

Pro & Prebiotics

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Major Takeaways



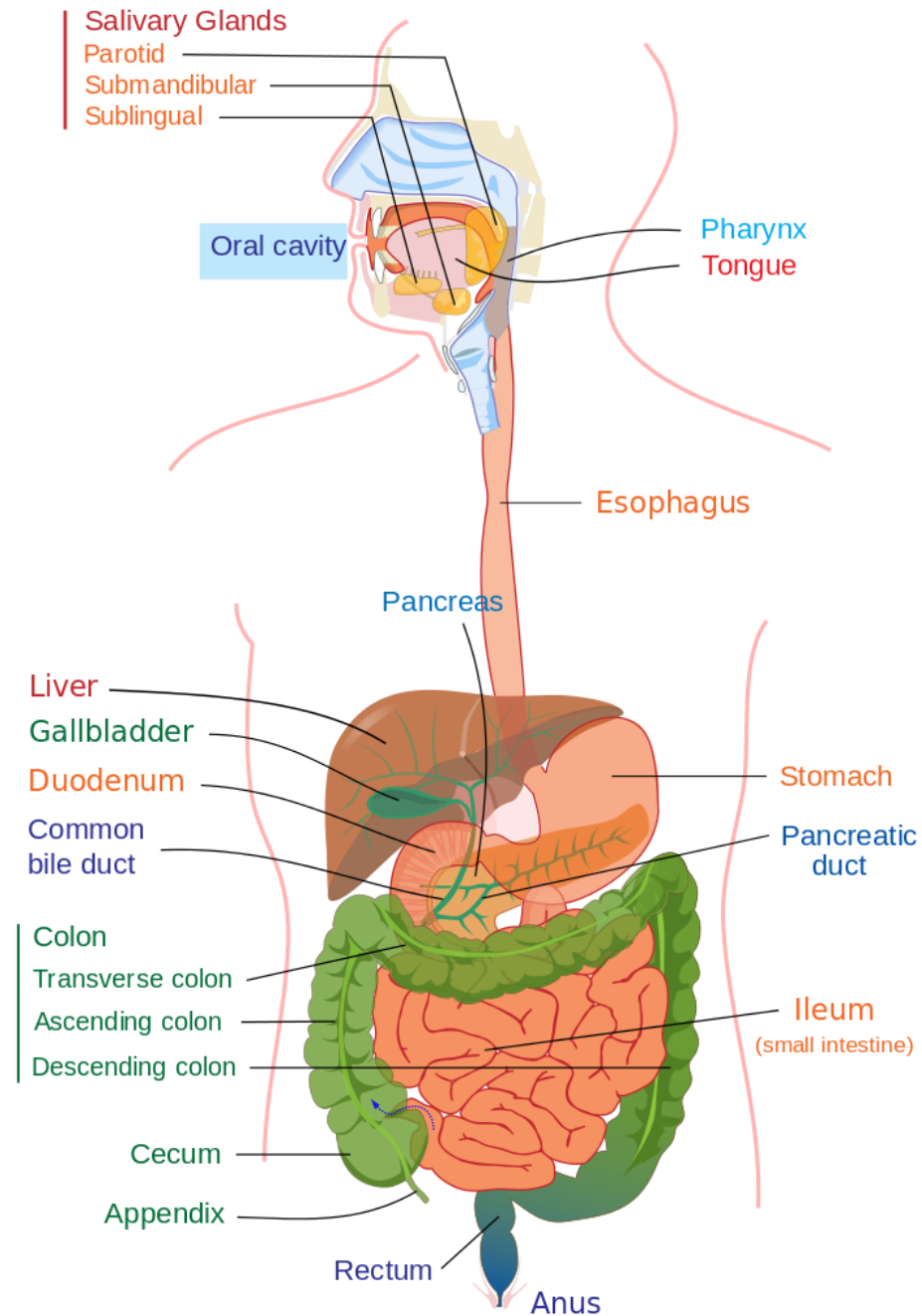
Definitions of Pro & Prebiotics



Types of Pro & Prebiotics



Considerations in Formulating
Probiotics



Healthy Digestion

- Digestion
 - Breaking down macromolecules
 - Mostly in **stomach & small intestine**
- Absorption
 - Moving digested molecules from the GI tract into the body
 - Mostly in the **small intestine**
 - Some in **large intestine**
- What happens in the **large intestine**?

Gut Microbiota

- Large intestine is a fermentation vat

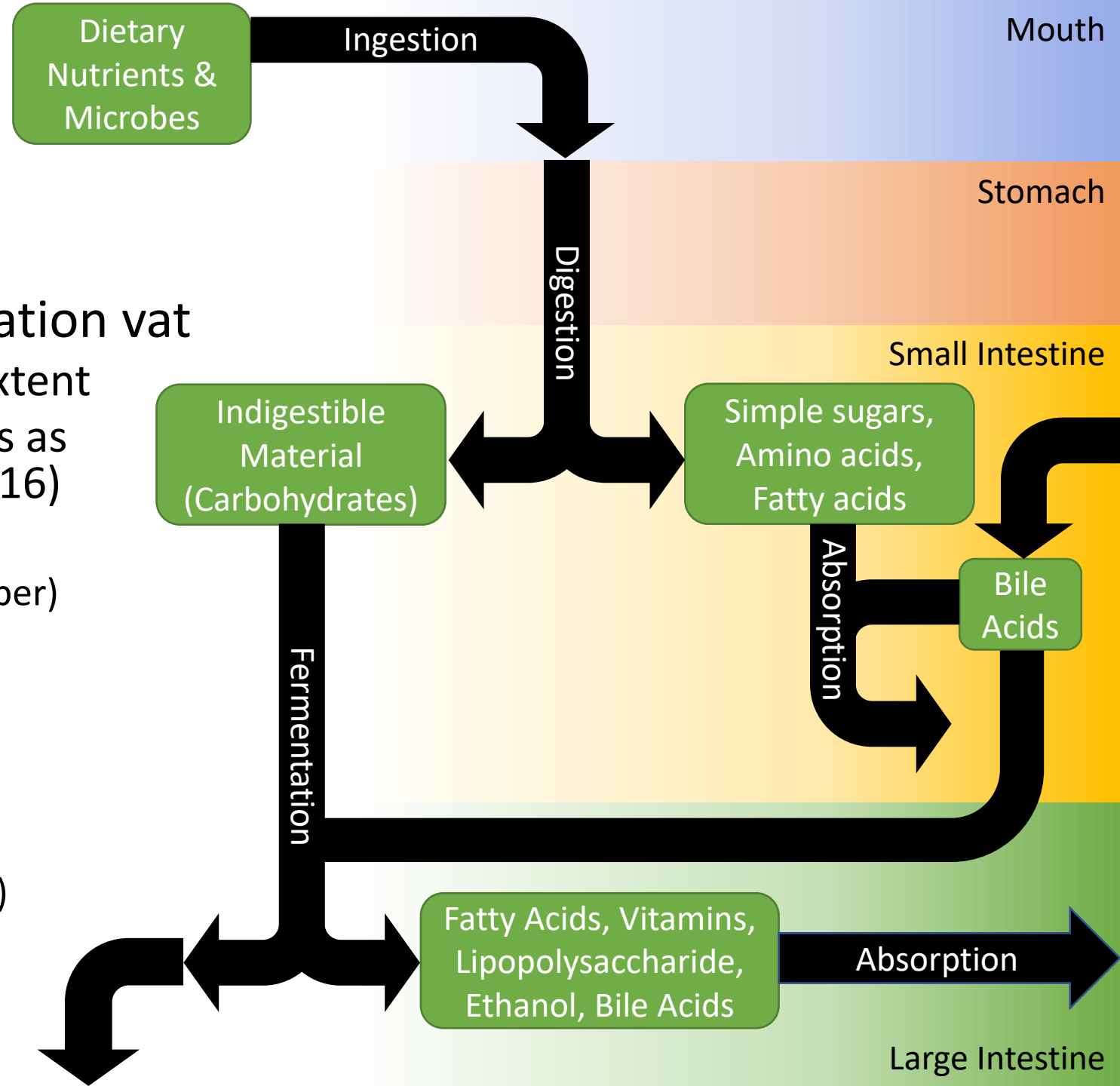
- Small intestine, to a lesser extent
- About as many bacterial cells as human cells (Sender et al 2016)

- Substrates:

- Indigestible carbohydrates (fiber)
- Plant compounds
- Bile acids
- Etc

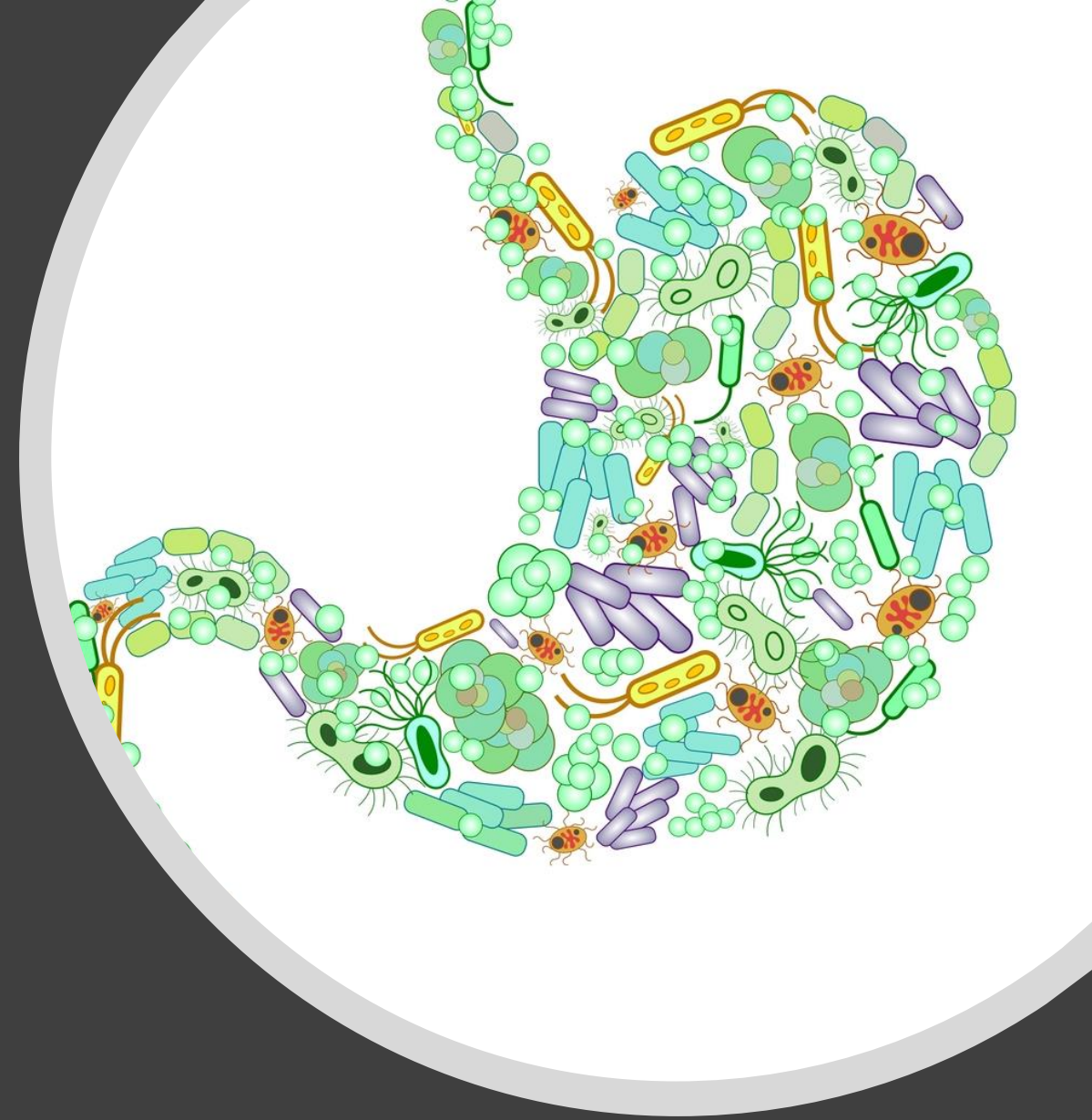
- Products:

- Vitamins (B12 and K)
- Short chain fatty acids (SCFAs)
- Lipopolysaccharides
- Etc



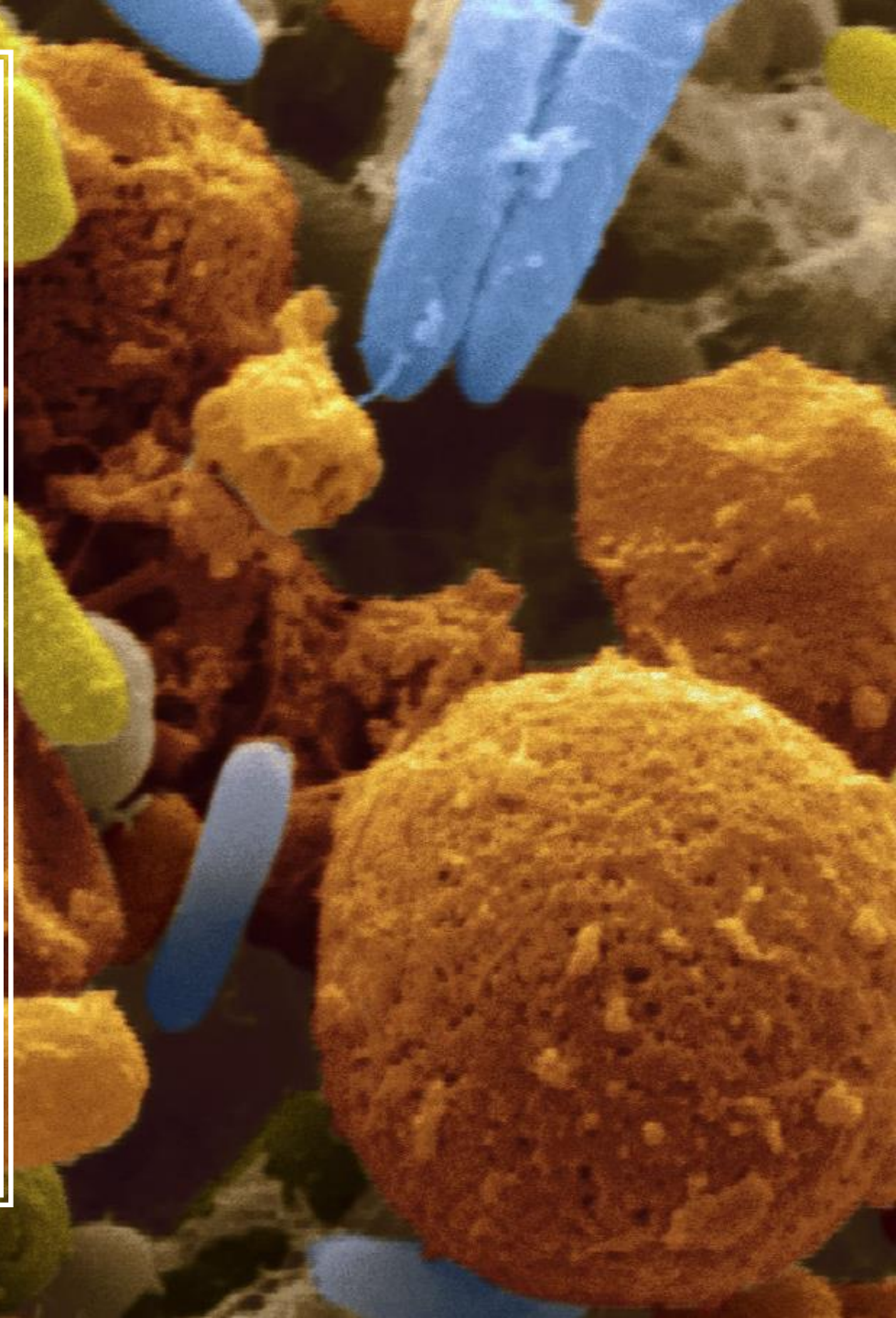
Gut Microbiota – Function & Health

- Convert bile acids (carcinogenic effects)
 - Lipoproteins from bacterial cell walls can increase inflammation
 - Produce short chain fatty acids and Vitamins B/K (essential nutrients)
 - Complex interactions with immune system
 - Modulation of epithelial barrier function
 - Microbial competition acts as a barrier to pathogens
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- Many species contribute to each effect
 - Each species can have multiple effects



Microbial Community

- 500-1600 species in healthy adult human gut
- The degree of diversity is associated with positive health outcomes
- Constantly introducing new microbes through diet
- **Allochthonous** bacteria
 - Transient, only present in gut if they are being continually introduced
- **Autochthonous** bacteria
 - Long-term residents of the gut, do not have to be continually re-introduced
 - Capable of physically adhering to the walls of the gut
- Dietary microbes, food sources (fiber), and antimicrobial agents all affect the community makeup



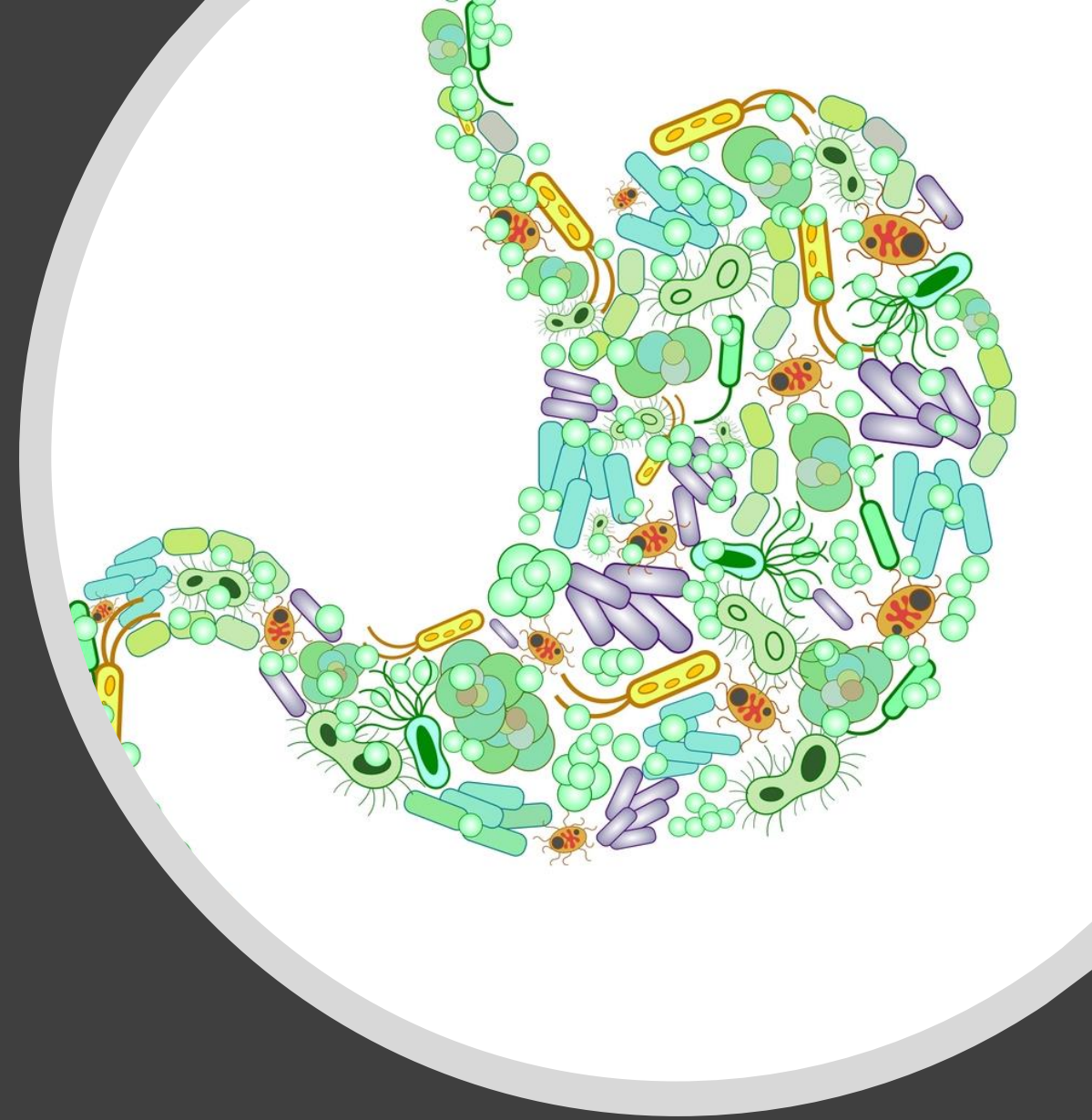
Clostridium Difficile

- Aka *C. diff*
- Common hospital infection in patients on antibiotics
 - Normal microbiota begin to die off
 - Antibiotic-resistant *C. diff* takes over colon
 - Produces toxins, leads to diarrhea and intestinal bleeding



Fecal Transplants

- New therapy used to treat *C. diff* and chronic GI diseases
- Feces from a healthy donor is transplanted into a diseased colon
 - Contains many species of live & dead microbes, bacteriophages (viruses), bile acids, short chain fatty acids, etc
 - Short term effects: improvement of symptoms
 - Long term effects: changes in microbial community composition
- It isn't entirely clear which component is the active ingredient
- Most studies using individual microbes, microbial cocktails, bacteriophages, etc have not yet replicated the efficacy of fecal transplants *in vivo*





Probiotics - Definitions

- Could refer to live microbes as an ingredient or the finished product
- Also called “Live Biotherapeutic Products”
- FAO Definition (2002):
 - “live microorganisms which, when administered in adequate amounts, confer a health benefit on the host”
- Could be a:
 - Drug
 - Dietary Supplement
 - Food
- Microbes must be alive



Probiotics – Common Characteristics

- Common microbes:
 - *Lactobacillus* bacteria
 - *Bifidobacterium* bacteria
 - *Bacillus* bacteria (for when sturdy spore-formers are needed)
 - Yeasts are seen rarely (<1% of healthy microbiota)
- Common delivery mechanisms:
 - Capsules
 - Fermented milk (e.g. yogurt, kefir)
- Can have one microbial strain or multiple

Prebiotics



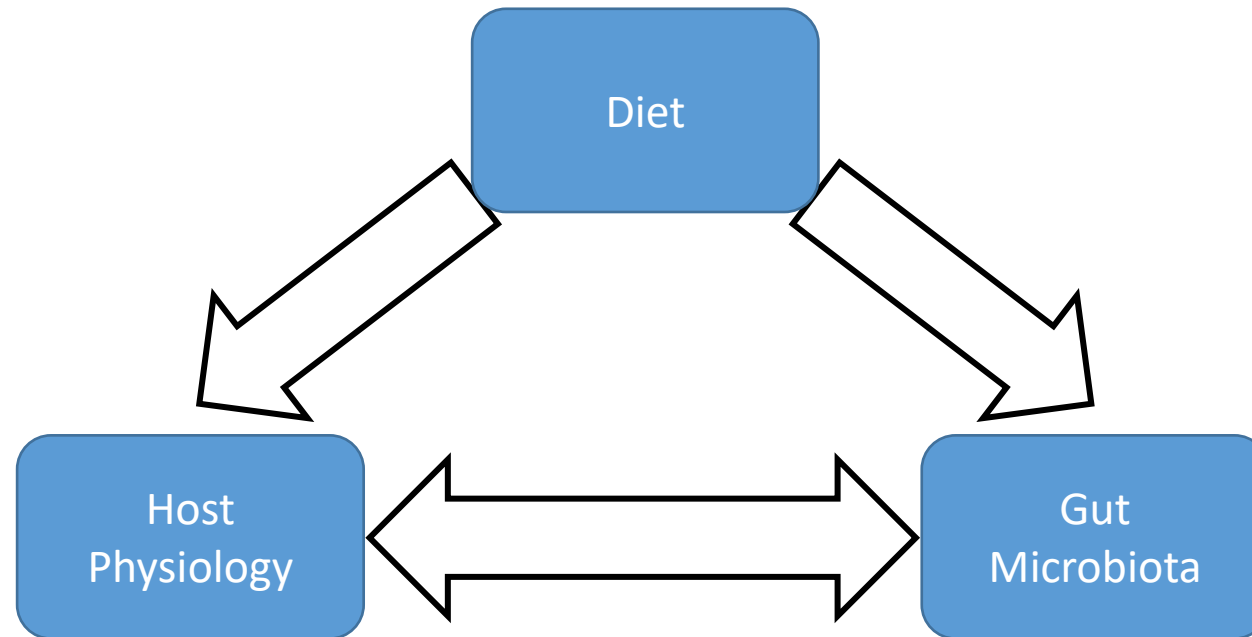
- Definitions:
 - “A nondigestible Food Ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improves host health” (Gibson & Roberfroid 1995)
 - “Undigested dietary carbohydrates” which are fermentable by colonic bacteria into short chain fatty acids (Bird et al. 2010)
 - “Nonviable food component that confers a health benefit to the host associated with modulation of the microbiota” (FAO 2008)
- No FDA definition
- Some specific prebiotics are FOSHU-regulated in Japan

Prebiotics – Common Characteristics



- Most common health claims (outside of US):
 - GI health
 - Maintaining healthy immune system/preventing inflammation
 - Diabetes management (reducing glycemic spikes & insulin resistance)
- Most common prebiotics: Indigestible carbohydrates
 - Cellulose, an indigestible glucose polymer
 - Fructose polymers/Fructans/Fructooligosaccharides/FOS (e.g. Inulin)
 - Lactose
 - Resistant Starch- Physically protected or chemically modified starch
- Some definitions include secondary plant metabolites (e.g. polyphenols)

Host-Microbe-Diet Interactions



Takeaways

Pro & Prebiotics

- Gut microbes & fermentative substrates from diet necessary in some form for digestive health (can be naturally present)
- Affect overall health by affecting the microbiome

Types of Probiotics

- Vegetative vs Spore-forming
- Single vs Multiple strain

Types of Prebiotics

- Indigestible carbohydrates
- Polyphenols & antimicrobials

Formulating Probiotic Products

- You can only make a structure/function claim about digestive health
- Probiotic cultures must be alive

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