

Impact of the Gut's Microbiome on COVID

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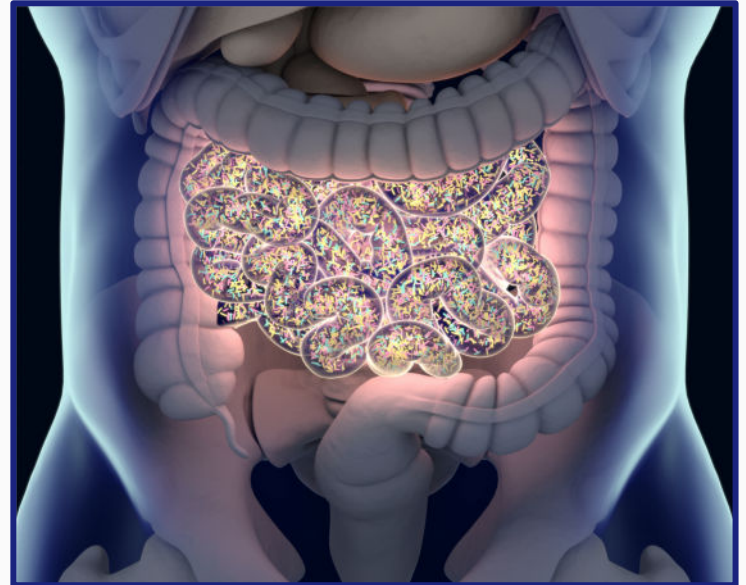
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March 23, 2022

The Gut Microbiome

- “Good” & “Bad” bacteria” reside in the gut
 - ~100 trillion microorganisms make up the gut microbiota
 - Bacteria, viruses, archaea, protozoa, and fungi
- Aside from skin, the gut is the largest organ exposed to the outside world (constant exposure to toxins, bacteria, viruses, etc.)
- Diverse microbiota is essential for proper development, immunity, & metabolic health
- Microbiome moves in and out of balance quickly (affected by epigenetics)
 - Dysbiosis: imbalance of the gut microbiota
- All disease begins in the gut & results as a dysfunction of gut health!



Immune System and the Gut

- Development of innate and adaptive immune systems are closely linked to your gut composition
 - Gut balance helps regulate immune response → lack of microbial diversity and impaired metabolic function leads to poor immune response
- A study, ***Role of the Microbiome in Human Development***, found that animals that lack a gut microbiota have poor development of immune cells, weakening their immune system
 - Immune cells require a healthy gut microbiota for their production and function
- About half of our antibodies are made in the gut lining

The Gut is the Guardian to Our Health & Gateway to Disease: Gut-Immune Connection

- The gut is the motherboard to our immune system
 - 70-80% of immune cells in our body are found in the gut and depend on a healthy gut flora to function
 - “Good” bacteria produce beneficial compounds that optimize immune system functioning
 - A broken gut microbiome leads to poor immune resilience



COVID-19 & The Gut

- Impressive connection between gut health and severity of COVID-19
 - Poor gut health adversely affects COVID-19 prognosis
 - Prevalent GI symptoms once infected with COVID-19 demonstrate the importance of the gut for this virus
- 1. Leaky gut and dysbiosis give the virus access to circulation, the digestive tract, and internal organs**
 - a. Because these organs have high ACE2 receptors, they are likely to engulf the virus
 - b. A healthier gut microbiome may lead to decreased expression of the ACE2 receptors
 - 2. The virus gains entry through the ACE2 receptors, which have a large reservoir in the small intestine**
 - a. Poor gut health correlates with increased expression of ACE2 receptors

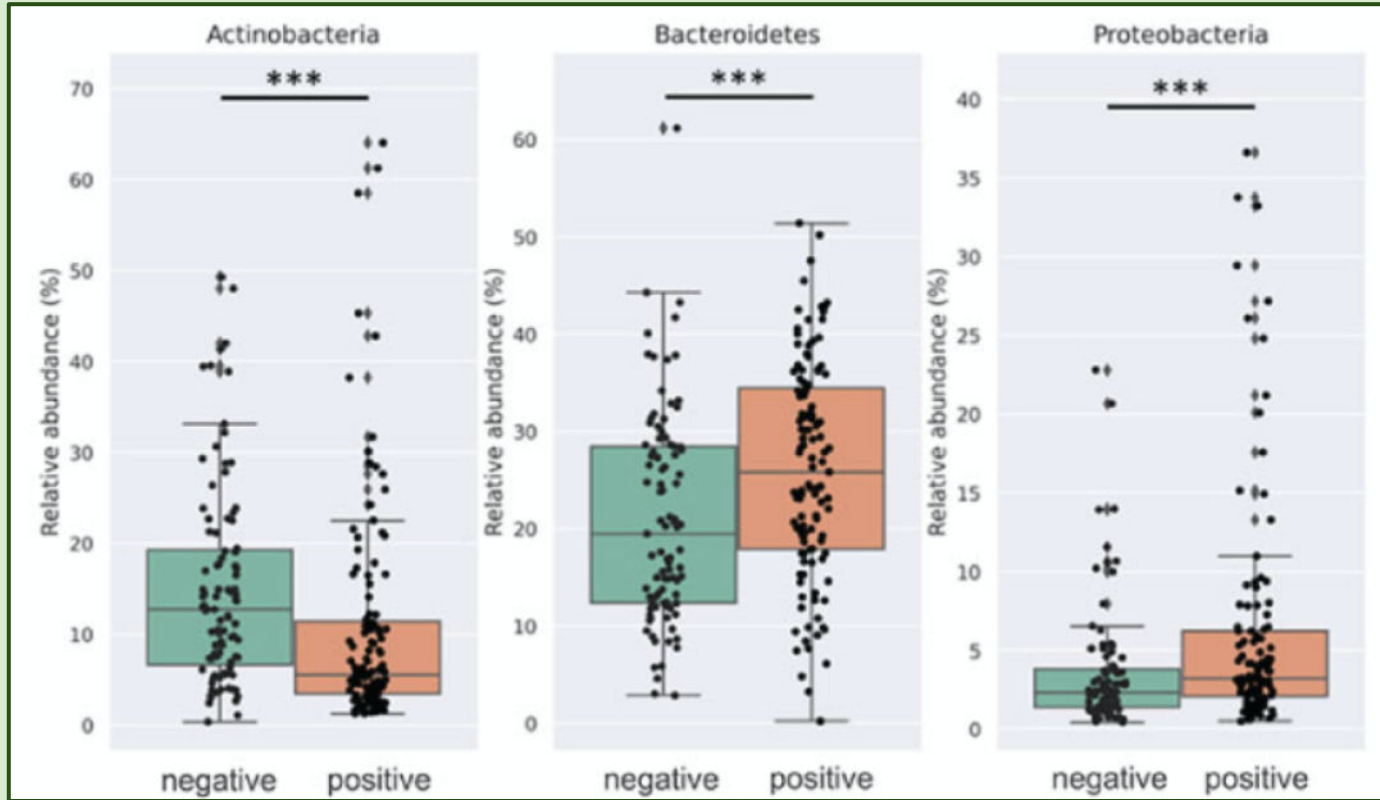
The Gut Composition at a Species Level

- Overall lower species richness of the gut microbiome both during and after COVID-19 infection
- The diversity of the actinobacteria phylum in the gut microbiota is decreased during COVID-19 infection
 - Composed of mostly gram-positive bacteria, including Bifidobacterium
- Bifidobacterium & Lactobacillus bacterium levels are decreased during a COVID-19 infection
 - ***Bifidobacterium*** (Actinobacteria)→ Immune-modulating effects that can help reduce cytokine storm, very important in our innate immune response
 - ***Lactobacillus bacterium*** (Firmicutes) → play a large role in the digestive tract and female genital system, assists in immune response
- Faecalibacterium is also decreased during COVID-19 infection
 - Depleted levels are correlated with severity of infection
- Bacteroides and Enterobacteriaceae increased during COVID-19 infection

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The Gut Composition at a Species Level



- Lowered levels of actinobacteria in positive patients
- Higher levels of bacteroidetes in positive patients
- Higher levels of proteobacteria in positive patients

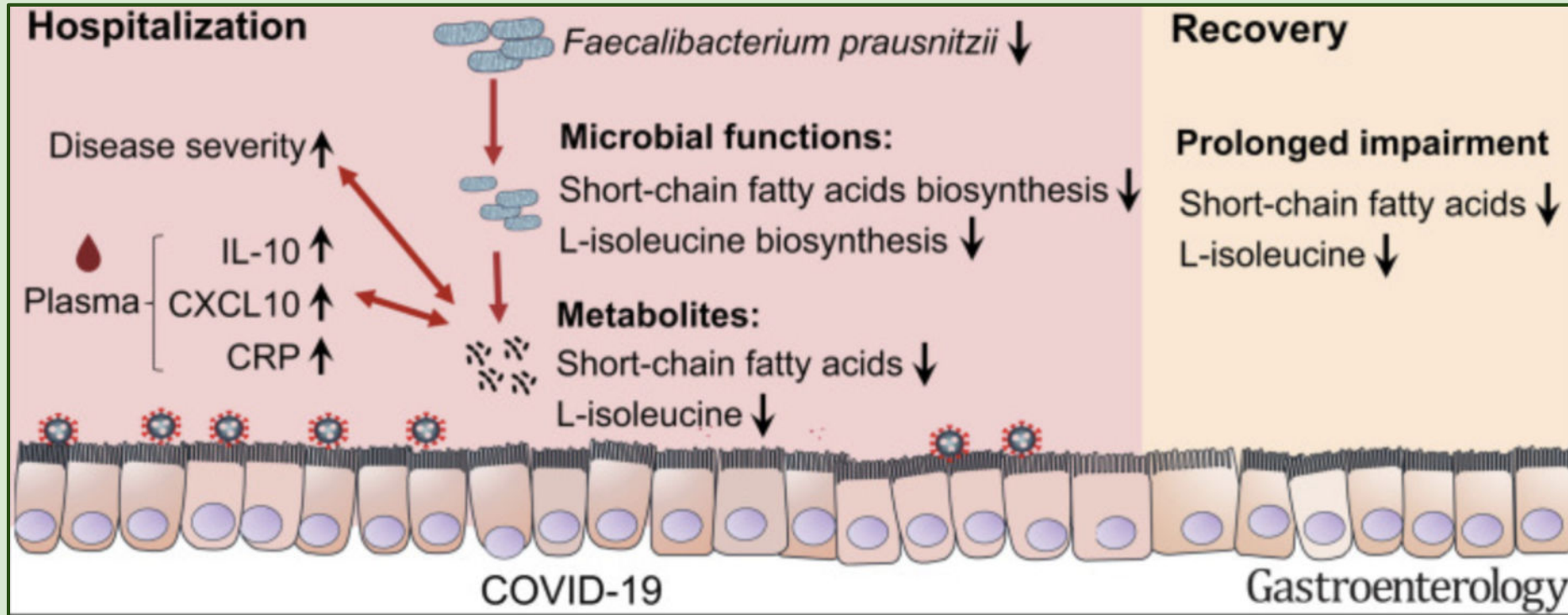
Short Chain Fatty Acids & COVID-19

- Short Chain Fatty Acids (SCFAs) are important in regulating immune responses to viruses and maintaining a strong intestinal barrier
- Groups of gut bacteria that are involved in the metabolism of SCFAs are severely decreased in patients with dysbiosis and leaky gut
- SCFAs have been hypothesized to down regulate the ACE2 receptors in the gut, an important part of the pathophysiology of COVID-19
 - A decrease in SCFAs, and the diversity of the gut microbiome correlates with a poorer prognosis

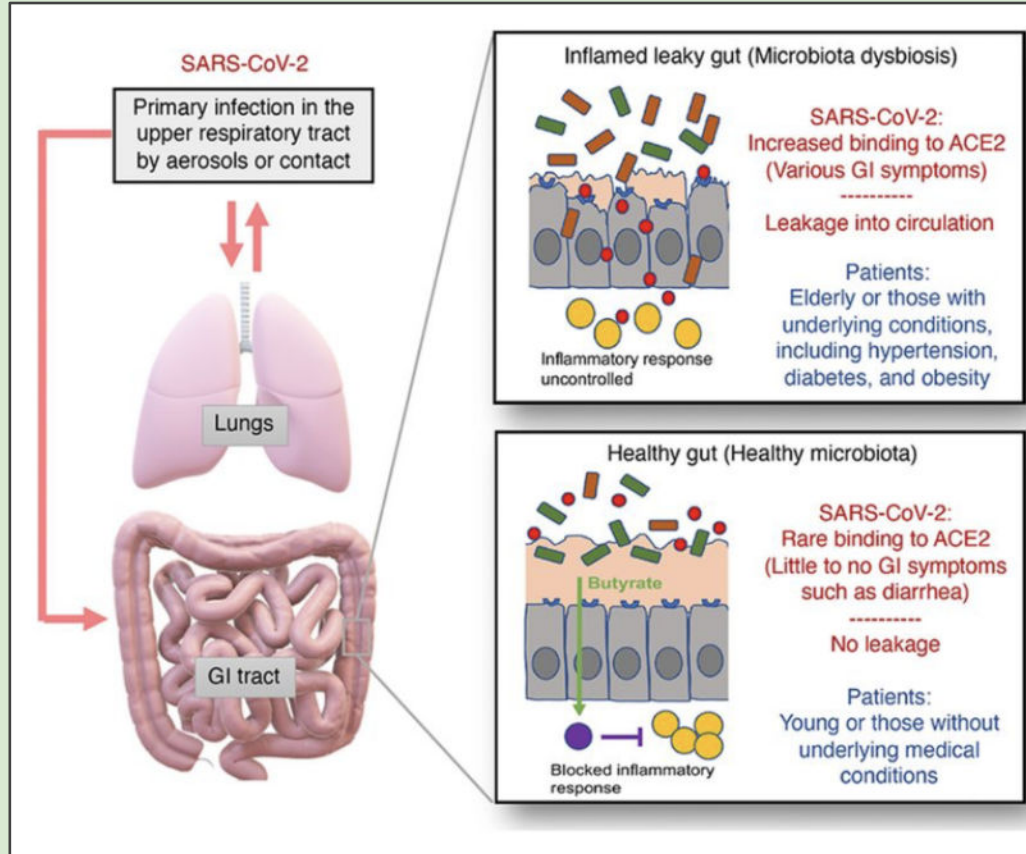
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Faecalibacterium and Short Chain Fatty Acids Depletion in COVID-19



Spike Protein and ACE2 Receptors



Gut microbiota dynamics in a prospective cohort of patients with post-acute COVID-19 syndrome, Gut (2022).

- Found 26 species of bacteria reduced and 14 increased bacteria species
 - **Decrease in:** (“good” bacteria)
 - *Bifidobacterium pseudocatenulatum*, *F. prausnitzii*, *R. inulinivorans*, and *Roseburia hominis*
 - Related to immunity
 - *Faecalibacterium prausnitzii*
 - **Increase in:** (“bad” bacteria)
 - *Ruminococcus gnavus* and *Bacteroides vulgatus*
 - *Blautia obeum*
 - *Streptococcus anginosus*, *Streptococcus vestibularis*, *Streptococcus gordonii* and *Clostridium disporicum*
 - Thought to be related to respiratory symptoms in long hauler COVID

