarring, which interfere with liver cell function and blood circulation and can often lead to blood backflow. Symptoms include weakness, weight loss, fatigue, abdominal swelling due to fluid accumulation, clotting defects, jaundice, and tenderness and enlargement of the liver. Tests for cirrhosis include prolonged prothrombin time and decreased albumin. Cirrhosis is untreatable and when advanced ends in portal hypertension, liver failure, hepatic coma, and death. As already mentioned, the primary tests for cirrhosis include prothrombin time (a test that measures how long it takes blood to clot) and decreased albumin. As discussed earlier, the liver makes all prothrombin and fibrinogen (clotting factors) for the blood, as well as albumin, the major blood protein. Thus, tests indicating low levels of these proteins would be indicative of liver problems.

## Liver enzyme tests

A simple liver blood enzyme test is often your doctor's first step in determining liver problems. The test is simple. Under normal circumstances, liver enzymes reside exclusively within the cells of the liver, but if the liver is injured for any reason, these enzymes spill out into the blood stream. Thus, if tests reveal them in the bloodstream, it's an "indication" of problems. Specifically, your doctor is looking for the two aminotransferase enzymes: aspartate aminotransferase (AST or SGOT) and alanine aminotransferase (ALT or SGPT). Again, if these enzymes are found in the bloodstream, they are indicative of liver problems. They are not, however, conclusive.

| | | | | |
|---|---|---|---|---|
| CHOLESTEROL | | 215.0 | MG/DL | 120-233 |
| CHOL. PERCENTILE | H 75.0 | | PERCENTILE | |
| TRIGLYCERIDES | H 230.0 | | MG/DL | 50.0-200 |
| PROTEIN, TOTAL | | 7.60 | GM/DL | 6.50-8.30 |
| ALBUMIN | | 4.10 | GM/DL | 4.00-5.00 |
| BILIRUBIN, TOTAL | | 0.41 | MG/DL | 0.20-1.50 |
| BILIRUBIN, DIRECT | | 0.06 | MG/DL | 0.00-0.20 |
| ALK PHOSPHATASE | | 69.0 | UNITS/L | 30.0-110 |
| GGT | | 18.0 | UNITS/L | 5.00-80.0 |
| AST (SGOT) | H 46.0 | | IU/L | 5.00-43.0 |
| ALT (SGPT) | H 65.0 | | IU/L | 5.00-60.0 |
| AMYLASE, SERUM | | 33.0 | UNITS/ | 0.00-100 |

Higher-than-normal levels of these liver enzymes do not automatically mean that you have liver problems. For example, high levels of these enzymes can be caused by muscle damage -- such as that produced by intense exercise. Moderate alcohol intake can also raise levels as can aspirin. Also, even if the levels are raised as a result of real liver problems, the actual levels are not indicative of the extent of liver damage. For example, patients with hepatitis A may demonstrate

very high levels for one to weeks before the condition, as mentioned earlier, totally resolves itself and goes away. On the other hand, patients with chronic hepatitis C infection typically show very little elevation. Again, liver enzyme tests merely indicate a potential problem.

## Bilirubin test

In addition to the liver enzyme test, the prothrombin time test, and the albumin test mentioned above, a complete liver panel will usually include one more test, the bilirubin test. Again as we discussed last issue, the liver excretes bilirubin, the broken-down pigments from dead red blood cells, by metabolizing it with bile salts and excreting it through the feces. Bilirubin is what makes our feces brown. If for some reason, bilirubin is not excreted (as in obstructive jaundice) the feces will turn clay-colored. Likewise, if bilirubin is found in the bloodstream, it's indicative that something is amiss in the liver and that bilirubin is flowing in the wrong direction -- out into the bloodstream.

## Gallstones and the biliary system

As we discussed last issue, gallstones don't start in the gallbladder; they are related to cholesterol metabolic defects originating in the liver itself. They also happen to be associated with obesity and pregnancy. Essentially, if the cholesterol produced in your liver is **too thick** and becomes **too concentrated** in the bile and sits **too long** in the gallbladder, it can crystallize and form gallstones. It is estimated gallstones result in some 600,000 hospitalizations and more than 500,000 operations each year in the United States alone. Bottom line: it's one of the most prevalent digestive disorders known.

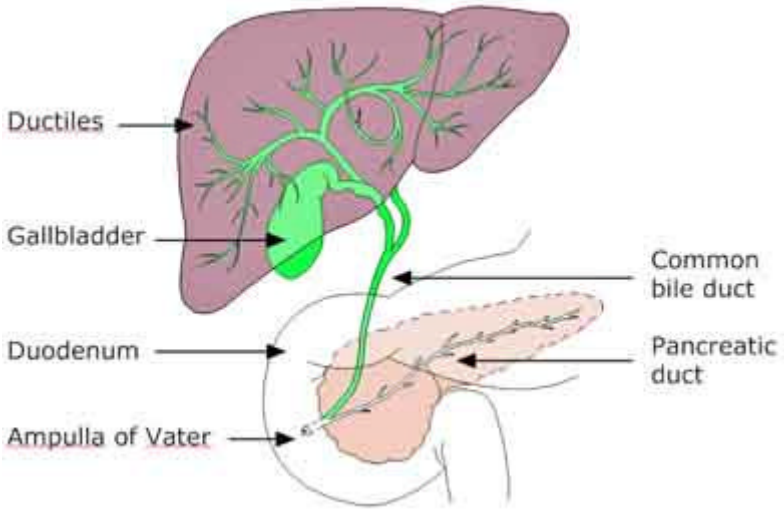
The usual treatment is laparoscopic surgery to remove the gallbladder. The surgery itself has now become so routine that it can be completed in about an hour and the patient leaves the same day -- back to work the next day.

However, because it does not address the underlying cause of the problem (metabolic issues in the liver), gallbladder surgery often does not resolve the patient's discomfort. And because it eliminates the body's regulating mechanism for the release of bile when needed, it often creates new digestive problems of its own. In fact, after gallbladder removal, some 13% of patients report persistent pain. Another 17% report chronic diarrhea, and another 20% report intermittent digestive problems and pain. The bottom line is that although surgeons will report an almost 100% success rate for the surgery, patients will report a 50 % failure rate. It's all a matter of perspective. The surgeon considers the surgery successful if the patient survives, there are no immediate problems, and she collects her fee without a lawsuit. The patient, unfortunately, has to live with the long term results.

### *The biliary tree*

The biliary tree is the anatomical term for the treelike path by which bile is secreted from the liver on its way to the duodenum.

It is referred to as a tree because it begins with a multitude of small branches coming from the thousands of liver lobules which empty into the common bile duct, which is sometimes referred to as the trunk of the biliary tree. Hanging off the trunk, tucked up into the liver is the gallbladder. It is a secondary outpouching, if you will -- an outpouching of the bile duct coming from the liver, which is itself an outpouching of the digestive tract. The gallbladder lies in a groove under the liver, between the two lobes, and is a soft, thin-walled sac, shaped like a fat carrot, with its narrow end pointing toward the bile ducts.




### *Liver duct system*

Bile drains from the ultra small bile ducts (ductiles) that service each of the liver's tens of thousands of lobules into progressively larger ducts, culminating in the common bile duct. The right and left hepatic ducts join just outside the liver to form the common hepatic duct.

Bile passing through the common bile duct exits and enters the gallbladder through the cystic duct. Most physicians refer to the gallbladder as a vestigial organ (as they do the appendix) -- meaning that it's lost most of its original function and now pretty much "gets in the way." To them, this explains why the gallbladder does not usually empty completely, which allows gallstones to form -- leading to pain, infection, inflammation, and even cancer. This also explains why they remove upwards of half a million gallbladders a year in the United States alone.

They are wrong!

The gallbladder serves a definite function. It is not vestigial. It regulates the flow of bile so that it can "push out" into the digestive tract in bursts as needed to assist in the digestion of fats. In fact, the gallbladder will contract to squeeze out stored bile when stimulated by a fatty meal. Without the gallbladder, bile merely dribbles out in a constant flow, thus being present when not required and insufficiently present when needed. This can lead to a whole series of digestive problems including poor digestion, intestinal distress, diarrhea, and an inability to fully break down fats. In fact, many people, as they age, need to take an ox bile supplement (available at all health food stores) with their meals to compensate for insufficient bile in their digestive tracts. If you have digestive problems after eating fatty meals, it's one of the first things you (and your doctor) should look at.

It is important to understand that problems with the gallbladder rarely stem from the gallbladder itself. They stem from the liver, which if not functioning properly will manufacture bile that is

prone to "stoning." Thus removing the gallbladder does not eliminate the problem; it merely eliminates ONE place problems can manifest. Where else can problems manifest? If you follow the biliary tree down past the gallbladder, you will find that the common bile duct joins the pancreatic duct before entering the duodenum through the ampulla of Vater. And there's the problem. Although stones and sludge formed in the liver can no longer get trapped in the gallbladder (if it's been removed), they can still quite easily get lodged in the pancreatic duct and ampulla of Vater. This causes the digestive juices secreted by the pancreas to back up into the pancreas itself and start inflaming and digesting pancreatic tissue. This is called pancreatitis.

In other words, by merely removing the gallbladder and not addressing the underlying problem of "bad bile" being formed in the liver, you may potentially merely be moving symptoms from the gallbladder to the pancreas. Fortunately, there are alternatives. Dietary changes will often help. But the best way to optimize the health of your liver, gallbladder, and pancreas is to regularly cleanse and flush the liver and gallbladder.

## The liver gallbladder flush

Of all the things I talk about in my books and newsletters, the one that medical doctors have the hardest time with is detoxes and flushes. In fact, the "scientific" community will regularly speak out against the concept. But most of that hostility comes from confusion, misunderstanding, and prejudice. Yes, it's true that there is a great deal of "noise" that contributes to that confusion. A search on the internet shows that the word detox has been associated with everything from shampoos to footpads. On the other hand, it's not that hard to separate the wheat from the chaff--if one wants to. Certainly there's a whole lot of chaff in the medical community that must be ignored: hormone replacement therapy, angioplasties, and Tamiflu to name just a few.

That said, the principle of the liver/gallbladder flush is simple. You deprive the body of all fats and oils for a period of time to allow bile and cholesterol to build up in the liver and gallbladder. You then consume a drink containing a large amount of olive oil, which requires the liver and gallbladder to purge all of their bile in an attempt to digest this sudden intake of fat. This produces a figurative "wringing" action on both the liver and gallbladder causing them to empty. In addition to the purging of bile and cholesterol, a good flush will also help the liver purge accumulated fats and toxins. There are several cautions when doing a liver/gallbladder flush.

- You will want to have done an intestinal cleanse before doing the liver flush. Why? Because when the liver and gallbladder purge, they dump into the duodenum. If the intestinal tract is not flowing smoothly the purged bile and toxins can either backup into the bloodstream through the liver or be reabsorbed into the bloodstream through the intestinal tract. This can lead to a cleansing reaction.
- You will want to soften any gallstones before doing the flush. Otherwise, if the stones are large and hard, it will be quite painful (possibly even harmful) when the hard rough stones are squeezed through the bile ducts. At one time I used to recommend products such as Phosfood Liquid, Super Phos 30, and liquid extracts of chanca piedra. And they work. In the end, I designed my own softening formula that works far better and faster than these other alternatives -- often in a matter of one to two hours. But more importantly this formula helps with all kinds of stones including kidney, gallbladder, and

pancreatic. In any case, you will want to do one of these programs before doing a liver detox to soften the stones.

### *One day versus five day liver cleanses*

If you search under liver flushes on the net, you will find two programs recommended -- a five day program and a one day program. The principles of both programs are the same. The one day program is essentially the same as the last day of the five day program. I prefer the five day program for a number of reasons.

- You get to build the strength of the morning purge drink from one to five tablespoons of olive oil over five days. This not only provides a cumulative effect; it also allows the body to adapt, thus making the five tablespoon drink easier to handle.
- Whereas both programs will purge the gallbladder, the five day program does a much better job of purging the liver too.
- The five day program is accompanied by herbal teas and tinctures that also contain:
    - Lipotropics so they help purge fats from the liver
    - Antiparasitic herbs so they help flush parasites from the liver
    - Liver rebuilding herbs such as milk thistle and Picrorhiza kurrooa that help regenerate liver function
    - And are accompanied by juice fasts that help the entire body rebuild and repair itself

### *What you can expect on the liver detox*

If you are so inclined (and you should be), you should examine what you deposit in the toilet during the liver/gallbladder flush. Check for "stones" which may or may not be visible. The bile from the liver gives some stones their typical green color, but also look for black, red, and brown stones, as well as stones with blood inside them. During the course of the cleanse, some people will pass many. Be glad, because the more you pass, the healthier you become. You may also find untold numbers of tiny white cholesterol "crystals" mixed in with the waste. But do not be fooled. Oftentimes, the olive oil is converted into little "soap beads" in the intestinal tract, and many people confuse these little beads with actual stones. Also, keep in mind that if you are softening your stones before doing the flush, they will develop the consistency of toothpaste -- thus they will be significantly elongated when "squeezed" out and not look very beadlike at all. And if you are taking psyllium during the program (which I recommend), most of the waste will be encased by the psyllium and not be visible at all.

If you don't notice anything, though, it doesn't mean the flush is not working. Also, many people don't have gallstones. But they do have toxins and accumulated fat in the liver, and those are being purged. In the end, though, it's not what you see, it's how you feel. Wait for a few days after the cleanse and then evaluate. Did you lose weight? Do you feel lighter and cleaner? Did your senses come alive? Does food taste better? Are colors brighter? Is your breathing a little easier, less congested? These are the true evaluations of the liver detox.

### *Go to the liver detox site*

I am not going to go into the details of how to do a liver flush in this newsletter. It's too involved to cover in a single newsletter, and we've covered it in great detail at the Baseline of Health® Foundation website. Everything you need to know is there including things like:

- Everything you need to buy
- Exactly how to make the morning flush drinks
- What to eat and juice during the flush
- Daily walkthroughs and hour by hour schedules
- What to do if you're diabetic
- What to expect
- Live Q and A sessions

Check it out at: Baseline of Health Foundation Liver Detox and Blood Cleanse

And that concludes our section on the pancreas, liver, and gallbladder.

## Anatomy Of The Small Intestine

We return to our exploration of the intestinal tract from a natural health perspective, but this time we shift gears a bit. So far, we've covered everything from the mouth through the duodenum (taking time to discuss the ancillary outpouchings along the way: the pancreas, liver, and gallbladder). And throughout, the emphasis has been on digestion. But now as we reach the small intestine, things change. Absorption becomes the dominant issue. Yes, a great deal of digestion still occurs in the small intestine, and we will cover that, but the overall emphasis is on absorption. In fact, if you ignore exceptions like the direct absorption of alcohol from an empty stomach, close to 100% of all nutrient absorption in the human body takes place in the small intestine. Obviously then, its proper functioning is crucial to our health.

Here we explore the anatomy of the small intestine to give us

a functional understanding of how it is constructed to do its job and also provide us with a shared vocabulary that we can subsequently use as we explore exactly how the small intestine completes digestion of food and selectively absorbs the nutrients your body needs.

## Macro anatomy of the small intestine

The small intestine, also called the small bowel, serves two primary functions in the body.

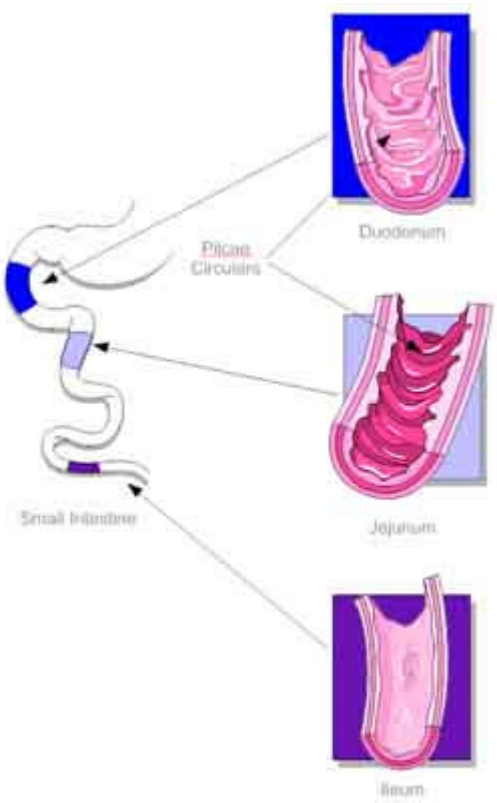
- If the diet consists primarily of cooked and refined carbohydrates and fats, and if no supplemental enzymes are taken with your meals, these compounds will be mostly intact when they reach the small intestine. Digestive juices in the stomach work on proteins, not carbs and fats. That means that for most people, the small intestine is the final stage for the enzymatic digestion of carbohydrates and fats – keeping in mind that oftentimes they are never fully digested and pass unabsorbed into the bowel where they contribute to gas and bloating as bacteria begin to work on them.
- That said, the primary role of the small intestine is the absorption of nutrients broken down by digestion. These include, the absorption of:
    - Proteins (amino acids)
    - Carbohydrates (monosaccharides)
    - Fats (lipids)
    - Vitamins
    - Minerals
    - Enzymes
    - Water

Technically, the small intestine begins at the pylorus valve that separates the stomach from the duodenum and ends at the ileocecal valve that separates the ileum from the large intestine. The bulk of the small intestine is suspended from the body wall by an extension of the peritoneum called the mesentery. The small intestine is approximately 20-23 feet long, depending on how and when it's measured, and it is divided into three sections:

- Duodenum
- Jejunum
- Ileum

Although precise boundaries between these three segments of bowel are not readily observed, there are microscopic structural differences among them.

### *Duodenum*




The name duodenum actually derives from its length and literally means “twelve” inches. It runs from the pylorus valve to the ligament of Treitz (a band of smooth muscle that extends to the diaphragm and works to hold the small intestine in place). Although technically part of the small intestine, the duodenum is almost 100% involved in digestion, not absorption. As such, we have discussed it in great detail already and will not focus on it in this newsletter.

### *Jejunum*

The jejunum runs from the ligament of Treitz to the mid-small bowel and encompasses roughly 40% of the length of the small intestine. It has numerous muscular folds called plicae circulares, and we will explore it in some detail in the next newsletter. The term "jejunum" derives from the Latin and means "empty of food." The name, however, actually came from the ancient Greeks who noticed that at death this part of the intestine was always “empty of food.” Hence, the name jejunum.

### *Ileum*

The third division of the small intestine is the ileum, which runs from the mid-small bowel to the ileocecal valve at the entrance to the large bowel (colon) and encompasses roughly 60% of the length of the small intestine. The word "ileum" comes from the ancient Greek and means "twisted," which actually has a dual meaning. First, when viewed during surgery (or after a Trojan sword has slit open your midsection), the ileum actually looks twisted. The second reference is that the ileum is most often the site of twists that can cause obstructions in the small intestine.

### *Plicae circulares*

As mentioned above, when referencing the jejunum, the small intestine is not flat internally, but is thrown into circular folds. These folds are known as “plicae circulares” and are prominent inside the small intestine from the duodenum to the mid-ileum. They serve a dual purpose:

- They increase surface area for enhanced absorption.
- They cause the chyme to move through the small intestine in a corkscrew motion, which aids in mixing the chyme. Effectively, the folds act as baffles.

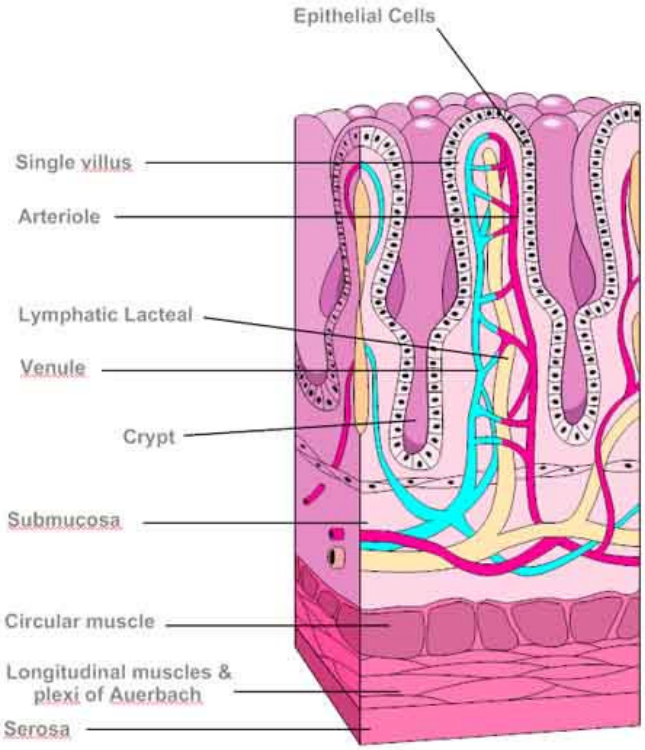
### *Blood supply of the small intestine*

Identifying the blood supply of the small intestine is more important for surgeons than for our discussion of the small intestine as it relates to natural health. Nevertheless, very quickly:

- The duodenum is supplied by the gastroduodenal artery and by branches of the superior mesenteric artery.
- The jejunum is supplied by jejunal branches of the superior mesenteric artery.
- The ileum is supplied by the ileal, right colic, ileocolic, and appendiceal branches of the superior mesenteric artery.

**The microstructure of the small intestine**

If examined closely, the surface of the small intestine has the appearance of soft velvet. This is because it's covered by millions of small projections called villi which extend about 1 mm into the lumen (the empty space inside the small intestine). But villi are only the most obvious feature of the intestinal wall. As we've already discussed, the mucosa (the innermost layer of the intestinal wall) contains a number of different cells including: a self-renewing population of epithelial cells, secretory cells, and endocrine cells. Let's look at the intestinal wall in a little more detail.




The small intestine has the same four layers as the rest of the GI tract, but they are modified for maximal absorptive power.

- **Serosa** -- the peritoneal covering of the external surface of the small intestine.
- **Muscularis –** the muscle layer that governs peristalsis. In particular, it contains:
    - A thin layer of **longitudinal muscles** that stretches the intestine.
    - A thicker layer of **circular muscles** that closes off sections of the intestine as required to allow the intestine to work, move, and grind the chyme in that section over and over before it releases it into the next section of the small intestine…where the process repeats again. We will explore this action in more detail in the next newsletter. (Note: paralytic ileus is the absence of normal GI tract muscle contractions (peristalsis) and can be caused by anything that irritates the peritoneum sufficiently.)
    - **Myenteric plexi of Auerbach,** which coordinate peristalsis. Specifically, the plexi (intersecting groups of nerve cells) are located in the longitudinal muscle layer of

the small intestine. The nerve cells in each plexus primarily project to the circular muscle layer and play an important role in regulating gut motility.

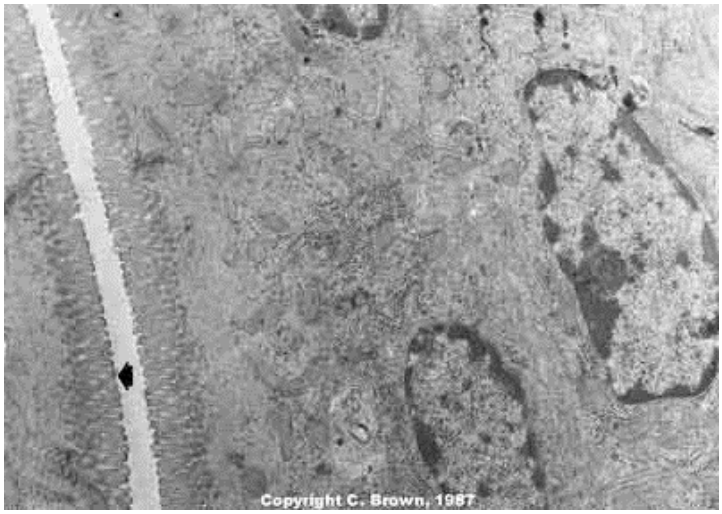
- **Submucosa** – connective tissue. The submucosa consists of dense connective tissue, although fat cells may be present. In fact, all three sections of the small intestine (the duodenum, the jejunum, and the ileum) are all characterized by modifications of the submucosa. The submucosa in the small intestine contains:
    - **Arterioles**, **venules**, and **lymphatic vessels** (lacteals) that regulate the flow of blood and lymph fluids going to and from the mucosa of the small intestine. As a side note, the lymphatic vessels also play a key role in the absorption of fats from the small intestine, something we'll talk more about a bit later.
- **Mucosa** – villi. This is the grand prize, where most of the action in the small intestine takes place. Accordingly, we will now focus on this layer.

### *Villi*

Villi are projections into the lumen covered predominantly with mature, absorptive enterocytes, along with a spattering of mucus-secreting goblet cells. These cells live only for a few days, die and are shed into the lumen to become part of the chyme where they are digested and absorbed. And yes, if you wish to think of it that way, we are all cannibals eating our own intestinal walls. The word villi literally means "tuft of hair," which is exactly what the villi look like. In fact, they are fingerlike projections of the mucosa, with approximately 40 villi/sq mm inside the wall of the small intestine. As discussed earlier, each single villus contains an arterial and venus capillary (arteriole and venule) and a lacteal (the lymphatic equivalent of a capillary). Note: the lymphatic system is a circulatory system that exchanges fluid between cells, drains into veins in the neck, and can absorb fat. In the small intestine, the lacteals transport fat from the digestive tract into the circulatory system.

### *Microstructure of a single villus*

Each villus contains multiple absorptive cells on its surface. And protruding from the surface of these absorptive cells on each villus are a vast multitude of microvilli. Microvilli are minutely small hair-like projections that serve to increase the surface area of each villus.




Microvilli lined up along the edge of a villus

How many microvilli are we talking about?

Hold your breath. Each villus has approximately 200 million microvilli/sq mm. This creates a velvety surface on the walls of the small intestine known as the brush border.

And how much does the brush border of microvilli increase the surface area of the wall of the small intestine involved in nutrient absorption?

Again, hold your breath.

All in all, if the small intestine is viewed as a simple pipe, its surface area totals about half a square meter. But it is not a simple pipe. Factor in the mucosal folds, the villi, and the microvilli, and the absorptive surface area of the small intestine is in fact approximately 250 square meters - the size of a tennis court! This increases the absorptive power of the small intestine exponentially.

Intestinal glands are located in the crypts of Lieberkuhn at the base of the villus (see illustration above). The cells/glands here secrete intestinal juices. Toward the base of the crypts are stem cells, which continually divide and provide the source of all the epithelial cells in the crypts and on the villi. The way they divide is actually quite interesting. One daughter cell from each stem cell division is retained as a stem cell – thus perpetuating the untainted original source. The other daughter cell differentiates along one of four pathways to become either an enterocyte, an enteroendocrine cell, a goblet cell, or a Paneth cell. Enterocyte cells migrate up the crypts, and onto the villi, where they become the mature epithelial absorptive cells essential for extracting nutrients from the chyme. Virtually all nutrients, including all amino acids and sugars, enter the body across these absorptive cells that form the epithelium covering the villi.

Note: After crossing the epithelium of the villi, most nutritional molecules diffuse into the capillary network inside the villus diagrammed above, and then into the bloodstream. Some molecules, fats in particular, are transported not into capillaries, but rather into the lymphatic vessels (lacteals), which drain from the intestine and rapidly flow into blood via the thoracic duct.

Specifically, cells/glands found in the crypts of Lieberkuhn, at the base of villi, include:

- Paneth cells are in the deepest part of the glands. They secrete lysozyme (a bacteriocidal enzyme), and they are phagocytes. Their purpose is to protect against invaders that have made their way into the intestinal tract along with the food we eat.
- Enteroendocrine glands are the deepest part of the glands. The cells here secrete three hormones: secretin (S-cells), CCK (CCK-cells), and gastric inhibitory peptide (K-cells).
- Brunner's glands are in the deepest part of the duodenal mucosa. They secrete alkaline mucous to neutralize acid.
- Goblet cells secrete lubricating mucous.
- Peyer's patches are sections of lymphatic tissue that detect foreign elements in the GI tract and signal the immune system. (Again, you can bring a lot of bad stuff in through your mouth that needs to be dealt with.)

### Ileocecal valve

The ileocecal valve is a small muscle located on the right side of the body (left side on most illustrations) between the small and large intestine, thus marking the end of the small intestine. It is essentially a one way check valve that allows the final stage of chyme to pass into the large intestine for final water extraction and stool making. (Note: once chyme enters the large intestine, it is called fecal matter.) If functioning properly, the valve will open and close as required. Unfortunately, it doesn't always function properly. Sometimes it sticks in the open position, which allows fecal matter to back up into the small intestine, where it can then contaminate the nutrient extraction process. And sometimes the valve sticks in the closed position, which can lead to constipation. Both of these conditions are very toxic and are easily triggered by bad diet (heavy alcohol consumption in particular), dehydration, and stress.

It should be noted that problems with the ileocecal valve are, for the most part, not acknowledged by the medical community, almost never diagnosed, and no effective treatments are offered. Fortunately, there are highly effective natural health options.

- Chiropractic and homeopathic treatments
- Self massage
- Dietary changes

## Physiology Of The Small Intestine, Part 1

And now we reach the heart of the intestinal tract. Everything so far has been preparation for this discussion. Digestion, or breaking food down into smaller bits, is certainly important -- crucial even -- but to what purpose? The purpose, quite simply, is to get the nutrition inherent in the food you ate ready so that it can be absorbed into your body where it can be used by each and every single cell to survive and carry on its individual function. When it comes to the intestinal tract, the key is absorption. It's not what you eat or digest that matters; it's what you absorb. And when it comes to absorption, the small intestine is the portal for virtually all nutrients that enter into the bloodstream.

Note: much of this discussion is easy to understand, but the core of it, the actual act of absorption is quite technical and involves some chemistry. As always, I will only deal with as much chemistry as is absolutely necessary -- and will present it in such a way as to make it comprehensible.

## Digestion -- setting up absorption

Before we can get to absorption, we have to cover the final stages of digestion that take place in the small intestine. In fact, you get a combination of mechanical and chemical digestion and some absorption in the small intestine. Early in the intestine it is mostly digestion, very little absorption. However, the further on you move down the digestive tract, the more the ratio swings in favor of absorption. Effectively, the entire small bowel (duodenum, jejunum, and ileum) is devoted to these two processes: digestion and absorption. Digestion itself is divided into mechanical and chemical phases.

### *Mechanical digestion*

Mechanical digestion, as we alluded to in our exploration of the anatomy of the small intestine, is the result of two very different, but complementary actions:

- Segmentation contractions chop, mix, and roll the chyme (the mixture of food and digestive juices).
- Peristalsis slowly propels the chyme forward toward the large intestine.

Segmentation represents localized activity in the small intestine, whereas peristalsis represents the more global movement that takes place throughout the entire intestinal tract.

In segmentation, circular muscles constrict and divide the small bowel into segments -- each about 3-4 inches long. A muscle then contracts between the two other muscles and subdivides the segment. This is repeated many times per minute so that the chyme is moved back and forth in the same area of the segment. Localized contractions crush and mix food within that segment alone. This action mixes the chyme with intestinal juices and prolongs its contact with the absorptive surface of the small intestine. Relaxation allows the segments to coalesce, thus allowing chyme to move on down the intestinal tract -- pushed by peristalsis.

Peristaltic contractions represent a global movement that is designed to move chyme through the entire length of the small intestine and ultimately complement the mechanical process of segmentation that holds chyme in individual segments of the intestinal tract. Peristalsis is completely under the control of the autonomic nervous system and is coordinated by the myenteric plexi (plexuses). The myenteric plexus, also known as Auerbach's plexus, is a network of nerves between the circular and longitudinal layers of the muscles surrounding the intestinal tract.

It should be noted that peristaltic activity is weak (as opposed to segmentation), which means that food stays in the small bowel for a relatively long time (4-6 hours). And it should also be noted that peristalsis can be fairly easily slowed or even stopped by outside factors. Culprits include appendicitis, surgery, medication, and even very large meals. On the other hand, there are certain things that can increase peristalsis such as laxatives and certain kinds of illness or toxicity. As anyone who has experienced food poisoning or stomach flu would know, peristalsis is quite capable of shooting food through the intestinal tract when required. In simple terms, the body responds to toxins in the intestinal tract by adhering to the old bromide, "The solution to

pollution is dilution." In effect, the body pours fluid into the intestines and increases peristalsis to eject and weaken toxins in cases such as bacterial contamination. In extreme situations such as presented by cholera, victims may actually die of dehydration from massive diarrhea. Note: in cases of massive diarrhea, you cannot drink enough water to compensate for the loss of fluids. Without the use of massive IV's, you will die of dehydration.

It should also be noted that in the period between meals, when the small intestine is for the most part empty, peristaltic contractions continue throughout the entire small intestine. Think of it as housekeeping activity, designed to sweep the small bowel clear of debris. This movement is the cause of "growling" that can be heard when people have not eaten for awhile.

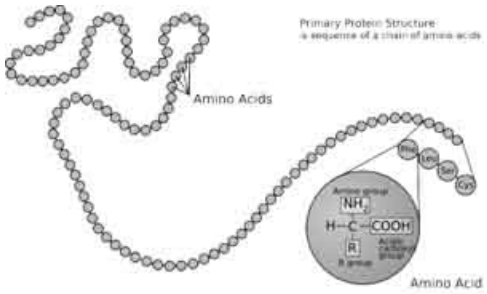
## Chemical digestion

By the time chyme reaches the small bowel, it is a mix of partially digested carbohydrates, lipids, and proteins -- not yet ready for absorption. Digestion must be completed in the small intestine, because the colon will not absorb nutrients to any significant degree. As I mentioned earlier, the ratio of digestion to absorption changes dramatically as the chyme moves through the small intestine and is exposed to ever more chemical digestion. Specifically, digestion for each type of nutrient proceeds as follows.

### *Proteins*

Proteins are denatured (unwound) by acid and broken down by pepsin in the stomach. For the most part, they arrive as polypeptides (short-chain amino acids) in the small intestine. The extent of breakdown into polypeptides is dependent on several factors such as:

- The amount of proteases that arrive undamaged with the food to significantly break down proteins before being neutralized by the release of stomach acid (about 45 minutes after food enters the stomach) -- or the use of supplemental digestive enzymes to make up the difference.
- The ability of the stomach to produce sufficient stomach acid to denature the protein. If the protein is not unwound from its tight ball-like structure into a long chain, pepsin won't be able to work on it.
- Sufficient pepsin production to chop up the protein into its smaller component chunks.
- Any use of antacids or proton pump inhibitor drugs, of course, totally compromise the ability of the body to break down proteins in the stomach since they suppress the stomach acid required to unwind the protein.

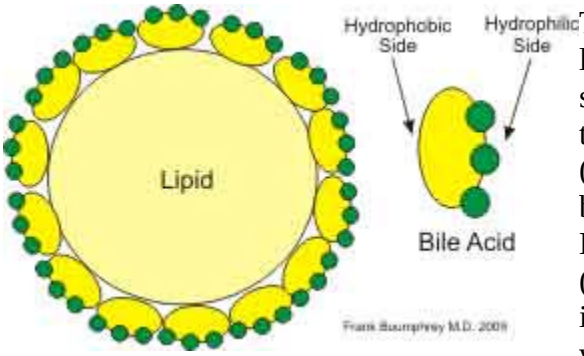


Any breakdown not accomplished in the stomach must now be compensated for in the small intestine -- in addition to the small intestine's role in breaking down short-chain amino acids into even smaller molecules capable of being absorbed into the bloodstream. In either case, after proteins leave the stomach, breakdown continues in the small bowel by activated pancreatic enzymes, including trypsin, chymotrypsin, and elastase (which breaks down elastin fibers). All three are necessary because they each act at different places in the amino acid sequences.

In addition, brush border cells of the small bowel excrete more peptidases -- enzymes such as aminopeptidase and dipeptidase -- that complete the splitting of the amino acids into ever smaller components. Ultimately, this creates molecules small enough to transport across the brush border cells and into the bloodstream.

### *Lipids (fats)*

Some lingual and gastric lipases (fat digesting enzymes) have already been at work, but the major job of fat digestion takes place in the small bowel. Again, if fats are consumed uncooked or unprocessed or if supplemental digestive enzymes are consumed with the meal, the equation changes. But in lieu of that, at this point in the process, fats are composed mainly of triglycerides (three fatty acids bound to glycerine). It is the action of pancreatic lipase in the small bowel that breaks them down into smaller, potentially absorbable components. Specifically, pancreatic lipase splits off a monoglyceride, leaving two of the lipids still attached to the glycerine.




To a significant degree, the ability of pancreatic lipase to break down lipids is regulated by how soluble those fats have become. It should be noted that lipids in their natural state are not water-soluble (that is, they do not dissolve in water). This is where bile, regulated by the gallbladder, comes into play. Bile salts (from the liver and gallbladder) emulsify (break into small droplets) the fat for easier entry into water solutions -- or more technically, into water suspensions. If you have gallstones, or have had your gallbladder removed, you will tend to have incomplete breakdown of lipids in your small intestine, resulting in fatty stools and a tendency to intestinal discomfort. In addition, and even more important, malabsorption of lipids prevents the body from receiving any of the nutrients dissolved in the fat. We're talking about vitamins A, E, and D, tocotrienols, and Omega-3 fatty acids to name some of the more familiar ones.

### *Carbohydrates*

Unless you chewed your food properly (to pick up amylase from your saliva), or took supplemental enzymes with your meal, carbohydrates, for the most part, enter the small intestine intact. Once there, however, they are cleaved into sugars by pancreatic amylase. Further down the small bowel, *maltase*, *sucrase*, *lactase*, isomaltase and *alpha dextrinas*, secreted by the brush border cells, act on the remaining carbohydrates, cleaving off the component simple sugars one sugar at a time. For example:

- Maltase acts on maltose -- cleaving it into its component parts, glucose and glucose.
- Sucrase acts on sucrose -- cleaving it into glucose and fructose.
- Lactase acts on lactose -- cleaving it into its component parts, glucose and galactose. Note: if lactase levels are insufficient, lactose intolerance develops. Bacteria ferment the unbroken lactose, and excess gas is produced.

Note: pancreatic lipase and amylase in the blood are used to measure abnormal function of damaged pancreatic cells.

## Absorption

Again, everything we've talked about so far is about preparing the chyme for absorption into the bloodstream. Ninety to ninety-five percent of nutrition is absorbed in the small bowel. By the time chyme has reached the small intestine, it has been mechanically broken down and reduced to a liquid by chewing and by mechanical grinding in the stomach. In addition, partial chemical digestion may already have taken place as the result of enzymes in the food itself and enzymes found in saliva. As discussed previously, the effect of those enzymes can be extensive (up to 70% of total digestion) or virtually non-existent depending on how cooked and processed the food is and how much it is chewed. The use of supplemental digestive enzymes, of course, can change that equation dramatically. And finally, the action of stomach acids and pepsin serve to denature proteins and begin the process of breaking them down, making them readily amenable to final breakdown in the small intestine.

Thus, once inside the small intestine, the "partially" digested chyme is exposed to pancreatic enzymes and bile, which ultimately break down the chyme into "component" forms of protein, carbohydrates, and fats capable of being absorbed.

By the end of its passage through the small intestine, virtually everything of value to the body has been extracted from the chyme. We're talking about:

- Water
- Electrolytes (sodium, chloride, potassium)
- Proteins, carbohydrates, and fats (which have been broken down respectively into amino acids, glucose, and fatty acids)
- Vitamins, minerals, antioxidants, and phytochemicals

Let's now look at this process in detail.

## The absorption of water in the intestinal tract

Virtually all of the water that enters your intestinal tract, in whatever form, is absorbed into the body across the walls of the small intestine -- primarily through the action of osmosis. Incidentally, osmosis is defined as *the movement of water across a semi-permeable membrane from an area of high water potential (closer to distilled water) to an area of low water potential (water that contains a lot of dissolved osmotically active molecules such as electrolytes and some*

*nutrients)*. Incidentally, since its molecules are so large, the chyme that enters the intestinal tract from the stomach has only a minimal impact on osmotic pressure. However, as it is progressively broken down, its ability to increase osmotic pressure rises dramatically. For example, undigested starch has little effect on osmotic pressure, but as it is digested, each starch molecule breaks down into thousands of molecules of maltose, each of which is as osmotically active as the single original starch molecule. The net effect is to increase the osmotic pressure by a factor of several thousand times over the original starch molecule. Thus, as digestion proceeds, the osmotic pressure increases dramatically, thereby pulling water into the small intestine. In addition, crypt cells at the base of each villus (in the duodenum and jejunum) secrete electrolytes (chloride, sodium, and potassium) into the small intestine which further increases the osmotic pressure to pull water into the lumen (the empty space in the small intestine). On the other hand, as the osmotically active molecules (maltose, glucose, amino acids, and electrolytes) are absorbed out of the lumen and into the bloodstream, osmotic pressure decreases relative to the electrolyte rich water of the bloodstream, and water is thus reabsorbed back into the body.

The bottom line is that if the secretion and absorption of water doesn't balance, we become either bloated or dehydrated. With that in mind, we can take a look at a water balance sheet.

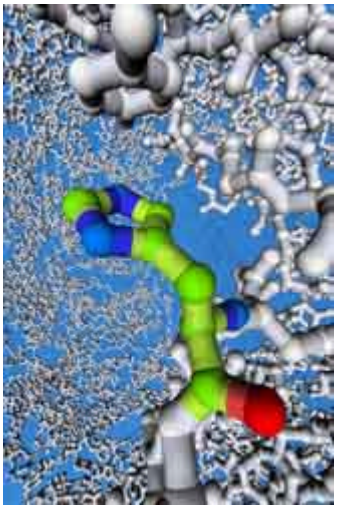
| | | |
|---|---|---|
| Production and intake: | | |
| | Saliva | 1.0 liter |
| | Swallowed liquids | 2.3 liters (most contained in the food we eat) |
| | Gastric juice | 2.0 liters |
| | Bile | 1.0 liter |
| | Pancreatic juice | 2.0 liters |
| | Intestinal juice | 1.0 liter (primarily from brush border cells) |
| | Total | 9.3 liters (average 154 lb man) |
| | | |
| Recycled and excreted: | | |
| | Small intestine reabsorption | 8.3 liters |
| | Colon reabsorption | 1.0 liter |
| | Excreted in feces | 0.1 liter |
| | Total | 9.3 liters (average 154 lb man) |

Thus we can see that the water that enters the digestive tract and that is used in the digestive process is matched to a remarkable degree by the water that is recycled and excreted. In a healthy body, they are perfectly balanced, give or take a tenth of a liter. Keep in mind that the water lost through other means needs to be accounted for in balancing intake and outflow for the entire body. Sweat, for example, can account for anywhere from 100 to 8,000 ml (about 8.5 quarts) lost per day. You lose another quart as water vapor that passes out of your body as you breathe each day -- as anyone knows who watches their breath on a cold day. The amount lost in your urine will pretty much balance out the difference between the amount above and beyond the bare 2.3 liters you consume in your drink and food and the tenth of a liter lost in your feces and what you lose in your perspiration and breath. The bottom line is that your body will seek to balance the intake and outflow of the water it deals with every day -- to prevent bloating or dehydration. At any point it fails to do so, you will end up visiting your doctor.

Keep in mind that even small imbalances between fluid intake and output can cause major problems. Diarrhea is a common symptom of disease and can kill patients through dehydration. On the other hand, rapid over-consumption of water or other liquids, though rare, can cause a rapid drop in sodium and electrolyte levels in the bloodstream and can cause death. Or if your body loses the ability to effectively pass water through your kidneys, you suffer from edema (swelling in your legs), which puts an added burden on your heart.

So, how much water should you drink in addition to what you get in your food? Despite some medical claims to the contrary, I'm still a big fan of 64 ounces a day -- give or take, as circumstances dictate (body weight, temperature, how much you perspire, etc.).

## Physiology Of The Small Intestine, Part 2



We just discussed the physiology of digestion in the small intestine and started our discussion of nutrient absorption. Effectively, this is the heart and soul of our entire series on the digestive tract. Ultimately, everything that happens in the digestive tract is designed to get nutrients into the bloodstream. The final step in the process, absorption, is in many ways the most fascinating part of the discussion. Stomach acid unwinding proteins and pepsin breaking them down -- that's simple stuff. How the body actually recognizes amino acids and peptides and then transports them across the wall of the small intestine, that's remarkably complex and fascinating…and important to understand in terms of optimizing your nutritional uptake and, ultimately, your health.

Note: this is a fairly technical discussion. However, my goal is to

make sure you understand enough of it so that:

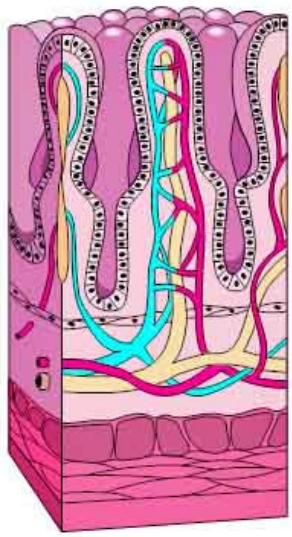
- You are never overwhelmed by the technical for very long.
- You walk away with an overall understanding of how nutrients are absorbed in the small intestine.

## Absorption

Virtually all nutrients, including all amino acids and sugars, enter the body by crossing the enterocytes (the absorptive cells found in the small intestine) that make up the epithelium layer that covers each and every villi (the hair-like extensions that project from the wall of the small intestine). There are two routes by which molecules make their way from the small intestine into the bloodstream:

- **The transcellular route** -- across the plasma membrane of the enterocytes.
- **The paracellular route** -- across tight junctions between the enterocytes.

For the most part, the tight junctions of the paracellular route are impermeable to **large** organic molecules such as dietary amino acids and glucose. Those types of molecules are transported exclusively by the transcellular route. Transcellular absorption of nutrients can take place by active transport or by diffusion. Active transport involves the expenditure of body energy, whereas diffusion occurs simply through random molecular movement and, therefore, without the use of body energy. Water for example, is transported through the intestinal mucosa by diffusion (isosmotic absorption); on the other hand, the absorption of amino acids and sugars involves active transport. This is one of the main reasons that eating a large meal can put you to sleep. You literally exhaust your body digesting and absorbing nutrients -- until down the road, those same nutrients ultimately make their way into your body's individual cells, thus, once again energizing you. Depending on the food you eat, you gain on the exchange -- deriving more energy as the cells absorb the nutrients than was lost in digesting those nutrients and getting them into the bloodstream.



In any case, after passing through the epithelium into the villi, most of these molecules then cross over into the capillary network found inside each villus, thus making their way into the bloodstream. Fats, as we discussed when exploring the anatomy of the small intestine, behave differently. Instead of diffusing into the capillaries, they make their way into the lacteals, the lymphatic vessels present in each villus. From there, they drain from the intestine and rapidly flow through the lymphatic system and ultimately into the bloodstream by way of the thoracic duct.

The process of crossing the epithelium into the villus, however, is not simple. In fact, the process varies for each nutrient. Or to put it another way, the epithelial tissue covering the villi is not uniform throughout the small intestine -- or for that matter, from top to bottom in a single villus. Individual epithelial cells vary in both their makeup and functionality. In fact, each villus has a multitude of different receptor sites, **specific for**

**each nutrient**. Each type of protein fragment and each type of carbohydrate fraction has its own particular receptor site it uses for absorption. In addition, as mentioned earlier, some nutrients diffuse through the spaces between the epithelial cells (the paracellular route) -- spaces that vary throughout the intestinal tract, which has a significant impact on permeability. This becomes particularly important when we talk about the absorption of supplemental proteolytic enzymes (which are protein molecules). Unlike food proteins, proteolytic enzymes can actually use the larger spaces between cells to transport themselves out of the small intestine.

The bottom line is that as chyme (the mixture of broken down food and digestive juices) travels through the small intestine, it is exposed to a wide variety of absorption sites, each with very different characteristics. These absorption/receptor sites differ in the number and type of transporter molecules found in the plasma membranes of each individual cell. And once again, keep in mind, each individual villus is comprised of multiple enterocytes…each with a multitude of receptor sites. In other words, there are a vast number of receptor sites in the small intestine.

### *The chemistry of absorption*

The key to the absorption of most nutrients in the small intestine is the electrochemical pump powered by electrolytes (primarily sodium) which works across the epithelial cell boundary of the villi. In fact, this is not unique to cells in the small intestine. Every single cell in the body is required to maintain a low concentration of sodium inside the cell (with a correspondingly high concentration of sodium outside the cell), which is required for the movement of nutrients into the cell and waste out of the cell. Correspondingly, potassium levels tend to be high inside cells and low in the areas just outside them. In addition, the presence of a large number of Na+/K+ ATPases (ATP enzymes) need to regulate and power the reaction. This means that the cells of the body require the expenditure of energy (in the form of ATP) to power the process

> [Biomedx note: Jon Barron's discussion here references the sodium/potassium pump. While this will lend understanding to some of the absorption discussion, it should be noted that the mechanism of action may be a bit different than the sodium pump theory intimates. The work of Gilbert Ling has disproven the pump theory. Replacing it is an association/induction relationship which is Ling's hypothesis of the cells living state, all of which holds up to scientific scrutiny unlike the pump theory. Alas, long held theories in the academic world do not depart easily. Ling's work has yet to be accepted and taught in mainstream academia. ]

Every cell in the small intestine has three types of gateways that combine to move nutrients in and waste out.

- The actual sodium pump that is used to move sodium into the cell and potassium out of it. It carries three sodium ions into the cell and two potassium ions out with each action of the pump. (Don't panic; we'll explain this in more detail in a moment.)
- The leak channels for both potassium and sodium. If sodium continually moved into cells and potassium out, then in short order the cell would become electrically unbalanced. To help maintain the electrical balance of the cell, there are sodium and potassium ion "leak" channels in the membrane of each cell. These channels are normally closed, but even when closed, they "leak", allowing accumulated sodium ions to leak back out of the cell and excess potassium ions to leak back in, as needed down

their respective concentration gradients. In other words, the leak channels work in conjunction with the sodium pump, and are used to maintain the electrical differential that drives the pump. This is known as the cell membrane potential.

- The receptor sites make use of this electrical potential to carry nutrients (specific to each receptor site) into each cell. Let me repeat that one more time: each receptor site is specific to a particular nutrient. One receptor site transports glucose. Another site transports a specific type of amino acid. And so on. (A little later, we will discuss exactly how this works.)

To summarize, there are three types of gateways. The first two gateways are specific to the sodium pump and are used to maximize the potential of the cell to absorb nutrients. The third gateway is specific to pulling nutrients into the cell. Here's a clean explanation of how it works.

### *Carbohydrates*

Most dietary carbohydrates (even most simple sugars such as sucrose and lactose) cannot be absorbed in the intestinal tract. The monosaccharides (glucose and galactose), on the other hand, are actively transported with sodium. Monosaccharides, however, are only rarely found in normal diets. Rather, as described in Part 1 of our discussion of the Physiology of the Small Intestine, they are derived by enzymatic digestion of more complex carbohydrates in the small intestine. In summary, glucose and galactose are taken into receptor sites found on the villi by co-transport with sodium using the same transporter.

Now, for the briefest of moments, let's get technical. (Hang in there; it's actually understandable.)

The specific transporter molecule that carries glucose and galactose into the absorbing cell on the intestinal wall is SGLUT-1, also known as the sodium-dependent hexose transporter. This molecule will only transport the combination of a glucose and sodium ion into the cell together; it will not transport either molecule alone.
It works as follows:

- The transporter molecule is initially oriented facing into the small intestine. At this point, it can only bind sodium - not glucose.
- The act of binding sodium inside the transporter molecule triggers the opening of the glucose-binding pocket.
- This causes glucose found in the small intestine to also bind inside the transporter cell. The binding of the glucose molecule triggers the transporter molecule to reorient so that the pockets holding sodium and glucose are moved so that they face inside the cell.
- The sodium now moves off into the cell's cytoplasm, which triggers the glucose to also unbind and move off into the cytoplasm.

- The emptying of the transporter molecule triggers it to reorient back to its original, outward-facing position. And the cycle starts again.
- The transport of galactose works in exactly the same way.

Once inside the enterocyte, glucose, galactose and fructose are transported out of the cell through another hexose transporter called GLUT-2 and on into capillaries that are found within each villus.

As we've already discussed, this is called active transport because it requires the use of ATP and requires the expenditure of some energy both for pulling the sugar molecules into the enterocyte, and then on out of the cell into the bloodstream. However, some time later, after using the sugars to power the body's cells, the end result is a net gain of energy.

Fructose, of course, is the other simple sugar readily absorbed in the small intestine. The transport of fructose, though, involves an entirely different process. It is absorbed through something called facilitated diffusion (facilitated by Glut5) and requires no added energy (ATP) to cross into the bloodstream. The ability of fructose to be absorbed so easily into the system is indicative of its high reactivity in the body -- and therefore also indicative of some of the problems it can present when consumed in a "pure" form such as high fructose corn syrup. When bound with fruit fiber, it behaves differently. It breaks down more slowly and is absorbed more slowly -- thus presenting fewer problems.

As we mentioned earlier, the receptor sites for sugars are specific for sugars. This allows for an interesting option. Certain forms of fiber (which are also carbohydrates) can actually fill these receptor sites making them unavailable for use by the sugars for about an hour. Now, although these fibers can fill the sites, they are not transported into the cell. Instead, they occupy the site for up to an hour (again making those sites unavailable to any sugars for that period of time) until they are eventually rejected by the gateway and move out of the receptor site, then on down the digestive tract and out through the large bowel. Why is this important? Because the use of a sugar metabolic enhancement formula based on these fibers can modulate sugar uptake -- slowing down and evening out the absorption of sugar -- thus helping to avoid insulin spikes. The health benefits can be profound.

### *Proteins*

After digestion, the proteins consumed in our food have been broken down into single amino acids, dipeptides, and tripeptides. These protein "pieces" are actively transported across the duodenum and jejunum. In fact, the mechanism by which amino acids are absorbed is virtually identical to that of monosaccharides, but takes place in different receptor sites. Amino acids are transported by sodium through nutrient gateways built into the cell walls of enterocytes. Dipeptides and tripeptides, on the other hand, are transported in a similar manner, but with hydrogen, not sodium, as the transporter. Again, since we're talking about active transport involving the use of ATP, varying amounts of energy are required in the absorption of proteins.

It should be noted that as with carbohydrates, the transporter receptor sites are specific to amino acids and specific to different types of amino acids. In fact, there are several sodium-dependent

amino acid transporters -- including one each for acidic, basic, and neutral amino acids. Once again, these transporters bind their specific amino acids only after binding sodium. The fully loaded transporter then dumps sodium and the amino acid into the cell's cytoplasm, followed by its reorientation back to its outward facing position.

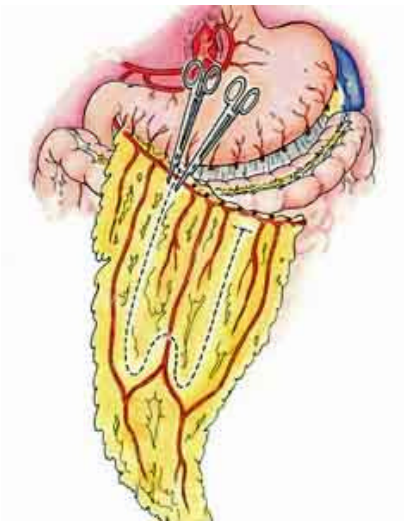
### *Lipids*

After digestion, the fats in our meal have been broken down into fatty acids, monoglycerides, and glycerol. They are absorbed primarily by simple diffusion of small particles across the brush border (the name for the **microvilli**-covered surface of the epithelial cells that line the small intestine) and by a small amount of active transport. The key here is the size of the fatty particles; they must be small in order to be absorbed. That's where bile salts come in. The presence of a controlled flow of bile salts which break up the fats into tiny particles is essential for proper absorption of fats. If your gallbladder is not functioning properly or has been removed, you will have a problem absorbing fats. If you have a problem digesting fats for any reason, an option is to use ox bile tablets available at most health food stores. Supplemental digestive enzymes with lipase will also assist.

Another lipid of importance that is absorbed in the small intestine is cholesterol. As it turns out, cholesterol is readily absorbed in the small intestine. Specifically, a transport protein (NPC1L1) has been identified that transports cholesterol from the lumen (the interior space) of the small intestine into the enterocytes.

Note: unlike proteins and sugars, fats do not go directly into the bloodstream. They transport into the lacteals (tiny lymphatic ducts) found in the villi, and then travel through the lymphatic system and ultimately into the bloodstream. And in fact, fats do not enter the bloodstream in the form in which they were absorbed into the enterocyte. Once inside the enterocyte, fatty acids and monoglycerides are synthesized into triglycerides. These triglycerides are then packaged with cholesterol, lipoproteins, and other lipids into particles called chylomicrons. It is the chylomicrons that actually are transported into the lacteals and on into the bloodstream. Many doctors believe that a high triglyceride count in your bloodstream is actually more indicative of potential heart problems than a high cholesterol number.

### *Omentum*



Okay, we need to revert to a little anatomy for a moment and talk about the omentum. It's not really an organ, and it doesn't really relate to digestion or absorption so it hasn't made any sense to talk about it so far in our series on the intestinal tract. It does, however, relate to fat storage, and in that regard it makes sense to talk about it in terms of what happens to a large chunk of the fat we absorb.

The omentum actually has two parts -- the greater and the lesser. To keep things simple we'll focus on the greater omentum, which hangs from the bottom of the stomach and extends down the abdominal cavity, then back up to the posterior abdominal wall

after connecting with the transverse colon. The greater omentum is mostly made up of fat. It stores fat and provides a rich blood supply to the stomach. Specifically, it plays the following roles:

- It's a fat depository, having varying amounts of adipose tissue. It's one of your body's primary storage sites for fat.
- Immune contribution, having milky spots of macrophage collections.
- Infection and wound isolation; It may also physically limit the spread of intraperitoneal infections. The greater omentum can often be found wrapped around areas of infection and trauma.

For the most part, these are "medical" considerations, but one aspect of the omentum will ring a bell for many readers. Sometimes when people lose a lot of weight, they wonder why their stomachs are still large and fatty. It's often because of the fat stored in the omentum. The fat in the omentum is often the **last fat to go** when losing weight. If you want to lose the gut, you have to lose the fat from the omentum too.

Note: the lesser omentum is an attachment of the peritoneum that lies between the liver and the upper edge of the stomach. It carries the vessels that run to the stomach and liver.

## Vitamins and Minerals

The thing to understand about vitamins and minerals is that for the most part, your body doesn't like isolates, can't absorb them, and considers them toxic if by chance they are absorbed. In general, your body prefers its vitamins and minerals bound to food -- in their natural form, primarily bound to carbohydrates and some proteins. In fact, as might be guessed from all that we've learned about absorption in the small intestine, it's actually the small lipids, sugars, and amino acids attached to the vitamins and minerals that the individual cells of your body recognize and absorb, not so much the vitamins and minerals themselves. Effectively, they just tag along for the ride into the cells. All that said, there are still important differences in how the different vitamins and minerals are absorbed.

### *Fat soluble vitamins*

Assuming that your liver and gallbladder are working properly and that bile salts are breaking fats down into smaller, more absorbable particles, there is little problem absorbing the fat soluble vitamins -- even when in an isolated form -- such as d-alpha-tocopherol vitamin E. The bottom line is that the fat soluble vitamins (including vitamins A, beta- carotene, D, E and K) are diffused right along with their lipid carriers across the brush border of the cells found in the ileum. Likewise, they then travel with their associated fats on into the lymph system and then into the bloodstream.

The problem with using vitamin isolates when supplementing the fat soluble vitamins is not one of absorption or even one of toxicity (where the body thinks the isolate is a toxin). Rather, the problem is one of completeness. For example, consuming vitamin E as d-alpha-tocopherol leaves behind the seven other components of vitamin E (gamma, beta, and delta tocopherol -- plus the

four tocotrienols: alpha, beta, gamma, and delta). Likewise, supplementing with beta carotene or vitamin A leaves behind the several hundred other carotenoids that usually accompany them in nature -- such as alpha carotene. Is that important? Yes, very!

Studies have shown that alpha carotene is one of the most powerful carotenoids and has a strong inhibitory effect on the proliferation of various types of cancer cells such as those affecting the lungs, stomach, cervix, breast, bladder and mouth. It works by allowing normal cells to send growth-regulating signals to premalignant cells. Carrots, for that matter, contain approximately 400 different carotenoids in addition to beta carotene, and many of those carotenoids are far more powerful than beta carotene itself. If all you're getting is beta carotene, you're missing out. And if all you're getting is synthetic beta carotene, you may actually be hurting yourself.

### *Water soluble vitamins*

The water soluble vitamins such as vitamin C and most of the B vitamins are mainly absorbed in the jejunum. They are taken into receptor sites found on the villi by co-transport with sodium using the same transporter system used to carry monosaccharides into the bloodstream. These vitamins do present a problem when allowed to enter the bloodstream as isolates, no longer bound to their appropriate carbohydrates. First, by not being bound to the carbohydrates, it severely limits the amount of absorption that can take place (much of the supplement is wasted and passed on out through the rectum). Second, if absorbed in an isolated form, they are toxic to the body and are carried to the liver as "poisons." The liver then neutralizes their toxicity through a process called conjugation that combines them with proteins. Although conjugation of water soluble vitamins stresses the liver (forcing it to do extra work), it does neutralize the toxic effect of the isolated water soluble vitamins and makes them usable by the cells of your body.

### *Minerals*

Minerals are absorbed in a small area at the top of the duodenum next to the pyloric valve where chyme passes out of the stomach. This is the primary absorption site for the bivalent minerals, including iron, calcium, magnesium, and zinc. The problem with minerals is that they are not easily absorbed in their raw isolated state (think oyster shells and iron filings) because of their electrical charge, which is opposite that of the intestinal wall. At first glance, this might seem like a good thing since opposite charges attract. Unfortunately, they attract to the extent that the minerals "stick" to the intestinal wall and do not get absorbed into the bloodstream. Eventually, the chyme moving through the intestinal tract pushes these "sticky" minerals down through the small intestine and on out through the rectum. Absorption of isolated minerals is about 3-5%. In a non isolated state, when bound to food, the charge is hidden, and absorption will be some ten times greater.

Manufacturers selling vitamin isolates, use a compromise. They chelate their minerals by wrapping amino acids around them. The amino acids "cover" the electrical charge and allow the minerals to be absorbed in the duodenum. Unfortunately, although the charge is obscured, isolates are not user friendly when it actually comes to utilization by the individual cells. In this case, absorption and utilization by individual cells are not the same thing and the rate of cell utilization is significantly less with chelated minerals. Food bound minerals, on the other hand,

are easily absorbed through the small intestine AND they are readily utilized by every cell in the body.

An exception to this rule is what some marketers call "ionic minerals." This is just a fancy way of saying that the mineral particles in the supplement (usually in a liquid form) are so small that the electric charge they generate is not strong enough to prevent its absorption. The bottom line is that good ionic mineral supplements (or their equivalent) are readily absorbed.

One other factor to consider is that the bivalent minerals are **competitively** absorbed because the area of absorption in the duodenum is relatively small. This means that an excessively high intake of one bivalent mineral in particular may occupy the entire absorption area and make the absorption of other bivalent minerals difficult. It also means that you need to supplement your minerals in an evenly balanced form rather than mega dosing on one mineral. To look at it another way, taking regular high doses of iron will impede the absorption of calcium, magnesium, and zinc leading to a series of other nutrition problems.

## Proteolytic Enzymes

Many so called experts say that you cannot absorb proteolytic enzymes. First, they claim that as proteins, they are broken down by stomach acid and pepsin in the stomach unless they are enterically coated. Then other experts say that even if they did survive, their molecules are too big to pass through the walls of the small intestine. Whenever, I hear these arguments, I'm always reminded of the apocryphal story of the engineer who proved that bumblebees can't fly. Applying the principles of aerodynamics, he PROVED that based on their size, weight, the size of their wings, and the physiological limits of how fast they could flap them, that bumblebees could not fly. Of course, how valid is a proof when the evidence before your eyes demonstrates it's nonsense?

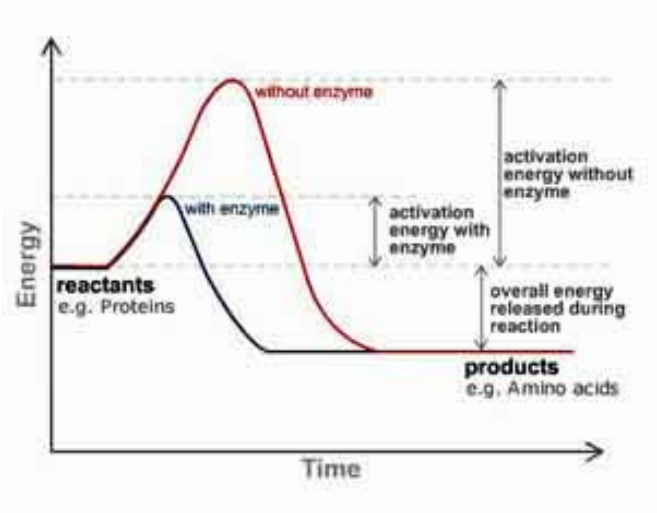
The absorption of proteolytic enzymes is a lot like the story of bumblebees. In the end, it doesn't matter how many ways you try and prove that they can't be absorbed; in the end, you can both measure them in the bloodstream and, more importantly, quantify the results of their presence in your own body.

In any case, let's first deal with the digestive juice issue first. There are two rebuttals:

- Not all enzymes are destroyed by stomach acid and pepsin. Many are merely inactivated until they reach a friendlier pH environment such as found in the small intestine. Want an example of an enzyme that can survive stomach acid and digestive juices -- in fact it thrives in a high acid environment? How about pepsin itself! Pepsin is an enzyme. Not only is it not destroyed by stomach acid; it's actually activated by it. So much for the statement that all enzymes are destroyed in the stomach. (Really! Who are these people?)
- And even if all proteolytic enzymes were destroyed by digestive juices, instructions for using most such formulas tell you to take them between meals -- when no digestive juices are present. Thus the issue is moot and the need for enteric coating moot…at least in a well designed formula used properly.

When I designed my own proteolytic formula, pHi-Zymes, I specifically selected enzymes that survive the stomach environment. It's actually not that hard to do. The key is to use non-animal derived enzymes. Oral supplementation with non-animal derived enzymes, such as microbial enzymes -- those manufactured by a fermentation process of Aspergillus, for example, possess unusually high stability and activity throughout a wide range of pH conditions (from a pH of 2-10). This enables them to be more consistently active and functional for a longer distance as they are transported through the digestive tract. Bottom line: they are not destroyed by stomach acid or pepsin.

Now let's address the issue of absorption. The standard medical assumption is that no dietary protein is absorbed in an undigested form -- pretty much without exception. Rather, since their molecules are too large, dietary proteins first must be digested into amino acids or di- and tripeptides before they can be absorbed. At first blush, that seems to exclude undigested enzymes (which are indeed proteins) from absorption. The clinker, though, is that enzymes, although they are proteins, are not dietary proteins. They are very different in function and structure; they are biochemical catalysts. In fact, enzyme molecules are much smaller than dietary proteins. In fact, they are smaller than DNA molecules. They are indeed small enough to be absorbed. The bottom line is that supplemental proteolytic enzymes can cross the intestinal wall.




How exactly then are they transported across the mucosal membrane of the small intestine? The definitive answer appears to be unknown at this time. Nevertheless, studies indicate that proteolytic enzymes are able to increase the permeability of the mucosal epithelium and, hence, facilitate their own absorption by a mechanism of self-enhanced paracellular diffusion (i.e., across the tight junctions between the epithelial cells).

At this point, it's probably worth abandoning our attempt to argue against the critics and return to the bumblebee analogy and examine what's before our eyes. The bottom line is that if we can demonstrate that proteolytic enzymes consumed orally can later be found in the bloodstream, then we know they are absorbed no matter how many experts tell us they can't get there -- even if we don't know exactly how they got there. And in fact, there are a plethora of studies that prove they reach the bloodstream.

- There are at least 17 studies that prove that nattokinase enters the bloodstream.
- Seaprose-S has at least six studies proving its efficacy on individuals with bronchial and sinus mucous as well as inflammatory issues.
- As for bromelain, there have been a number of studies over the years that substantiate its efficacy in the treatment of inflammatory disorders of the musculoskeletal system.

When summarizing the argument pro and con on the absorption of non-enterically coated proteolytic enzymes in the intestinal tract, I'm reminded of the movie *Chicago*. The husband of Kitty (**Lucy Liu**) says to his wife when caught in bed with two women, "Are you going to **believe** what you see or what I say?" In the end, it doesn't matter what some experts say, proteolytic enzyme supplements can be seen in the bloodstream…and their benefits can be seen by anyone who uses them.

## Fatigue after eating

And now let me touch on one final topic before concluding this newsletter on the absorption of nutrients in the small intestine: fatigue after eating. This appears to be one of those oxymorons that people have a hard time understanding. How can eating sometimes exhaust us?

We know that we can drink Gatorade or have a Snickers bar for quick energy in the middle of the day. But why is it that when we eat a larger, healthy, full spectrum meal (proteins, carbohydrates, and fats) that we actually feel enervated and sleepy for some time after eating, before the energy kicks in. And the answer is actually quite simple.

Digesting and absorbing food is energy intensive and exhausts the body. It takes energy for the body to produce stomach acid and pepsin. It takes energy for the body to produce the pancreatic enzymes that assist in digestion in the small intestine. And as we've seen in this newsletter, it takes energy to actually absorb proteins and carbohydrates across the enterocytes, into the villi, and on into the bloodstream. All in all, the body expends a great amount of energy getting nutrients into your bloodstream -- enough energy so that you feel exhausted after eating a large meal. And the larger the meal, the more exhausted you feel. It is not until the digested/absorbed nutrients actually make their way through the bloodstream and on into every single cell in your body that you get your energy back. In the end, you gain more energy than you expended, and it is that energy that is used to power your body. But it can take several hours after eating to go from a negative expenditure of energy to a positive intake of energy and balance the scales out.

As a side note, taking supplemental digestive enzymes with your meals significantly decreases the fatigue factor experienced after eating large meals since they relieve your body of so much of its digestive work.

## Conclusion

Okay, that concludes our exploration of the small intestine, both digestion and absorption. Next we will pick up with the ileocecal valve, the gateway between the small and large intestines. From there we will explore how chyme (actually called fecal matter at this point) moves on through the large intestine and on out through the rectum. We will also explore all of the problems that can occur, including colorectal cancer and some of the options you have in dealing with them -- both medical and alternative.

## The Colon

We turn now to the large intestine, or colon, which absorbs any remaining water in the feces and transfers them to the rectum for excretion. As part of our exploration, we will also explore the various reflexes that move feces into and through the colon. And finally, we will conclude by examining the complicated anal sphincter muscle that controls passage through the anus and then discussing the physiology of defecation. Along the way, we will also explore those things that can go wrong in the colon -- from colon cancer to diverticular disease -- and the options you have to correct them.

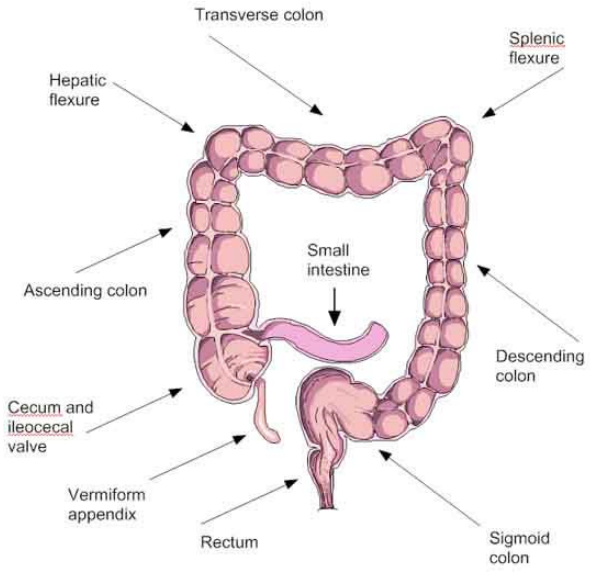
Let's begin by looking at the anatomy of the colon, rectum, and anus.

## The colon, rectum, and anus

The large intestine (aka the colon or large bowel) is the last part of the digestive system and has two primary functions:

- It extracts water and salt from solid wastes before they are eliminated from the body. It should be noted that by the time chyme enters the large intestine, 90% of its water has already been absorbed in the small intestine. On the other hand, as we saw earlier, absorbing that final ten percent is essential for maintaining proper hydration in the body. If the secretion and absorption of water doesn't balance, we become either bloated or dehydrated. It's also essential for firming up the stools and preventing diarrhea. (The large intestine does not play a major role in the absorption of nutrients in the body.)
- It uses bacteria that reside in the colon to ferment and break down any unabsorbed food material that passed through the small intestine unabsorbed. These materials consist largely of amylose (forms of starch), undigested protein, and "indigestible" carbohydrates. The bacteria break down some of these materials for their own nourishment and create acetate, propionate, and butyrate as waste products, which in turn are used by the cell lining of the colon for nourishment. Fermentation by bacteria also produces methane gas, hydrogen gas, and assists in the breakdown of bile salts. Note: intestinal gas is primarily swallowed air. Only 20% consists of the methane and hydrogen produced from fermentation by bacteria.

Anatomically, the large intestine begins with an area called the cecum (caecum), which extends on up through the ascending colon, across the body through the transverse colon, then down towards the anus through the descending colon. It ends in an s-shaped "trap" area called the sigmoid colon, which leads to the rectum, and then on out through the anus. In total, it is about five feet (1.5 meters) in length. On average, it is about 2.5 inches wide, but generally starts much wider in the ascending colon and narrows by the time it reaches the sigmoid colon. The pH in the colon varies between 5.5 and 7 (slightly acidic to neutral).




Structurally, the walls of the colon are similar to the small intestine. All of the underlying layers are virtually identical. The serosa (outside covering), muscularis (layer of muscles that control peristalsis), and submucosa (connective tissue), are all the same. The mucosa, the actual surface on the inside of the large intestine, however, is different. Since nutrient absorption is not a factor, there are no villi. Instead, we find a smooth velvety surface with pits dropping deep into the mucosa. The pits are for absorbing water. Note: mucous is secreted by the mucosa to lubricate the colon, but enzymes are not secreted.

### *The ileocecal valve*

The ileocecal valve is actually a fold of muscle controlled mucosa located in the cecum between the small and large intestine that serves as the inlet valve of the colon. It acts as a one way valve to allow food wastes to flow from the small intestines into the first part of the colon, the cecum, but prevents waste in the colon from leaking back into the small intestine. It is the distension of the cecum, caused by the chyme entering from the small intestine that actually triggers the closing of the ileocecal valve. The ileocecal valve also has a second related function -- to prevent the contents of the ileum from passing into the cecum prematurely. Note: once chyme (food mixed with digestive juices) passes through the ileocecal valve and enters the cecum, it picks up a new name. It is now designated as fecal matter, and it is still fecal matter if it backs up through a malfunctioning ileocecal valve and reenters the small intestine.

The proper function of the ileocecal valve is to open and close upon demand. When this muscle sticks in the open position, it allows fecal matter back into the small intestine. Not healthy! When the muscle is stuck in the closed position, it causes constipation. The main causes of these two conditions are improper diet and stress; and either condition can seriously affect the body. Alcohol in particular can cause the valve to stick in the open position, resulting in the toxic feeling associated with hangovers.

### *The cecum*

Shaped like a pouch, the cecum (also spelled caecum) is where the colon begins. It sits on the right side of your body (left when viewed from the front as seen from an anatomy POV) and, as already mentioned, is connected to the small intestines through the ileocecal valve. Its sole function is to receive waste from the small intestine as it pours through the ileocecal valve.

### *Appendix*

Located below the ileocecal valve are the vermiform and retrocecal appendixes. The retrocecal appendix is located inside the cecum and rarely causes a problem. The vermiform ("wormlike add-on") is the familiar appendix that dangles from the cecum and can frequently become inflamed or infected and require surgery. Like the gallbladder, the medical community considers the appendix to be vestigial -- an evolutionary holdover primarily used by ruminants for hard to digest foods, particularly woody foods. The thinking is that in people, it's become less and less important over time -- shriveling to a wormlike vestigial organ that gets infected. However, thanks to surgeons who now save anyone with appendicitis, there's no evolutionary imperative for the appendix to disappear, so it continues. At least that's the medical thinking.

But as with the gallbladder, that thinking may be a misapprehension, and the vermiform appendix may not be as vestigial as is medically assumed. There is now evidence that the appendix may be of significant importance -- that it plays a powerful role in the functioning of the immune system and that it serves as a storage area for beneficial bacteria.

According to a paper published in the *Journal of Evolutionary Biology*, the appendix serves a dual function. First, it makes, trains, and directs white blood cells. Second, it serves as a type of

warehouse or storage compartment for "good bacteria" that boost the immune system when help is required. According to the research, the appendix holds on to reserves of "good bacteria" so that when bad bacteria flourish or a nasty case of diarrhea reduces the colonies of good bacteria, the appendix can send in reinforcements. These bacteria may also influence white blood cells to clear up any infections in the gut. The studies cited in the paper clearly indicate that the appendix does indeed influence white cell function. So once again, it appears medical science may have "vestigialized" an important functioning organ.

### *The traffic junction*

The three organs just discussed, the cecum, the ileocecal valve, and the appendix form what can be described as a traffic junction designed to control the flow of waste into the large intestine. Ideally, they should be cleared of waste on a continual basis -- daily at the very least.

This can most easily be achieved by using the squatting position when evacuating your bowels. (If you are not presently visiting a rural village in India where the toilet is a hole in the ground, you can always use a toilet footstool.)

In the squatting position, the left thigh supports the descending and sigmoid colons so as to minimize straining and help squeeze fecal matter on into the rectum for imminent evacuation. In addition, the squatting position helps relax the rectal muscles to facilitate evacuation. Meanwhile, the right thigh presses against the lower abdomen on the right side of the body, thereby "squeezing" the cecum to force waste upwards into the ascending colon and away from the appendix, ileocecal valve, and small intestines.

As a result of waste being pushed up out of the cecum, the appendix is kept free of waste and is unlikely to ever get infected. In addition, pressure from the right thigh also helps the ileocecal valve stay securely closed to guard against any leakage of waste into the small intestine. Finally, as the result of the reduced pressure required for evacuation, the squatting position is a highly effective treatment/preventative for hemorrhoids.

### *The large intestine*

Once fecal matter arrives in the **cecum**, it begins its journey through the rest of the large intestine and on out of the body. The **ascending colon**, on the right side of the abdomen, is about 25 cm (10 inches) long in humans. It extends from the cecum straight up the right side of your abdominal cavity to just under the liver, where it makes a sharp right angle bend to the left (in what is known as the hepatic flexure) and becomes the transverse colon. The ascending colon receives fecal material as a liquid. The muscles of the colon then move the watery waste material forward and slowly begin the absorption of all excess water.

The **transverse colon** runs straight across the body from right to left, from the hepatic flexure to what is called the splenic flexure (the right angle bend on the left side of the body just below the spleen). As you may remember from our last newsletter, the transverse colon hangs off the stomach, attached to it by the greater omentum. It is about 18 inches long.

The transverse colon is unique among the other parts of the large intestine in one important way: it is mobile. The ascending, descending, and sigmoid colons are pretty much locked into place and do not move noticeably. Not so for the transverse colon. This becomes particularly important later in the newsletter when we talk about prolapsed colons. It should also be noted that colon cancer starts to become more frequent as we enter the transverse colon, with its incidence steadily increasing as we move further along the bowel, peaking when we reach the sigmoid colon and the rectum. One other note on the transverse colon: in some people who are not evacuating their bowels properly, it can become a major storage area for fecal matter. Again, this will be a factor when we talk about prolapsed colons.

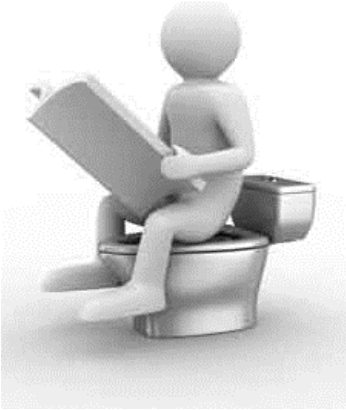
The **descending colon** runs from the end of the transverse colon on the left side of the body, from the splenic flexure to the beginning of the sigmoid colon and is about 12 inches in length. The function of the descending colon in the digestive system is to store food that will be emptied into the rectum. It is also in the descending colon that stools start to become semi solid as they move on to the sigmoid colon.

The **sigmoid colon** is about 18 inches long and is S-shaped. In fact, sigmoid means S-shaped. It begins just after the descending colon and ends just before the rectum. Stools more or less complete their solidification in the sigmoid colon. Additionally, the walls of the sigmoid colon are muscular and contract to forcefully "move" stools into the rectum.

The **rectum** begins at the end of the sigmoid colon and is about four to six inches in length. It is defined by its powerful muscles and by the fact that it sits outside the peritoneal lining (the lining of the abdominal cavity). Essentially, the rectum serves as a holding area for fecal matter. Internally, the rectum contains little transverse folds that serve to keep the stool in place until you're ready to go to the bathroom. When you're ready, the stool enters the lower rectum, moves into the anal canal, and then passes through the anus on its way out. Stimulus of the rectum (giving you the urge to go to the bathroom) occurs both internally (which is an involuntary stimulus) and externally (which occurs when you voluntarily squeeze the muscles. Note: by the time they reach the rectum, feces are composed of water salts, desquamated (peeled off or shed) epithelial cells, bacterial decay products, and undigested food (fiber, etc.). Also, the rectum is an excellent absorber. It can be used to instill (insufflate) water, salts, medication, and/or herbs rapidly -- almost as fast as if administered intravenously.

The **anus** is the end of the trail. Its function is to control the expulsion of feces. The flow of fecal matter through the anus is controlled by the anal sphincter muscle.

### *Physiology of defecation*



The feces end up in the rectum via mass peristalsis. Receptors signal distension of the rectum to the brain. This is a conscious perception. The defecation reflex is initiated when parasympathetic (involuntary) stimulation from the spinal cord contracts the longitudinal rectal muscles. This causes pressure to increase in the rectum. Pressure is added to the rectum by voluntary contraction of the abdominal muscles. Parasympathetic stimulation (again

involuntary) relaxes the internal sphincter of the anus. This increases the urge to defecate. Finally, the external sphincter is opened by voluntary relaxation, which allows the feces to pass out of the body. This can be postponed by voluntary contraction. This is useful since it allows us to wait for an appropriate time/place to go to the bathroom. However, continually postponing defecation begins to dull the evacuation response over time -- leading to chronic constipation. Then again, voluntary postponement can be overwhelmed by conditions such as diarrhea or long term weakening of the muscles. And finally, sphincter muscles weakened by age, disease, or trauma can cause incontinence (inability to hold feces in). Note: bulky, indigestible fiber acts like a "colonic broom" to move feces through the system more quickly, carrying fat, cholesterol, and carcinogens with it.

## Things that can go wrong

According to medical doctors, digestion time (from entering your mouth to passing through your anus) varies depending on the individual. For healthy adults, according to the Mayo Clinic, "It's usually between 24 and 72 hours. After you eat, it takes about six to eight hours for food to pass through your stomach and small intestine. Food then enters your large intestine (colon) for further digestion and absorption of water. Elimination of undigested food residue through the large intestine usually begins after 24 hours. Complete elimination from the body may take several days." That means that, medically speaking, constipation is defined as anything fewer than three bowel movements per week. Or conversely, that normal could be defined as slightly less than one bowel movement every other day.

Quite simply, that's nonsense. It's merely the average elimination time that most doctors see in their patients. But keep in mind, 99% of those patients are eating the standard, fast food, highly processed, low fiber, modern diet. That's neither healthy nor "normal." It's merely what most people do, and most people are unhealthy -- or rapidly moving in that direction. In fact, normal digestion/elimination time is about 24 hours. You literally should have one major bowel movement for every meal you had the day before. You should be passing the waste from yesterday's breakfast when you get up in the morning, or shortly after today's breakfast. Yesterday's lunch should pass around lunchtime and dinner around dinner time. Holding waste in the colon for longer periods of time is one of the single biggest factors in the onset on many major diseases -- not just the colon specific diseases we will discuss below.

### *Colon cleansing*

Other than eating a healthy, high fiber, largely raw food diet, the single best thing you can do for your overall health and the health of your colon is a semi-annual colon cleanse. Any program designed to improve our health or to eliminate disease from our bodies must begin with intestinal cleansing and detoxification. It is the "sine qua non" of health (literally, "without which, there is not").

Look for a program that addresses all of the following aspects of intestinal health:

- Remove all old fecal matter and waste from the colon (to clear the drain, if you will).

- Help remove all the heavy metals and drug residues that have accumulated in the body as a result of having your drain plugged.
- Strengthen the colon muscle so that it works again.
- Repair any damage, such as herniations and inflammations of the colon and small intestine.
- Eliminate the presence of polyps and other abnormal growths that have been allowed to flourish because of an unhealthy intestinal environment.
- Rebuild and replenish the various "friendly" bacteria cultures that ideally should line virtually every square inch of the tube -- again, from mouth to anus.

### *Surgical terminology*

A minor digression before we continue! It probably would make sense to define a handful of surgical terms that you are likely to hear from your doctor if you ever have to visit her for any of the conditions below.

- ‘tome -- to cut
- ‘ectomy -- to cut out, as in appendectomy and cholecystectomy
- ‘otomy -- to cut open and then close again, as in colotomy
- ‘ostomy -- to cut open and make (semi) permanent, as in colostomy

### *Colon cancer*

The most obvious place we see problems associated with not regularly evacuating the bowels is when it comes to colon cancer. Feces remain in the colon for a long time, and carcinogens in feces (which are concentrated to their maximum degree at that point) are currently assumed to explain the prevalence of colon cancer -- second only to lung cancer in the number of deaths it causes each year in the US.

Fecal matter maintains contact with the wall of the large intestine wall for many hours (sometimes for many days if not effectively clearing your bowels on a daily basis). The longer the contact, the greater the problem. The more severe the constipation, the greater the problem. If this fecal matter contains carcinogens ingested with the diet, those carcinogens (some of which are found in grilled meat) have an excellent chance of affecting the wall of the colon -- particularly at places of the longest contact. Not surprisingly, the longest contact and the highest incidence of colon cancer occur in the sigmoid colon, just above the rectum and in the rectum itself.

Societies that eat high fiber, unprocessed diets (that move through the colon more quickly) have far lower incidences of colon cancer, diverticulitis, appendicitis, and coronary artery disease. That said, high fiber diets and proper elimination are not the only factors involved in colon cancer. You can still get colorectal cancer even if you do everything right. Genetics may play a role in up to 10% of colon cancers, for example. Exposure to toxins may also play a factor. Rancid fats in the diet (vegetarian included), too many Omega-6 fatty acids as found in most vegetable oils, and of course, a weakened immune system can all contribute to a higher risk of colon cancer. As always with issues of health, it's a question of odds…not guarantees.

### *Polyps*

A polyp is a projecting mass of overgrown tissue. It looks a lot like an inflated balloon, with the part you tie off attached to wherever it's growing from. Although it is not cancerous itself, virtually all colorectal cancer develops from polyps. When identified during a colonoscopy, polyps are snipped out on the spot thereby eliminating the risk of cancer…from that particular polyp. The same things that cause colon cancer are the things that cause polyps.

### *Prolapsed colon (Ptosis)*

Ptosis is defined as the abnormal descent (prolapse) of the transverse colon in the abdominal cavity. It is usually associated with the downward displacement of other viscera. It is actually quite common, although the degree to which the transverse colon may prolapse can vary wildly -- from very mild to a full V shape, with the middle of the colon actually dropping down all the way to the pelvis. It also should be noted that it is rare for the transverse colon to prolapse by itself without being accompanied by the prolapse of other abdominal organs. In fact, the term now most commonly used to refer to the condition is enteroptosis (entero referring to the entire intestinal area), which reflects this multi-organ reality. The condition will place pressure on all of the organs under it -- uterus, ovaries, prostate, gonads, and bladder. It will exacerbate any tendency towards constipation and will decrease circulation to all of the organs in the lower half of the abdominal cavity. Also, the more pronounced the condition is, the more likely it is to produce a lower "belly bulge" that won't go away no matter how much weight you lose or scrawny the rest of your body becomes.

The condition is more common in women than men and, in fact, frequent pregnancy is sometimes hypothesized as a contributing factor. But the truth is that although many causes (congenital anomalies, weakness of abdominal muscles from lack of exercise, heavy lifting, etc.) are all suspected, no definitive cause has been found. But there can be no doubt that storing undefecated fecal matter in the transverse colon while awaiting the slow evacuation of the bowels cannot help. In some people, pounds of old fecal matter can be found in the transverse colon waiting a chance to exit the body. And considering that constipation is far more common in women than in men, this would also account for the prevalence of ptosis in women.

How do you treat a prolapsed colon? Actually, medical science has little to offer in the way of help. Surgery is problematic and only rarely helpful. Instead, you need to rebuild your intestinal foundation so as to once again fully support the transverse colon. It is difficult to "fully" reverse

a prolapsed colon once it has occurred, but it is possible to "mostly" reverse it -- at least to the point it is no longer visible and no longer noticeably impacts your overall health. Protocol includes:

- An intestinal cleanse to remove any accumulated fecal matter in the transverse colon, thereby decreasing the weight of the organ, and therefore its tendency to prolapse.
- Use a toilet footstool to get your feet up to a squatting position to optimize your posture for more effective evacuation.
- Start exercising your abdominal muscles -- all of them. This means not just things like sits up, but more yoga based exercises such as uddiyana bhanda that actually lift the internal organs.
- Incorporate inverted postures such as a yoga shoulder stand or an inversion machine to hang upside down and let gravity do the work. Or just use a slant board to get your feet and lower body higher than your head.
- Walk.
- And deep massage that incorporates intestinal work can also help.

### *Crohn's, IBS, Ulcerative Colitis*

More Americans are hospitalized for digestive diseases than for any other type of illness. In fact, digestive diseases cost the United States alone an estimated $91 billion annually in health care costs, lost work days and premature deaths. And the bottom line is that virtually every single American will suffer from some form of chronic digestive disorder if they live long enough -- and the rest of the world is following close behind.

Four years ago, I wrote a newsletter on Crohn's disease, IBS, and ulcerative colitis. The information and recommendations still apply today.

### *Diverticular disease*

Diverticular disease represents one of the great conflicts between the alternative health community and the medical community. For several decades from the early 1900's to the 1940's, the alternative health community vehemently argued that the "modern" diet was creating outpouchings or herniations of the colon. The medical community's equally vehement response was that this was utter nonsense. After all, they argued, "We perform numerous autopsies and never see any evidence of it." And they called alternative health practitioners quacks. Nevertheless, starting in the 50's, they began to take possession of the problem and named it diverticulosis. And as is typical, they gave no acknowledgement to the members of the alternative health community such as John Harvey Kellogg, M.D., who identified the disease almost a half century before they did. Nor was there any acknowledgement that they had missed identifying the condition throughout almost a half century of autopsies -- something worth keeping in mind the next time you hear the medical community say that today's autopsies never provide any evidence of people retaining large amounts of old fecal matter in their colons.

Bragging rights aside, it is now understood by all concerned that many people have small pouches in the lining of their colon that bulge outward through weak spots. Each pouch is called

a diverticulum. Multiple pouches are called diverticula. The condition of having diverticula is called diverticulosis. About 10 percent of Americans older than 40 have diverticulosis. About half of all people older than 60 have diverticulosis. The incidence of diverticulosis has increased dramatically from just 10 percent of the adult population over the age of 45 who had this disease in 1952 to an astounding "every person will have many" diverticula, if they live long enough, according to the 1992 edition of the Merck Manual. We've certainly come a long way since the medical community's denial of the first half century.

## Comparison of digestive tract length

Back in September when we started this series on the digestive tract, I announced that as we proceeded, we would be comparing the digestive systems of humans to other animals to see what conclusions could be drawn as to what diet we should eat. And we have done that. We've compared teeth and seen that human teeth are nothing like the teeth of carnivores. We've compared stomachs and seen that once again, the human stomach is very different from that of carnivores and omnivores. In fact, when it comes to teeth and stomachs, humans most closely resemble animals that eat a diet that is mostly comprised of fresh fruit, vegetables, and nuts -- with, in some instances, a bit of raw meat thrown in for good measure.

Is this important?

Yes! The medical community bases its assumptions concerning the human digestive system on the "fact" that it is essentially designed as an omnivore system. But as I discussed in detail in *Lessons from the Miracle Doctors*, this is simply not supported by the evidence at hand. This distinction is not subtle…and not insignificant. Yes, the human body has an amazing ability to adapt to any diet we throw at it -- but not without consequences. And, in fact, many of the diseases we face today are the direct result of not understanding what our systems are designed to handle and the consequences we face as a result.

So, in this newsletter, we reach the last point of comparison: the length of the alimentary canal compared to the length of the body.

An examination of the carnivore intestinal tract reveals a short (relative to the length of their body) tract for fast transit of waste out of the body. The actual length of the carnivore bowel (small and large combined) is approximately 3--5 times the length of the body -- measured from mouth to anus -- a ratio less than half that found in humans. Fast transit of waste for carnivores is essential for two reasons. The faster the transit, the less opportunity for parasites to take hold. Also, meat tends to putrefy in the intestinal tract, so fast transit limits exposure to the byproducts of putrefaction.

As for the herbivore (cows, sheep, etc.) bowel, at 20--28 times the length of the body (from mouth to anus), it usually runs almost eight times longer than a carnivore's, since plant matter (unlike meat) is not prone to putrefaction, thus rendering quick elimination moot. Again, not much like us.

As for the bowel of the frugivore (gorilla, orangutan, chimpanzee, etc.), it runs about 10--12 times the length of the body from mouth to anus.

So which intestinal tract does the human alimentary canal most closely resemble? As we discussed in our Digestive System Overview, the entire system runs about 30 feet in length from mouth to the anus.

Let's total up the lengths we've identified so far:

- Esophagus equals one foot
- Small intestine equals 23 feet
- Bowel equals five feet (as cited above)

That's 29 feet. Add in the mouth, stomach, and rectum and you have a total length of approximately 30 feet. Now compare that to the length of the body (mouth to anus). Why mouth to anus and not head to toe? Because when calculating the body length of four legged animals, we don't stretch out the legs and add them in. We measure from mouth to tail, and so, for a valid comparison, we need to do the same with humans. In any case, mouth to anus is about 2.5 to 3 feet. That gives you a ratio of 10-12 to one. Bingo! It's an absolute match to the frugivore intestinal tract.

### *What should we eat?*

So, are we restricted to fruits and nuts? No. In fact, the frugivores we most closely resemble, the wild chimpanzees, periodically eat live insects and raw meat. Among the great apes (the gorilla, the orangutan, the bonobo, and the chimpanzee) and ourselves, only humans and chimpanzees hunt and eat meat on a frequent basis. Nevertheless, chimpanzees are largely fruit eaters, and meat comprises only about 3 percent of their diet -- far less than is found in the typical Western diet.

Is a vegetarian diet automatically healthier? Not necessarily. Some people actually do better when they include small amounts of meat in their diet -- although, to be sure, a balanced vegetarian diet appears to offer some protection against cancer and heart disease. Other factors in our diet, however, affect our health to a much greater degree than whether or not we eat meat. The bottom line is that, ethical questions aside, eating small amounts of meat, chicken, or fish probably comes down mostly to a personal choice. If you choose to, you can include meat in your diet without any significant health problems -- with the following provisos:

- Keep the amount small, three ounces a day or less.
- If you're going to eat meat, eat organic. Eat grass fed beef, free range chicken and eggs, wild caught fish.
- Avoid or minimize dairy. And if you must have it, have it raw -- or at the very least free of growth hormones. Remember, heat (pasteurization) denatures proteins, specifically making several dairy proteins relatively indigestible and highly allergenic.

- Include lots of water soluble fiber in your diet to keep the unabsorbed proteins moving through the digestive tract. If nothing else, incorporate a tablespoon of psyllium as part of your daily regimen.

[Biomedx note: Getting digestion working effectively can be the biggest plus for anyone regardless of diet, though if dietary considerations are not addressed, good luck. It pays dividends to explore what has been done in practice to see how adaptable the human condition is regarding diet, and how healthy people can be eating in ways you might never consider, or how sick someone can get when they embark on eating what they've been told is everything "right". An opposing view of the vegan or vegetarian perspective can be seen in the work of doctors like Weston A. Price (Nutrition and Physical Degeneration), Jan Kwasniewski (Homo Optimus), or Loren Cordain (The Paleo Diet). Equally important for consideration is proper mitochondrial operation and one's blood type in relation to dietary lectins.]

## Conclusion

We've covered the intestinal tract from mouth to anus. So what useful things have we learned?

- It's important to chew food thoroughly so that it mixes completely with the amylase in your saliva.
- Eat raw foods as much as possible so that your food is packed with live enzymes.
- Use digestive enzyme supplements with your meals to compensate for any shortage of live enzymes in your food. Any shortage causes the body to produce excess stomach acid to compensate.
- Do not drink a large amount of fluids (water, soda, beer) with your meals as that dilutes digestive juices, thus forcing the body to produce more excess stomach acid to compensate.
- How to correct excess stomach acid without using antacids or proton pump inhibitors.
- Why antacids ultimately lead to more stomach acid.
- Why proton pump inhibitors ultimately lead to nutrition problems.
- How to use self-massage, chiropractic adjustment and special exercises to correct hiatal hernias.
- Why it makes sense to regularly run a liver detox program to clean out your liver, pancreas, gallbladder, and kidneys.
- How to make sure you absorb the vitamins and minerals you eat or supplement with.
- How to rebuild and replenish the various "friendly" bacteria cultures that ideally should line virtually every square inch of the tube -- again, from mouth to anus.
- Why it makes sense to regularly run a colon detox program to clean out your intestinal tract -- particularly the large intestine.

We've covered the anatomy and physiology of everything from your teeth to your bowel, plus the organs of digestion including the liver, gallbladder, and pancreas. And even more importantly, along the way, we've explored the nature of diseases of the digestive tract (everything from hiatal hernia to acid reflux, from peptic ulcers to irritable bowel syndrome) and how to treat them naturally by working with your body, not against it.

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## The Wonders of HCl

This might be an appropriate moment to talk a bit more of Hydrochloric acid. As referenced in the above paper, the statement was made that it is the purpose of HCl to "unfold" proteins so they may then be further digested. Individuals do not typically think of hydrochloric acid in this fashion. Dr. Carey Reams (Reams Testing) had made comment that HCl is a special kind of acid due to its spin, which is opposite of other acids. This hits home with the unfolding protein perspective.

In the health fad industry, it is popular in some circles to say that everyone is too "acid" and this is the result of their ill-health. Yet, in the 1920's and 30's, there was a practice known as HCl Therapy, where doctors would directly, through oral, topical, intravenous or intramuscular injection, introduce hydrochloric acid directly into the body to provide tremendous positive benefit to fight a variety of diseases both related to infection as well as degeneration and cancer.

As reported by © Pat Block, ND on line at:
http://health-parameters.com/posts/hydrochloric-acid-therapy-hcl-therapy/

Dr. Burr Ferguson and Dr. Walter Bryant Guy pioneered the use of this therapy and reported their results in a periodical open to 'alternative' approaches called ***The Medical World***. When Dr. Ferguson began treating many kinds of bacterial infections successfully with intravenous infusion of 10cc of 1 in 1000 hydrochloric acid, he tried to publish his findings but no interest was shown in this cheap effective cure.

From his many experiences Dr. Guy formulated a theory that most disease conditions, acute infections, anemias, metabolic disturbances and malignant cell overgrowths are the direct result of blockage of the lymph channels. [Biomedx note: recall the review of the lymph system and Dr. Samuel West's similar perspective from the Rot & Rust text.]

Dr. Ferguson found that intravenous injections of dilute Hydrochloric Acid stimulated phagocytosis which cleaned up the stagnant lymph pond of the body and produced spectacular recoveries from apparently hopeless cases without harming the patient!!

Case histories of successful cures include **cancer (brain, prostate, skin, and colon), tumors or growths, pulmonary tuberculosis, convulsions, chronic bronchitis, migraines, tonsillitis, pneumonia, malaria, acne, bed sores, elephantiasis**, and so on.

Many of these, including cancer are a result of long-standing congested lymph channels. The result is a reduced nutrient supply to the involved tissues (resulting in lowered function and even localized necrosis and resultant infection), and accumulation of cellular wastes (resulting in swelling, weight gain and the formation of cysts and tumors and cancer). Analysis of blood samples after diluted Hydrochloric Acid injections showed that blood oxygen levels increased

drastically, increases in red blood cell and white cell counts, increased phagocytosis (removal of dead tissue, and other debris) all of which resulted in the cure of the disease.

You can see an on line copy of the old text ***Three Years of HCl Therapy*** at: http://arthritis-trust.net/Books/Three Years of HCl Therapy/index.htm

**Some quotes of interest from 'Three Years of HCl Therapy'**

Dr Guy writes, "The world is in sore need of a reliable, effective remedy for cancer and tuberculosis, also a preventive treatment. The writer does not claim that he has a perfected remedy, but he does claim, by repeated proofs, that this [Hydrochloric Acid] solution contains in itself an ability to promptly cause many precancerous lesions to disappear, that cancerous conditions of the internal organs, where other methods are so futile, are and have been dissipated, and that in cases too far advanced for recovery, relief of pain and distress is so marked that such patients believe they will entirely recover."

"The [Hydrochloric Acid] solution has been proved by the writer to be an effective and curative remedy in many cases of cancerous growths; also it points the way to the etiology of cancer and how cancer may be avoided."

"It has curative properties in diabetes, tuberculosis and other degenerative diseases."

"The late Dr. Willy Meyer, of New York City, wrote: "Exact pH measurements have revealed the fact, as shown by the literature, that malignancy is always associated with a high degree of alkalosis, and it has also been shown that the alkalosis precedes the malignancy. There can be alkalosis without malignancy, but it would seem that there can be no malignancy without alkalosis. The more virulent the malignancy, the stronger must be the alkalosis which sustains it." [HCl therapy reverses this.]

So why are people deficient in HCl? Dr. Guy reports, "What, then, are the causes of its disappearance in the gastric fluid, following eating of food? First, Prof. Austin (author of ***Manual of Clinical Chemistry***) says most conclusively that "hydrochloric acid secretion may be completely suppressed by emotion or worry."

I guess doctors Guy and Ferguson wouldn't think too highly of our acid-blocker therapies like Prilosec, Zantac and Nexium, etc. Their conclusions seem to implicate such therapies as promoting cancer and degenerative disease. Intravenous HCl was administered most commonly at the 1:1000 dilution. Intramuscularly both 1:1000 and 1:500 were used. Often, until a physician became comfortable, 1:1500 was used (of stock 35% HCl).

Laboratory grade 10% HCl may be found at educational and scientific websites. One can also obtain it from hardware stores (muriatic acid, usually 35%) but because those applications of muriatic acid do not require high standards of purity, it may be advisable to use a laboratory grade. Using a 10% HCl, 1:1500 corresponds to about 5 drops of 10% HCl in about 1/2 cup

water; 1:1000 corresponds to about 8 drops of 10% HCL in 1/2 cup water; 1:500 corresponds to about 16 drops of 10% HCL in 1/2 cup water.

**Naturopathic Application of Hydrochloric Acid Therapy**

Applications of Hydrochloric Acid therapy consistent with traditional naturopathy are the oral administration used by Dr. Guy et al. and the topical administrations used and reported by many doctors of that time and outlined in the above document and summarized below. Rectal implants have recently come into use and are also very effective.

**Oral Dosage**

Dr. Guy recommended 5-20 drops of a 3% Hydrochloric Acid solution 3 to 6 times daily well diluted. 'Well diluted' means that the 3% Hydrochloric Acid drops MUST be added to a minimum of 1/2 cup of water (in a glass container) before drinking. A greater dilution may also be used, for example the 20 drops of 3% may be added to 1 cup or more of water. At these dilutions the Hydrochloric Acid tastes like diluted unsweetened lemon juice. But don't worry about exact percentages. As a guide for you, I can comfortably sip on 15 drops of my 10% HCl in 1/2 cup of water (about 1:500). That strength would correspond to about 4 drops of the 35% HCl, or 30 drops of the 5% HCl, or about 50 drops of Dr. Guy's 3% in the same amount of water.

10 drops of 35% HCl in a full glass of water measures a pH above 4, which is less acidic than lemon juice or vinegar or apples. If this whole idea makes you nervoust), begin with 1 drop in 1 cup of water, stir with a non-metallic utensil (I use the eye dropper) and sip.

Increase by one drop at a time and sample until it is to your liking. I encourage you to write down your findings. You should use distilled water but set the water out overnight in a warm environment uncovered to allow some of the soluble volatiles to escape. (This is why the pH of purchased distilled water is greater than 7 when just opened. Volatile substances that evaporate before water in the distilling process are often captured and redissolved in the distillate if not allowed to exit first. This is quickly eliminated by boiling your distilled water uncovered for a minute or so.) You shouldn't use water with lots of dissolved solids in it as the HCl may react with those and lessen its therapeutic value.

As far as Dr Guy's daily oral dose of HCl (20 drops of 3%, taken 3 to 6 times/day, which is 60-120 drops daily), in other HCl concentrations this works out to:

**Dr Guy's total daily dose of HCl (may be in divided doses)**

60-120 drops of 3% HCl in minimum 1/2 or more cup water (glass container).
36-72 drops of 5% HCl " "
18-36 drops of 10% HCl " "
5-10 drops of 35% HCl " "

These number of drops can be put into a comfortable amount of water and sipped throughout the day. When taken orally HCl contributes to improved breakdown of protein products in the small intestine, which reduces hunger and helps with blood sugar regulation. Then it is absorbed into the lymph system where it clears up cellular debris in the channels back to the circulation.

The portal vein will carry HCl from the digestion to the liver where it can relieve lymphatic congestion there. HCl has an affinity for the lymph channels where it breaks down proteins (hydrolysis) that clog the lymph!!! Remember, worry suppresses our own production of HCl.

The medical doctors using HCl therapy so successfully began adding mineral chlorides and then used the term 'mineral acids' because they found that the addition of other mineral chlorides gave better results. One such additive which is easily available to all, and the most well-spoken of is Potassium Chloride (KCl). The herbalist John Christopher echoed their findings saying that cancer, tumors and cysts cannot exist in a body well-supplied with potassium. KCl is a salt substitute found in most grocery stores under the name Nu-Salt or No-Salt. Read the label. You can add 1/8 teaspoon to 1 cup water to which your HCl was added.

**Topical Application**

Topical applications of the HCl were done at the 1:500 and 1:250 dilution. These were swabbed into orifices to successfully resolve itching ears, nose sores/polyps and skin epitheliomas.

Fomentations (bandage soaked in dilute HCl and applied) were made for burns and reportedly stopped the pain immediately. These solutions were also sprayed onto the skin to resolve boils, skin ulcerations or other lymphatic congestion and in the sinuses to relieve congestion (may sting).

Dilute HCl was considered a very effective antiseptic as these applications were typically used to address infections or to avoid infection in the cases of burns. You can make this yourself.

First, stock lab concentrations of HCl are about 35% concentration. A 1:500 dilution would be about a .07% and a 1:250 would be a .15% dilution.

To make a cup (236 ml) of the 1:500 strength (.07%) from a 10 % HCl solution:

It would be 33 drops of 10% HCl in one cup (236 ml) of distilled water to make the 1:500 topical dilution. To make the stronger 1:250 dilution, double the amount of drops in the same amount of distilled water, or, use the same amount of 10% HCl drops in 1/2 cup water. Remember that Hydrochloric Acid even though very dilute, will react with metals so avoid contact with metal containers, utensils, measuring devices or jewelry.

**Rectal HCl Retention**

The 'whats' and 'hows' of retention enemas or implants is described elsewhere on health-parameters.com website. Basically this is a dilution of HCl that is inserted rectally and held until it is absorbed by those tissues. One poster the websited uses 3-4 drops of his 35% HCl in about 4 teaspoons (20 cc) of distilled water and uses a rectal syringe to administer that small amount. He credits this practice with putting his leukemia in remission. So 3 drops of 35% HCl would correspond to 10 drops of 10% HCl or 20 drops of 5% HCl in the same amount of water. To begin you should try a lower dosage to make sure it is comfortable.

The HCl is absorbed by the portal vein and goes to the liver where it improves any lymphatic stagnation in that area. It also enters the lymph system of the lower pelvic cavity, breaking any large proteins that are clogging the lymph flow up the main return. To make the solution draw up the 20 cc's of distilled water into the syringe and then place that amount of water into a small empty (shot) glass. Add the HCl drops, stir (with the glass dropper), and then draw up the solution back into the syringe. Add the tip and then implant and retain as described.

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[Biomedx note: In an earlier journey to the office of T.C. McDaniel when he was still in practice, (T.C. is discussed in the Rot & Rust text on zeta potential), it was learned that he was very big on HCl therapy. When visiting, a patient came in to get a direct intramuscular injection of an HCl dilution. Thought it was interesting at the time.

As most natural health practitioners will not be giving an IV or other injection, one thing to consider is iontophoresis. It could certainly be one methodology to deliver HCl to a target location. Iontophoresis is simply using electric current to carry or deliver a chemical payload. A simple iontophoresis unit is a galvanic skin device as used in the skin care marketplace. A simple device can be had for $150 give or take. It basically outputs a DC (direct voltage) electrical current. One polarity will drive things into the tissue, the opposite polarity pulls things out. A flip flopping polarity is often used in therapy.

Putting a dilute HCl solution on the area of interest and then painting the iontophoresis unit for 20-30 seconds or so could be one alternative to addressing a localized issue when injection is not possible.]