



The Neurology of the Gut - "The Second Brain"

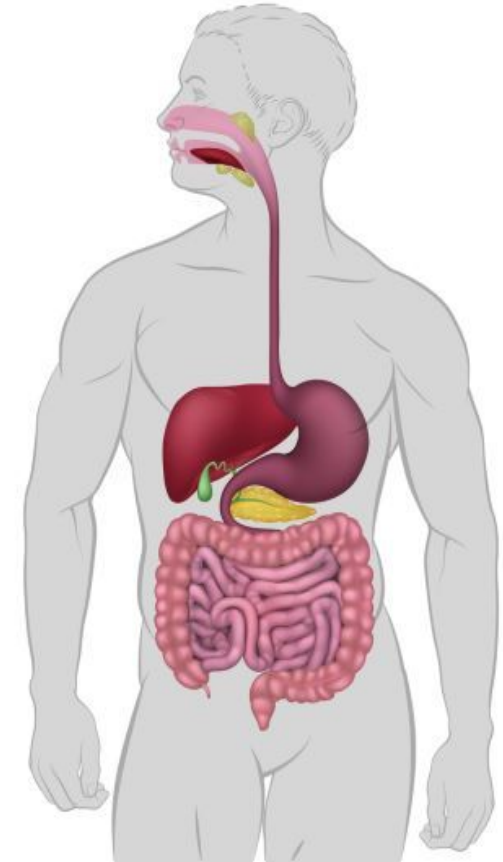
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May 28, 2020

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The Gastrointestinal System

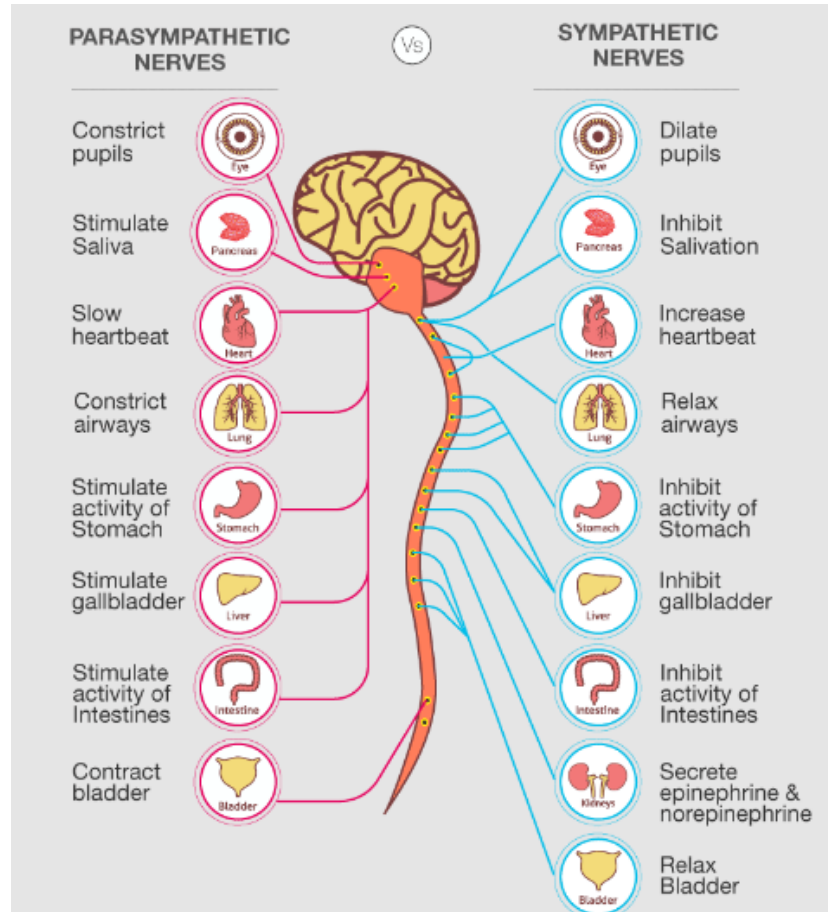
- Largest microbial, endocrine, immune organ
- Three Main Functions
 - Transportation
 - Digestion
 - Absorption of Food
- Accessory Organs
 - Liver
 - Gallbladder
 - Pancreas



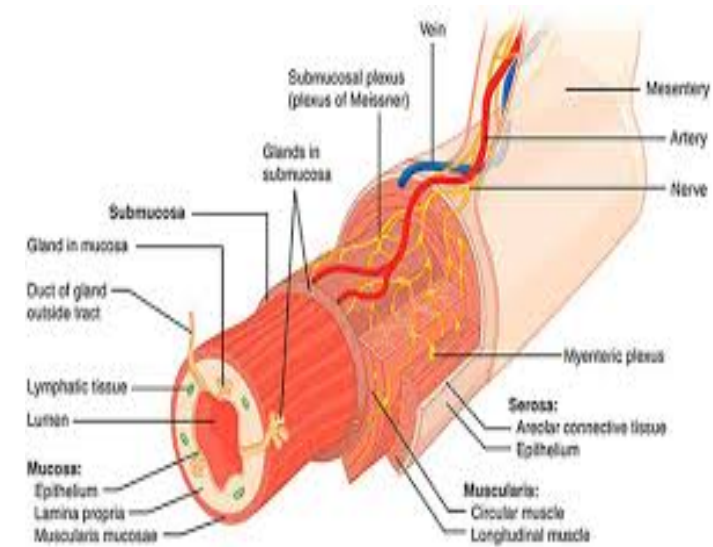
Divisions of the Human Nervous System

- **Central Nervous System (CNS)-**
 - Brain & Spinal Cord
- **Peripheral Nervous System (PNS)**
 - Somatic- Voluntary control
 - Autonomic- Largely unconscious
 - **Sympathetic-**
 - Spinal nerves → internal organs → brain
 - *Fight or flight*
 - **Parasympathetic-** spinal cord and brain.
 - Primarily Vagus Nerve (CNX)
 - *Rest & digest*
 - **ENTERIC** –innervates gastrointestinal tract, pancreas and gallbladder
 - Myenteric (Auerbach's Plexus)-
 - Submucosa- (Meissner's Plexus)

Sympathetic, Parasympathetic, Enteric



ENTERIC NERVOUS SYSTEM



Enteric Nervous System

- 500 million (100) neurons
- 9 meters
- Can operate independently of the brain and spinal cord
- Every CNS neurotransmitter

Gershon, M. D. (1998). *The second brain: The scientific basis of gut instinct and a groundbreaking new understanding of nervous disorders of the stomach and intestine*. New York: HarperCollins.

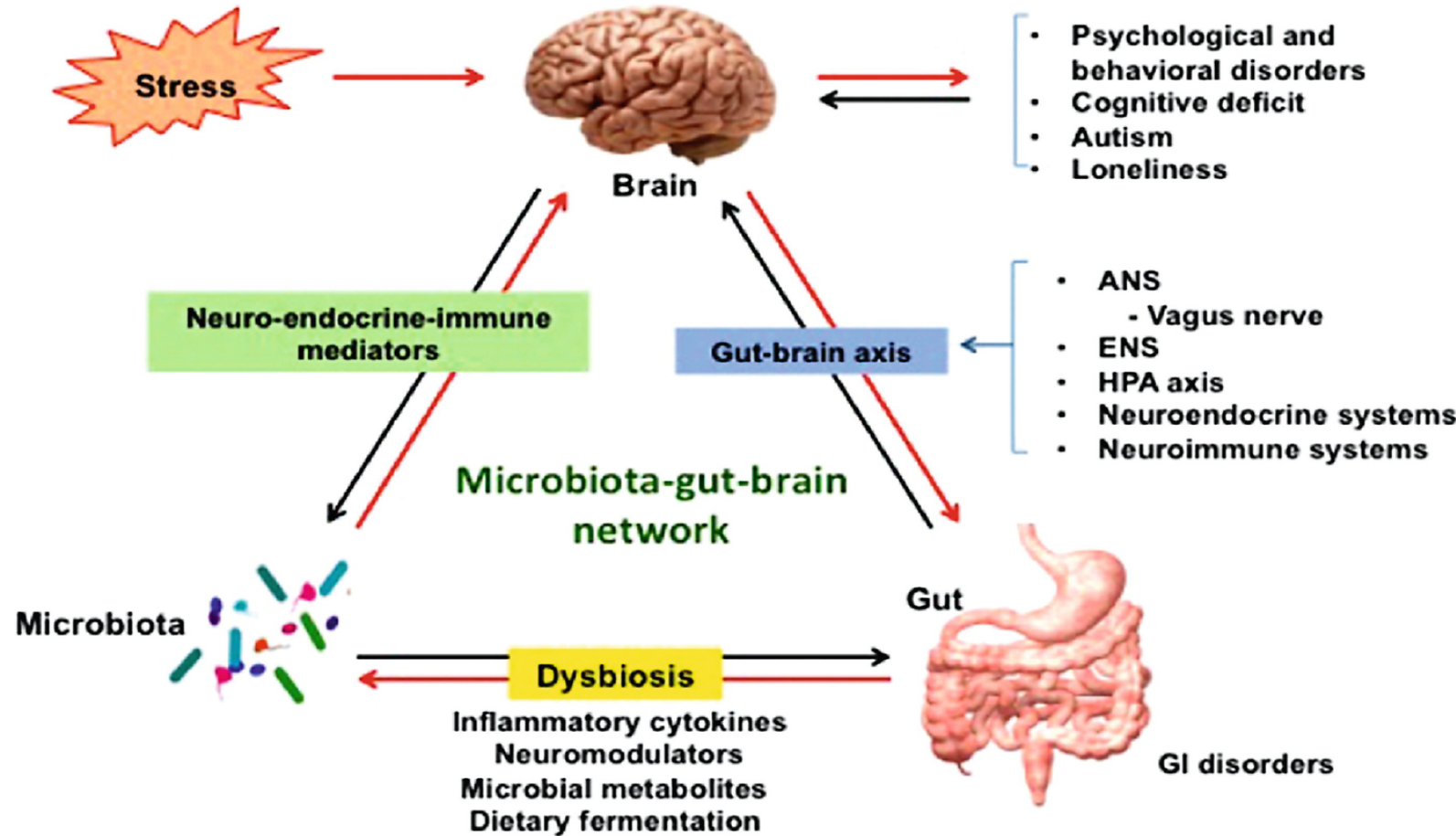
Gut-Brain Axis Conversation-

- **Complex intersystem cross-talk**

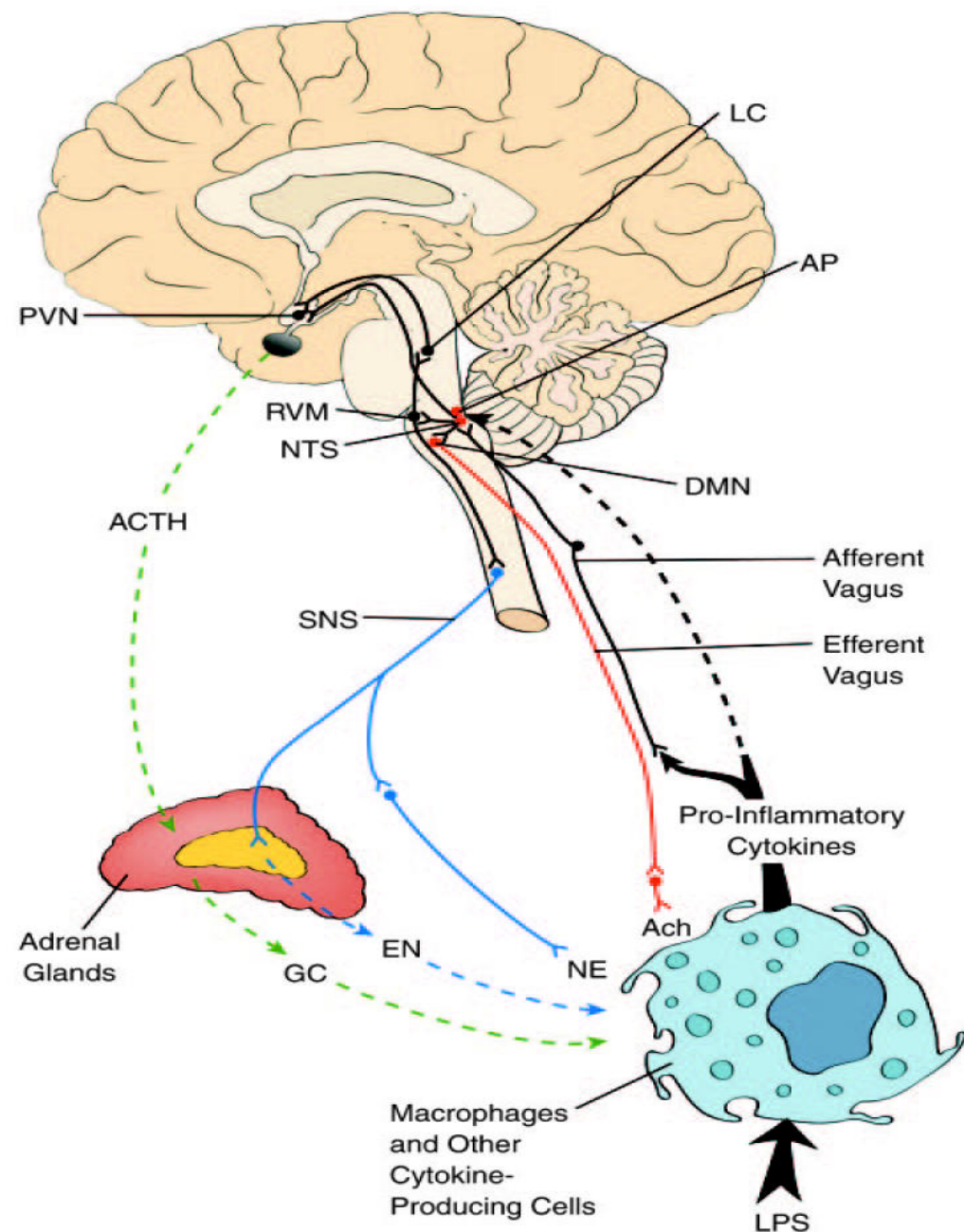
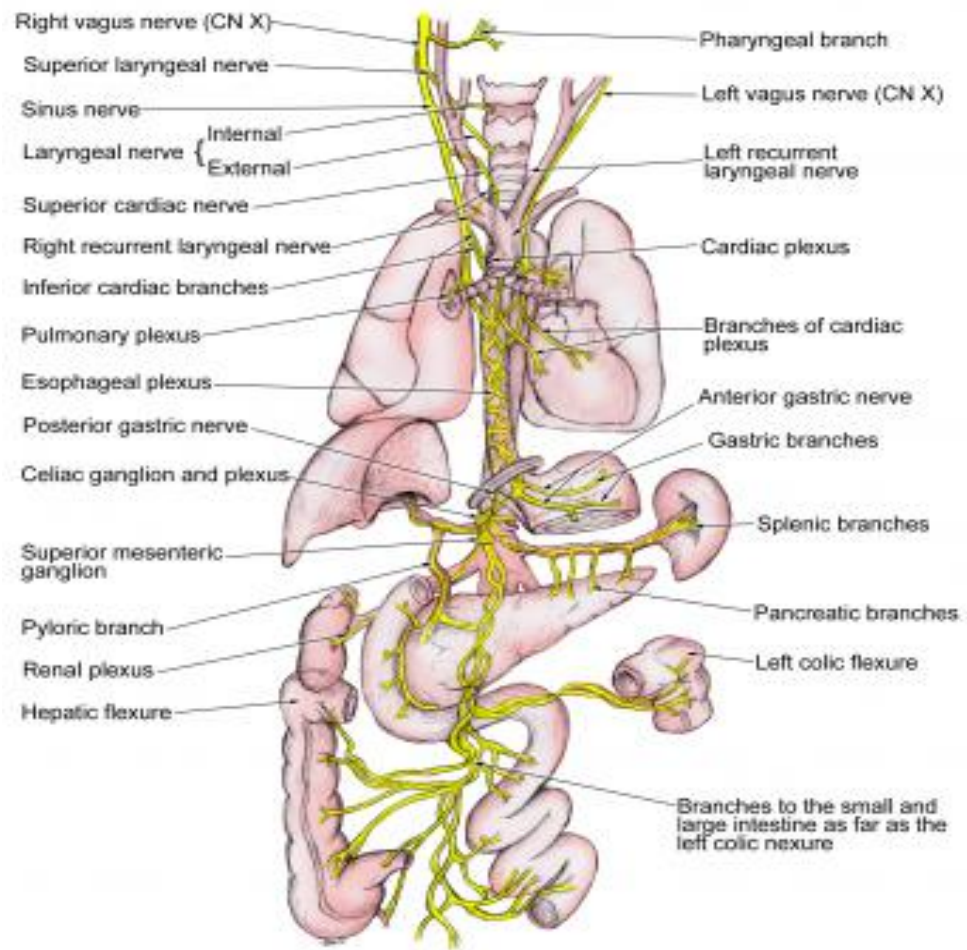
- Autonomic Nervous System
- Endocrine (HPA)
- Immune (cytokine and chemokines)
- Circa 10^{14} microorganisms

- **Vagus Nerve (CNX)-**

- Communicates between brain and gut
- Relaxation with deep breathing
- Anti-inflammatory signaling
- Lowers heart rate and blood pressure
- Fear management – “gut feeling”

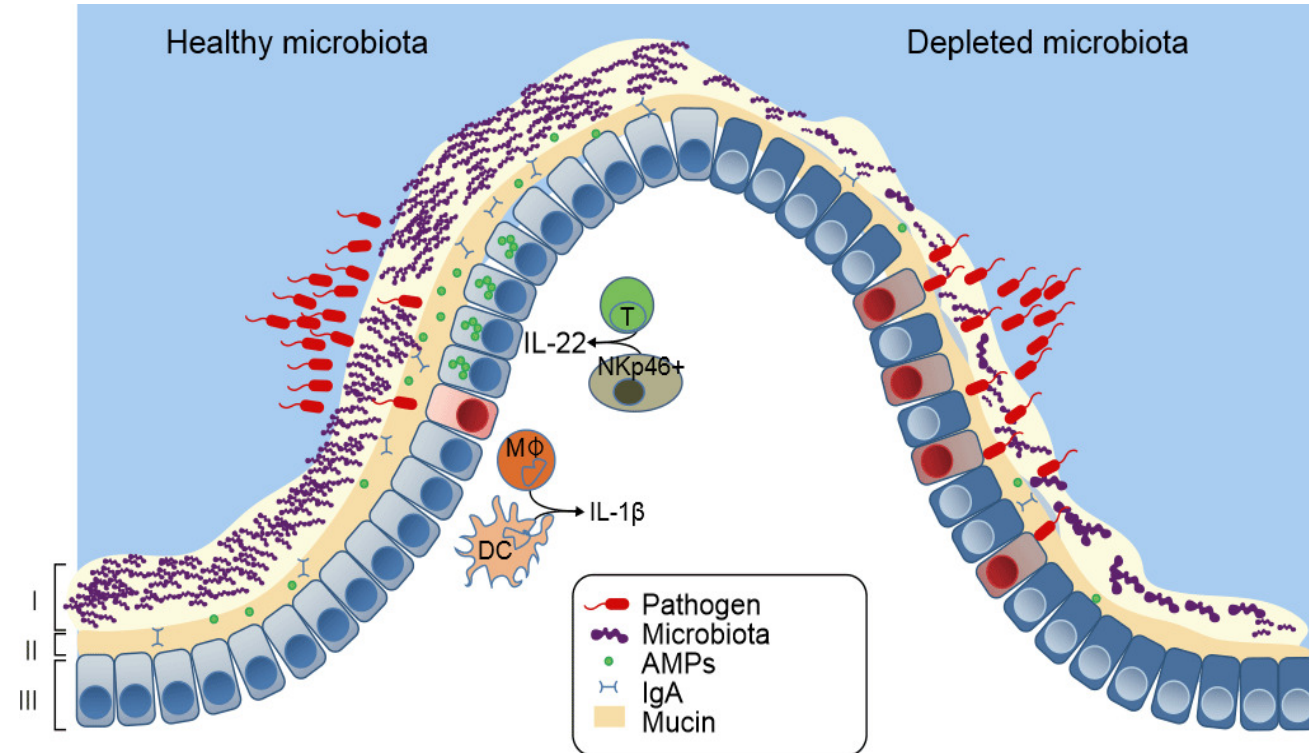


Vagus Nerve/HPA AXIS



Microbiome/Microbiota

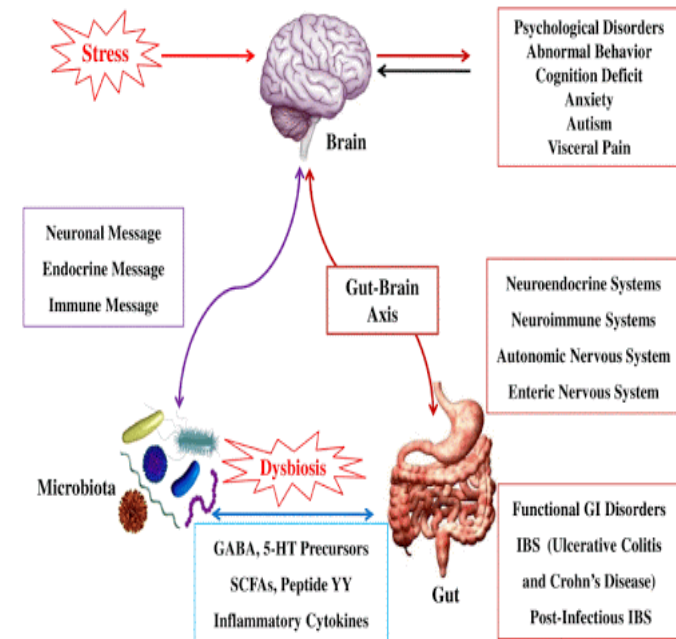
- Microbiome- (bugs + genes)
- Microbiata (bugs)
 - 500 + Species/30 different genera
 - 1 million → 1 trillion organisms/gram



Kamada, N., Seo, S.-U., Chen, G. Y., & Núñez, G. (2013). Role of the gut microbiota in immunity and inflammatory disease. *Nature Reviews Immunology*, 13(5), 321–335. <https://doi.org/10.1038/nri3430>

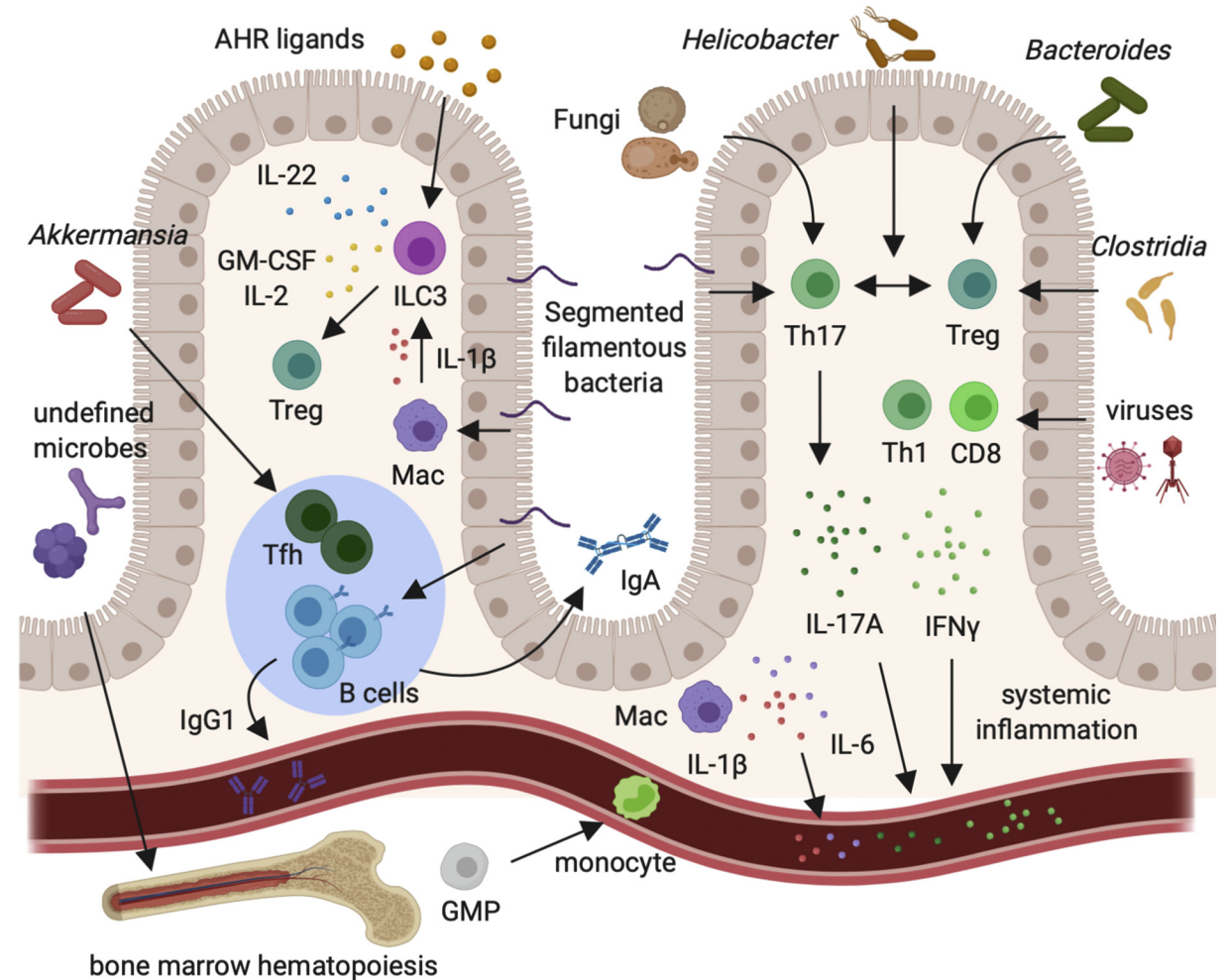
Microbiata & Gut Brain Axis

- Vagus Nerve–
- Neuro Endocrine signaling –
- The Immune System -80%
- Altered Intestinal Impermeability
- Microbial Metabolite Production
- Interference with Tryptophan metabolism –95% Serotonin
 - **Tryptophan** is present in most protein-based foods particularly in the following:
 - chocolate
 - Oats
 - dried dates
 - Milk
 - Yogurt
 - cottage cheese
 - red meat, eggs, fish, poultry
 - Sesame
 - Chickpeas
 - almonds
 - sunflower seeds
 - pumpkin seeds
 - Buckwheat
 - Spirulina
 - Nuts- cashew, almonds, pistachios



Microbiata and Disease

- Stimulate Immune system
- Break down food toxic compounds
- Protection against pathogenic compounds
- > 500 species

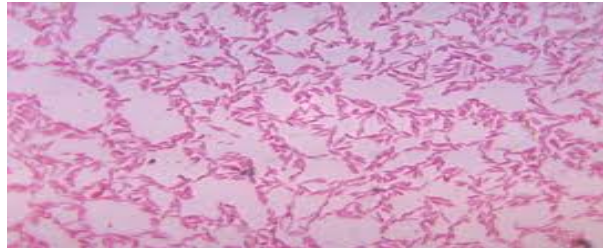


- “All disease begins in the gut” – Hippocrates

Microbiata- Vitamin B Synthesis

B12

Adenosylcobalamin

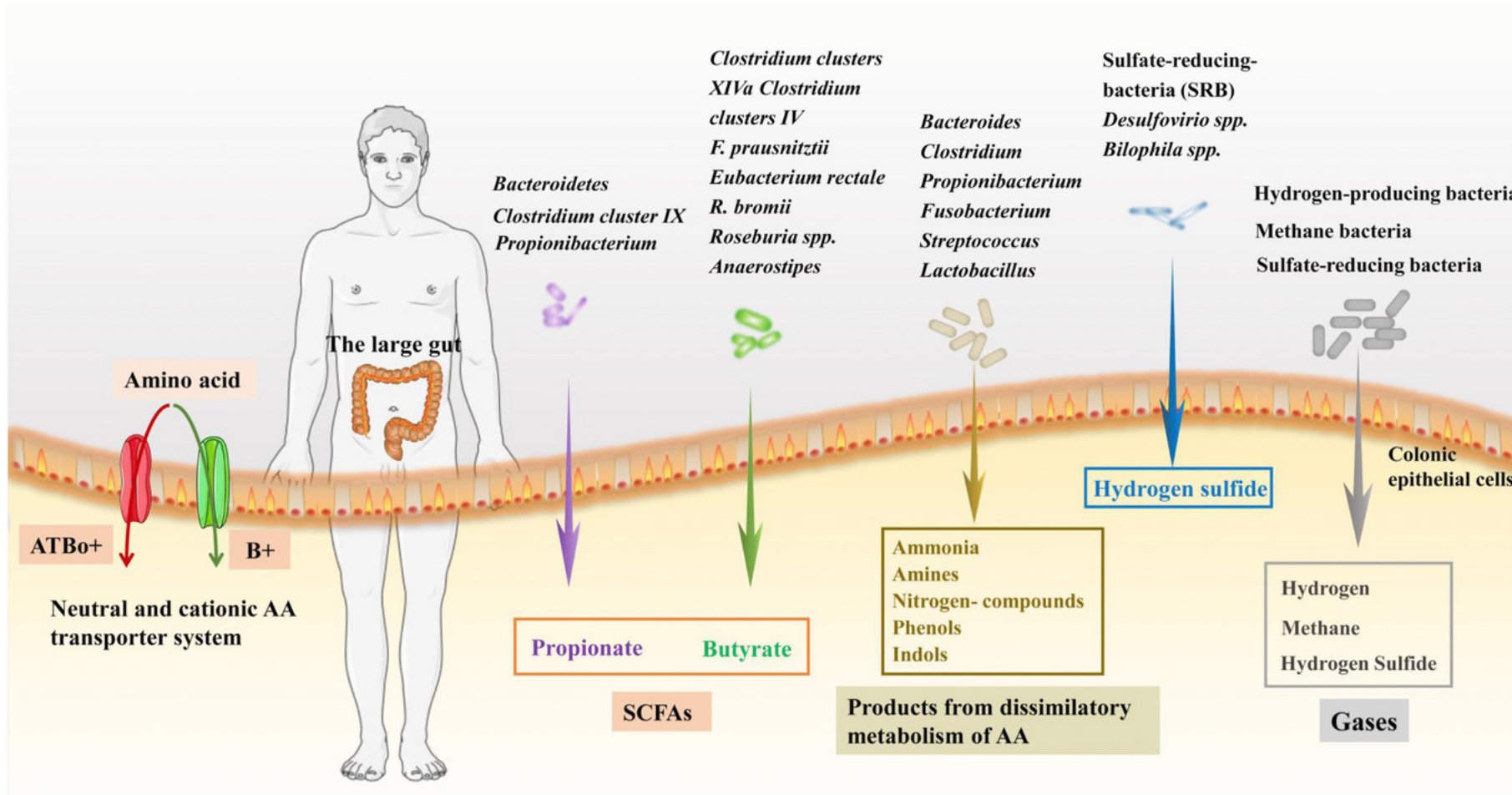


Bacteroides fragilis
Prevotella copri
Clostridium difficile
Faecalibacterium prausnitzii
Ruminococcus lactaris
Propionibacterium freudenreichii
Lactobacillus plantarum
Lactobacillus coryniformis
Lactobacillus s reuteri
Bifidobacterium animalis
Bifidobacterium infantis
Bifidobacterium longum
Fusobacterium varium

Yoshii, Ken, et al. "Metabolism of Dietary and Microbial Vitamin B Family in the Regulation of Host Immunity." *Frontiers in Nutrition*, Frontiers Media S.A., 17 Apr. 2019, www.ncbi.nlm.nih.gov/pmc/articles/PMC6478888/.

Vitamin Synthesis by Intestinal Bacteria, *Nutrition Reviews*, Volume 1, Issue 6, April 1943, Pages 175–176, <https://doi.org/10.1111/j.1753-4887.1943.tb08031.x>

Microbiata -Amino Acids



Ma, N. and Ma, X., 2020. *Dietary Amino Acids And The Gut-Microbiome-Immune Axis: Physiological Metabolism And Therapeutic Prospects.*

Categories of Bacteria

- **Pathogenic Bacteria, viruses, parasites**
 - Disease causing
 - Produce intense symptoms
- **H. Pylori**
 - Resides in stomach
 - Linked to stomach ulcers
 - Affects hydrochloric acid production
- **Normal Flora/Good Bacteria**
 - Comprises immune system
 - Digest food
 - Produce vitamins & amino Acids
- **Opportunistic Bacteria**
 - Seek opportunity to overgrow/proliferate- timing
 - Linked to autoimmune disease
- **Candida**
 - Some normal
 - Too much → bloating, brain fog, skin issues

Disruption of the Gastrointestinal Microbiome

- **Gastrointestinal Symptoms**

- Abdominal pain
- Constipation
- Crohn's Disease
- Diarrhea
- Food Poisoning
- Gastric cancer
- Gastroesophageal reflux
- Irritable Bowel Syndrome
- Small Intestinal Bacterial Overgrowth
- Ulcer
- Ulcerative colitis
- Vomiting

- **Autoimmune Conditions**

- Ankylosing Spondylitis
- Reactive Arthritis
- Rheumatoid Arthritis

- **Allergic Diseases**

- Asthma
- Eczema

Prebiotics– Healthy Microbiata

- Fermented foods e.g. Sauerkraut & kimchi
- Garlic, Onions
- Jerusalem Artichoke (inulin)
- Cruciferous vegetables- broccoli, cauliflower, kale, Brussel sprouts
- Tempeh
- Apples
- Flaxseed-
- Kefir & yogurt
- Jicama, Yakon & Burdock
- Asparagus
- Banana

Soluble and Insoluble Fiber

- **Soluble Fiber**

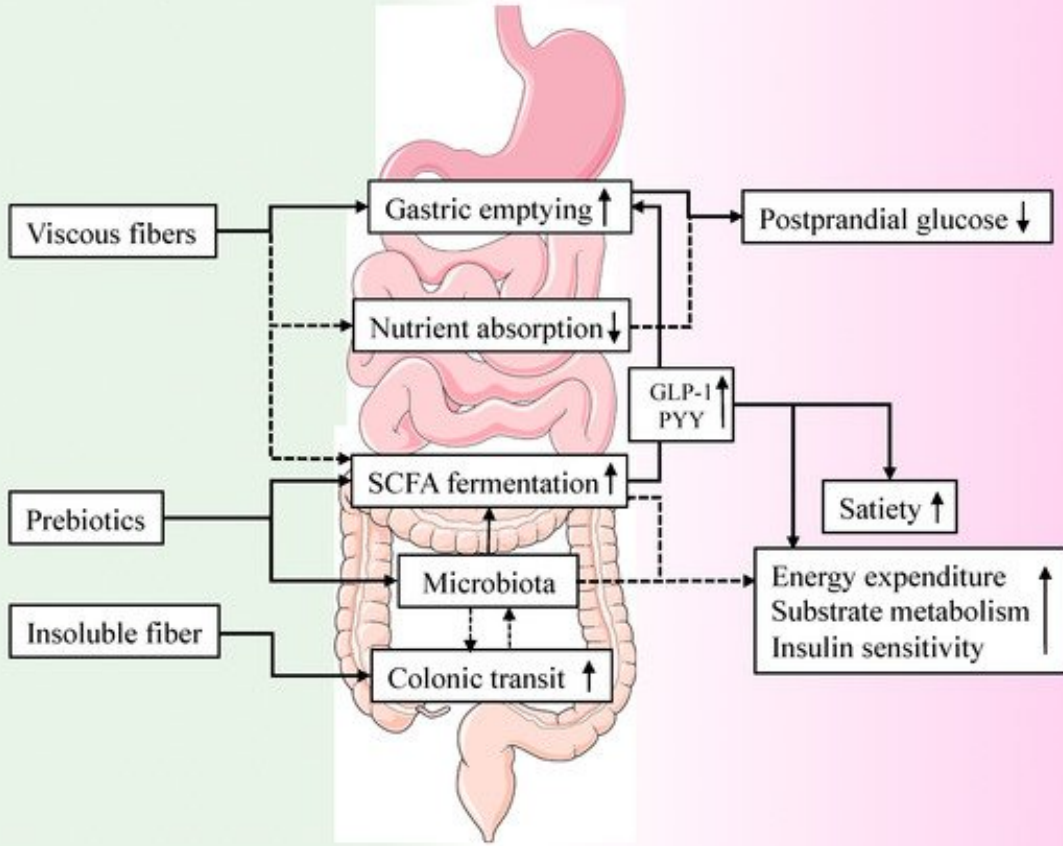
- Dissolves in water
- Gel like substance
- Entraps sugars, cholesterol, fat
- Slows absorption into body
- Prebiotic
 - Inulin
 - Fructo-oligosaccharide
 - Galacto-oligosaccharide

- **Insoluble Fiber**

- Does not dissolve in water
- Moves through GI
- Promotes regularity

Dietary fiber intake

Metabolic Health



FIBER

Soluble

Insoluble



Importance of Diet

“Diet has a major impact on gut microbiota composition, diversity, and richness.”

Makki, K., Deehan, E. C., Walter, J., & Bäckhed, F. (2018, June 13). The Impact of Dietary Fiber on Gut Microbiota in Host Health and Disease [Review]. *Cell Host Microbe*, 23(6), 705-725. Retrieved May 25, 2020, from <https://pubmed.ncbi.nlm.nih.gov/29902436/>

Importance of Mastication

- Chew slowly and steadily 15-30 times per mouthful
- ↑ surface area → ↑ nutrient absorption-
- Water- not too much whilst eating
- Weight stability/weight loss/satiety
- Relaxed environment
- Saliva
 - Amylase (Ptyalin)
 - Lingual lipase
 - Saliva Peroxidase

Homework

- 50 Foods- 7 Day Challenge
- Dietary Diversity
 - Every different food has unique nutrients
 - ↑ HEALTH
 - ↑ Resilience
 - ↑ Robustness,
- How we eat is how we live!



Healthy Eating Websites

- Deanna Minnich <https://www.deannaminich.com>
- Physicians for Responsible Medicine <https://www.pcrm.org/good-nutrition/plant-based-diets/ffl>
- Dr Perlmutter <https://www.drperlmutter.com/nutrition/>

Contact Information



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