

# *Microbes Matter: Eating for Trillions*

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**Nutrition & Human  
Microbiome Laboratory**





# Objectives

- Define terms: Microbiota, Fiber, Prebiotics, Fermented Foods, Probiotics
- Compare and contrast fibers, prebiotics, fermented foods, and probiotics
- Recognize health benefits of consumption of fiber, prebiotics, fermented foods, and probiotics.
- List foods that provide sources of fiber, prebiotics, fermented foods, and probiotics.
- Create a plate that helps support the gut microbiota.
- Recall reputable sources on this topic.

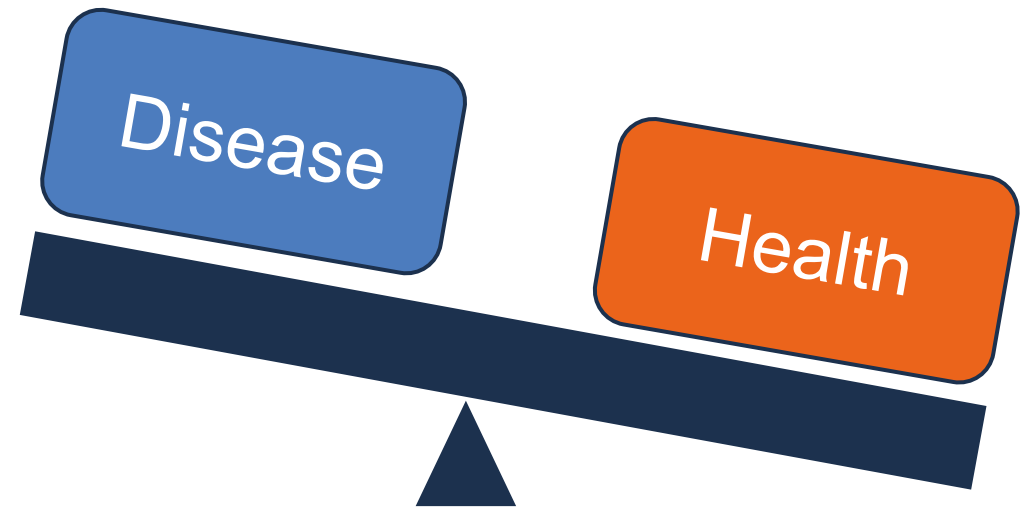


# Definitions and Overview

***Microbiota*** – a collection of microbes

***Microbiome*** - a collection of microbial genomes

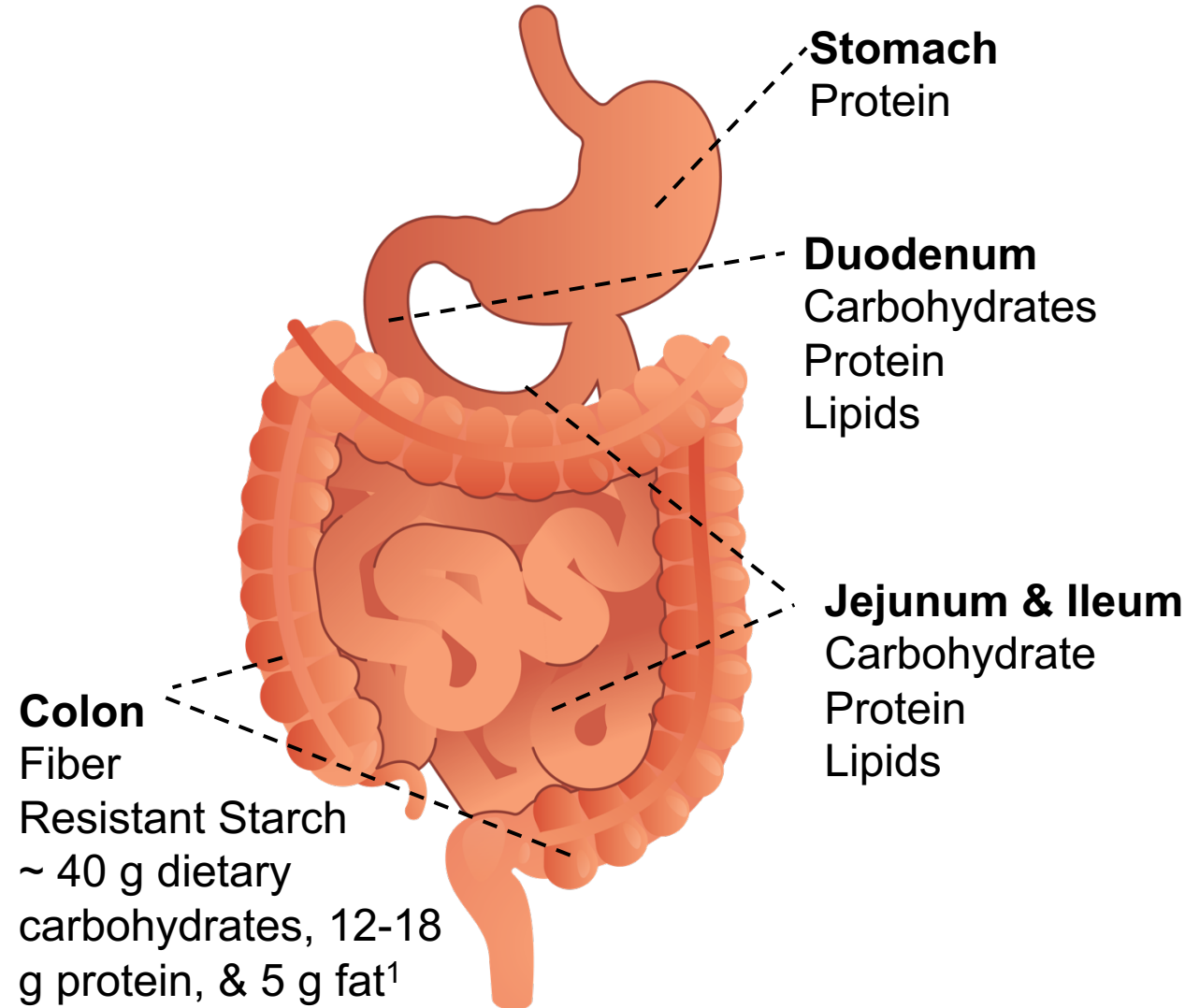
- **As many bacteria** as host cells in human body<sup>1</sup>
- **> 100x more bacterial genes** than our human genome<sup>2</sup>





# Diet, Gut Physiology, & Microbiota

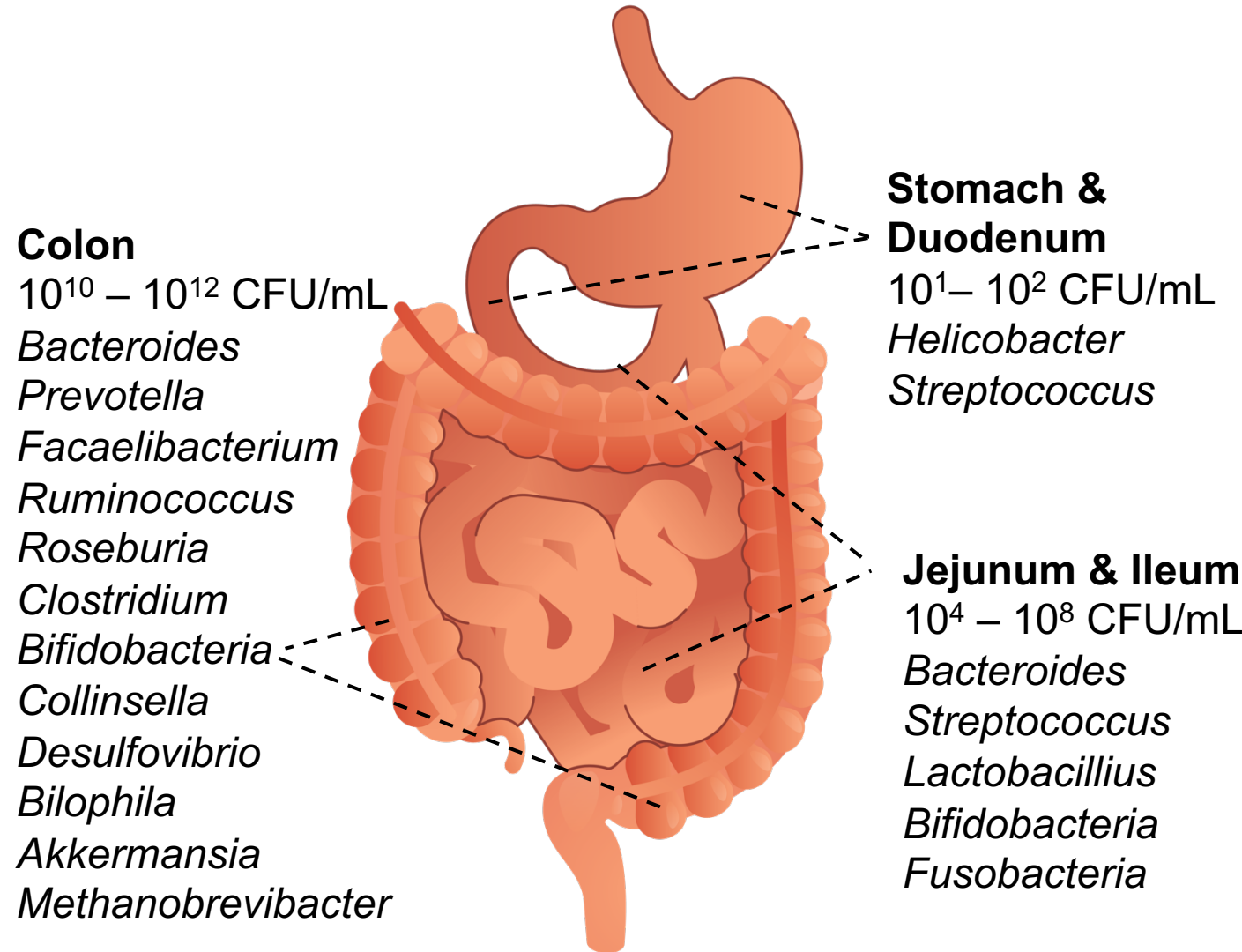
- Foods provides *nutrients for gut microbes.*





# Diet & Gut Physiology & Microbiota

- Foods provides ***nutrients for gut microbes.***
- The diet provides a ***source of microbes.***



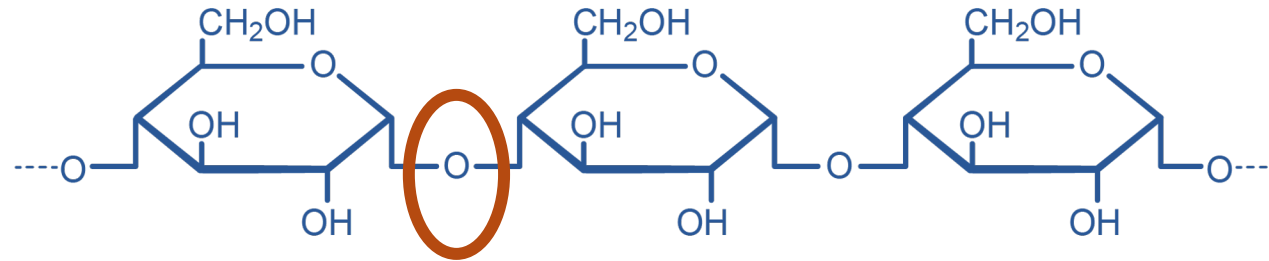


# Diet & Gut Microbiota

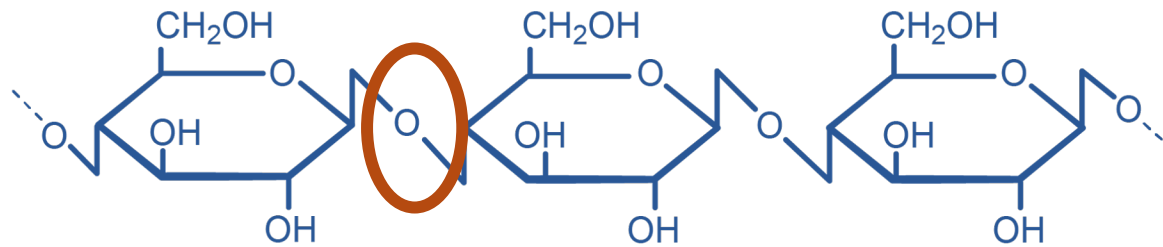
***Gut microbes metabolize nondigested dietary substrates.***

	<b>% Daily Value*</b>
<b>Total Fat</b> 4g	<b>6%</b>
Saturated Fat 2g	<b>10%</b>
<i>Trans</i> Fat 0g	
Polyunsaturated Fat 0g	
Monounsaturated Fat 0g	
<b>Cholesterol</b> 0mg	<b>0%</b>
<b>Sodium</b> 120mg	<b>5%</b>
<b>Total Carbohydrate</b> 44g	<b>15%</b>
Dietary Fiber 8g	<b>33%</b>
Soluble Fiber 5g	
Insoluble Fiber 3g	
Total Sugars 12g	
Includes 10g Added Sugars	<b>20%</b>
<b>Protein</b> 4g	

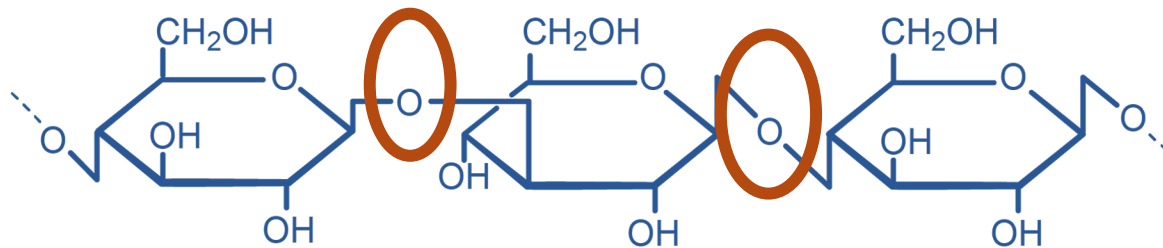
# Microbes Ferment Dietary Fiber



**Amylose:**  $\alpha$ -1,4 glucosidic bonds



**Cellulose:**  $\beta$ -1,4 glucosidic bonds



**$\beta$ -Glucan:** mixed  $\beta$ -1,3 and  $\beta$ -1,4 glucosidic bonds





# A Deeper Dive Into Diet & the Gut Microbiota





# Diet & Gut Microbiota

***How many plants did you consume in the last week (fruits, vegetables, grains, nuts legumes)?***

- Cross-sectional analysis of > 10,000 fecal samples from free-living people (citizen scientists) in the US, UK, and Australia
- Individuals completed health status and dietary questionnaires
- Found that individuals that consumed more plants (> 30 per week) had greater microbiota diversity than those that consumer less plants (< 10 per week).



# Plant Foods Affect the Gut Microbiota

## Walnuts<sup>5</sup>

*Faecalibacterium*  
*Roseburia*



## Almonds<sup>4</sup>

*Roseburia*  
*Lachnospira*



## Avocado<sup>1</sup>

*Faecalibacterium*  
*Lachnospira*



## Broccoli<sup>2</sup>

*Bacteroides*



## Oats & Barley<sup>3</sup>

*Roseburia*  
*Streptococcus*



1. Thompson SV, et al., *J Nutr* 2020
2. Kaczmarek JL et al., *J Nutr Bioc* 2018
3. Thompson SV, et al., *FASEB* 2016
4. Holscher HD, et al., *Nutrients* 2018
5. Holscher HD, et al., *J Nutr* 2018



# Plants contain fiber and prebiotics

**Dietary Fiber:** *Non-digestible carbohydrates in plants, and isolated or synthetic non-digestible carbohydrates that **benefit health**.*<sup>1</sup>

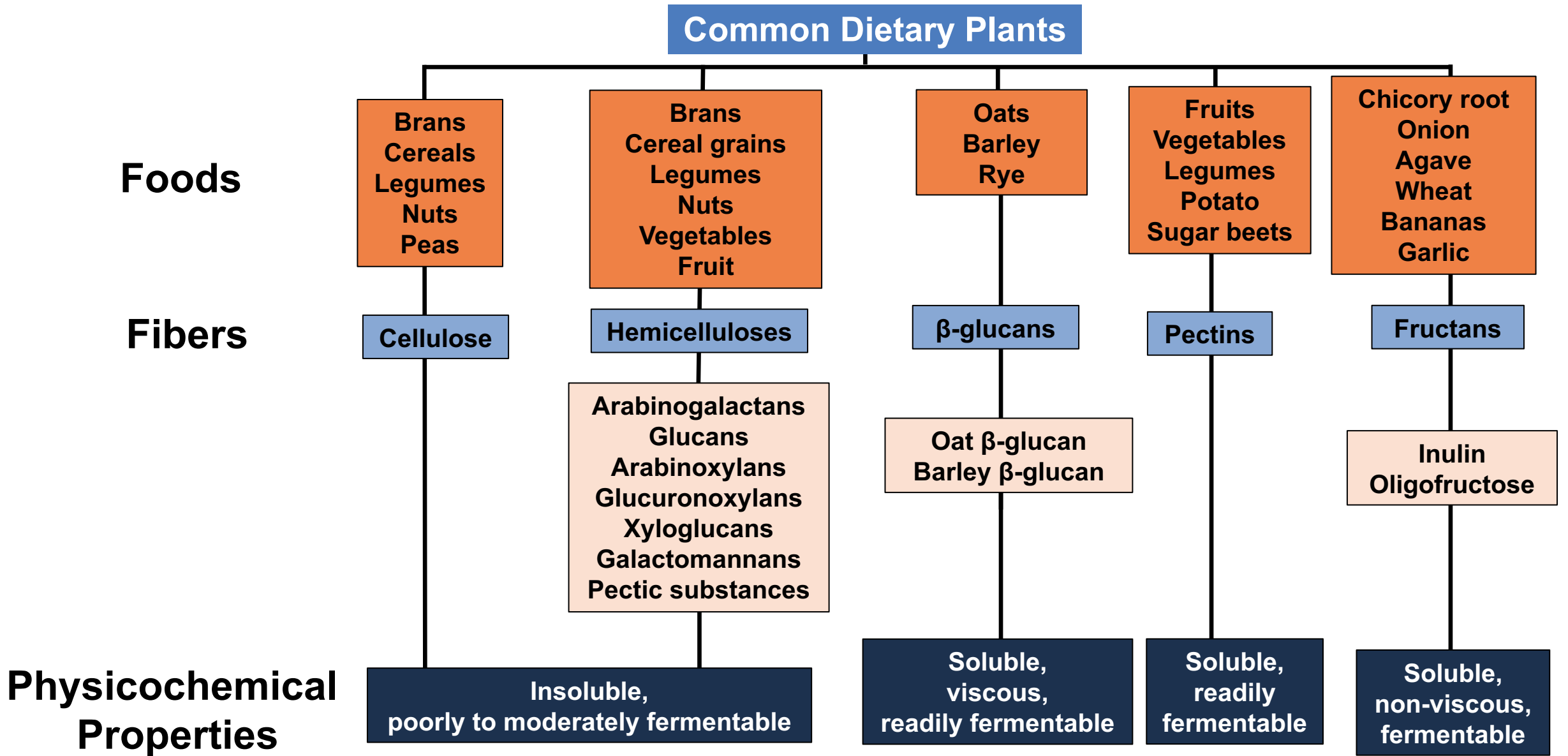
**Prebiotic** – *a substrate that is selectively utilized by host microorganisms **conferring a health benefit**.*<sup>2</sup>

1. U.S. Food & Drug Administration, 26 May 2017. Final ruling on dietary fiber definition.

2. Gibson, G. R., et al. (2017). Expert consensus document: The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of prebiotics. *Nature Reviews Gastroenterology & Hepatology*.



# Dietary Fibers in Foods





# Dietary Fiber Health Benefits

**Solubility:** dissolve in water (soluble) or remain as discrete particles (insoluble).

**Viscosity:** thicken when hydrated (gel-forming).

**Fermentability:** degree to which fiber, after resisting digestion, can be metabolized by microbes.

- ***Insoluble (bran)***
  - ▣ laxative effect
- ***Soluble, viscous, non-fermented (psyllium)***
  - ▣ cholesterol-lowering, improve glycemia, weight loss, stool normalization
- ***Soluble, non-viscous, fermentable (inulin)***
  - ▣ Reduce inflammation, weight loss
- ***Soluble, viscous, fermentable ( $\beta$ -glucan, pectin)***
  - ▣ cholesterol lowering, improve glycemia



# Prebiotics

**Prebiotic** – *a substrate that is selectively utilized by host microorganisms **conferring a health benefit.***

- ***Soluble, non-viscous, fermentable:***
  - ▣ Galactooligosaccharides (GOS)
  - ▣ Fructooligosaccharides (FOS)
  - ▣ Inulin
  
- Doses generally need to be 3.0 g/d or higher

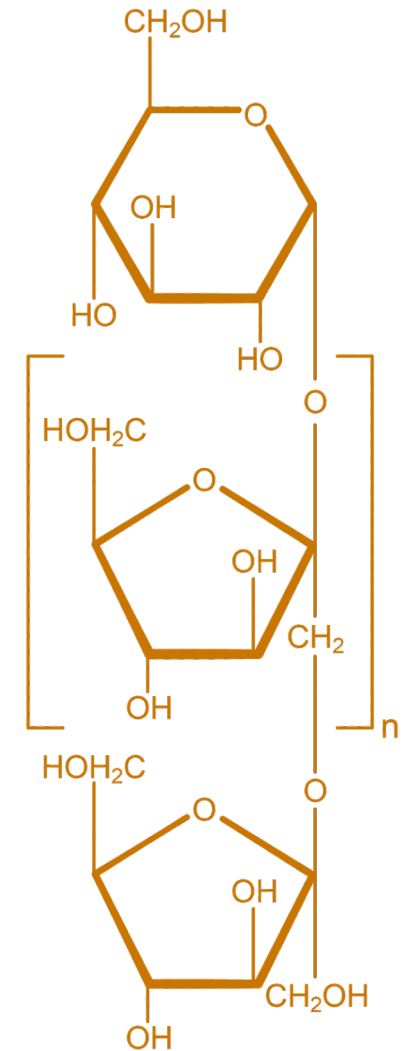
# Prebiotic Example: Inulin Type Fibers

## *Plant Sources (g/100g)*

- Wheat (2.5 g)
- Onion (4.3 g)
- Garlic (12.5 g)
- Leeks (6.5 g)
- Asparagus (2.5 g)
- Bananas (0.5 g)
  
- Agave
- Chicory root

## *Food Sources*

- Bars
- Cereals
- Yogurt
- Ice cream





# Prebiotics: Health Benefits

<b>Health Benefit</b>	<b>Prebiotic</b>
Satiety	Fructooligosaccharide (FOS)
Bone Health, calcium and other mineral absorption	FOS
Stimulation of neurochemical-producing bacteria	Galactooligosaccharide (GOS)
Urogenital health	GOS
Irritable Bowel Syndrome (IBS)	GOS
Skin health	GOS
Traveler's diarrhea	GOS
Allergy	FOS, GOS
Metabolic health: glycemia, dyslipidemia, inflammation	FOS, GOS





# Microbes Ferment Dietary Fiber

***Microbes Ferment Carbohydrates, Resistant Starch,  
Fiber, & Prebiotics***

**Dietary Fiber  
& Prebiotics**

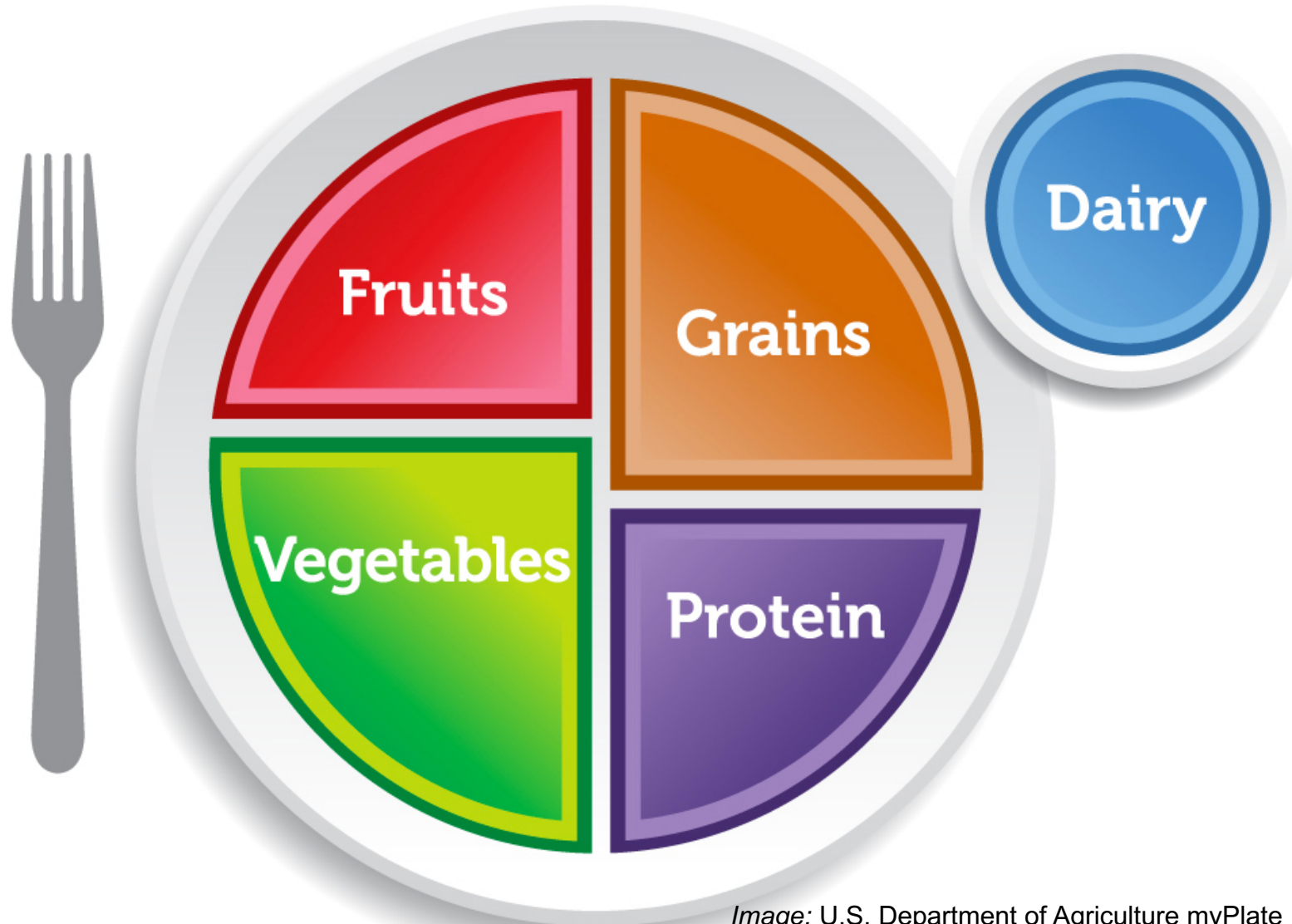


**Short-chain Fatty Acids  
(Acetate, Propionate, Butyrate)**

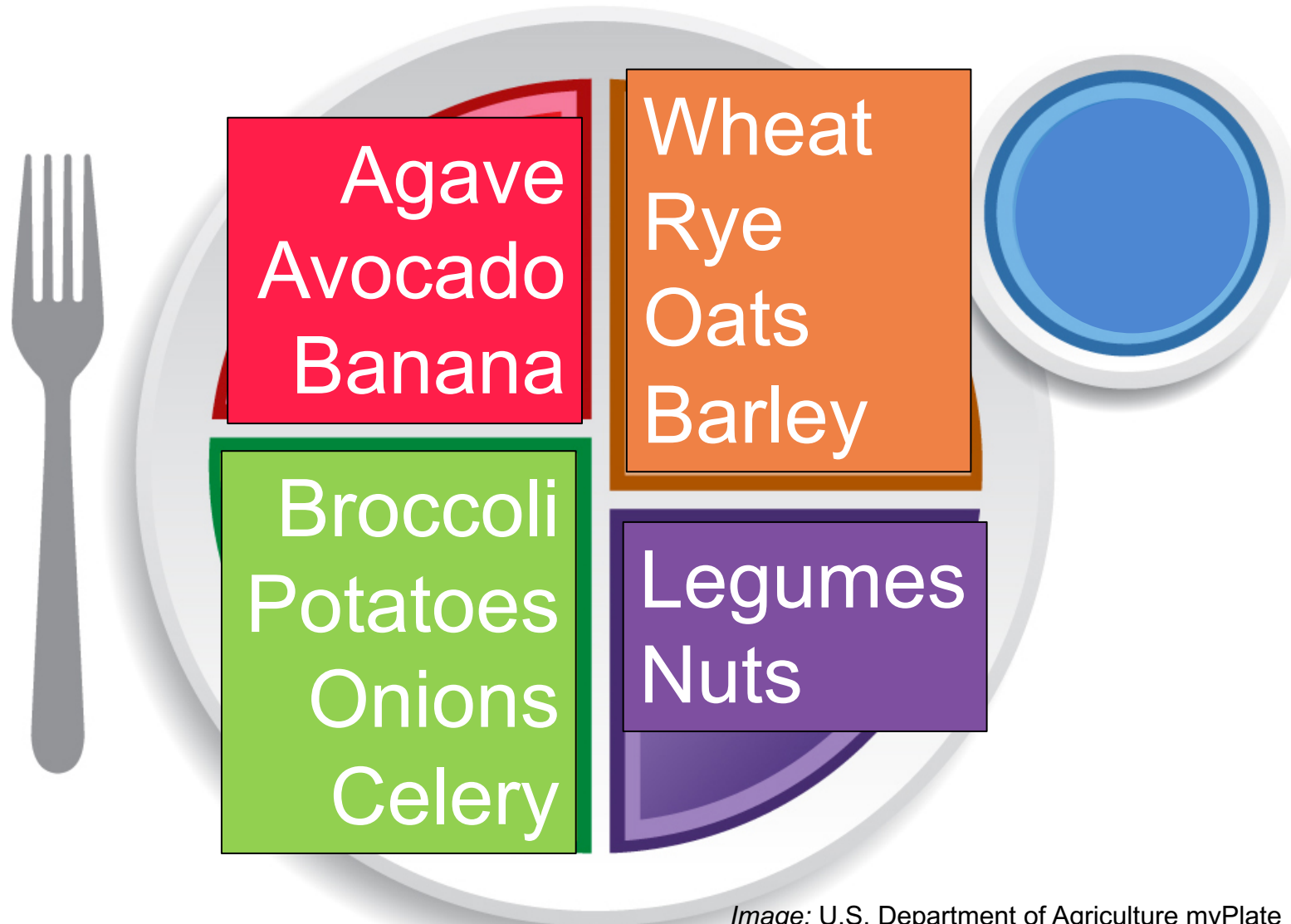
# Diet & Gut Microbiota



*Identify **foods** with **fibers** and **prebiotics**.*

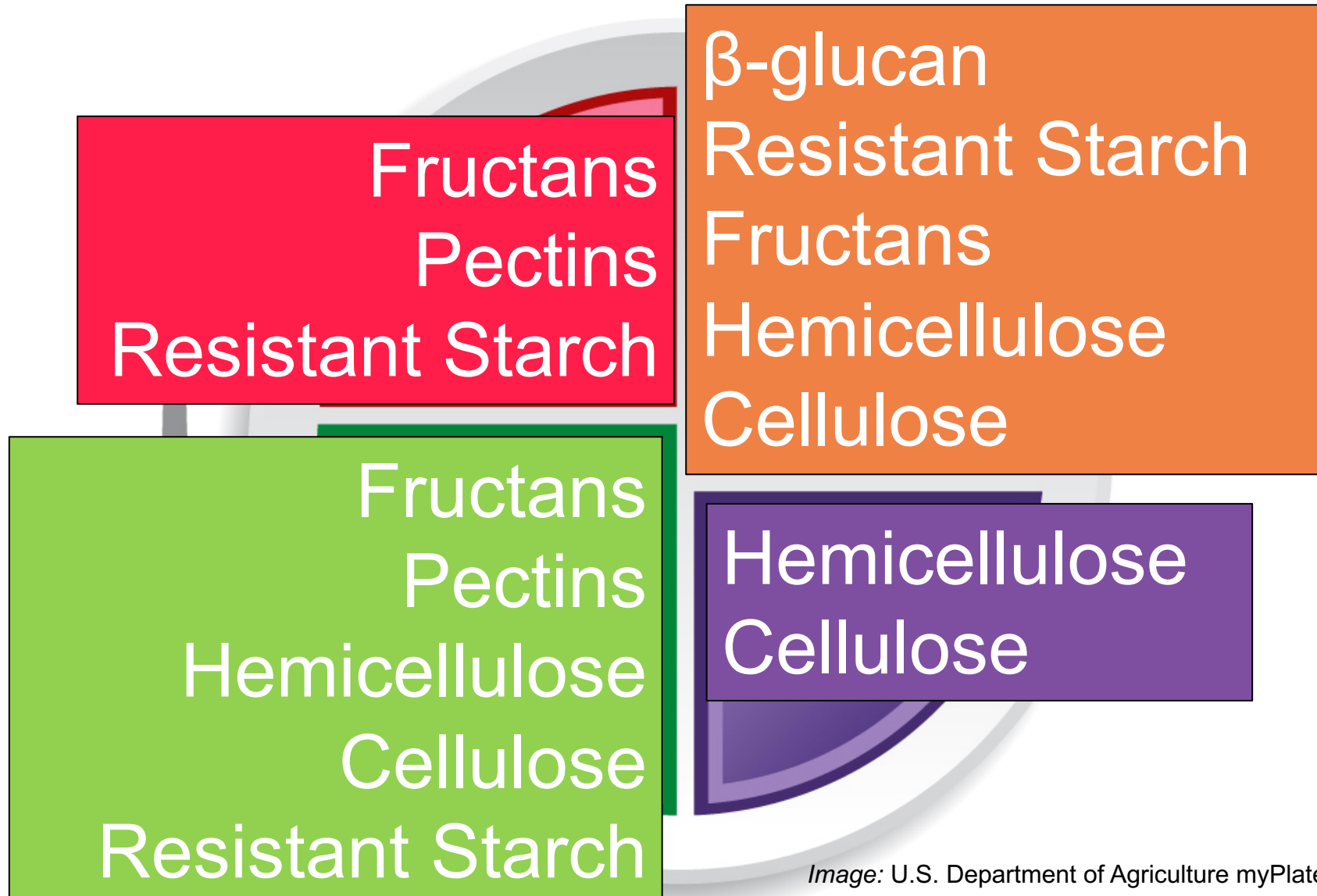


# Diet & Gut Microbiota





# Diet & Gut Microbiota





# Probiotics & Fermented Foods

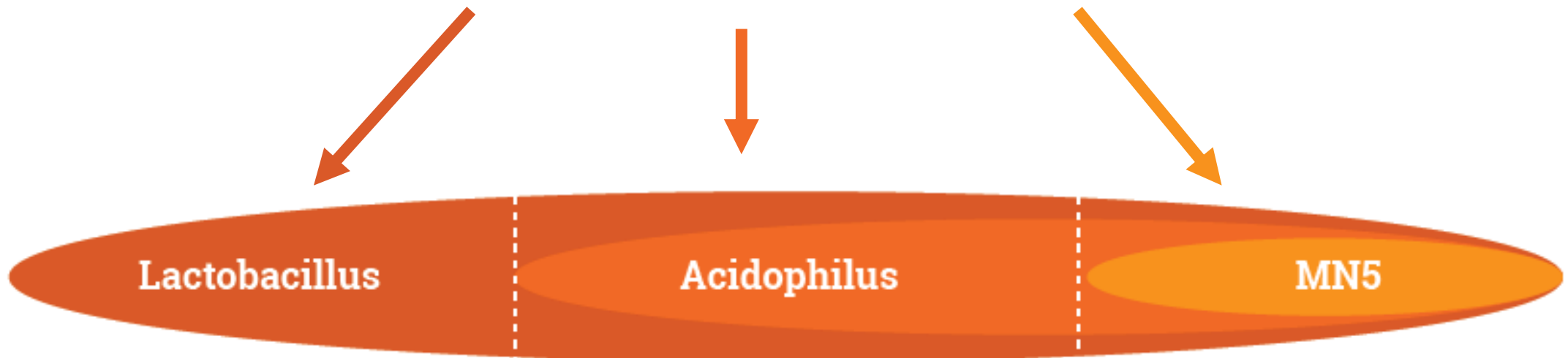


# Probiotics

*Probiotics are live microorganisms that, when administered in adequate amounts, confer a benefit to the host.<sup>1</sup>*

*Probiotic names are designated by*

**GENUS, SPECIES, and STRAIN**





# Probiotics

- Strains and dosages will impact health outcomes
  - Strains: taxonomically defined; genome sequence available
  - Doses must be adequate; range from 100 million to 450 billion CFUs

## Most commonly studied probiotics

- *Bifidobacterium*
  - *B. lactis*
- *Lactobacilli*
  - *L. acidophilus*
  - *L. casei*
  - *L. plantarum*
  - *L. rhamnosus*
  - *L. reuteri*
- *Saccharomyces boulardii*



# Probiotics: Health Benefits

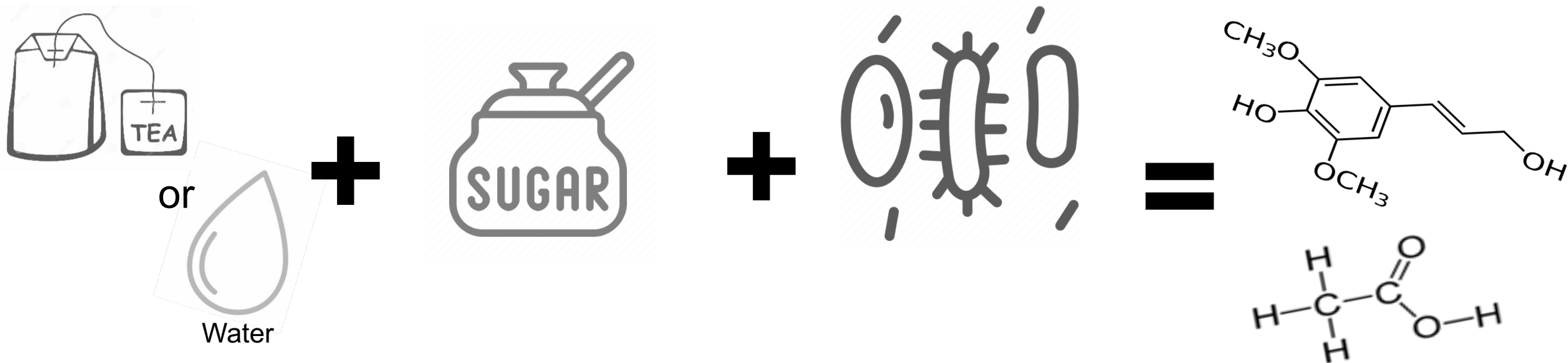
- Oral Health
- Abdominal pain
- Improving lactose digestion
- Motility
- Constipation
- Diarrhea
  - Antibiotic associated
  - Traveler's
  - *Clostridium difficile* associated
  - Infectious
- Immune health
- Stress and anxiety
- Colic
- Respiratory tract infections
- LDL and total cholesterol
- Blood glucose
- Urogenital health
- Infections
  - Hospital acquired
  - Community acquired





# Fermented Foods

Fermented foods are foods made through desired microbial growth and enzymatic conversions of food components





# Fermented Foods



Not all fermented foods contain live microorganisms and few contain probiotics.



Some fermented foods are heat treated (pasteurized, baked) or filtered, which inactivates or removes live microorganisms



Improve taste, texture, digestibility, concentration of certain vitamins, and remove/reduce toxins in foods



# Fermented Foods

Fermented		Not Fermented
<i>Fermented and retaining live fermentation microorganisms</i>	<i>Fermented but fermentation microorganisms killed or removed</i>	
Yogurt Sour cream Kefir Most cheeses Miso Natto Tempeh Fermented vegetables Dry fermented sausages Most kombuchas Some beers	Bread, including sourdough (baked) Shelf-stable pickles and other fermented vegetables (heat-treated) Sausage (smoked) Soy sauce (heat-treated) Vinegar (heat-treated) Wine, most beers, distilled spirits (filtered) Coffee and chocolate beans (roasted)	Chemically-leavened bread Fresh sausage Vegetables pickled in brine Chemically-produced soy sauce Non-fermented cured meats and fish





# Fermented Foods: Health Benefits

- Reduce body fat
- Improve blood cholesterol
- Reduce in blood pressure
- Reduce risk of type 2 diabetes
- Improve bone mineral density
- Reduce muscle soreness after exercise

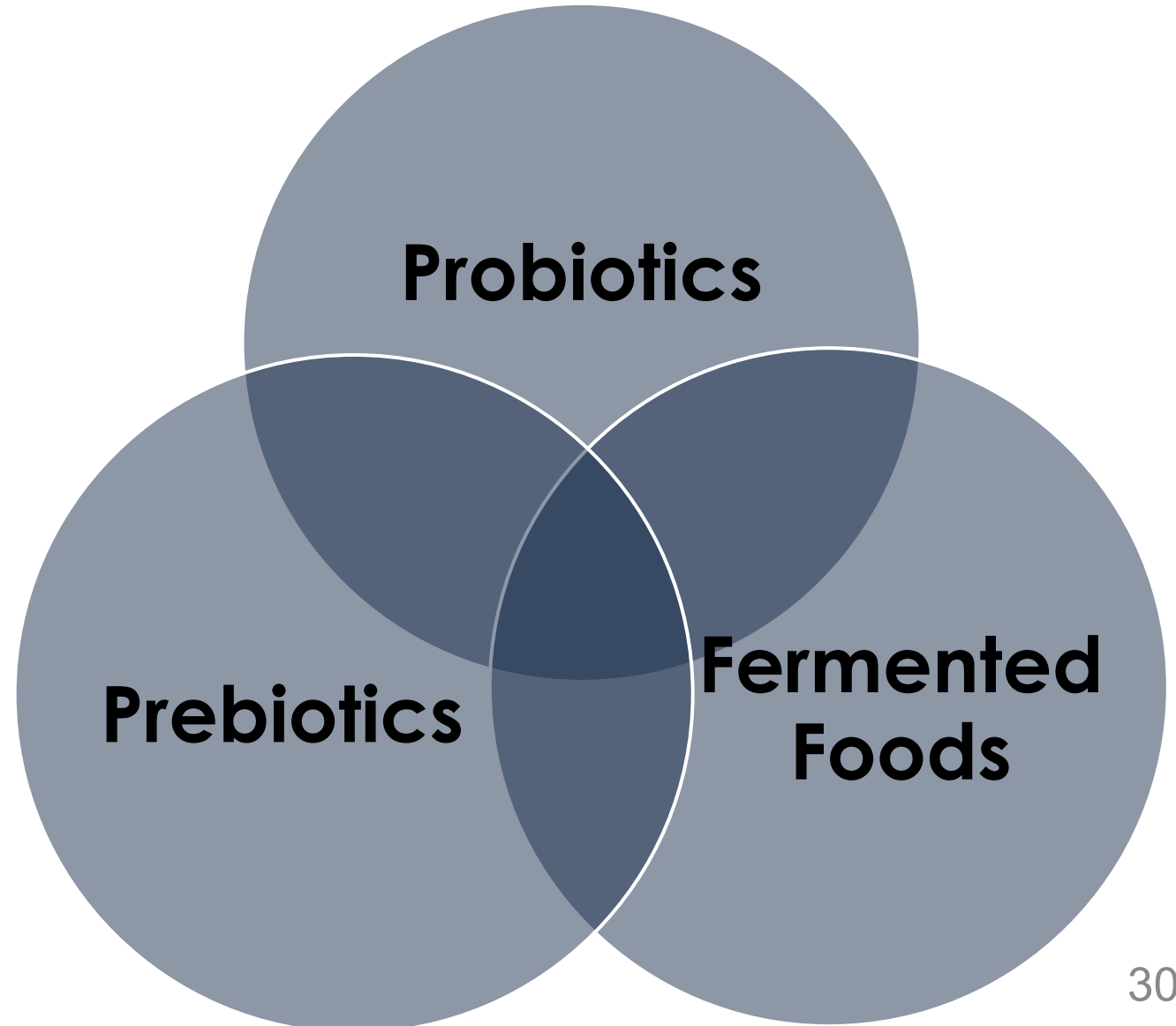


# Applications



# Sorting out the differences

Asparagus  
Capsules  
Cereal  
Kombucha  
Olives  
Yogurt





# Sorting out the differences: Answers

Asparagus: Prebiotic

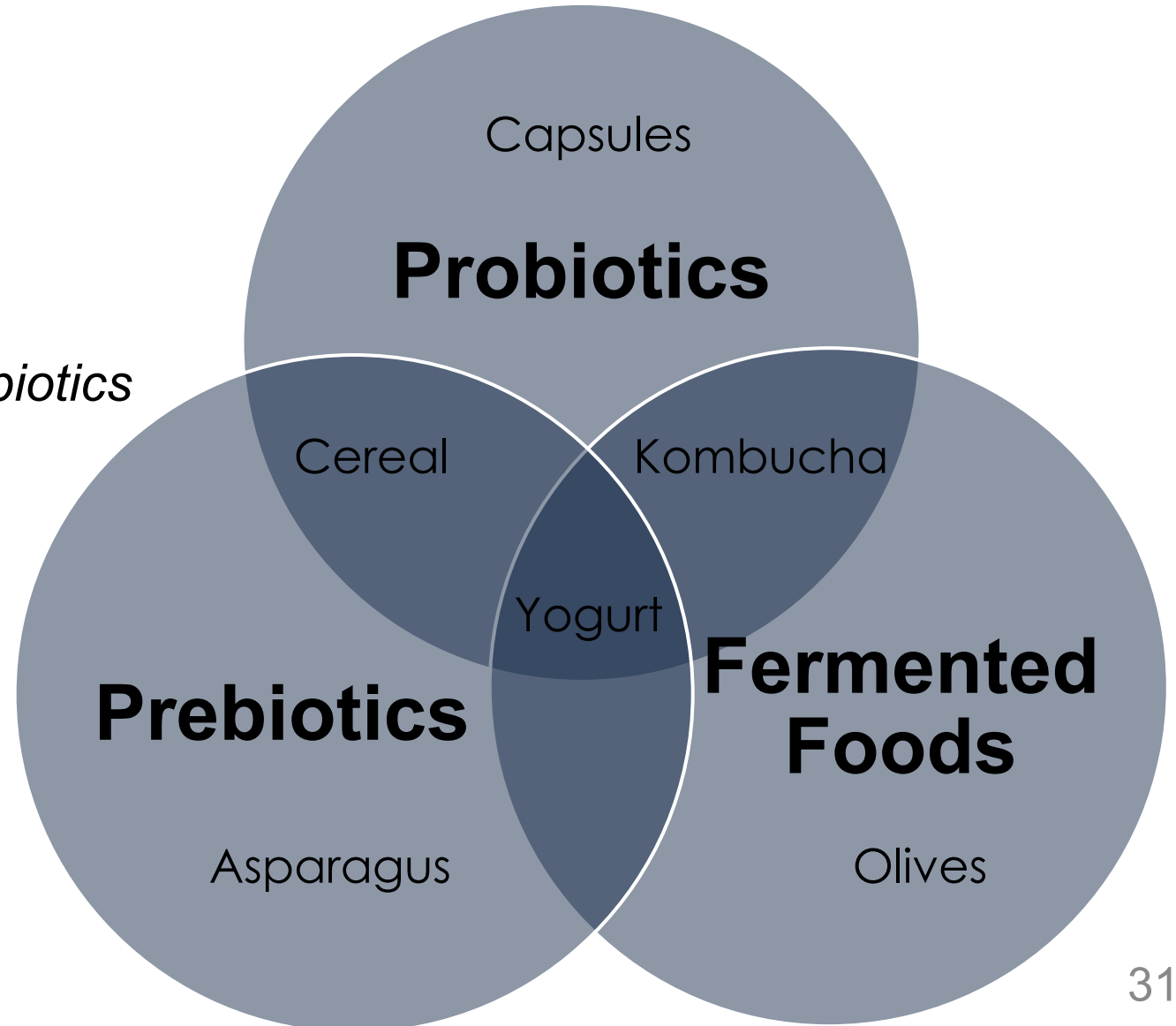
Capsules: Probiotics

Cereal: Prebiotics & *Probiotics*

Kombucha: Fermented Food & *Probiotics*

Olives: Fermented Food

Yogurt: Fermented Food, *Probiotics*, & *Prebiotics*





# Checking the Label

## Ingredients

Whole Grain Wheat, Cane Sugar, Inulin, Natural Flavor, Brown Rice Syrup, *Bifidobacterium Lactis* HN019, Contains 2% Or Less Of Coconut and Sunflower Oil, Natural Flavor, Salt, Mixed Tocopherols (Vitamin E) For Freshness





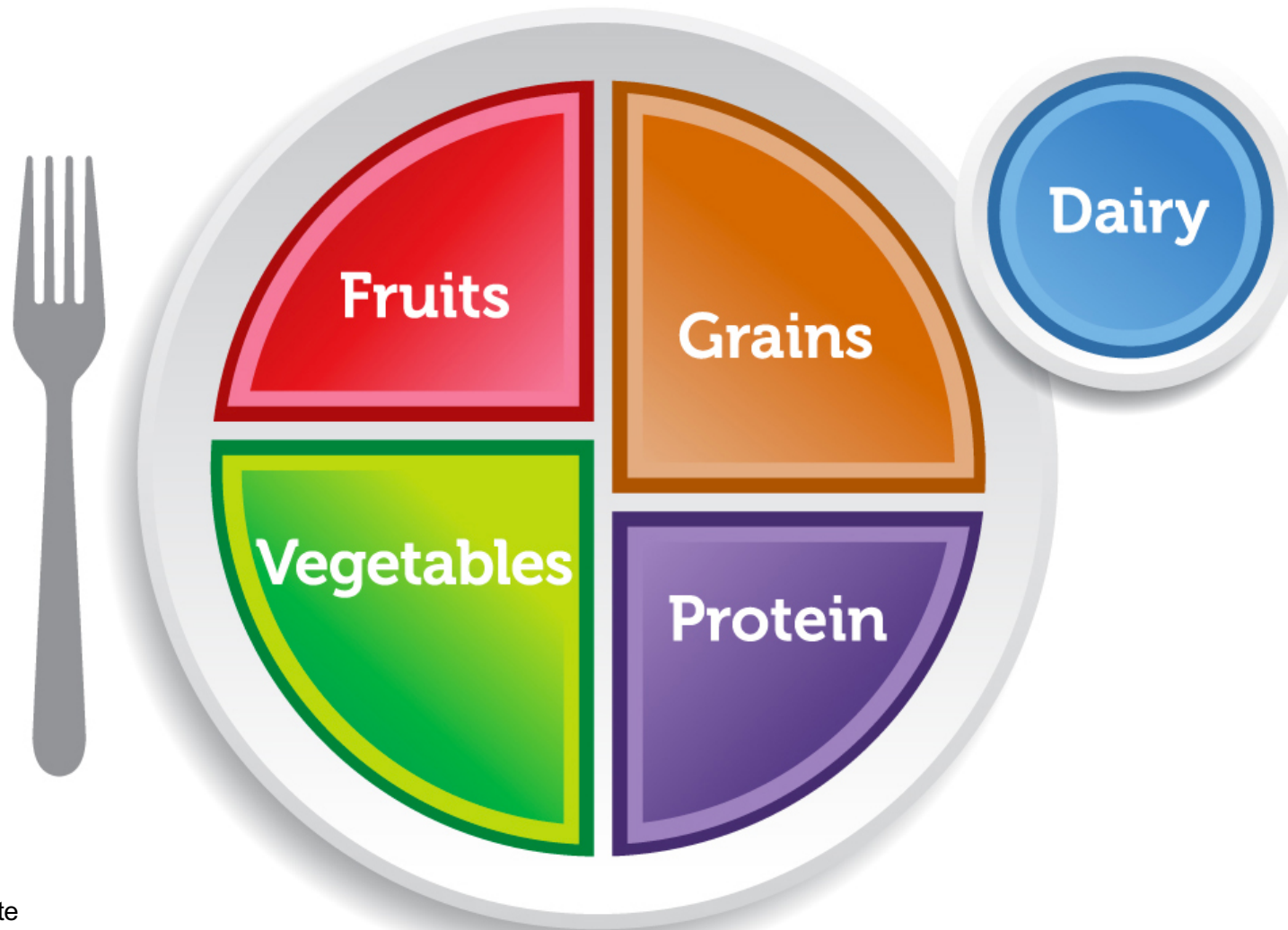
# Checking the Label

## Ingredients

**Whole Grain Wheat**, Cane Sugar, **Inulin**, Natural Flavor, Brown Rice Syrup, ***Bifidobacterium Lactis HN019***, Contains 2% Or Less Of Coconut and Sunflower Oil, Natural Flavor, Salt, Mixed Tocopherols (Vitamin E) For Freshness

# Eat the Rainbow to Support Gut Health

*Fiber, Prebiotics, Probiotics & Fermented Foods*

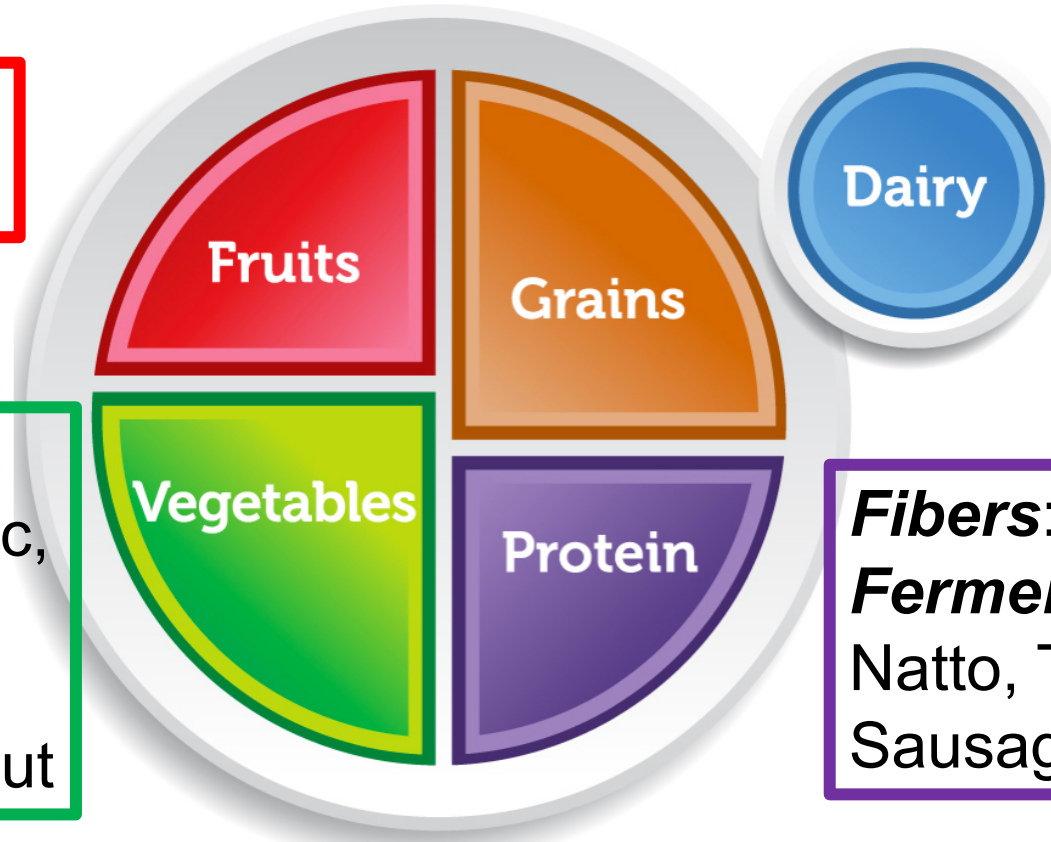




# Eat the Rainbow to Support Gut Health

**Fiber:** Avocado  
**Prebiotics:** Banana

**Fiber:** Broccoli  
**Prebiotics:** Artichokes, Garlic, Leeks, Onions  
**Fermented Foods:** vegetables, kimchi, sauerkraut



**Fiber & Prebiotics:** wheat, barley, rye  
**Fermented Foods:** boza, bushera

**Fermented Foods:** Cheese, Kefir, Yogurt

**Fibers:** Walnuts & Almonds  
**Fermented Foods:** Miso, Natto, Tempeh, Fermented Sausages



# Practical Applications

- **Fiber & Prebiotics**

- Eat the rainbow: eat lots of different types of plants
- Aim for 5 a day

- **Probiotics**

- Read the label
  - Strain Specificity
  - Adequate Dose
- Duration

- **Fermented Foods**

- Live microbes in the diet benefit health
- Looks in the refrigerated section

- **For more information**

- [International Scientific Association for Probiotics and Prebiotics \(ISAPP\)](#)
- [US Probiotic Guide](#)
- [American Gastroenterological Association \(AGA\)](#)
- [World Gastroenterology Organisation \(WGO\)](#)



# Key Takeaways

1

**Diet** impacts the human gut microbiota.

2

Consumption of **foods, which contain fiber,** impact the gut microbiota.

3

**Probiotics, prebiotics,** and **fermented foods** impact health.



# Test Your Understanding

<https://forms.gle/BNmXUsT1DdNNZdJD8>

# Discussion



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