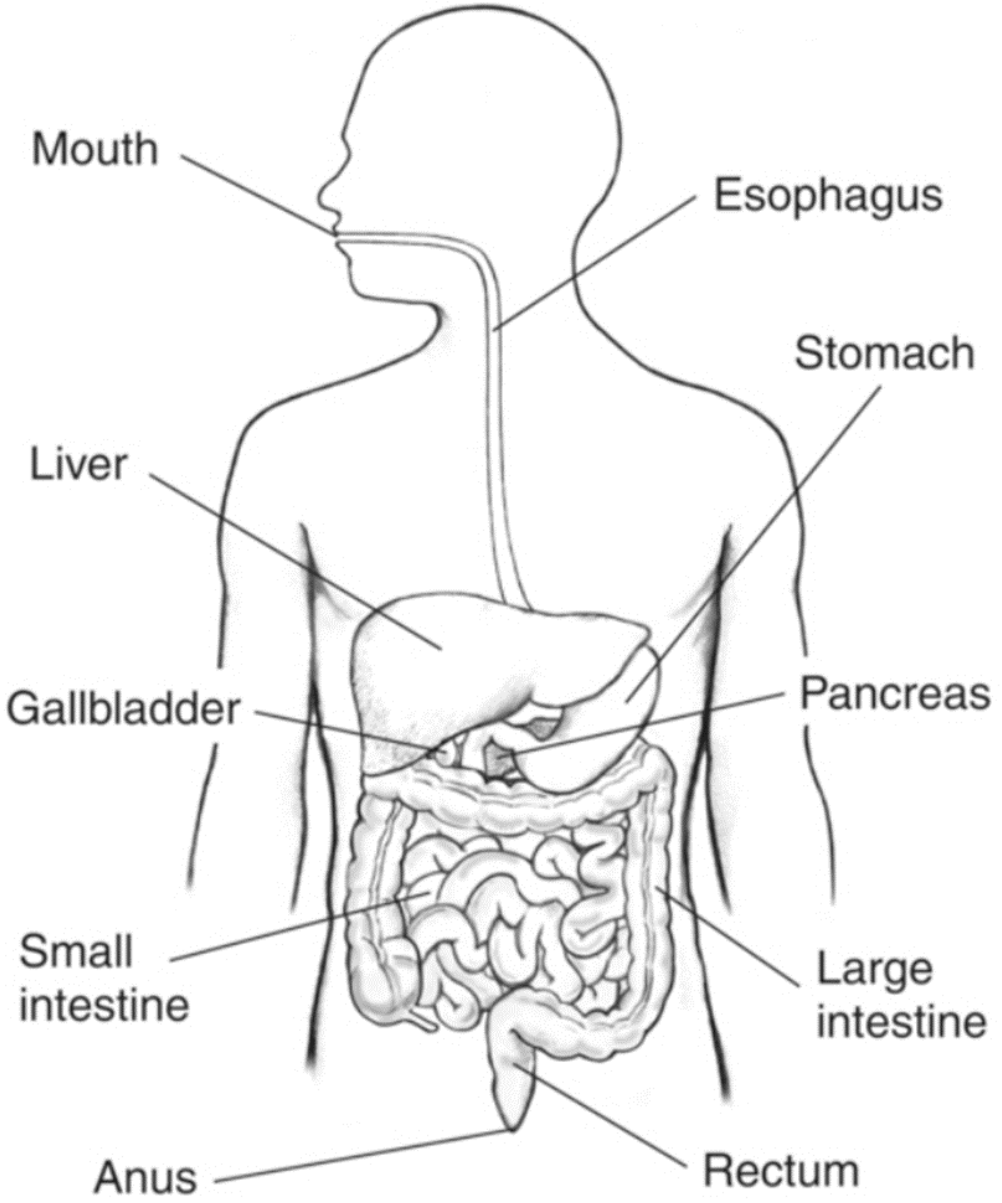
Understanding Digestion

by Tamar Clarke, MLS, MPA

Spring 2024

August 5, 2024

Disclaimer: This presentation is for educational purposes and not a substitute for qualified medical care.



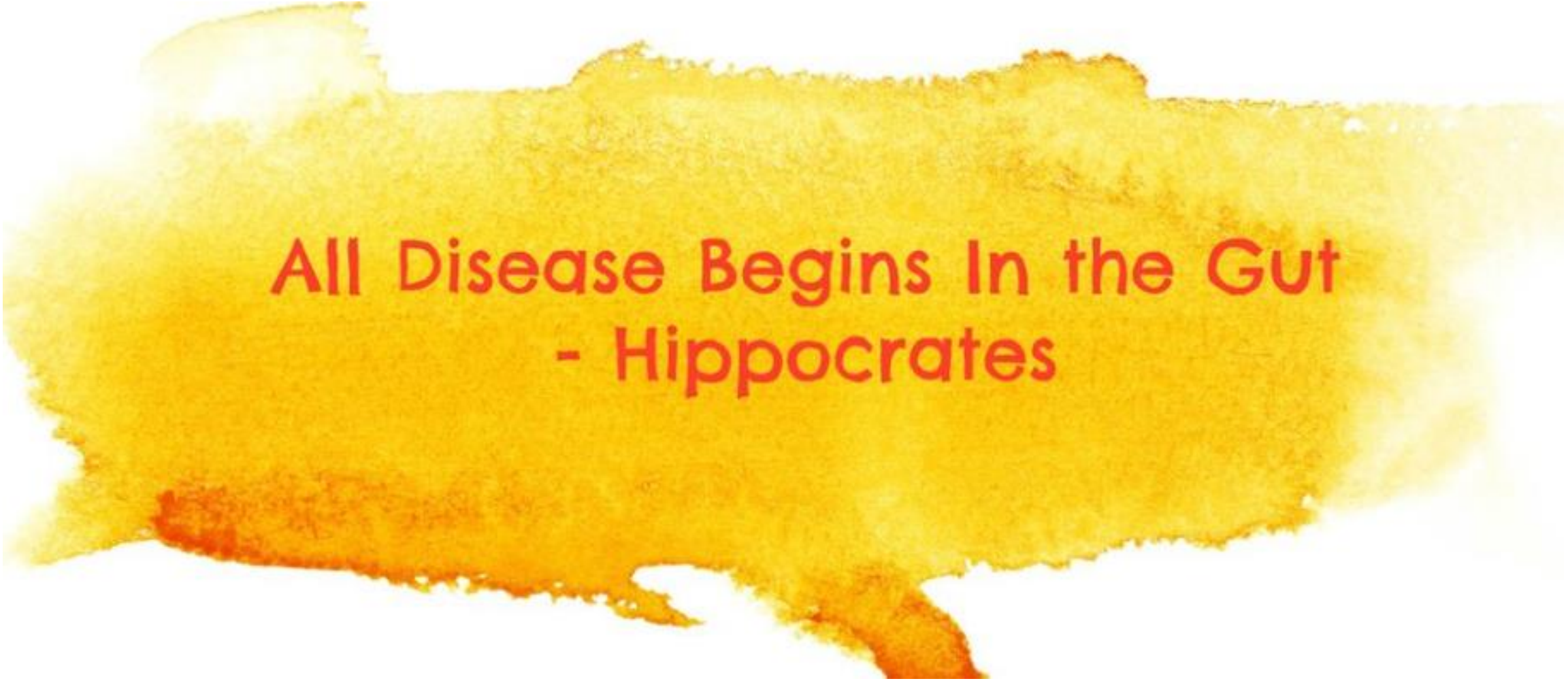
Source: NIH

Opening

- Oh, my stomach hurts! What do you do when you have stomach ache? You have plenty of company.
- Digestive issues in this country (U.S.) are at an all time high.
- 200 million doctor visits annually in the U.S. are on digestive issues.
- All diseases begin in the gut, a three letter word that addresses our digestive system (a vast majority).
- 70% of the immune system is in your gut. This is important for people experiencing immune system issues.
- Antibiotics and vaccines affect the gut flora (or microbiome).

Opening Continued

- Most people don't like to talk about it, but having digestive problems is more common than you think. In fact, 60 to 70 million people are affected by some type of digestive disease, according to the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) at NIH.
- Hey, we are not supposed to talk about our poop. It is not a topic for polite company. However, our poop can tell us a lot about our digestive health.
- An important fact that needs to be shared is that our gut health plays a major role in mental and brain health. A number of brain chemicals are actually produced in the gut.
- 30% to 40% of Americans complain about digestive issues.



Note: Many diseases do start in the gut, not 100%.

“All disease begins in the Gut” by Hippocrates

- Hippocrates, the father of modern medicine, once suggested that “all disease begins in the gut”.
  - While this statement is not entirely accurate, there is evidence to suggest that many chronic metabolic diseases are caused or influenced by chronic gut inflammation.
  - The bacteria in your gut and the integrity of your gut lining can have a significant impact on your health.
  - Undesirable bacterial products called endotoxins can sometimes leak through your gut lining and enter your bloodstream, causing chronic inflammation. (Note: It looks like there are a number of sources for chronic inflammation. Endotoxins is waste from our cells.)
  - This inflammation has been linked to many serious conditions such as obesity, heart disease, type 2 diabetes, metabolic syndrome, Alzheimer’s disease, depression, and more.

Role of the Digestive System

- Our digestive system accepts the food that we digest and turns it into molecules. Food has a number of roles. They include:
  - Energy
  - Maintenance
  - Growth
  - Repair
  - Eliminate Waste
- Our digestive systems includes a number of players that play a role in healthy digestion. This includes major players and accessory players.

Overview

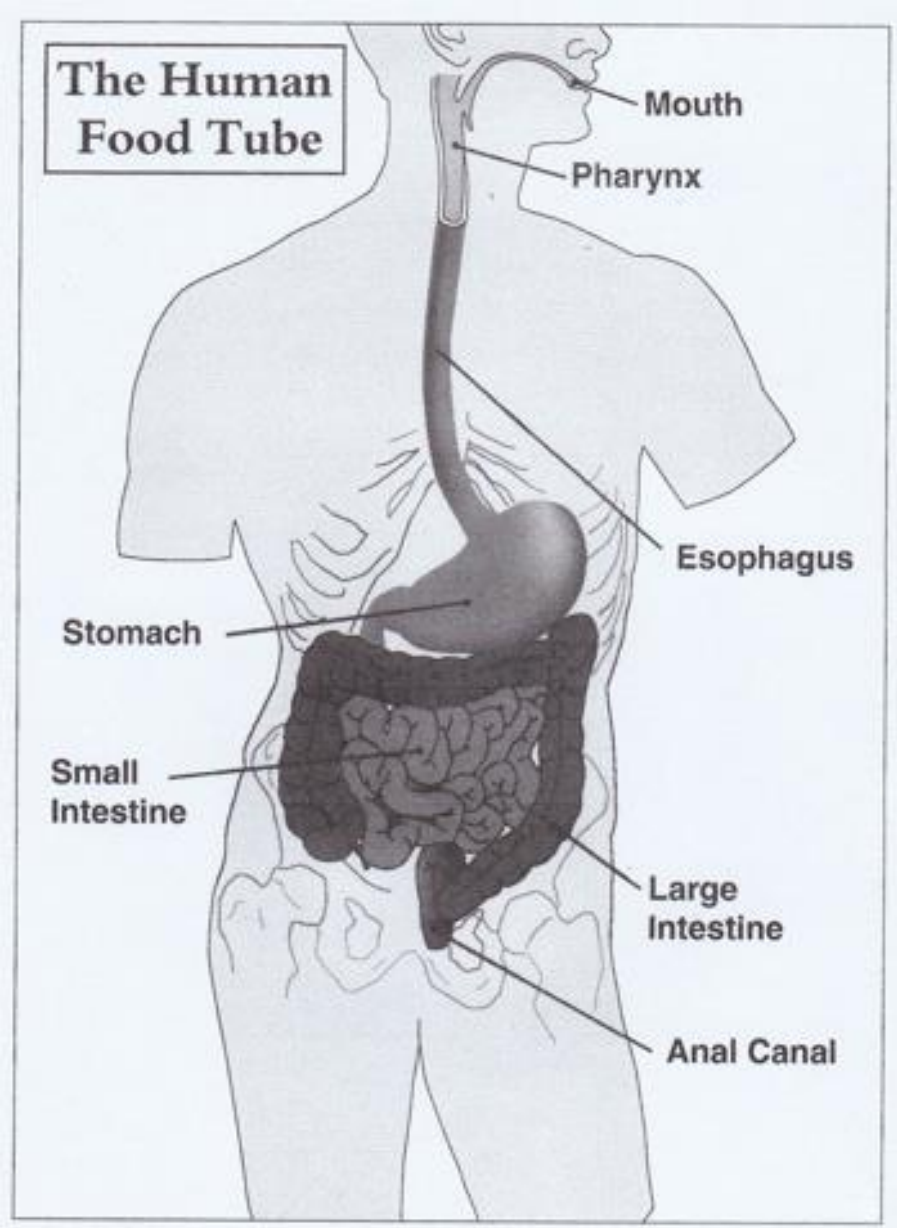
- Opening
- All disease begins in the gut by Hippocrates
- Role of the Digestive System
- Digestive System Overview
  - Major Players
    - Mouth
    - Stomach
    - Small Intestines
    - Large Intestines
- Digestive System Overview continued
  - Accessory Players
    - Teeth, Tongue, and Salivary Glands
    - Esophagus
    - Gallbladder
    - Liver
    - Pancreas
    - Appendix

Appendix

- Digestive System in More Detail (two)
- Components of the Digestive System (Detailed)
- Bibliography
- Carnivore Diet
- Glossary
- DIGIN
- The 5 Rs for Healing the Gut
- Supplements and food to Repair Gut Health
- Dysbiosis
- Enzymes
- Health Issues Associated with Gut Issues
- Leaky Gut Syndrome / Intestinal Permeability
- Microbiome
- Nutrient Chart
- pH levels throughout the digestive system
- Prebiotics
- Probiotics
- Proteolytic Enzymes
- Supplements for Food Sensitivities and Allergies
- Testing
- Types of Diets for Specific Health Issues

Digestive System Overview

- Two Components to our Digestive System
  - The Major Players
    - Mouth (Oral Cavity: tongue, teeth, saliva glands)
    - Stomach
    - Small Intestines
    - Large Intestines
  - The Accessory Players
    - Esophagus
    - Gallbladder
    - Liver
    - Pancreas
    - Appendix



Source: The Digestive System by Pam Walker and Elaine Wood, (Publisher: Lucent Books), page 11 (2003)

Major Players of the Digestive System: Mouth

- In our mouth, the saliva contains amylase and lipase. Amylase is an enzyme that breaks down carbohydrates and lipase is an enzyme that breaks down fats.
- A third enzyme is protease, which is used to break down protein. (Note: Protein digestion begins in the stomach.) Note: It is important to chew protein type of foods.
- Dental health plays a major role in our overall health.

Major Players of the Digestive System: Stomach

- It is the body's blender
- It contains hydrochloric acid
- The esophageal sphincter – It keeps the stomach acid from backing up. It can also be food that backs up.
- The stomach chops, dices, and liquefies food into chyme. It is also the beginning of protein digestion.
- Gastric Juices includes
  - Enzymes
  - Hydrochloric Acid
  - Hormones
  - Intrinsic Factor
- Pepsinogen – when it is exposed to hydrochloric acid, it becomes pepsin. It begins the protein digestion, breaking protein into short chains called peptides
- Hydrochloric Acid – it is produced by the parietal cells in the stomach. HCl kills microbes. When the parietal cells become less efficient, production of HCl and intrinsic factor declines.
- Stomach has a thick coating of mucus.
- Intrinsic Factor needed to absorb vitamin B12.

Source: Lipski, 4th ed., page 15; Lipski, 5th ed, page 25

Major Players of the Digestive System: Small Intestine

- It is 15 to 20 feet long.
- It is where food/nutrients is digested and absorbed.
- It is absorbed through villi and microvilli.
- Small intestine produces
  - Digestive enzymes
  - Absorbs nutrients
  - Block absorption of substances that are not useful or helpful to the body
- Small Intestine has three components, each component absorbing minerals and nutrients
  - Duodenum (12 inches)
  - Jejunum (11 feet)
  - Ileum (8 feet)

Source: Lipski, 4th ed., page 18; Lipski, 5th ed. Page 26

Major Players of the Digestive System: Small Intestine continued

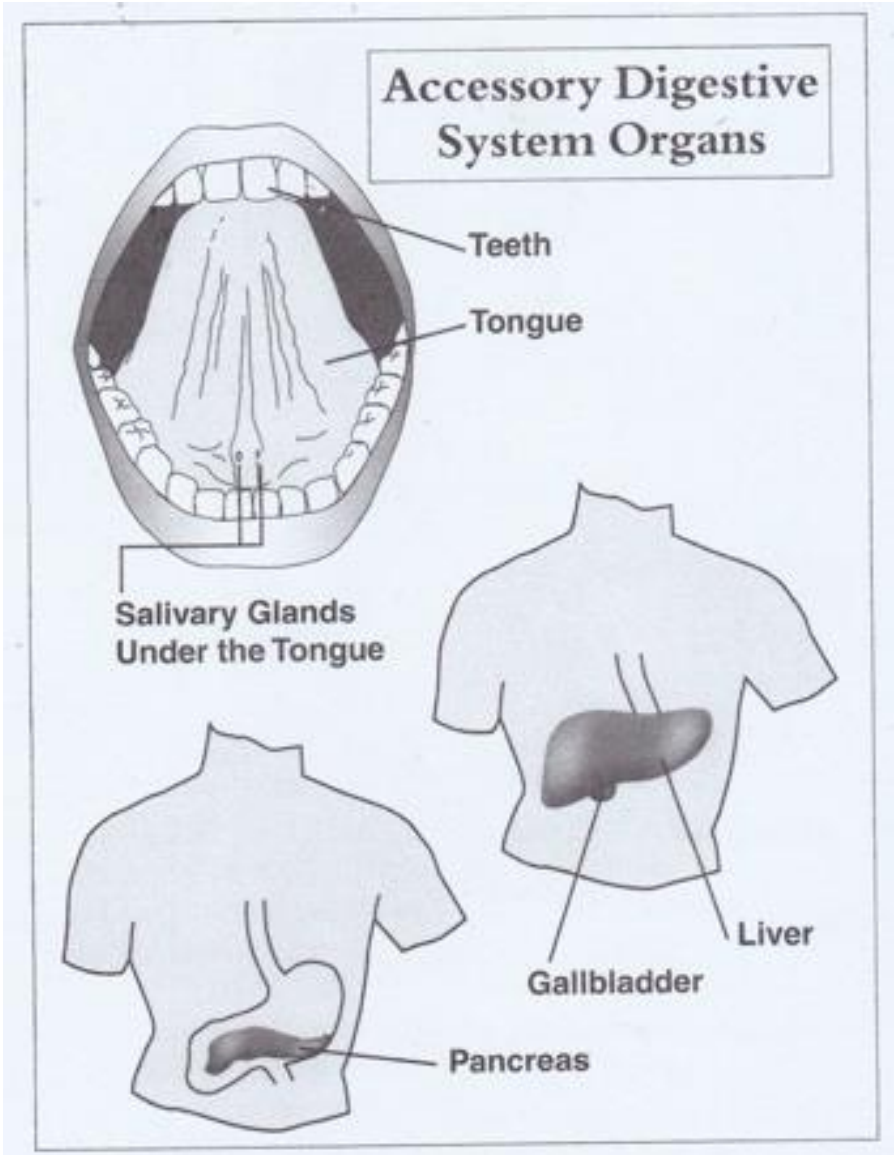
- Inside the small intestine is a protective barrier to keep microbes, undigested food particles, metals and chemicals from entering the blood stream.
- Molecules that regulate the intestinal barrier:
  - Actin
  - Catenins
  - Claudin 1
  - Cingulin
  - E-cadherin
  - JAM-1
  - Occludin
  - Zonulin
- Enterocytes are cells (one layer) lining the inside of gut lumen and is one cell thick.
- When there is inflammation, this can prevent absorption of nutrients, causing malabsorption.
- Intestinal mucus – It normally blocks bacteria from moving to other parts of the body.

Source: Lipski, 5th ed, pages 53-54

Major Players of the Digestive System: Large Intestines

- It pulls 80% of the water from the chyme.
- The large intestines has three parts:
  - Ascending colon (right side)
  - Transverse colon (across)
  - Descending colon (left side down)
- Bacteria
  - Bifidobacteria ferments fibers that become short chain fatty acids
    - Butyric
    - Propionic
    - Acetic
    - Valerate
  - Butyric acid is a main fuel for colonic cells
    - Low butyric acid is associated with ulcerative colitis, colon cancer, active colitis, inflammatory bowel disease
    - Diarrhea means water not being absorbed
    - Constipation – the stools sit too long in the colon

Source: Lipski, 4th ed., page 21-22



Source: The Digestive System by Pam Walker and Elaine Wood, (Lucent Books), page 18

Note: We also cover the esophagus and the appendix.

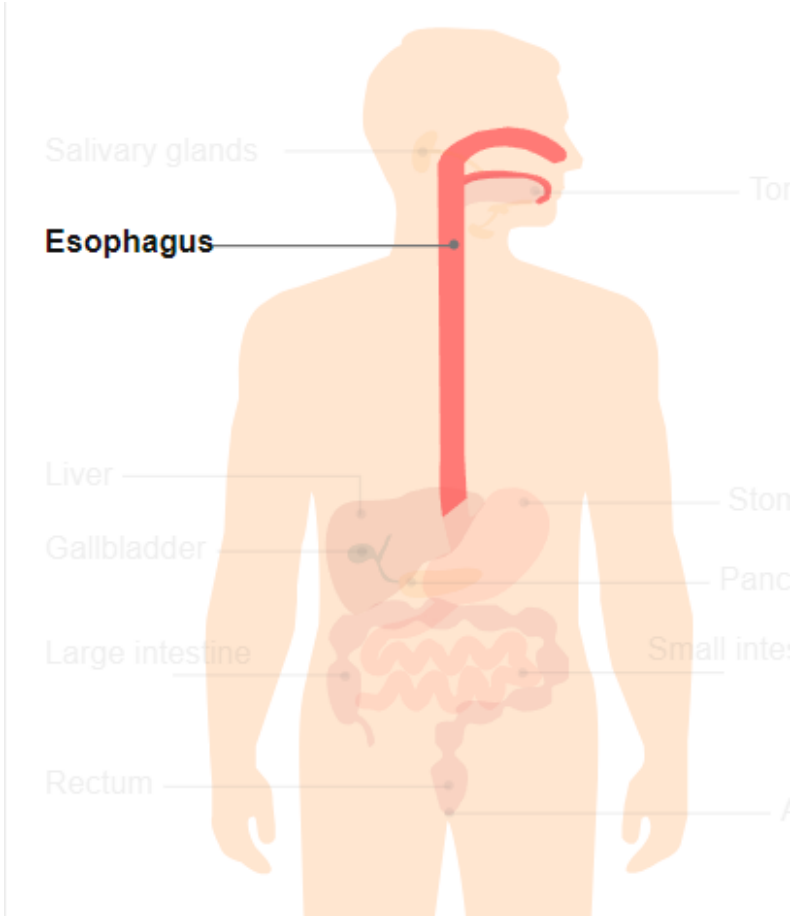
Accessory Players of the Digestive System: Teeth, Tongue, and Salivary Glands

- The beginning of our digestion begins in the mouth.
- Our teeth play a major role in breaking down food components into small ones, making these components more nutrient absorbable as the matter moves down the digestive system. It has a mechanical role.
- Our tongue can display a bit of information about what is going on in our body. (Note: Important to chew food into the smallest pieces possible.)
  - Facilitates digestion
  - Facilitates chemical digestion (lingual lipase)
  - Has sensation of tastes, texture, and temperature of food
  - Role in swallowing
  - Role in vocalization
- The Salivary Glands
  - They are endocrine glands that secrete saliva in the mouth area, to keep the area moist.

Accessory Players of the Digestive System: Esophagus

- The esophagus has a function.

1. Anatomy and Location:
    1. The esophagus is a hollow, muscular tube that connects the back of the throat (pharynx) (also mouth) to the stomach.
    2. It lies behind the windpipe (trachea) and in front of the spine, situated in the center of the chest within an area called the mediastinum.
    3. On average, the adult esophagus is approximately 10 to 13 inches long and about three-fourths of an inch thick at its narrowest point.



Accessory Players of the Digestive System: Esophagus continued

1. **Function**:
    1. The primary role of the esophagus is to transport food and liquid from the mouth to the stomach.
    2. When you swallow, food and liquid move from your mouth to your throat (pharynx).
    3. A small muscular flap called the epiglottis prevents food and liquid from entering the windpipe (trachea).
    4. Another flap, known as the uvula, helps prevent liquid from passing upward into the nasal cavity.
    5. At the opening of the upper esophagus, there's a ring-shaped muscle called the upper esophageal sphincter (UES). It senses when food or liquid is approaching and allows entry into the esophagus.
    6. Muscular contractions (peristalsis) propel the food downward through the esophagus.
    7. The food then passes through the diaphragm and reaches the lower esophagus.
    8. At the opening of the lower esophagus, there's another ring-shaped muscle called the lower esophageal sphincter (LES).a It senses food and liquid, relaxing to allow passage into the stomach. When no food is present, it remains closed to prevent stomach acid from entering the esophagus.

Common Problems:

1. Issues with the esophagus include conditions like acid reflux and GERD and (gastroesophageal reflux disease).
2. Heartburn, a burning sensation in the middle of the chest, is a frequent symptom of esophageal problems.

Source: Wikipedia, https://en.wikipedia.org/wiki/Esophagus

Accessory Players of the Digestive System: Gallbladder

- Holding tank for bile
- Releases bile as needed to break down fats
- Bile salts enables absorption of fat soluble vitamins; makes the fats more water soluble.
- Bile is made from cholesterol.
- Bile secretes immunoglobulins that protect our intestinal mucosa.
- When our bile salts are low, our bodies make up to 15 times more cholesterol (page 35, Lipski). (Note: It raises questions about the use of statin drugs to address cholesterol issues.)
- Most common problem are gallstones (when bile becomes too concentrated, stones may form). Another problem can be bile reflux, when bile backs up into the stomach.
- Gallbladder disease is directly related to diet.

Source: Lipski, 5th ed., page 31

Accessory Players of the Digestive System: Liver

- We cannot live without a healthy liver.
- The liver has 500 functions.
- It manufactures 13,000 chemicals and has a 2,000 enzyme system
- It regulates the metabolism of carbohydrates, fats, and proteins.
- It manufactures bile to emulsify (break down) fats for digestion.
- The liver makes and brakes down many hormones, including cholesterol, testosterone, and estrogen.
- The liver regulates blood sugar levels
- The liver processes all food, nutrients, alcohol, drugs, and other materials.
- It is a storage house for a number of nutrients (glycogen, fats, B12, vitamin A, vitamin D, vitamin E, vitamin K, zinc, iron, copper, magnesium)
- All vitamins and minerals have to be enzymatically processed by the liver before we can use them
- Liver breaks down toxins digested with our food.
- Bile emulsifies fats, and buffers the intestinal contents.
- Liver stores environmental toxins;
  - Detoxify what they can
  - Stores what they cannot detoxify
- Liver is also part of the immune system.

Lipski, 4th ed., page 20, page 195; Lipski, 5th ed., pages 30-31

Accessory Players of the Digestive System: Liver, continued

- The liver has a three stage phase in detoxification. They all have to work together and work with the gallbladder.
  - Phase I – Uses the cytochrome p 450 enzyme system. Enzymes break down the harmful toxins into intermediate forms. Some toxins are ready for elimination where others need to enter phase II detoxification pathways.
  - Phase II – Phase 2 liver detoxification adds a water soluble group to the reactive site on a toxin. It is called reduction/oxidation and conjugation, enabling a toxin or substance to be ready to be escorted out of the liver. Phase 2 liver detoxification includes 6 major detoxification pathways (in alphabetical order):
    - Acetylation
    - Amino Acid conjugation
    - Glucuronidation
    - Glutathione conjugation
    - Methylation
    - Sulfation

Sources: Lipski, 4th ed., page 192, and Phase 1 and 2 Liver Detox Pathways & how to Open Phase 3 Detox

Accessory Players of the Digestive System: Liver, continued

- Phase III- This phase needs gallbladder support. In this phase, the liver detox eliminates the water-soluble toxins through the bile and out of the gallbladder.
- Note: Amber talks about a 2.5 phase as well. Toxins from the liver enters the gallbladder. All three phases need to be open to safely detox.

Lipski, 4th ed., page 192 and Phase 1 and 2 Liver Detox Pathways & how to Open Phase 3 Detox

Accessory Players of the Digestive System: Pancreas

- The Pancreas has two roles
  - Aid in the digestion of food
    - Secretes bicarbonate-rich alkaline fluid, to neutralize the acidity of chyme
    - Produces specific digestive enzymes
      - Pancreatic amylase
      - Trypsin, chymotrypsin, carboxypeptidase, and elastase. They work on proteins.
      - Pancreatic lipase and colipase break down fats.
      - Ribonuclease and deoxyribonuclease digest old RNA and DNA.
      - Low levels of pancreatic enzymes can lead to nutritional deficiencies. (This includes vitamin B12.)
  - Produce insulin and glucagon (regulate blood sugar)
    - Pancreas produces hormones such as insulin, glucagon, somatostatin and pancreatic polypeptide.

Source: Lipski, 4th ed., page 19; Lipski 5th ed. Pages 28-30. Also, the pancreas may be playing a role in our immune system as well.

Accessory Players of the Digestive System: Appendix

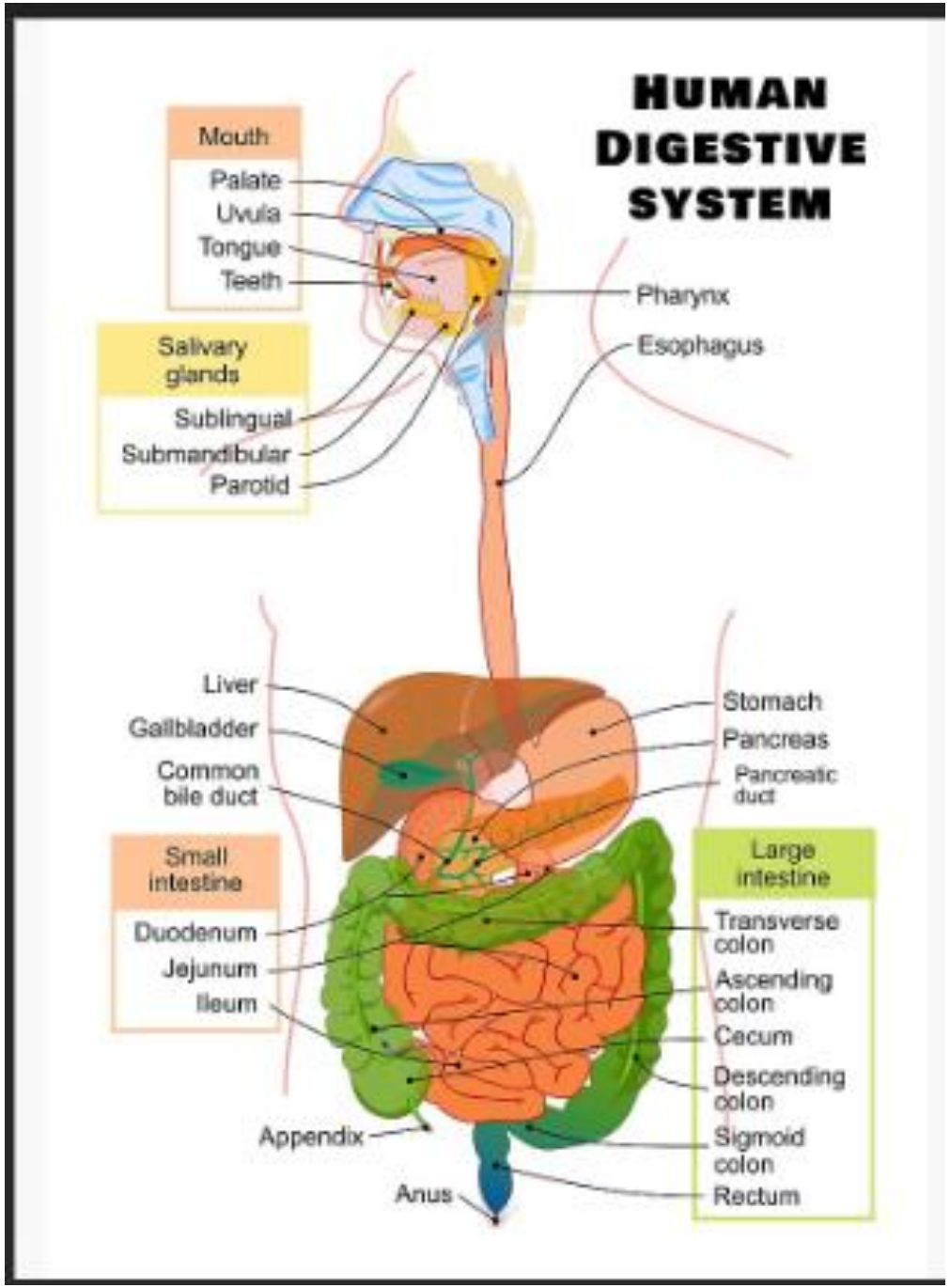
- The appendix is also part of the digestive system.
- It contains a great deal of lymphatic tissue.
- It has a major role in the first decades of life.
- It helps with the maturation of B-lymphocytes, a type of white blood cell.

Source: Lipski, 5th edition, page 3221

Appendix

- Digestive System in More Detail (two)
- Components of the Digestive System (Detailed)
- Bibliography
- Carnivore Diet
- Glossary
- DIGIN
- The 5 Rs for Healing the Gut
- Supplements and food to Repair Gut Health
- Dysbiosis
- Enzymes
- Health Issues Associated with Gut Issues
- Leaky Gut Syndrome / Intestinal Permeability
- Microbiome
- Nutrient Chart
- pH levels throughout the digestive system
- Prebiotics
- Probiotics
- Proteolytic Enzymes
- Supplements for Food Sensitivities and Allergies
- Testing
- Types of Diets for Specific Health Issues

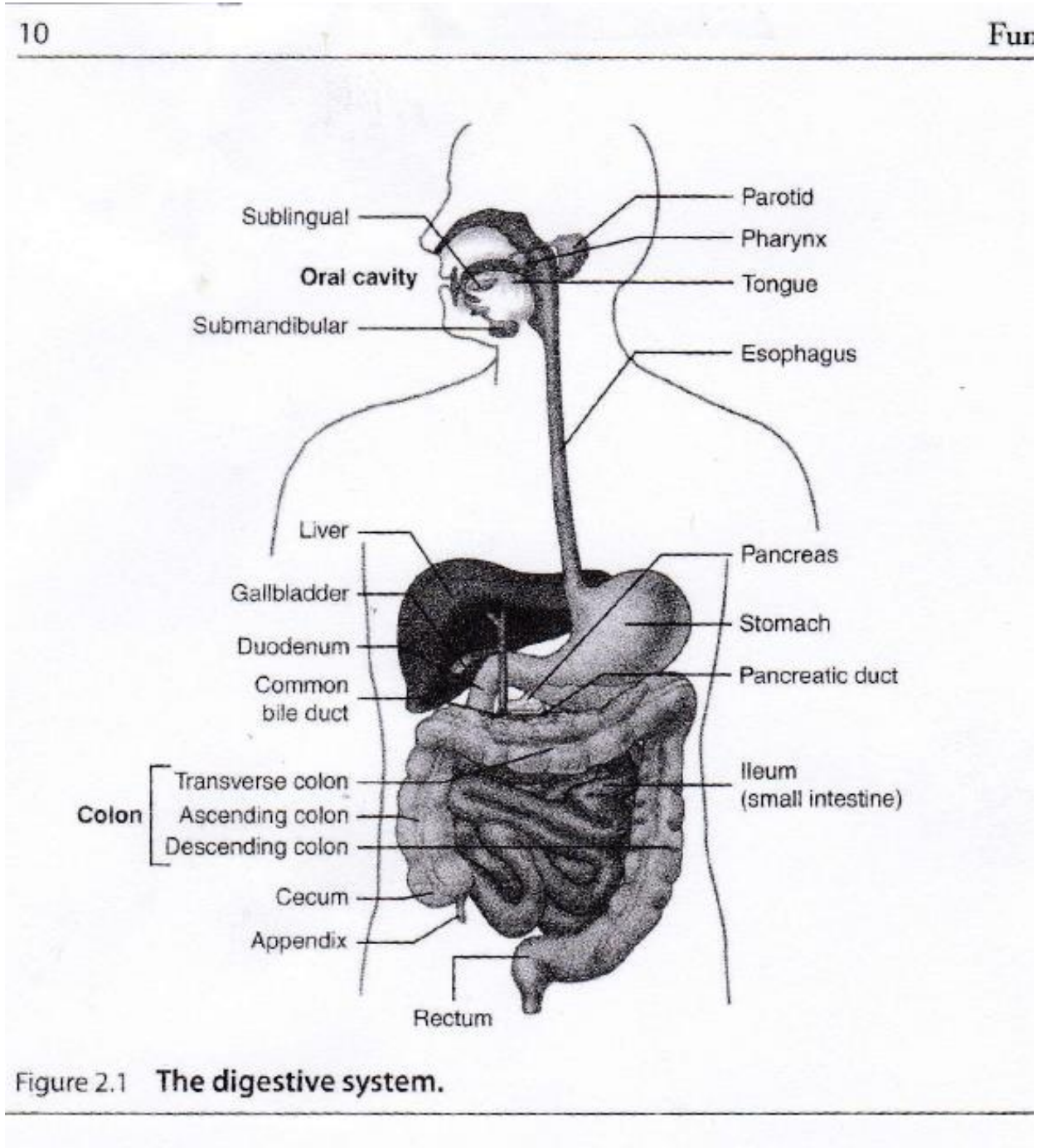
Appendix: Digestive System Illustration (one of two)



Source: https://www.redbubble.com

Appendix: Digestive System Illustration (two of two)

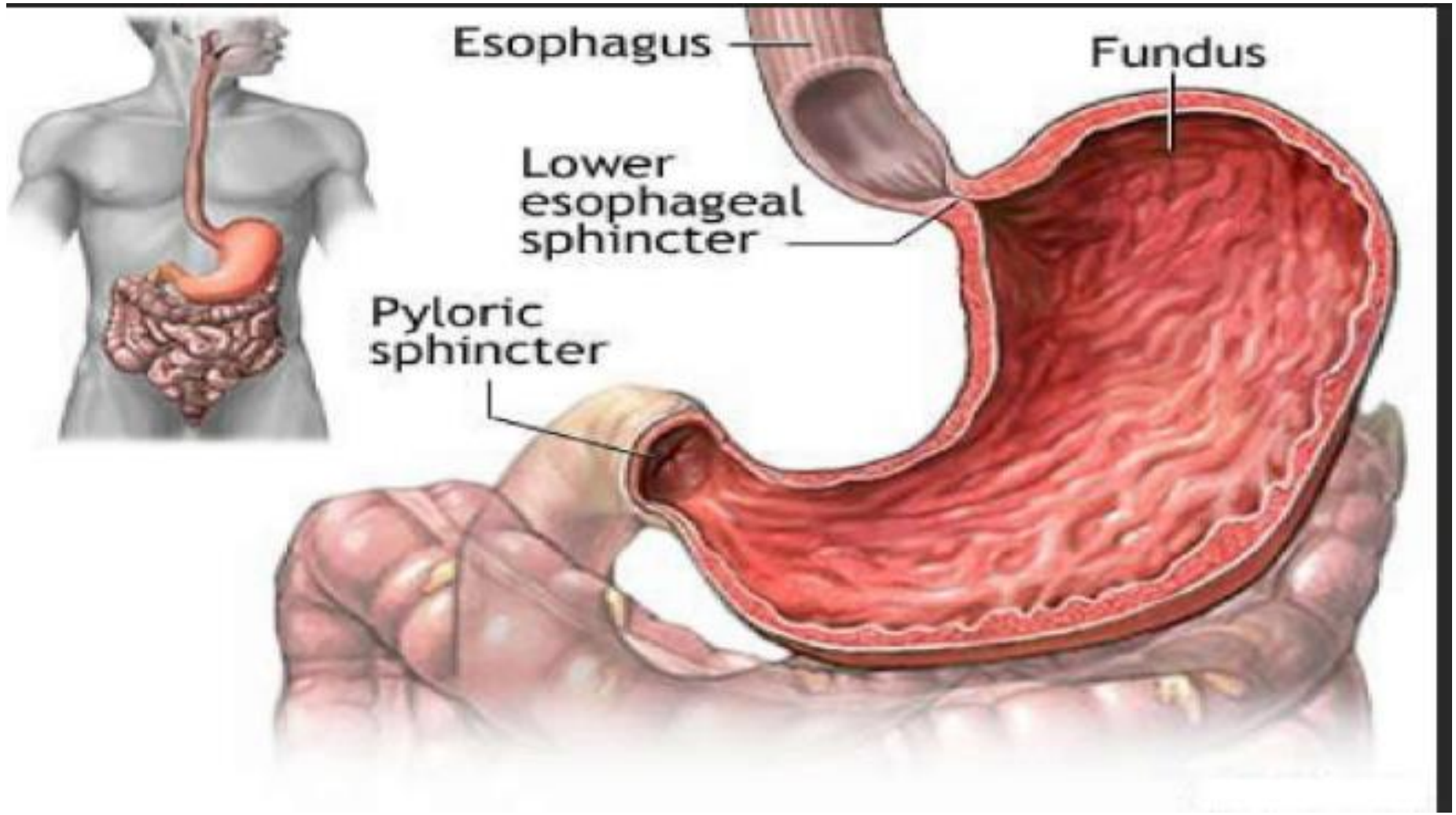
Source: Digestive Wellness, Lipski, 4th edition, page 10



Components of the Digestive Tract (Players)

- Oral cavity – Mouth (Teeth, Tongue, Salivary)
- Esophagus
- Stomach (upper and lower esophageal sphincter)
- Liver – The body's fuel filter. It has 500 functions. It manufactures 13,000 chemicals.
- Gallbladder – It is the holding tank for bile. Bile helps to break down fats
- Pancreas –
  - Aids in the digestion of food
  - Produces insulin and glucogen. This helps regulate sugar.
  - It produces hormones
- Large Intestine
  - Transverse
  - Ascending
  - Descending
- Small Intestines
  - Duodenum
  - Jejunum
  - Ileum
- Rectum
- Appendix
- Other Parts of Our Digestion-Microbiome or Gut Flora

Source: Lipski, 4th edition



Source: https://healthjade.com/what-is-the-esophagus/

Appendix: Esophagus Issues with the Esophageal Sphincter (upper and lower)

- The esophageal sphincters are bands of muscles at the top and bottom of the esophagus — the muscular tube that passes food and drink from the mouth to the stomach. Esophageal sphincters open and close the esophagus at either end.

- The top sphincter prevents air from flowing into the esophagus while breathing, while the bottom sphincter prevents food from flowing back up the esophagus. Doctors call these sphincters the upper esophageal sphincter (UES) and the lower esophageal sphincter (LES).

- Disorders of the esophageal sphincters may affect breathing, eating, and digestion. For example, weakness in or pressure on the lower esophageal sphincter may cause food to flow back up the esophagus, causing reflux and the sensation of heartburn. Conversely, when the LES does not relax to allow food to pass through, food may remain in the esophagus.

Source: The esophageal sphincter: Upper, lower, and how it works by Zawn Villines, posted on January 28, 2022, medically reviewed by Kelsey Trull, PA-C and url: https://www.medicalnewstoday.com/articles/the-esophageal-sphincter

Appendix: Bibliography

- The Carnivore Code: Unlocking the Secrets to Optimal Health by Returning to Our Ancestral Diet (2020) by Paul Saladino, MD (Publisher: Fundamental Press)
- The Digestive System (2003) by Pam Walker and Elaine Wood (Publisher: Lucent Books)
- Digestive Wellness, 4th edition, strengthen the immune system and prevent disease through healthy digestion (2012) by Elizabeth Lipski, Ph.D., CCN, CHN (Publisher: McGraw-Hill) Note: Covers in detail specific conditions including arthritis.
- Digestive Wellness, 5th edition, strengthen the immune system and prevent disease through healthy digestion (2020) by Elizabeth Lipski, Ph.D., CCN, CHN (Publisher: McGraw-Hill).
- Internet Resources:
- Title: The esophageal sphincter: Upper, lower, and how it works and url: https://www.medicalnewstoday.com/articles/the-esophageal-sphincter
- Title: Phase 1 and 2 Liver Detox Pathways & How to Open Phase 3 Detox, posted September 17, 2020 by Amber. And url: https://www.ambersnaturalnutrition/liver-detoxification-pathways/
- Title: Proteolytic Enzymes and url: https://www.britannica.com/science/proteolytic-enzyme
- Title: The Ultimate Guide to Using Enzymes with Hashimoto's by Izabella Wentz, PharmD, FascP and url: https://thyroid pharmacist.com/articles/using-enzymes-to-overcome-hasimotos/
- Title: What is the Esophagus? And url: https://healthjade.com/what-is-the-esophagus/

Appendix: Bibliography continued

- Internet Resources:
- Title: The esophageal sphincter: Upper, lower, and how it works and url: https://www.medicalnewstoday.com/articles/the-esophageal-sphincter
- Article Title: Parkinson's disease from the Gut to the Brain by Suvi Mahonen, 2019
  Journal Title: Nexus or www.nexusmagazine.com
  Volume: December 2019-January 2020, pages 53-56
  Note: The magazine is located in Australia. A small fee is required for this article.
- Title: Protein Metabolism (Anatomy and Physiology) and url: https://open.oregonstate.education/aandp/chapter/24-4-protein-metabolism/
- Title: Proteolytic Enzymes and url: https://www.britannica.com/science/proteolytic-enzyme
- Title: Stomach Acid, pH, and Health by Keith Halperin, DC and url: https://sa1s3.patientpop.com/assets/docs/18418.pdf
- Title: What is the Esophagus? And url: https://healthjade.com/what-is-the-esophagus/

Appendix: Bibliography continued

- Title: The Ultimate Guide to Using Enzymes with Hashimoto's by Izabella Wentz, PharmD, FascP and url: https://thyroid pharmacist.com/articles/using-enzymes-to-overcome-hasimotos
- Also, YouTube Videos on Digestive Health
  - Dr. Josh Axe, DC, DNM, CNS
  - Dr. Dr Will Bulsiewicz, MD (gastroenterologist)
  - Dr. William Davis, MD
  - Dr. Sten Ekberg
  - Dr. Mark Hyman, MD
  - Barbara O'Neil (Australian Alternative Health Practitioner)
  - Dr. Michael Ruscio, DC, DNM

Appendix: Carnivore Diet

- Another interesting resource to read when it comes to digestion and nutritional health is a book called the Carnivore Code by Paul Saladino, MD. It is basically a meat based (and fish) diet. (Note: It is listed in the bibliography.)
- Besides discussing the benefits of eating animal protein, Dr. Saladino discusses how some of the nutrients are more easily absorbed from animal proteins. A number of these nutrients are covered.
- Also, Dr. Saladino compares how these nutrients are handled from animal sources versus plant based sources. Plants contain substances, some them known as lectins or oxalates, that are designed to discourage anyone from eating them. That includes insects, other animal life, fungi, and etc.
- It needs to be noted that Dr. Saladino eats some carbohydrates.

Appendix: Glossary

- Acid/Alkaline – It has to do with measuring the pH levels.
- Autism – 2/3's have GI dysfunction (Lipski, page 104, Lipski, 5th ed., page x)
- Betaglucuronidase – It can be measured in stool as a marker of hormone reabsorption. (Lipski, 5th ed., page 33)
- Biofilms – A fairly new topic. When biofilm become dysbiotic, they are difficult to eradicate.
- Bowel Transit Time – It can be tested with charcoal tablets or red beets. It should be between 12-24 hours.
- Candida – It is basically a fungal infection. As much as a third of the population can be affected by candida.
- Carnivore Diet – An all meat diet; considered an original diet of our ancestors
- Catalyze – Catalyze means to cause or speed up a process or reaction by serving as a catalyst. A catalyst is typically a substance that is able to trigger or expedite a process without being affected or consumed itself. In a broader application, the term can refer to anything that incites or initiates change or action.
- Commensals – Normal bacteria in the gut

Appendix: Glossary

- Conjugation – Bacterial conjugation is a fascinating process through which bacterial cells exchange genetic material.
- Demulcents – A substance that relieves irritation of the mucous membranes by forming a protective film. They have a soothing effect (Lipski, page 101)
- Dietary Fiber- There are two types of fiber. One is soluble and the other is in insoluble.
- Digestive Enzymes –
  - Amylase (in saliva) – digest carbs
  - Lipase – digest fats
  - Protease – digests protein
  - Others
    - Pectinase – digest pectin in fruit
    - Phytase enzymes – help break down phytic acid
  - Note: as we age, our enzyme deficiencies increase

Appendix: Glossary

- Dysbiosis – It is an imbalanced ratio of good bacteria and the bad bacteria. Symptoms vary from person to person. Dysbiosis weakens our ability to protect ourselves from disease causing microbes. It plays a role in a number of health issues. Different types of dysbiosis. (Covered on another slide in more detail) (Source: Lipski, page 71-2; Lipski, 5th ed, page 95-96)
- Endotoxins – toxins produced by our bodies and cells
- Enteric Nervous System (ENS) – It is known as the second brain. The digestive system and the brain are interconnected through the vagus nerve. (Lipski, page 103)
- Environmental Illness – It can be another type of enzyme deficiency.

Appendix: Glossary continued

- Enzymes – a protein that catalyzes a reaction; heat destroys enzymes; enzymes have been used to treat cancer in Europe. Enzymes can help with a number of health issues such as Crohn's, ulcerative colitis, hay fever, pulmonary fibrosis, sinusitis, and MS. (Lipski, 5th ed., page 49)
- Epithelial cells - The intestinal walls consist of epithelial cells, which absorb nutrients from food while preventing harmful compounds from passing into the bloodstream. Connecting the epithelial cells are occludin tight junction molecules, which prevent potential pathogens from passing into the bloodstream. Occludin is regulated by zonulin, a protein that tells occludin when to open or close the junctions. Epithelial cells are a single layer of cells that comes in direct contact with your food .
- Food Intolerances – Lack of enzymes to handle these foods (Lipski, page 156)
  - Fructose intolerance
  - Gluten intolerance
  - Lactose intolerance

Appendix: Glossary continued

- Functional Medicine – It is a type of medicine that is personalized for the individual and seeks to address causes behind health issues. In this situation, doctors listen to their patients and use lab testing to get a more complete picture of what is going on.
- GALT – Gut-Associated Lymphoid Tissue – Their role is to absorb nutrients and it is 2/3's of the immune system.
- HCl – Ways to increase HCl levels is:
  - Bromelain
  - Mixed protease enzymes (also known as proteolytic enzymes)
  - Papain
  - Pepsin

Appendix: Glossary continued

- IG (Immunoglobulin) – Different types, IgA, IgE, IgG, IgG4, IgM (Source: Lipski, 4th ed., page 158)
- Immune System – 70% of the immune system is located in the gut.
- Inflammation, Digestive – means inflammation and immune imbalance (has a number of causes) (Source: Lipski, 4th ed., page 96)
- Leaky Gut (Intestinal permeability) – When substances leak from the chyme into the blood stream in the gut. (Note: Several slides cover this topic.)
- Lectins – found in plant foods, long periods of cooking destroys most of the lectins (Sources: Lipski, 4th ed, page 157 and Lipski, 5th ed, page 129, more information)
- Mental Health Issues – 70% to 90% of those with IBS, they can also have mood anxiety disorders, schizophrenia, depression, panic disorder and more likely to have fibromyalgia and migraines. (Source: Lipski, 4th ed., page 104)

Appendix: Glossary continued

- Metabolic enzymes - There are 75,000 metabolic enzymes and they have multiple roles. They are made from proteins and need correct pH levels. (Source: Lipski, 5th ed., page 47)
- Microbiome – Those with autism have major gut issues as opposed to those who are healthy, they do not have these issues. The microbiome varies in different areas of the body (brain, blood, skin, kidneys). (Source: Lipski, 5th ed., page 66) Imbalances of the microbiome affect a number of health conditions.
- Neurotransmitters – The gut manufactures neurotransmitters. They are brain chemicals.
- Occuldin - Occludin is a transmembrane protein that regulates the permeability of epithelial and endothelial barriers. It was first identified in epithelial cells as a 65 kDa integral plasma-membrane protein localized at the tight junctions. (Source: Wikipedia)

Appendix: Glossary continued

- Parasites – Some are harmful and some are beneficial. It can be a factor in allergies, damaged intestinal lining, and IBS. Comprehensive stool tests show 23.5% of those tested had parasites. Comprehensive parasite testing is recommended for prolonged digestive symptoms. (Sources: Lipski, 4th ed, page 84 and Lipski, 5th ed., page 117)
- Pathogens – The bad bacteria that is imbalanced with the good bacteria is what causes health issues.
- Peptides – Smaller components of amino acids
- Peristalsis – Muscular movement that move matter within the body.
- Prebiotics – It is food for probiotics. (More info in Lipski, 5th, page 78)

Appendix: Glossary continued

- Probiotics - Probiotic bacteria offers benefits. Friendly microbes also manufacture a number of nutrients, including vitamin K, B-Complex vitamins and folic acid. Some species increase our absorption of minerals including calcium, copper, iron, magnesium and manganese. Probiotics improve peristalsis, help normalize bowel transit time. They can prevent diarrhea (traveler's diarrhea). (More info in Lipski, 5th ed, page 83)
- Postbiotics - Postbiotics are bioactive compounds made when the healthy bacteria in your gut ferment. They are also known as metabiotic, biogenic, or simply metabolites.
- Protease - any of numerous enzymes that hydrolyze (break down) proteins and are classified according to the most prominent functional group (such as serine or cysteine) at the active site.
- Proteolytic enzyme –
  - Any group of enzymes that break the long chainlike molecules of proteins into shorter fragments known as peptides.
  - They break down into smaller components, amino acids.
  - Proteolytic enzymes are present in bacteria, archaea, certain types of algae, some viruses, and plants.
  - Proteolytic enzymes are also produced by the body, especially by your pancreas.
  - These enzymes are involved in protein digestion, growth, tissue repair, inflammation and immune function. These enzymes can also be obtained from certain foods or supplements.
  - (Source: Britannica online and Microsoft Bing)

Appendix: Glossary continued

- Secretory IgA –
  - A group of antibodies in the gut mucosa.
  - It is on the constant alert for foreign antibodies.
  - Low levels, means that it is more susceptible to infection.
  - Those with ulcerative colitis or Crohn's had low levels of sIgA.
  - High levels can result in viral infections, CMV, Epstein-Barr, and HIV. It can also be an indicator of how well your immune system is working. (Source: Lipski, 4th ed., page 94-8)
- SIBO – Small Intestinal Bacteria Overgrowth –Bacteria from the large intestine travel to the small intestine. It can be present in IBS, fibromyalgia, RLS (Restless Leg Syndrome), and interstitial cystitis. (Source: Lipski, 4th ed., page 81)
- Symbiotic Bacteria – They are also called probiotics. They make vitamins and regulate immune function.

Appendix: Glossary continued

- Symbiosis – It is interaction between two different organisms living in close physical association, typically to the advantage of both.
- Translocation of bacteria – The correct bacteria in the wrong place can cause problems (SIBO)
- Vagus Nerve – a nerve that connects the gut with the brain. It plays a number of roles. (Source: Lipski, 5th ed, page 137)
- Zonulin - Zonulin (haptoglobin 2 precursor)[is a protein that increases the permeability of tight junctions between cells of the wall of the digestive tract. It was discovered in 2000 by Alessio Fasano and his team at the University of Maryland School of Medicine.

Appendix: DIGIN Model (Lipski)

- D: Digestion and Absorption
- I: Intestinal Permeability
- G: Gut Microbiome
- I: Inflammation and Immune
- N: Nervous System

Appendix: the 5 Rs for Healing the Gut

- The Five Rs
  - Remove nutrient depleted foods
  - Replace processed foods with whole foods, nutrients, digestive enzymes, hydrochloric acid, and bile salts
  - Reinoculate (repopulate) beneficial probiotics and prebiotics
  - Repair – Using foods and supplements (listed on the next slide)
  - Rebalance – Stress Management, Improved Sleep habits, exercise and movement

Source: Lipski 4th ed., page 30

Appendix: Supplements and food to Repair Gut Health

- Aloe
- Boswellia
- Cabbage (food)
- Celandine
- Cranesbill
- Duodinum glandular
- EFA
- Fasting
- Fiber (food)
- Gamma-oryzanol,
- Geranium
- Glutamine
- Goldenseal
- Licorice
- Marshmellow Root
- N-acetyl glucosamine
- Okra (food)
- Quercetin
- Rice Protein Powders (food)
- Wormwood

Appendix: Supplements and Food to Repair Gut Health continued (Lipski, page 141)

Cooked foods

- Protein
  - Beverages
  - Bone broths
  - Bone Marrow
  - Cultured/Fermented Vegetables
  - Dahl
  - Dairy – try goat's milk
  - Eggs (poached, soft boiled)
  - Fats

Eat Frequently and in small amounts

- Other
  - Fruit
  - Herbs/spices
  - Grains (well cooked, more water)
  - Soups
  - Stews
  - Vegetables (1/2 plate)
  - Well cooked meats

Appendix: Supplements and food to Repair Gut Health (Restoring Gut Integrity)

- Cabbage Juice, cabbage family foods, bone broths, vegetable broths, fresh vegetable juice, aloe vera juice, okra, slippery elm tea, lozenges, they all help heal the small intestine. (Source: Lipski, page 47)
- Nutrients:
  - Glutamine
    - Alkalizes the body
    - Decreases risk of infection
    - Stimulates slgA
    - Decreases risk of bacterial translocation
  - Zinc
  - Probiotics
  - Quercetin
  - Proteolytic enzymes
  - Digestive Enzymes

Appendix: Dysbiosis

- Dysbiosis – It is an imbalanced ratio of good bacteria and the bad bacteria. Symptoms vary from person to person. Dysbiosis weakens our ability to protect ourselves from disease causing microbes. It plays a role in a number of health issues. There are different types of dysbiosis. (Source: Lipski, page 71-2)
- Dysbiosis can be tested by:
  - Crook's yeast questionnaire
  - Comprehensive stool testing
  - Organic Acid Testing
  - Hydrogen or methane breath testing for SIBO
  - Antigen testing for H. pylori, c. difficile
- Dysbiosis Treatment (Different Types of Treatments)
  - Avoid sugar and limit carbs
  - VSL-3 (3.6 trillion) for UC
  - Lactobacillus – 10 – 100 billion live organisms
  - Saccharomyces - 250 to 3,000 mg
  - Bifidobacterium (10-100 (Lipski, page 75)
  - Note: High levels of probiotics needs to be done under medical supervision.

Appendix: Enzymes

- Enzymes in the digestive system play a major role in the digestive process. Some of these enzymes are:
  - Gastrin
  - Hydrochloric Acid – When parietal cells become less efficient, production of hydrochloric acid and intrinsic factor falls.
  - Methylmalonic acid (MMT)
  - Mucopolysaccharides
  - Pepsinogen

Appendix: Enzymes continued

- Izabella Wentz, PharmD, FASCP has written a comprehensive article addressing the use of enzymes for Hashimoto's (a thyroid condition).
- She lists the role of enzymes. There are three main roles:
  - Digestion (helps to break down complex molecules into smaller components)
  - DNA replication (enzymes helps with this process, DNA information is copied every time a cell divides)
  - Detoxification (helps the liver with the detoxification process)
- She also specifies the 7 types of beneficial enzymes. They are:
  - Broad spectrum digestive support enzymes
  - Protein digestive enzymes
  - Liver and gallbladder support
  - Pancreatic enzymes
  - Veggie enzymes
  - Gluten/dairy digestive enzymes
  - Systemic enzymes

Source: The Ultimate Guide to Using Enzymes with Hashimoto's by Izabella Wentz, PharmD, FASCP.

Note: Apparently, enzymes play a role in a number of other health conditions.

Appendix: Health Issues Associated with Gut Issues

- Appendicitis
- Colon Cancer
- Constipation
- Crohn's Disease
- Diarrhea
- Diverticular Disease
- Hemorrhoids
- Irritable Bowel Syndrome (IBS)
- Parasites
- Rectal Polyps
- Ulcerative Colitis

Source: Lipski, 5th ed, page 33

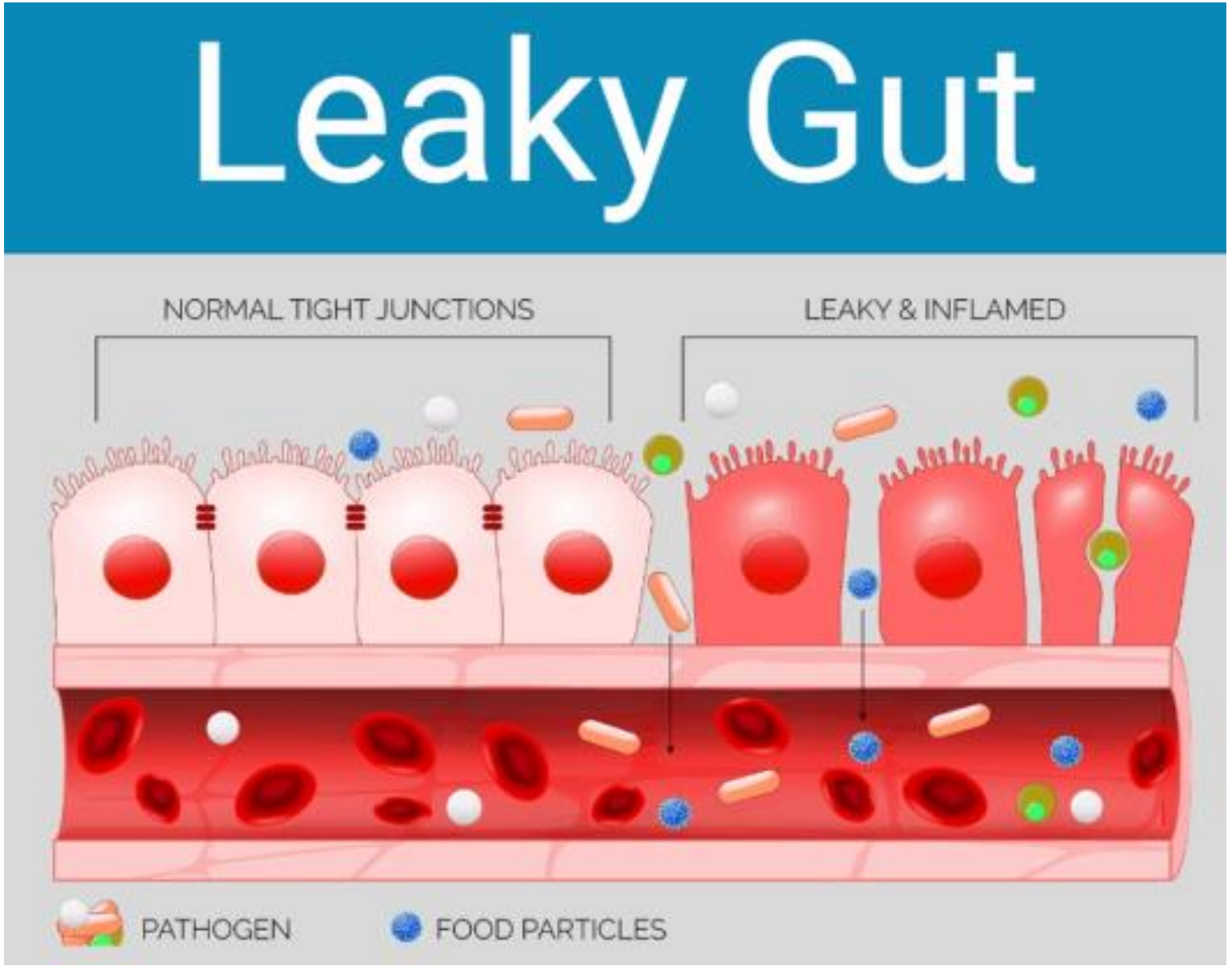
Appendix: Health Issues Associated with Gut Issues continued

- Liver Health Issues
  - Fatty Liver
  - Hepatitis
  - Cirrhosis of the liver
- Gallbladder Health Issues
  - Stones
  - Bile Reflux

Appendix: Leaky Gut Syndrome (Intestinal Permeability)

- Leaky Gut Syndrome can produce the following problems:
  - Allergies
  - Celiac disease
  - Chronic Fatigue Syndrome (CFS)
  - Crohn's
  - Food sensitivities
  - HIV
  - Migraines
  - Osteoarthritis
  - Skin problems
  - Trigger autoimmune issues

Lipski, 4th ed., page 18, Lipski 5th ed, page 55



Source: Source: https://drruscio.com/what-is-leaky-gut/

Looking at this diagram, see the blood vessel with various components.

This is one area when the foods/drinks that we digest comes into contact with our intestinal lining and with leaky gut issues, these substances leak into the blood stream.

Appendix: Leaky Gut Syndrome (Intestinal Permeability) continued

- Testing for Leaky Gut Issues (in alphabetical order):
  - Bacterial lipopolysaccharide (LPS)
  - Indirect Testing
  - Lactulose-Mannitol Testing
  - Serum diamine oxide (DAO)
  - Zonulin-1 or zonulin antibody testing
  - (Source: Lipski, 5th ed., page 57)

Appendix: Microbiome

- More and more research is coming out about the importance of our microbiome and its powerful effect on our immune system
- It can:
  - Affects our nutritional status and health
  - Affects whether or not we are fat or thin
  - Contributes to our rate of aging
  - Influence by the effect of drugs
  - It includes bacteria
  - Part of the immune system
  - Protects us from microbial and parasitic diseases
  - (Source: Lipski, page 51)

Appendix: Microbiome continued

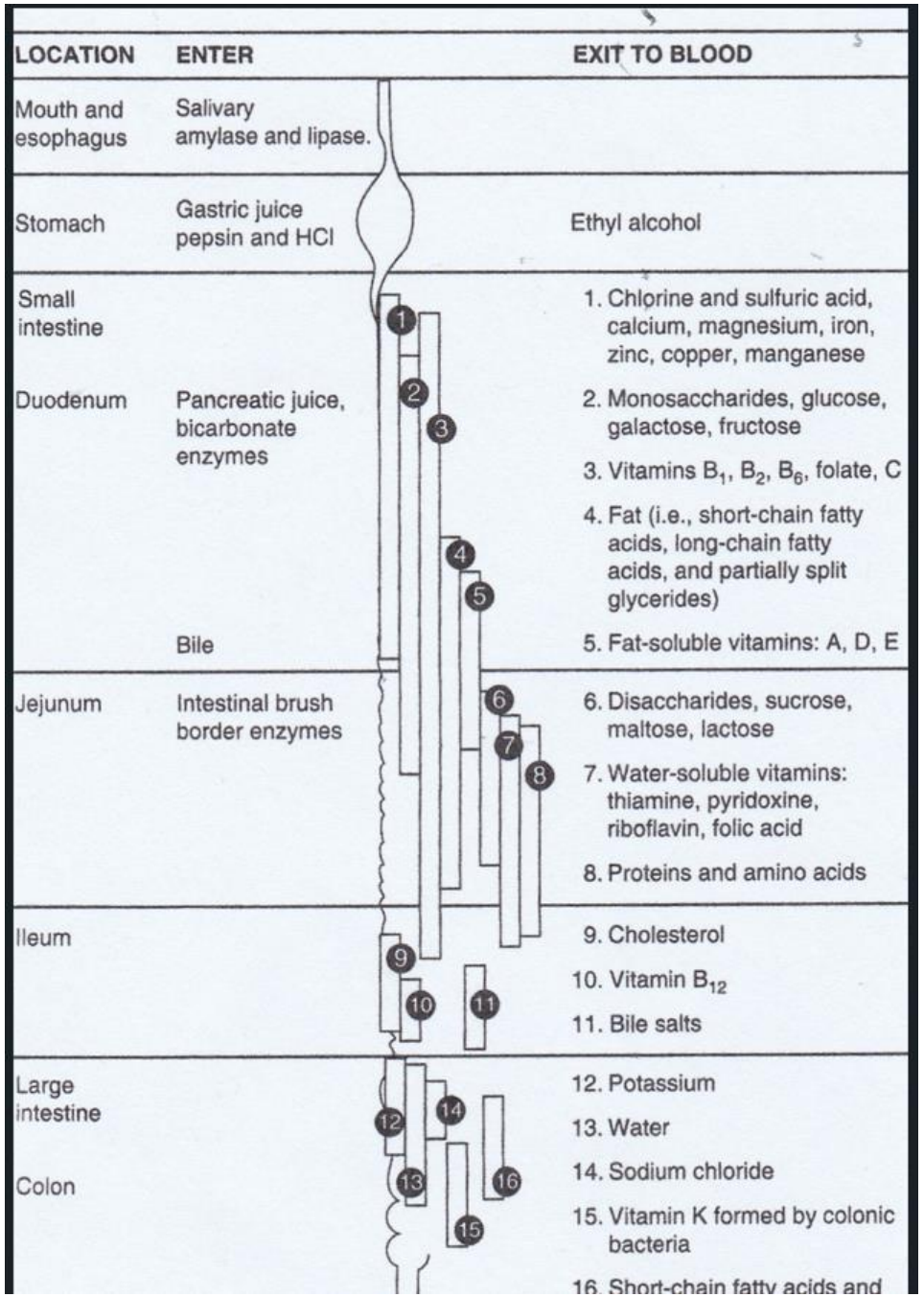
- The gut flora contains 500 to 1,000 types of bacteria
- Two major families of bacteria (80%)
- Types of bacteria
  - Bacteriodetes
    - Bacteroides
    - Prevotella
  - Firmicutes
    - Clostridium
    - Enterococcus
    - Lactobaccillus
    - Raminococcus
  - Actinobacteria
    - Bifidobacteria

Source: Lipski, 4th ed., page 52

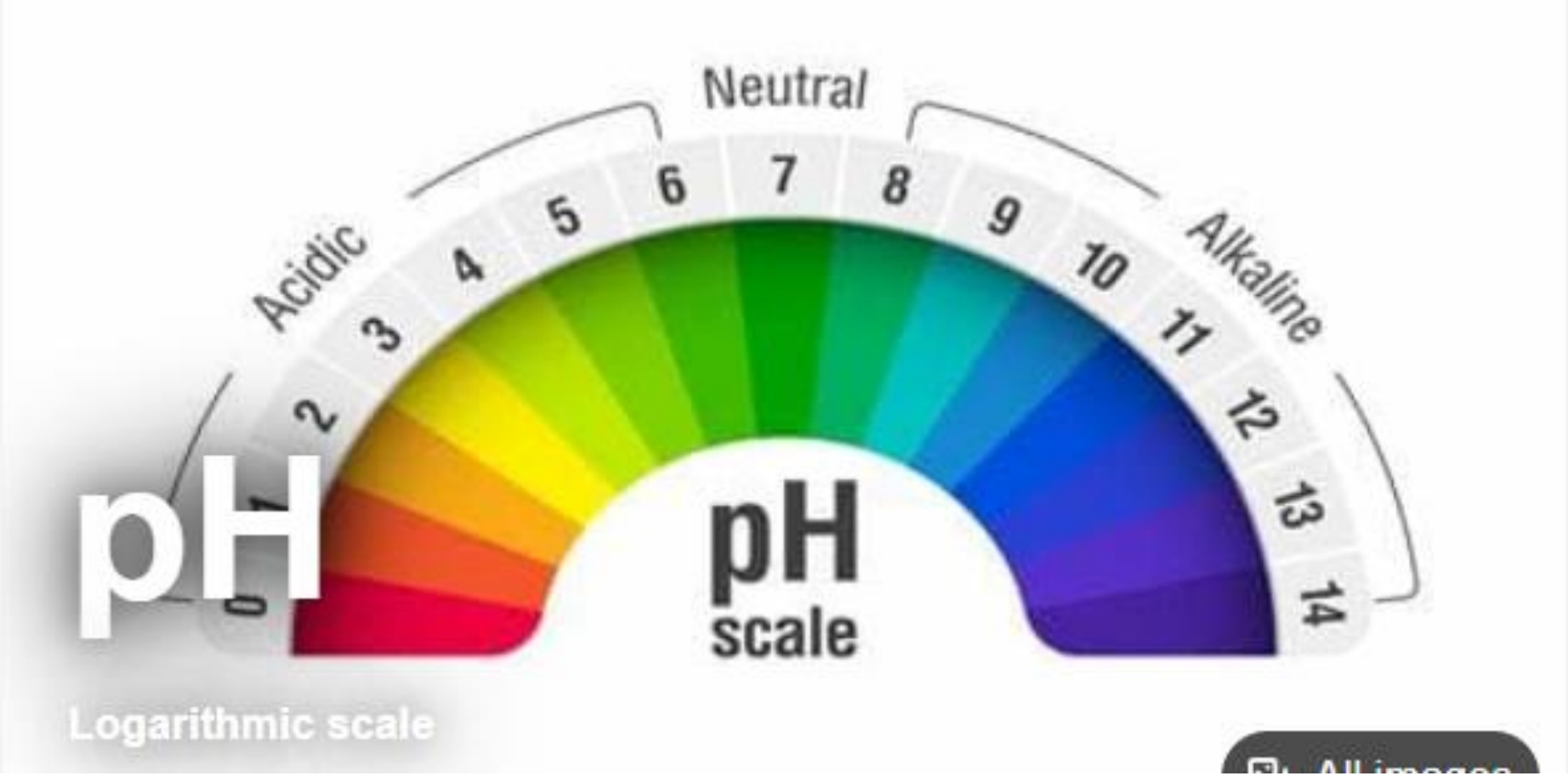
Appendix: Nutrient Chart

Showing where in the digestive tract that specific nutrients are produced or absorbed into the bloodstream

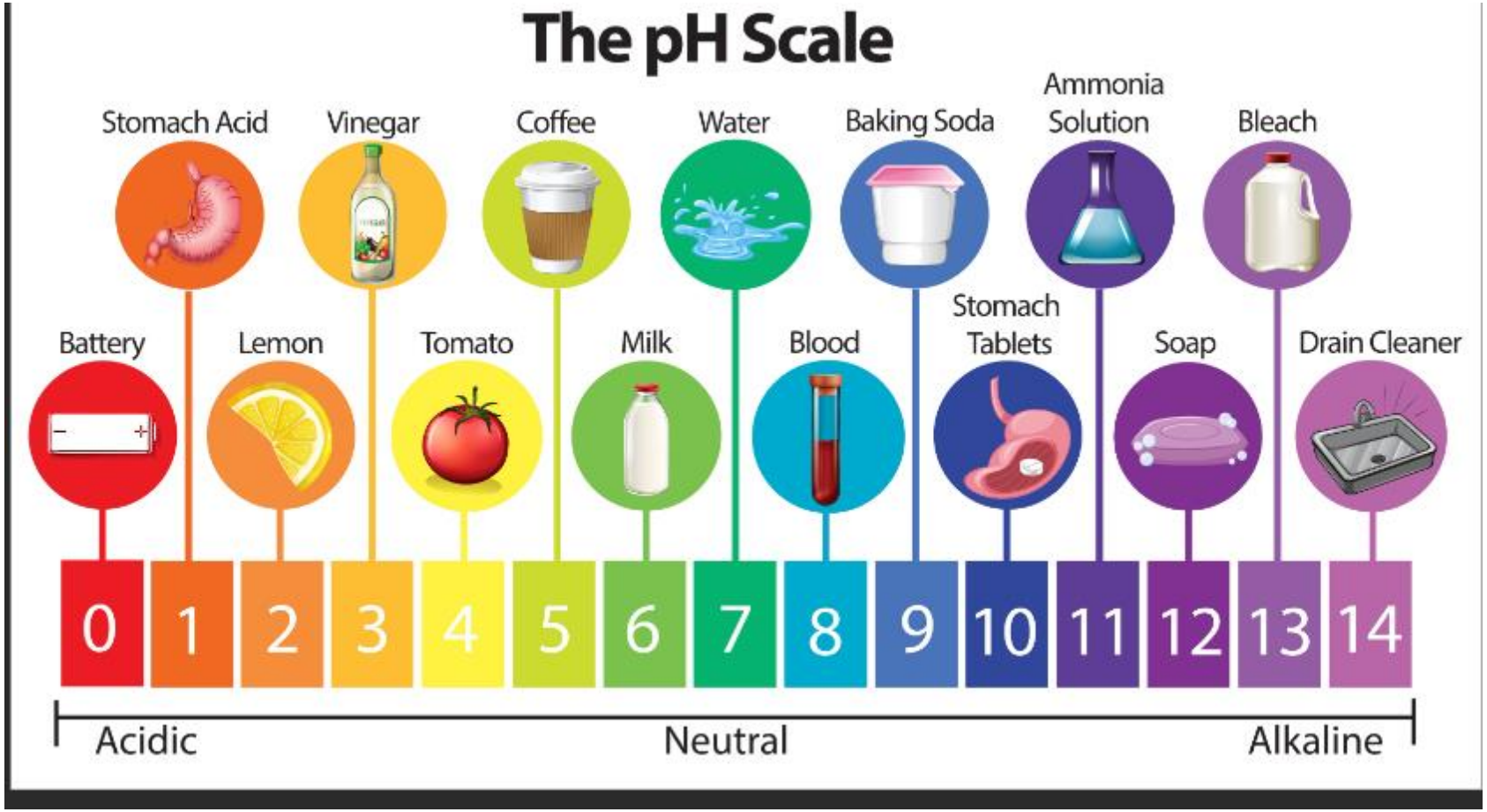
Source: Lipski, 5th ed. Page 29



Appendix: pH Chart



Appendix: pH Chart (version two)

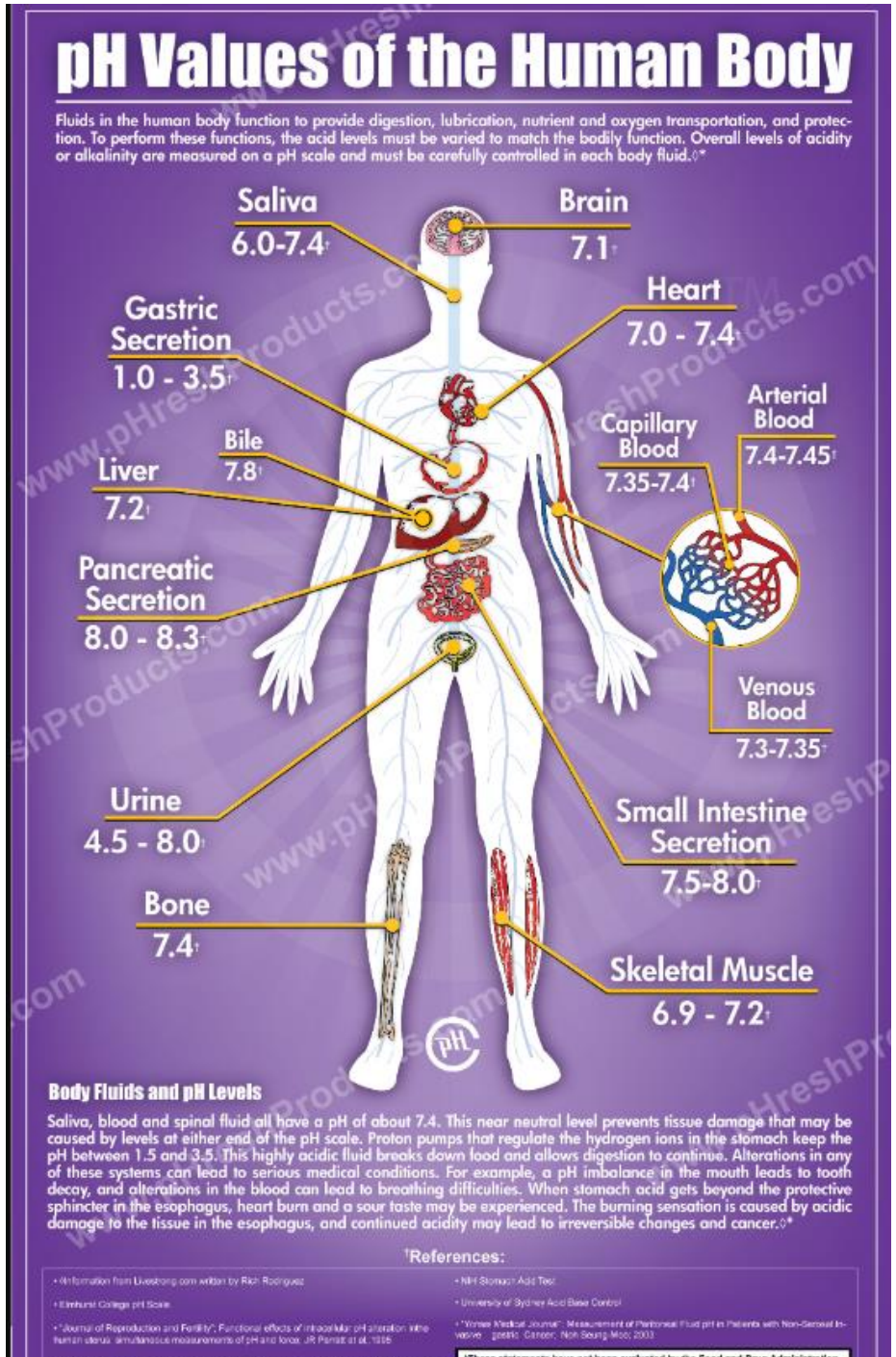


Source: https://www.dreamstime.com/education-poster-ph-scale-education-poster-ph-scale-illustration-image119210202

Appendix: pH Levels Throughout the Digestive System

- The lower number is acid and the higher number is alkaline.
- Normal pH in the body is 7.0, like water
- The stomach has a high acid level to help with digestion. The normal pH range for the stomach is: 0.8 to 1.5.
- Fiber helps to keep intestinal pH in balance.
- Proper pH balance needed for bone health.
- pH levels vary throughout the body.

Source: Lipski, 5th ed, page 42, 52. 452.



Source: https://phreshproducts.com/blog/ph-values-of-the-human-body/

Appendix: pH Levels Throughout the Digestive System continued

- Blood pH is generally maintained at about 7.3 pH and relies on a buffer system of minerals for proper control over pH balance.
- The stomach requires a very acidic pH of 1.5 to 2.5 to maintain digestive health.
- Saliva has a pH of around 6.5–7.4.
- The digestive tract's pH can range from 1.5 to 7.0, depending on what stage of digestion is underway.
- The enzymes that help digest food in the stomach, such as pepsin, work best at a pH around 2, while those that function in the intestines, including peptidases and maltase, work best at a pH around 7.5.

Source: Bing.com

Appendix: Prebiotics

- Benefits of prebiotics:
  - Discourage growth of clostridia
  - Keeps blood sugar levels even
  - Lower colon pH
  - Prevent constipation and diarrhea
  - Promote growth of bifidobacteria and lactobacilli
  - Useful for people with liver disease
- Examples of prebiotics:
  - FOS
  - Inulin

Appendix: Probiotics continued

- There are specific probiotics worth mentioning that have beneficial properties.
- Lactobacillus Acidophilus
  - Prevents infections including candida, E. coli, H. pylori, and salmonella
  - Prevents and treats antibiotic associated diarrhea and traveler's diarrhea
  - Aids in digestion of lactose an dairy products
  - Improves nutrient absorption
  - Maintains integrity of the intestinal tract
  - Helps prevent vaginal and urinary tract infections
- Lactobacillus Reuteri
  - Inhibits growth of disease-causing microbes
  - Inhibits adherence of pathogens in the gut
  - Protective effective and therapeutic effect on vaginal infections
- Bifidobacteria Infantis
  - Helps treat colic, cradle cap, and eczema in infants and babies
  - May protect against bacteria that promote inflammatory bowel disease
  - Helpful to alleviate the symptoms of irritable bowel syndrome
- Saccharomyces boulardie
  - Safe for all people
  - Helps with Crohn's

Source: Lipski, page 58 (4th edition)

Note: Breast fed babies have better microbiome.

Appendix: Probiotics continued

- Healthy gut flora is essential to our gut and overall health.
- Benefits of Probiotics include:
  - Digestive
  - Heart
  - Immune benefits
  - Metabolic
  - Nutritional
- Friendly microbes help with:
  - Manufacture a number of nutrients including B vitamins
  - Increase absorption of minerals
  - Improve peristalsis
- Some probiotics can metabolize foreign substances such as mercury, pesticides, and radiation.
- While there are specific probiotics with specific properties, it is best to eat fermented foods. A number of cultures have specific types of fermented foods.
- When purchasing a specific type of probiotic, it is important to know specific species and strain. Refrigerated ones are better.

Appendix: Proteolytic Enzymes

- There are a number of proteolytic enzymes (to digest protein). Two major groups are:
  - Exopeptidases
  - Endopeptidases
- The exopeptidases target the end or terminal ends of proteins.
- The endopeptidases target the sites within the proteins. Endopeptidases employ various catalytic mechanisms. (Catalyze means that they cause change without changing themselves.) The endopeptidases have a number of substances:
  - Aspartic endopeptidases
  - Cysteine endopeptidases
  - Glutamic endopeptidases
  - Metallo endopeptidases
  - Serine endopeptidases
  - Threonine endopeptidases

Appendix: Proteolytic Enzymes continued

- Oligopeptidase is for enzymes that act specifically on peptides.
- Enzymes in the various parts of the digestive tract.
  - Stomach – pepsin (endopeptidase) Protein is only partially digested in the stomach.
  - Pancreas –
    - Pancreas produces a number of enzymes needed for breaking down proteins into their smallest components, into amino acids. It is used in the small intestine.
    - The pancreas also produces a protein called pancreatic secretory trypsin inhibitor, which binds to trypsin and blocks its activity. It is thought that in this manner the pancreas protects itself from autodigestion.

Source: https://www.britannica.com/science/proteolytic-enzyme*The Editors of Encyclopaedia Britannica* *This article was most recently revised and updated by* *Kara Rogers*

Appendix: Proteolytic Enzymes continued

- Small intestine – Proteins are partially digested. A number of enzymes are produced and come from the pancreas. The acinar cells in the pancreas are precursor enzymes. They are:
  - Chymotrypsinogen
  - Proelastase
  - Procarboxypeptidase
  - Trypsinogen
  - Trypsinogen is transformed to an endopeptidase called trypsin by an enzyme (enterokinase) secreted from the walls of the small intestine. Trypsin then activates the precursors of chymotrypsin, elastase, and carboxypeptidase. When the pancreatic enzymes become activated in the intestine, they convert proteins into free amino acids, which are easily absorbed by the cells of the intestinal wall.

Source: https://www.britannica.com/science/proteolytic-enzyme*The Editors of Encyclopaedia Britannica This article was most recently revised and updated by Kara Rogers*

Appendix: Supplements for Food Sensitivities and Allergies

- In addition to avoidance, food elimination diet, the following are helpful (Lipski, page 160)
  - Enzymes
  - Glutamine (to heal intestinal lining)
  - Herbs
  - Malic Acid
  - Mineral Salts
  - Probiotics
  - Quercetin (reduces pain)
  - Vitamin C
  - 4 Day Rotation Diet

Appendix: Testing

- Organic Acid Test (non-invasive, urine test), it can show: (Lipski, page 121)
  - B-Complex sufficiency
  - Carbohydrate metabolism
  - Detoxification status
  - Dysbiosis
  - Energy production
  - Fatty acid metabolism
  - Inflammatory Reactions
  - Methylation abilities
  - Neurotransmitter metabolism
  - Oxidative damage

Appendix: Testing continued

- Amino Acid Testing (Lipski, page 123)
  - This test sees if the body is able to break down food and cellular proteins into usable amino acids
- Breathe Levels of Hydrogen or methane (test for SIBO) (Lipski, 122)
- Candida Antibody Testing
- Comprehensive Stool Testing
- Electrodermal Testing (uses acupuncture points) (Lipski, page 127)
- Fatty Acid Testing
  - Need a balance of omega 3 and omega 6 essential fatty acids
- Food Allergies
- Fructose Intolerance Testing

Note: Testing for GI inflammation can be done on calprotectin and lactoferrin (both proteins) in the stool. They are elevated in a number of gut issues. Lipski, 5th ed, page 113)

Appendix: Testing continued

- Functional Liver Profile Testing (urine)
- Genetic testing (SNPs, APO-E, MTHFR-677)
- H. Pylori Testing
- Heidelberg Capsule Test (swallow a capsule and it is tracked)
- Hydrochloric (HCl Heidelberg Capsule Test)
- Indican Testing (Urine Test) (Lipski, page 123)
- Lactose Intolerance Test
  - Eliminate all dairy products for 10 to 14 days (self-test)
  - There are laboratory testing for lactose intolerance, also fructose and sucrose
- Parasitology Testing
- Secretory IgA Testing
- SIBO Testing

Appendix: Testing continued

- Newer Tests
  - Fecal immunochemical test (FIT)
  - Guaiac-based fecal occult blood test (gFOBT)
  - Stool DNA test (Cologuard)
  - CT colonographic

Source: Lipski, 5th ed, page 144

Appendix: Types of Diets for Specific Issues (in alphabetical order)

- Anti-Fungal Diets/Anti-Candida Diet
- Carnivore Diet (Meat and Fish)
- Casein Free Diet
- Elemental Diet (Fasting)
- Elimination Diet
- Fodmap Diet
- Gluten Free Diet
- Gluten Free/Casein Free Diet
- Gluten Free/Casein-Free/Egg Free Diet
- Gut and Psychology Syndrome Diet (GAPS)
- IFM Renew Food Plan
- Low-histamine/low bioactive amine diet
- Low Lectin Diet
- Oligoantigenic Diet
- Paleo Diet
- Six Food Elimination Diet
- Specific Carbohydrate Diet
- Wahls Diet

Source: Lipski, 5th edition, page 199

Conclusion

- A happy stomach or digestive system is much more likely to create a happy body and a happy mind.
- As we learn more and more how important a healthy and functioning digestive system, all of us as consumers and even health care practitioners, will pay more attention to our digestion.
- Furthermore, as we age, some changes occur in our digestive system, especially when it comes to digesting protein. A number of health issues result from having digestive issues.
- This PowerPoint just highlights some of the key factors and a beginning. Another interesting point is the role of the acid/alkaline or pH levels that varies along certain points of the digestive tract. A healthy digestive track even produces nutrients, too.
- A healthy digestive system and gut is needed for:
  - Our overall health
  - Our immune system
  - Our mental health