Food for Thought: Digest of Digestion & Nutrition
Rancho La Puerta

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The purpose of the digestive tract is to support life by providing the nutrition and energy we need for all of our body functions. The average human has over 37 billion cells, with 25 million new cells created every second. Each existing cell requires energy to fulfill its metabolic function. All human cells, except for red blood cells, has mitochondria that serve as the equivalent of an energy power plant. It is believed that eons ago mitochondria were free living unicellular organisms, such as archaea or bacteria. In a process known as endosymbiosis, they became incorporated into human cells, where they serve a vital function. Perhaps as a residue of their previous independent lives, mitochondria carry their own DNA, inherited in a matrilineal pattern. The more metabolically active the cell, the more mitochondria it has. The liver cells, as well as nerve cells are some of the most active in the body, with each cell containing over 2,000 mitochondria in the cytoplasm. On average, a human cell has over one million chemical reactions occurring every second. The energy and nutrition needs of the human organism are enormous, and the digestive tract must provide for all of this and more, as it also supplies the gut microbiome with its needs.

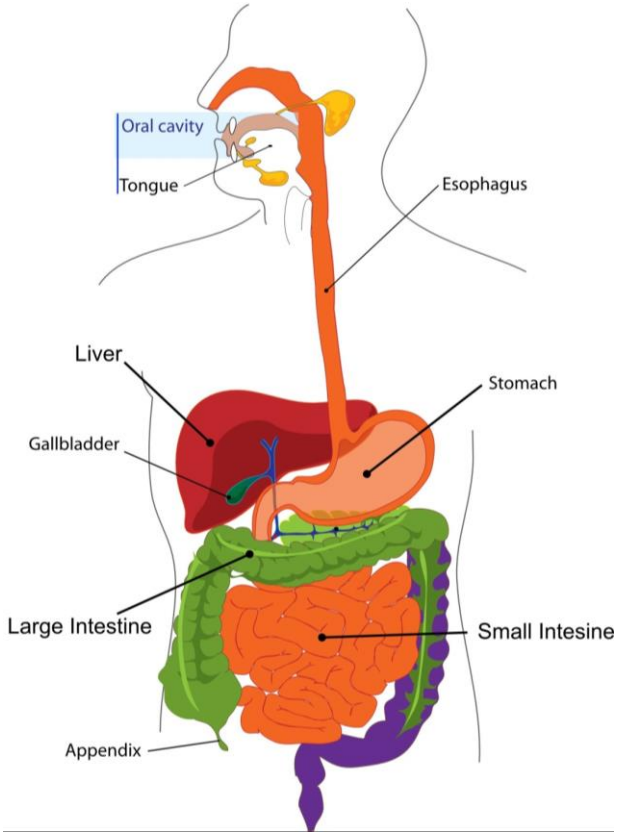
Perhaps the analogy is not the best one, but think of the digestive tract as the reverse of the assembly line, a disassembly line. A factory has a goal to be efficient and profitable, and may not win too many awards for architectural beauty. So too with the digestive tract, the process has been refined over eons of evolution, yet still have its primitive origins and end products. We begin our factory tour with a view much like you would get sitting in your car going through an automated car wash. Before you even go to the car wash, your brain has to make the conscious decision that this activity is what it wants to do. In the same manner, the mind begins the digestive process with the decision to satisfy its hunger call, or because an appetizing opportunity presents itself. When thinking about food and eating, the brain may activate the secretion of saliva and prime the digestive processes of the stomach and internal organs.

Much like the water hoses and spray that greet your vehicle as you enter the beginning of the car wash tunnel, the entrance of food to the mouth receives a similar welcome. Jets of saliva are secreted from the ducts of the salivary glands located strategically around the oral cavity of the mouth. Saliva that is in the

resting mouth is viscous and coats and protects the teeth and the inner surface of the mouth. The secreted saliva with eating or drinking is of a thinner waterier consistency. It has digestive enzymes including amylase to digest carbohydrates and lipase to digest fats.

If your carwash is as sophisticated as your digestive tract, it will have a crew to make sure your side mirrors are tucked in. It will also provide a prewash scrub of your tires to remove residue that would otherwise be difficult for the machinery to reach. The teeth, jaws, and tongue work together in a remarkable and powerful dance with very few of the missteps which would be the dance equivalent of stepping on toes, the biting of the tongue.

The food has to be processed into smaller more manageable portions than that what is found on your plate. Your dining utensils of fork, knife, and spoon are just the preliminary, as the teeth do the real work in preparing food for the process of digestion. The teeth are subdivided into distinct categories that have unique functions. The incisors cut the food as you bite into an apple and the canines tear the food apart as you dig into your pastrami sandwich. The molars crush and grind the salad and crunchy vegetables that you have as a side dish. The grinding and crushing break the plant cell walls apart that would otherwise protect its internal nutritious content from our digestive enzymes. They also increase the surface area of the food increasing their exposure to digestive acid and enzymes.



The chewing process assures that the saliva and its active enzymes are well mixed with the increased surface area of the food. They begin the process of breaking down the carbohydrates and lipids into their essential components to ready them for further digestion and absorption. The saliva also moistens the food and lubricates it for the coordinated swallowing motion of the tongue, teeth, palate, and pharynx. These muscles and organs work together to roll it into an easy to swallow food bolus. The muscles of the swallowing process include those that protect the larynx and airway. The epiglottis closes off the passageway to the trachea, bronchi, and lungs, to prevent aspiration into the airways as the food and saliva swallow takes place.

The coordinated action is developed with age, which is why small children should avoid foods, such as nuts, grapes, larger oval or rounded candies. These foods, if inappropriately swallowed into the airway, can lead to fatal choking episodes. Tragically a number of children die because the oval or rounded shape can completely block the airway. An irregular shaped object, which can be life threatening, rarely completely obstructs the airway and usually allows some air to pass. The complicated swallowing neuromuscular coordination can also be affected by neurological disorders, stroke, surgery or other conditions, which may lead to the risk of aspiration. Once swallowed, the food bolus is propelled down the esophagus by coordinated snakelike muscular action, known as peristalsis. It is not recommended, but the swallowing mechanism is so efficient that you can swallow against gravity while standing on your head.

The muscular valve at the junction of the esophagus and stomach is called the lower esophageal sphincter. The lower esophageal sphincter is designed to allow food and fluid to enter the stomach, with the door closed behind them once they leave the esophagus. If the valve opens at the wrong time, gastric acid, digestive enzymes, and food can flow back into the esophagus. The reflux of stomach contents into the esophagus can lead to symptoms of heartburn or mucosal damage. If the refluxed material goes all the way into the airway hoarseness, sore throat, aspiration, choking, or pneumonia can develop. If it occurs frequently gastroesophageal reflux disease (GERD) can predispose to a change in the normal flat squamous epithelium cell tissue lining the esophagus. The growth of columnar epithelium, more of an intestinal type tissue, in place of the squamous epithelium gives rise to a condition called a Barrett esophagus. This type of cell lining is at a higher risk for abnormal atypical cell changes and a higher risk of cancer development. Individuals with Barrett esophagus are frequently treated for GERD and monitored carefully with surveillance endoscopy and biopsy for pre-malignant changes.

The stomach is a churning caldron of muscular mixing contractions, concentrated acid secretion, and potent digestive enzymes. The vagus nerve and gut hormones play a crucial role in the intricate balance of enzymes, acid, nutrients, and motility. When the conditions are right, the pyloric sphincter of the stomach opens to allow the acid, enzyme, and food mixture to exit. This digestive material is now called chyme as it enters the first portion of the small intestine, known as the duodenum. In Greek, this means the width equivalent to twelve fingers, which is what its small size would measure using your digits. For its small size, the duodenum plays an amazing and complex part.

The highly acid chyme would quickly damage the lining of the duodenum if it did not respond quickly with the pouring on, much like a fire extinguisher, of sodium bicarbonate. The sodium bicarbonate is produced in the duodenum as well as by the pancreas. The sodium bicarbonate produced in the pancreas is released through the pancreatic duct, which empties into the duodenum through the Ampulla of Vater. The fire extinguisher analogy shares another aspect of the story. Perhaps you made a fire extinguisher in a science class, or home experiment, by adding baking soda that contains sodium bicarbonate and vinegar that contains acetic acid. This neutralization of acid is the same type of reaction that takes place in the duodenum, when the hydrochloric acid of the stomach meets the sodium bicarbonate released to neutralize it. When the two react they produce water, sodium chloride (salt), and large quantities of carbon dioxide. The carbon dioxide is released as large volumes of gas that appears as bubbles arising from the reaction. The carbon dioxide is used as a fire extinguisher in the science experiment since it is heavier than air and cuts off the oxygen supply that the flame requires.

In the human duodenum, the carbon dioxide generated as a side product of acid neutralization only serves to bloat and distend the gut with gas. The body is pretty remarkable in getting rid of the bloat relatively quickly, in that it absorbs the carbon dioxide into the bloodstream where it travels to the lungs and is exhaled. The bile ducts from the liver join the duct from the pancreas bringing digestive enzymes and bicarbonate that enter the duodenum through the Ampulla of Vater. Within the ampulla lies the muscular sphincter of Oddi. The name sounds like a character from the story of *The Wizard of Oz*, and

that would be an appropriate analogy. The coordinated release of hormones, enzymes, motility and vagal input is nothing short of wizardry.

Subconsciously, your body can sense what nutrients you have ingested. The body responds by releasing the correct recipe of enzymes, potent acid in the stomach, and bicarbonate in the duodenum, adjusting the pH as necessary. It adds just the right amount of bile to the mix, controls the timing and volume of stomach emptying, and controls the speed of transit and intensity of mixing contractions through the length of the intestinal tract. The majority of the sensing and control feedback takes place in a small confined space the width of twelve fingers, the duodenum.

Enzyme deficiencies can lead to inadequate digestion of foods, which can result in excess material for the gut microbes to ferment with excess gas production. Enzymes are large molecules that are highly selective catalysts that greatly accelerate metabolic reactions. These range from the digestion of food to the synthesis of proteins and DNA. They are often described as being analogous to a lock and key. Most enzymes are proteins that have specific three-dimensional structure that acts like a key, with the substrate acting as a lock. The molecules at the beginning of the process are called substrates, and are converted into different molecules called products. Most enzyme reaction rates are millions of times faster than reactions without the presence of the enzyme catalyst, and the enzymes are not consumed by the reactions and can be reused. Enzyme activity can be affected by other molecules such as inhibitors that decrease enzyme activity and activators that increase activity. Many pharmaceutical products, active ingredients from plants, and poisons are enzyme inhibitors or activators.

There are a wide variety of enzyme deficiencies and food intolerances that can be major contributors to gaseous distension and flatulence. Taking a Sherlock Holmes approach and trying an elimination diet is certainly reasonable. Enzyme supplements are commercially available and are another approach for an empiric trial if the suspect foods are not well defined. Medications can also interfere with enzyme activity and give rise to flatulence. Enzymes include proteases that digest proteins such as pepsin, pepsinogen, trypsin, trypsinogen, chymotrypsin, and chymotrypsinogen. Other enzymes include amylase, lipase, invertase, sucrose, maltase, lactase, and about one thousand six-hundred others! It is important to take the appropriate enzyme with the appropriate food. The right enzyme for the wrong food, or the wrong enzyme for the right food, will not make a bit of difference in helping your digestion. The most common enzyme deficiency is lactase resulting in lactose intolerance. With over one thousand six-hundred known enzymes it is best to do your own Sherlock Holmes detective work with elimination diets or challenges to identify the foods you are best to avoid, or others will be avoiding you because of the intestinal gas that results.

All plants harbor the ability to generate digestive enzymes to break down the starch content of their own seeds and fruit. That is how the fertilized seed gets its nutrition for growth. In fact, we can take advantage of this property to ease our digestion of plants by letting them germinate before ingesting them. For some plants like sprouts and beans that is a very doable suggestion. For other fruits and plants by the time they germinate the starches have lost all culinary appeal to us. What may be surprising is the variety and diversity of enzymes the plants generate across various species. They number in the thousands and the vast majority have yet to be identified and analyzed. The development of plant genomics has accelerated our understanding of the vast diversity of enzymes we are exposed to. A number of plants also generate proteases to digest the plant storage proteins that a number of varieties have a rich storehouse of. For example, wheat has many endopeptidases. The plant world also uses proteolytic enzymes in defense against insect pests, to avoid being consumed by animals that do not assist them in their propagation.

A calorie is simply a measure of the amount of energy within a food or substance. It is measured in a device called a bomb calorimeter, which incinerates the food in a chamber surrounded by a water bath, and measures the increase in water temperature. The number of calories in food is the optimal amount of

energy within the food if completely incinerated, and obviously the digestive tract is rarely as efficient as a furnace. A large percentage, if not the majority, of the calories are not extracted from the food and are eliminated with the digestive waste. The glycemic index is an indication of the rapidity with which the food is digested to allow the release and absorption of simple sugars. The higher the glycemic index the more rapidly sugars are absorbed, with blood glucose spikes contributing to insulin peaks and a greater likelihood of diabetes.

The microbes of the gastrointestinal tract, the gut microbiome, play a critical role in determining the extent to which calories are extracted from the food ingested. The glycemic index, which used to be associated with specific food types, is now believed to be more closely related to the nature of the gut microbiome. It appears that the microbiome can determine whether a diet leads to weight increase or decrease, as well as the glucose response which may contribute to diabetes. A number of companies are now offering gut microbiome analysis, with dietary recommendations tailored to the microbiome.

A calorie is a measurement of the energy contained within a food, and a calorie is a calorie. What is important to remember is that the calorie count of the food is not as important as is the net calories that are absorbed by the body, minus the calories utilized to process and absorb the food. If you ate 100 calories of glucose, a simple sugar known as a monosaccharide, you would not need to expend any energy to digest it, and only a small amount of energy to swallow and absorb it. If it only took 5 calories to process 100 calories of glucose, the net calorie absorption would be 95 calories. Celery has a very low-calorie content, and you expend more energy than the food contains to chew, swallow, digest, and absorb it. If you ate 100 calories of celery, you may burn up 120 calories to process it.

Protein takes the most energy to digest, with 20-30% of the total calories in protein consumed in its chewing, swallowing, peristalsis, digestion, and absorption. Carbohydrate processing usually utilizes 5-10% of its total calories, and fats only 0-3% of its calories. If simple glucose were packaged in difficult to open containers, theoretically you could lose weight by burning up more calories trying to get to the glucose than the food itself contains. If you were to simplify the concept, in general the calories in fat are more likely to be net calories, than calories of carbohydrates, and even more than the calories of proteins. The breakdown products of the digestive process are absorbed by a sea of finger-like projections called the villi. It looks like a field of waving wheat stalks; each upstanding villus is ready to use its enzymes and absorptive capacity to absorb nutrients. If you looked under the microscope, you would find that each villus has thousands of even smaller villi on its surface, given the appropriate name of microvilli.

All of these folds of absorptive tissue, if flattened out, would provide the equivalent absorptive capacity of a championship tennis court. A quote from Mark Twain also illustrates the concept of surface area: “If Switzerland were ironed flat it would be a very large country”. The long intestinal tunnel of eagerly awaiting absorptive villi is about twenty feet long, and it is an amazingly efficient system of digestion and absorption. If injured, the ability of the small bowel to digest and absorb nutrients is compromised. A condition that temporarily damages the small intestine, such as a viral or bacterial gastroenteritis often called stomach flu, can cause a blunting or shortening of the villi. The villous blunting will also lead to the loss of digestive enzymes that reside on the villi.

Without the ability to digest and absorb nutrients, the unabsorbed material can cause what is known as an osmotic diarrhea. People are often advised to avoid dairy products for a week or so after stomach flu to allow the villi and enzymes to recover. If you eat or drink lactose without waiting until the recovery is complete, you may end up with symptoms of temporary lactose intolerance such as gas and diarrhea. When the liquid chyme leaves the jejunum and ileum of the small intestine, it goes through the ileocecal valve to enter the colon. In the cecum of the colon lies the infamous appendix, which for thousands of years mystified science as to its purpose. It looks like its function has finally, and only very recently, been

identified. It stores a reservoir of intestinal bacteria, representing the healthy gut microbiome, from which the gut flora can be replenished after a bout of intestinal dysentery.

Human hair is just 100 microns thick, but the lining of the digestive tract is even thinner. It is only one cell layer thick, about 25 microns wide and 50 microns deep. At half the width of a human hair, this cellophane-like layer separates your vital body from the external environment. It allows the entry of nutrients, fluids, electrolytes, beneficial metabolites, neurotransmitters, hormones, and chemicals, while excluding toxins, parasites, pathogens, and harmful products. The gut lining is the interface with the external environment and supports over 90% of the entire human adaptive and humoral immune defense system that is continuously on guard. Each gut lining cell has a tight junction with the adjacent gut lining cells to provide a complete, contiguous, and continuous active defensive barrier. If the tight junctions are weakened, it becomes a potential breach of this critical defensive system known as a 'leaky gut'.

The ant is a remarkable and intelligent insect, with complex social networks and interactions. The ant colony has a sophisticated society with specific division of labor, with groups of ants assigned to food production, including farming and herding, feeding and rearing the next generation, soldiers for defense and offense, reconnaissance, and a variety of other activities. The ant has over two million individual cells, including over 250,000 cells in its well-developed brain. As complex as the ant is, especially compared to the single cell life form of bacteria, the average human is over 20 million times its size by volume. Even though much smaller than the whale, dinosaur, or elephant, humans are a staggeringly large and complex organism and life form. We contain over 37 billion human cells, with millions of chemical and metabolic reactions occurring every second in each individual cell. We produce 25 million new cells every second. We have to consume nutrients, energy, fluids, electrolytes, minerals, and metabolites through our digestive tracts to support all of the 37 billion human cells, as well as the 100 trillion cells of the gut microbiome, and eliminate the waste produced by this extremely active population.

With our enormous size and biomass, it is easy to be deceived into thinking that we represent the majority, and the microbial world the minority. The fact is that the numbers that count the most are not the quantity of cells or mass, but the genes and epigenetic modifiers. The human species, Homo sapiens, has approximately 22,000 genes. The number of unique species of microbes in the human microbiome is thought to number more than one million, with each having between 15,000 to 30,000 of their own unique genes. Likewise, our human organism is exposed to the millions of other unique species inhabiting our planet. We are exposed through the air we breathe, the foods we eat, the fluids we drink, the odors we smell, and the objects we touch. A single human gene can make over 200 different proteins.

Even more staggering than the hundreds of billions of genes, are the exponentially larger number of epigenetic factors, the majority of which arise from the 99% of DNA that do not code for genes. It is the height of irony that what scientists disparagingly labeled as 'junk DNA', is of critical importance to all life forms. The noncoding junk DNA generates microRNA which is distributed as exosomes throughout the nucleus, into the cytoplasm, into the blood, and the released into the environment via exhaled breath, sweat, bodily fluids, and waste. These active epigenetic factors can then influence the genes of others. Likewise, the microRNA exosomes of the gut microbiome are absorbed and enter into the human system. Over 35% of the metabolites and circulating microRNA exosomes in human blood are of bacterial origin, and an additional 15% are of fungal origin. They may have a profound epigenetic effect on human genome expression, and further analysis will undoubtedly find additional influencers from the rest of the microbiome such as Archaea, viruses, protists, prions, etc. The diverse life forms on Earth are much more closely interrelated than previously believed, and the very definition of human may need to be revisited. As we experience and influence our environment, the environment is also experiencing and influencing us.

As if this were not mind-boggling enough, we now know that genes can be transferred in ways other than the vertical transmission of inheritance. The horizontal transfer of genes from one species to another, commonly referred to as 'jumping genes', occurs with some regularity. Many people are familiar with the fact that about 2%of human DNA is not from Homo sapiens, but from a different species, the Neanderthals. Few people are aware of the more striking recent discovery that about 10% of the human genome is not even human at all, it is of viral origin. Undoubtedly as scientists shake the human genetic tree even more, further surprises will drop. Atmosphere scientists have proven that microbes are airborne and follow wind currents. On average over one million bacteria, and one billion viruses, are dropped from the wind and air over every square foot of planet Earth each day.

A relatively small number of microbes are pathogens, they can be the cause of specific diseases or alternatively cause illness in those who have an immune deficiency or are otherwise compromised. Although antibiotics are designed to eradicate specific bacterial pathogens, it is commonplace for them to be distributed throughout the whole body, not just the location of the infection. When taken orally, the highest concentration is often delivered to the gut microbiome, and many microbes besides the targeted pathogen can be eradicated or suppressed. As the microbiome is disrupted, opportunistic microbes replace those adversely affected by the antibiotic. Even a single brief course of antibiotics can generate long term or permanent consequences and disruption of the microbiome. The use of antibiotics has become so pervasive that most children have had several courses, unless limited access to health care or familial religious beliefs were in place. Newer classes of drugs to address pathogens include agents designed to treat viruses, protist, parasites, and fungus gave raises similar concerns.

While society and medical knowledge has reduced the indiscriminate use of these biological agents in human disease, the same cannot be said for the agriculture and food industry. The quantity of antibiotics used as a vehicle to increase gross food production is a high multiple of that used in human medicine. In addition, the use of hormones, pesticides, herbicides, and chemical toxins is rampant, with measurable levels found in the majority of the food supply, including produce, dairy, meat, poultry, fish, and grains. The popular herbicide glyphosate is structurally related to the amino acid glycine, and actually is classified as an antibiotic, antifungal, and antiparasitic, as it that targets unicellular life forms found in the soil and plant microbiome. It blocks the important shikimate enzyme pathway that produces ringed aromatic amino acids, including phenylalanine, tyrosine, and tryptophan. Tryptophan is the source of serotonin; phenylalanine and tyrosine are the source for dopamine, critical for human brain functions.

It should not come as a surprise that the human gut microbiome is partially populated by the microbiome of the foods we eat, including the soil and plants. Glyphosate (Roundup) is water soluble and so heavily overutilized by industry (four and a half billion pounds per year) that 75% of windborne soil samples and rainfall are contaminated. Even organic farms that have never used the product now produce crops with measurable amounts unless protected from wind and rain. As damaging as glyphosate is to the microbiome, there is a perhaps even greater concern. Aside from direct toxicity concerns, glyphosate is known to have adverse consequences in the gut microbiome leading to the release of zonulin, which is associated with the disruption of the gastrointestinal cellular lining. Zonulin interferes with the cellular tight junctions, the proteins that allow the single cell thick gut lining from the mouth to the anus to efficiently act as a contiguous barrier to unwanted pathogens and metabolites. Any agent, such as glyphosate, alcohol, non-steroidal anti-inflammatory drugs (e.g. ibuprofen), laxatives, that impairs the tight junctions and damages this barrier function can lead to what is described as a ‘leaky gut’.

The gut microbiome is heavily influenced by environmental factors, particularly the diet. Exposure to antibiotics, pharmaceuticals, toxins, probiotics, and virtually anything taken by mouth exposes the microbiome to its influence. Many people consume organic foods with the intent to protect their body and health. Unfortunately, even organic foods can be contaminated if the farmers use manure, an ‘organic

fertilizer', that is often contaminated with antibiotics, hormones, pesticides, and herbicides from commercial cattle and pig farms.

The gut microbiome is much more important than most people realize. The microbes of the body far outnumber the number of human cells. In fact, if you just go by the number of cells and not their mass, they outnumber human cells by ten to one. In other words, you as a living system are only ten percent human and ninety percent microbes! The vast majority of the microbes living within and on us are commensals. The term commensal is used to describe a symbiotic relationship from which both parties benefit. They are able to process foods that would otherwise be indigestible, and convert them to absorbable nutrients and metabolites. It is not an understatement to say that they are a requirement for our health and well-being.

The colon, unlike the small intestine, is less involved in the digestion of foods and nutrients. It is primarily involved in the absorption of water and sodium, as well as some fat-soluble vitamins such as vitamin K. The colon removes the excess moisture from the watery chime solidifying the stool as it transits the gut. The ability to conserve water is necessary, and without this ability the risk of dehydration would be substantially increased. The fecal material of the stool is stored in the rectum, and sigmoid colon, awaiting the right opportunity to be eliminated through defecation. A process or illness that impairs the colon's absorption of water will lead to more fluid in the stool and diarrhea. The loss of water and electrolytes as a consequence of diarrhea, unfortunately, remains a life-threatening condition in many parts of the world, especially for infants and children.

If the elimination of the feces is delayed, the moisture continues to be absorbed, and the stools can become harder resulting in constipation. Constipation itself can be self-perpetuating as it aggravates the situation because the stools become harder and more difficult to pass the longer they remain in the colon. The more common treatments for constipation attempt to increase the moisture content of the stool. The feces excreted can provide information about bowel health. For most people going about their daily activities, the passage of the feces itself is the end of the story of digestion. The human digestive system, like that of other animals, does not remove all of the contained nutrients from food. For other organisms, including the common housefly, the feces are thus an available source of nutrition. For them, the elimination of feces is just the beginning of their story of digestion and can play an important role in the transmission of disease back to humans.

By the way, there is something else besides feces which comes out of the 'tail pipe' of our digestive tract. Intestinal gas, also known as a fart (this is the proper English term, commonly found in the English literature and even used by royalty!), is also one of the waste products of digestion. Swallowed air also contributes to intestinal gas, and if makes you feel any better, the intestinal gas was for the most part created by your gut microbes, not you! Intestinal gas is ubiquitous. All living creatures generate gas from the cellular respiration of metabolism, and humans are no exception.

The bacteria in the colonic flora produce microscopic nanofarts and microfarts, which collect into larger bubbles of gas in the bowel. They are intermixed with the atmospheric air swallowed throughout the day and particularly at meals. As entertaining as they may be to adolescent males, there is growing evidence that they may be of social and scientific value as well. There have been discussions of reducing the methane production of cattle herds to reduce global warming. An alternative would be to capture the methane and use it for energy production. A graphic example of the energy potential is to imagine each cow with a permanently lit 100-watt light bulb under its tail, bringing a new meaning to the term 'tail light'. In medical diagnostics, the analysis of intestinal gas has demonstrated the ability to identify a variety of medical conditions, but it is unlikely to gain much popularity.

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The programs offered are continuously updated with cutting edge information. Well-spoken, enlightening, and entertaining the programs are also visually engaging. Frequently requested programs include To 'Air' is Human (intestinal gas), The Quest for Immortality (longevity & vitality), The Scoop on Poop (gut microbiome & scatology), Digest on Digestion (digestive health & nutrition), Medical WisDumb (marketing hype to health advances), Laughter (& Chocolate) is the Best Medicine (humor in health & wellness), Food for Thought (brain-gut-microbiome axis) and others. For further information, contact Dr. Weiss at speakingofhealth@gmail.com or weisscme@ucsd.edu.

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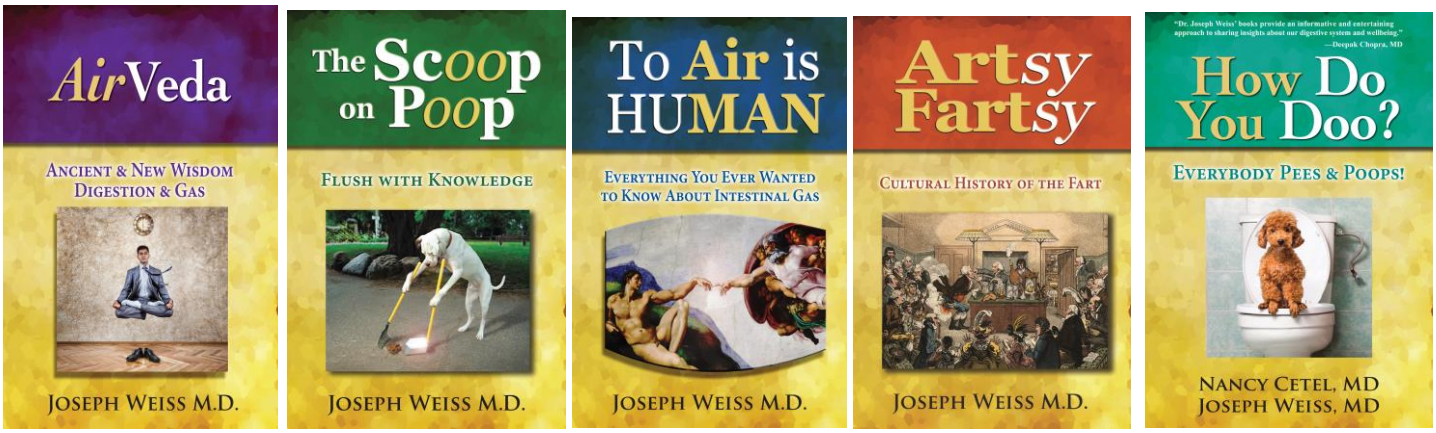

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To 'Air' is Human, Everything You Ever Wanted to Know About Intestinal Gas covers everything you ever wanted to know about the burp, belch, bloat, fart and everything digestive but were either too afraid or too embarrassed to ask. This volume is overflowing with practical information, fascinating facts, surprising trivia, and tasteful humorous insight about this universal phenomenon. amazon.com/Air-Human-Everything-Wanted-Intestinal/dp/1943760020

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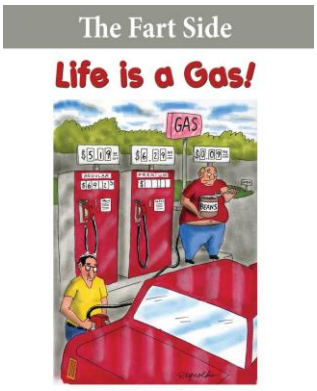
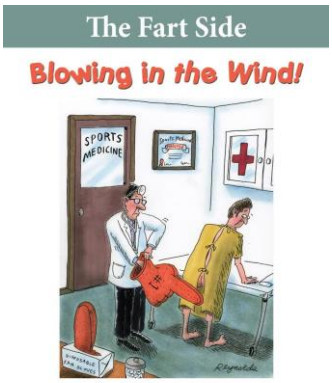
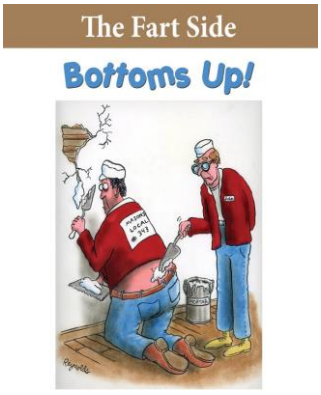
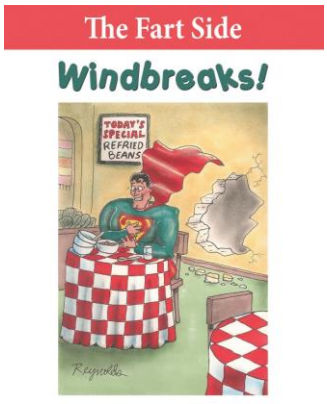
it! Additional informative relevant content to entertain the adult while the child is 'on the potty' is included. www.amazon.com/How-Do-You-Doo-Everybody/dp/1943760063









The Fart Side series is an enjoyable and informative collection of tasteful hilarious cartoons, fascinating factoids, and obscure trivia that will entertain and enlighten. Combining the award-winning talents of both a master cartoonist, and a physician professor, the volumes are proof that **'Laughter is the best medicine!'** The compact Pocket Rocket Edition! is 5" x 7", 96 pages, with 62 images and full color cartoons. The Expanded and Full Blast Edition! is 6" x 9", 122 pages, with 70 images and full color cartoons.

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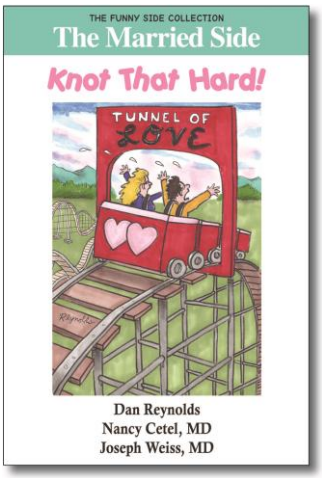

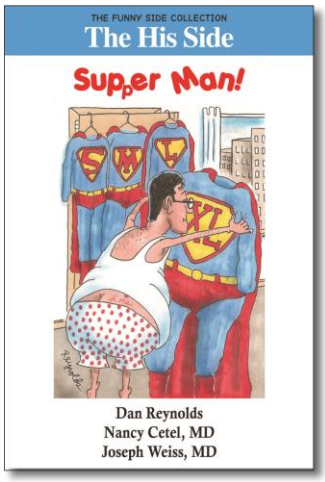

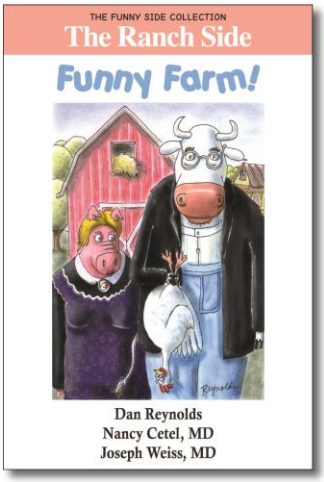

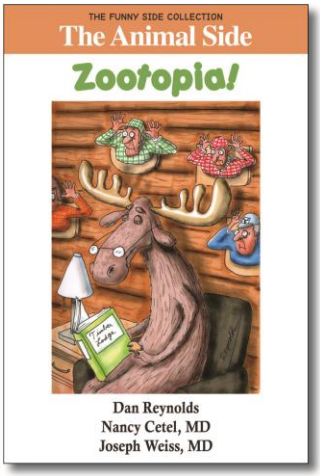

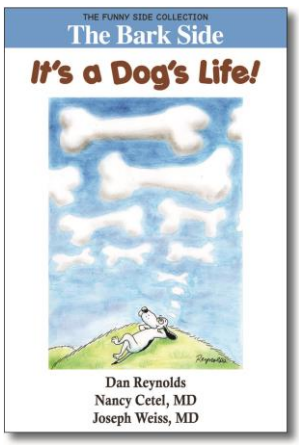

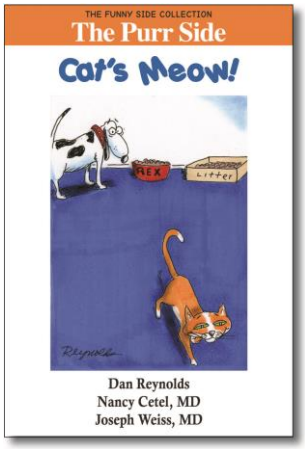

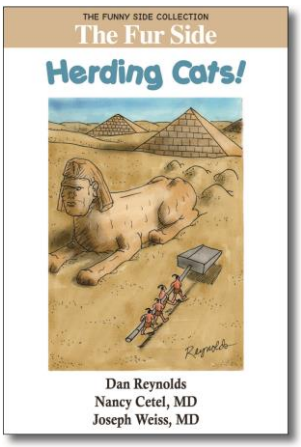

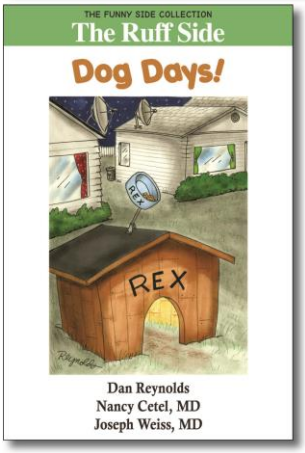

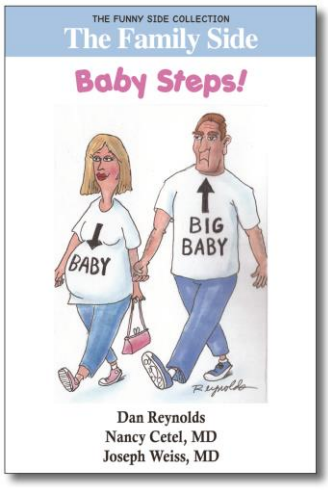

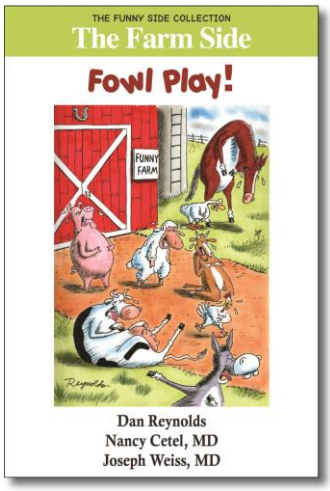

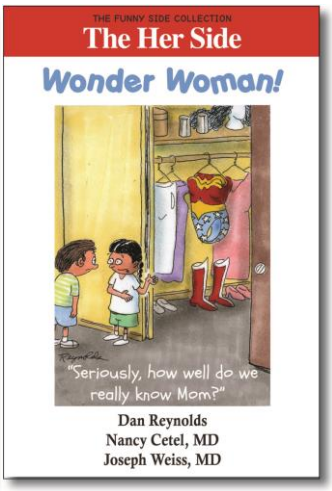

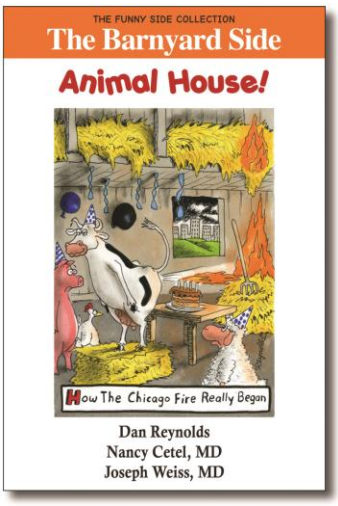

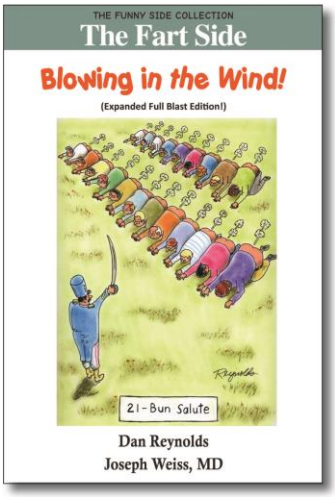

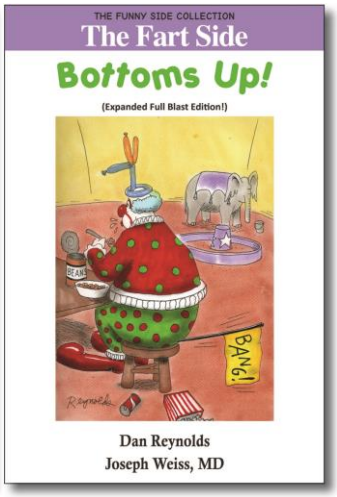

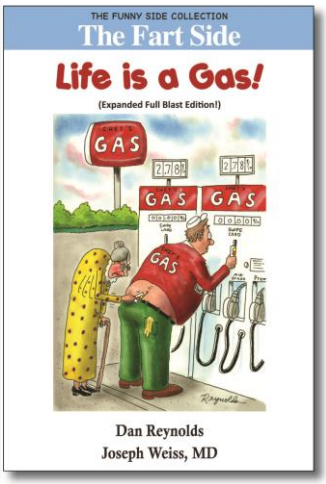

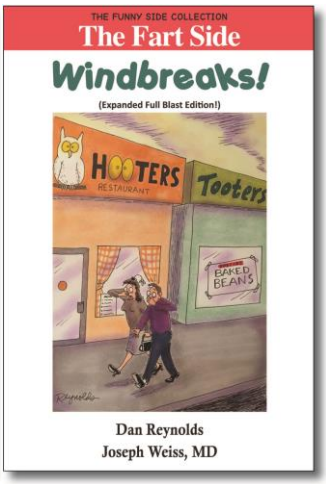

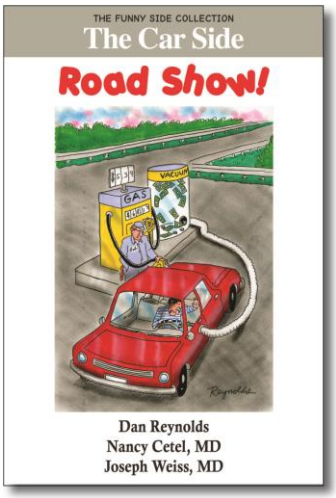

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