

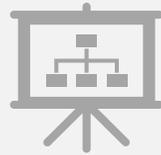
# Pro & Prebiotics

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# Major Takeaways



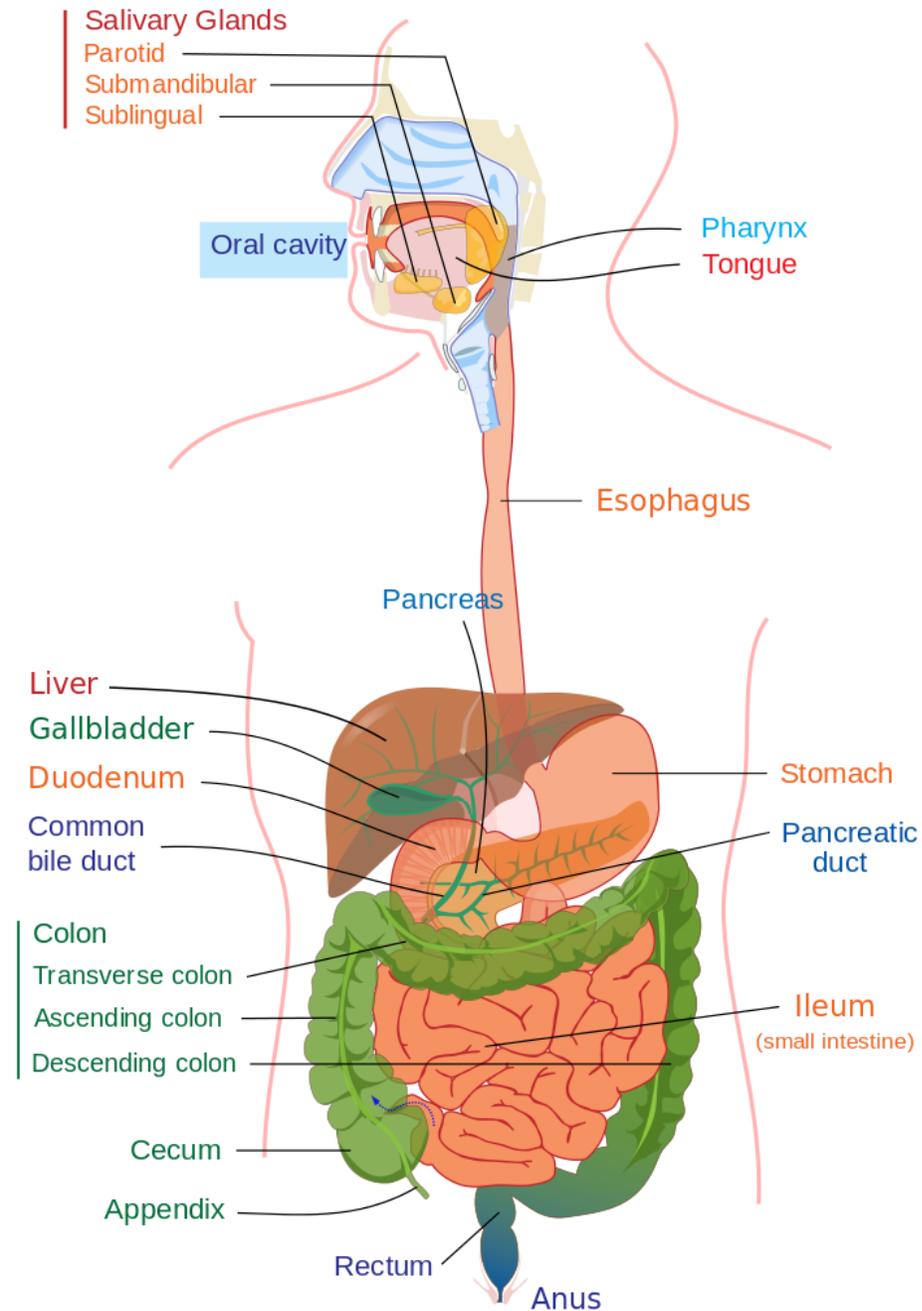
Definitions of Pro & Prebiotics



Types of Pro & Prebiotics



Considerations in Formulating  
Probiotics



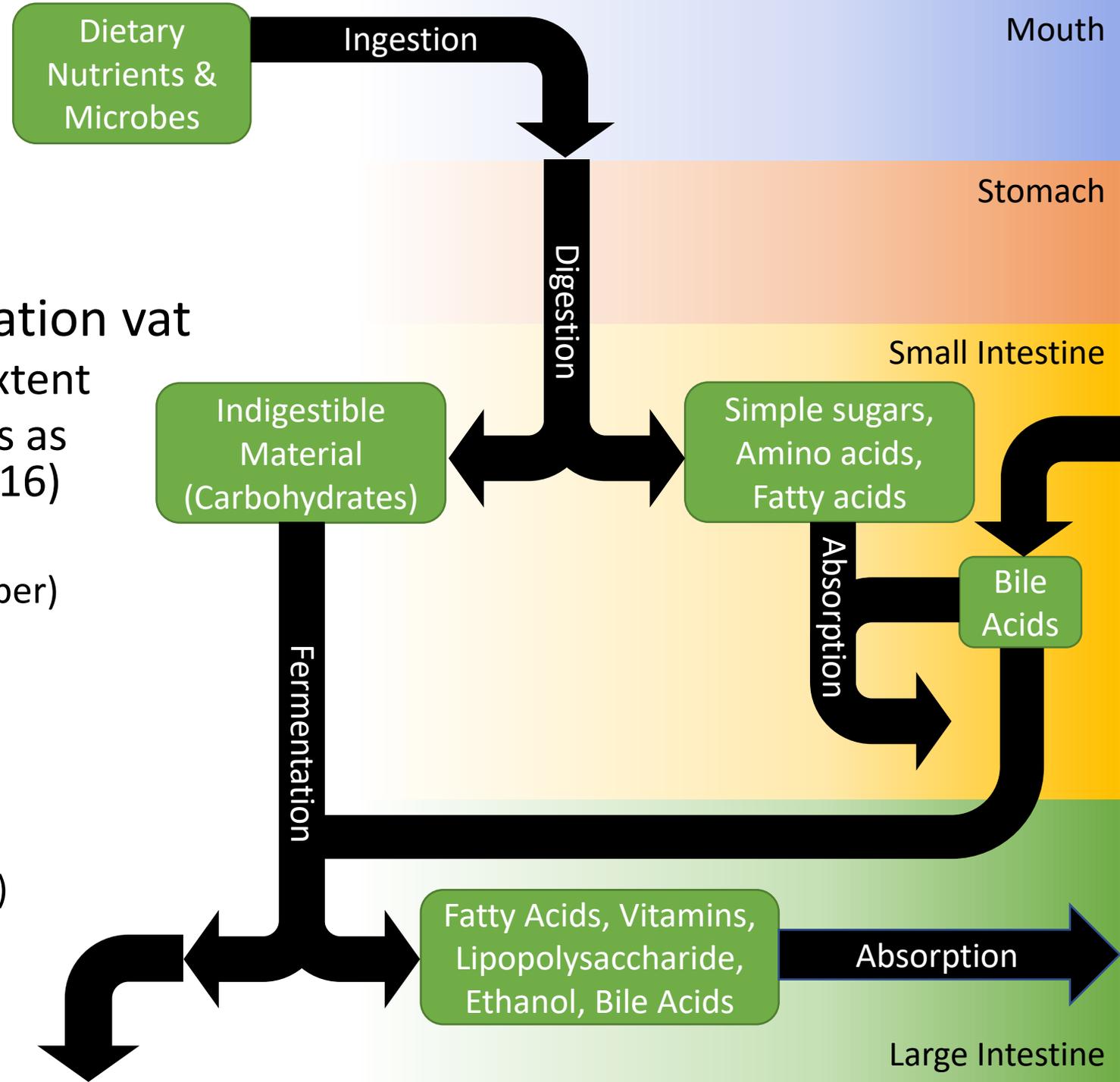
# Healthy Digestion

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- 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



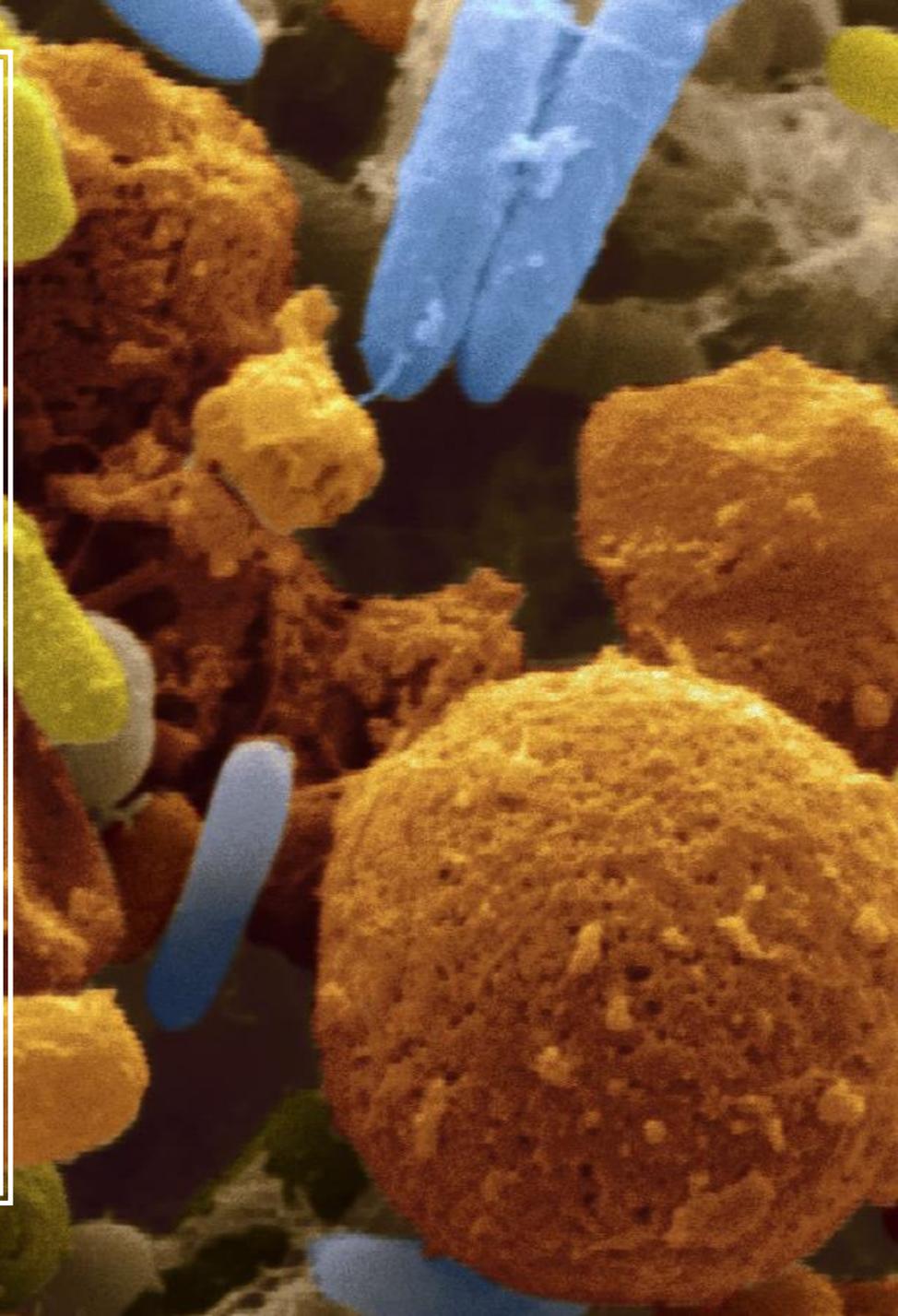
# Gut Microbiota – Function & Health

- 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
- 
- 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*

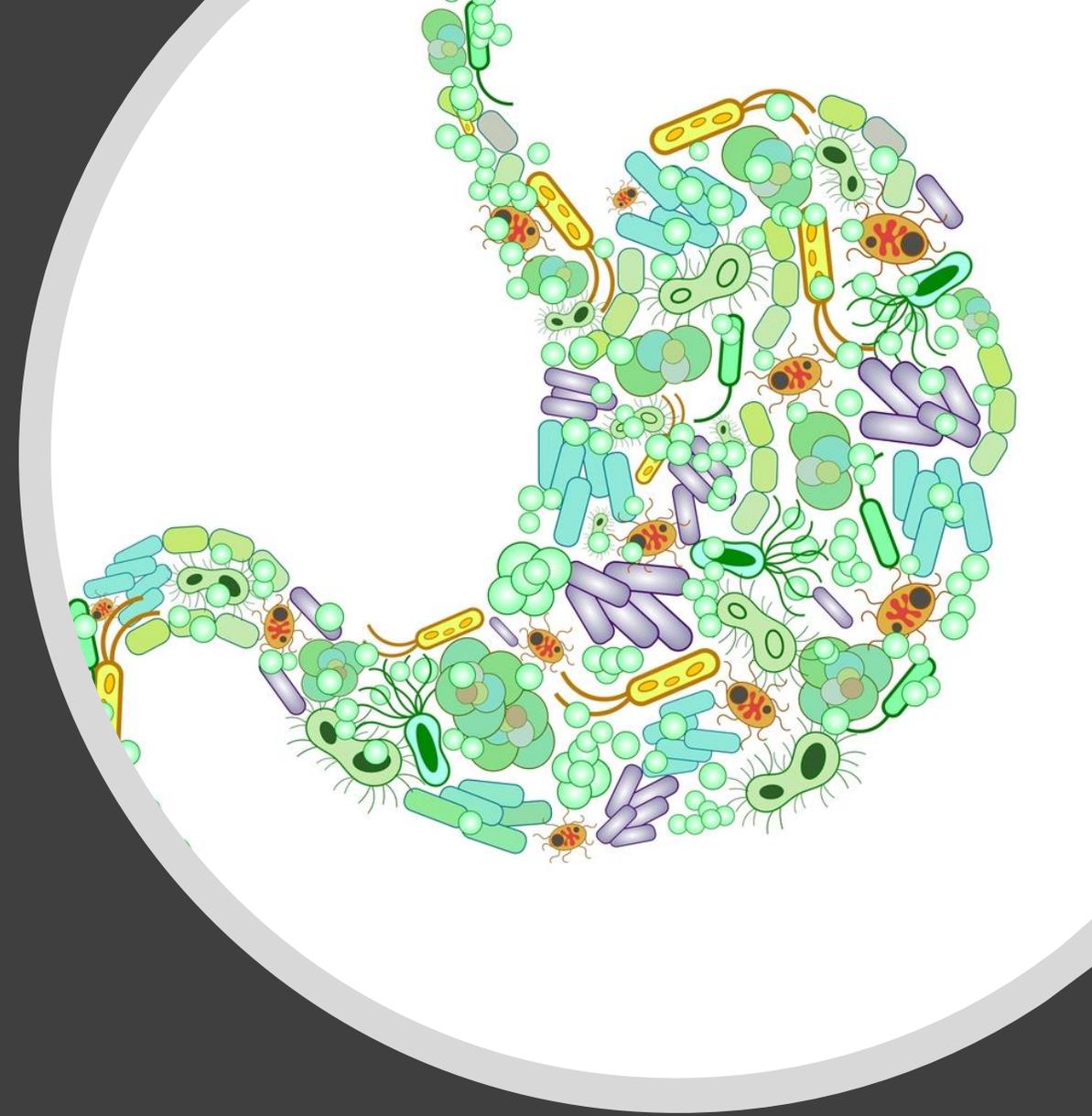
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- Aka *C. diff*
- Common hospital infection in patients on antibiotics
  - Normal microbiota begin to die off
  - Antibiotic-resistant *C. diff* takes over colon
  - Produces toxins, leads to diarrhea and intestinal bleeding



# 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



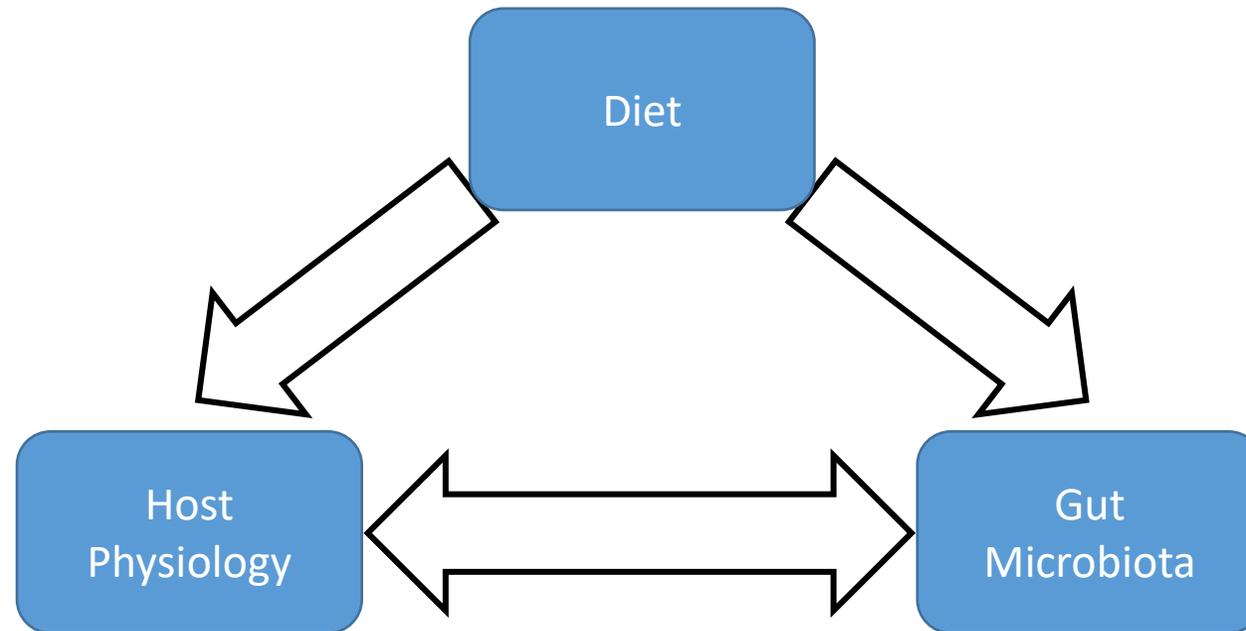
- Definitions:
  - “A nondigestible Food Ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improves host health” (Gibson & Roberfroid 1995)
  - “Undigested dietary carbohydrates” which are 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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