

Eating for Trillions: Translating Microbiome Science into Practice

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Microbiome Laboratory**

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Disclosures

AFFILIATION/FINANCIAL INTERESTS (prior 12 months)	ENTITIES
Employee	University of Illinois Urbana-Champaign
Scientific Advisory Boards	International Scientific Association for Probiotics & Prebiotics (ISAPP) American Gastroenterological Association (AGA): Gut Health Advisory Board & Microbiome Center Scientific Advisory Board
Grants/Research Support	Almond Board of California, General Mills, Hass Avocado Board, Tate & Lyle, USDA
Speaking honoraria	Danone, Haleon, National Dairy Council, New England Dairy Council, Olipop, St. Louis Dairy Council

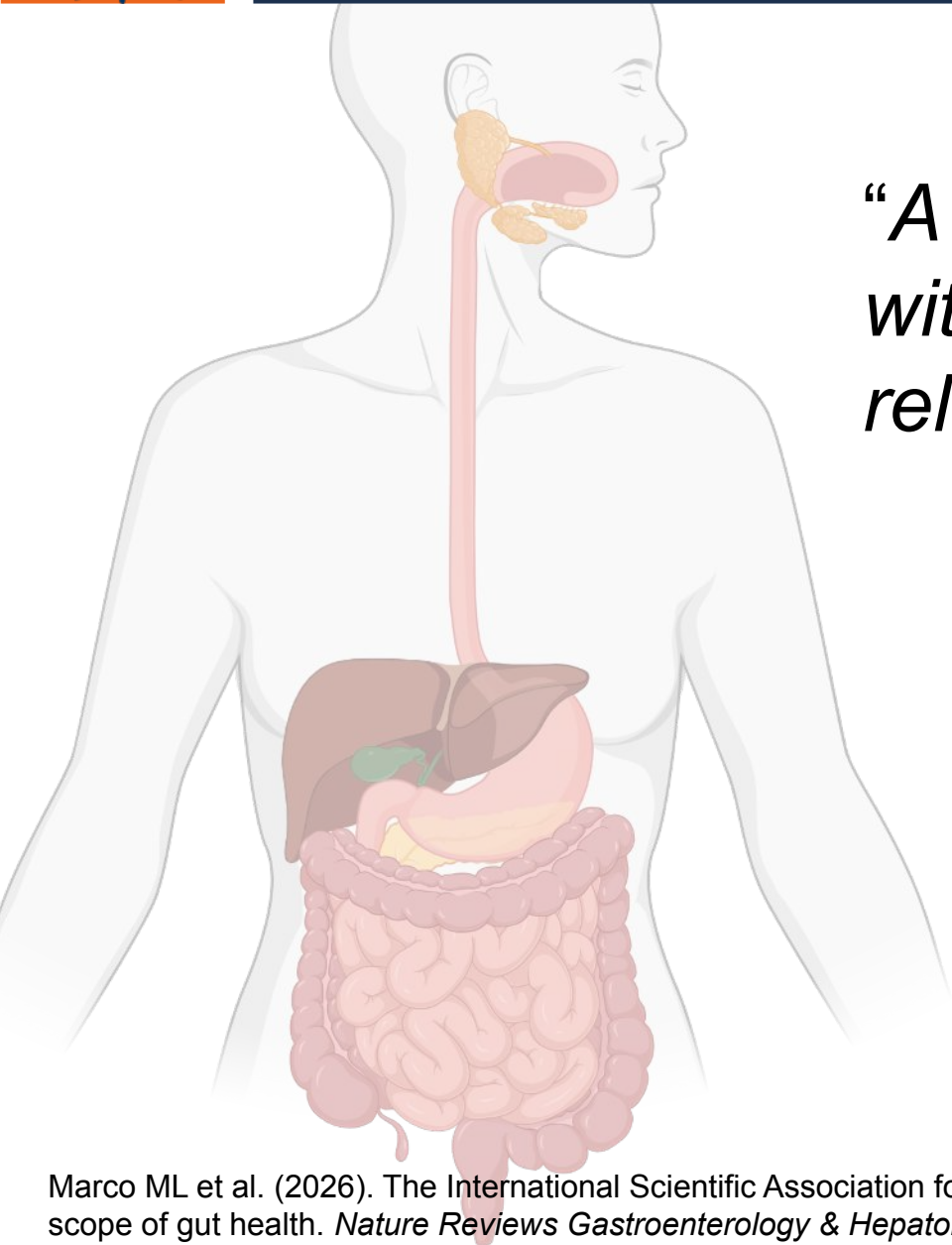


Objectives

- 1 Describe gut health and functions of the microbiome
- 2 Recall dietary components that nourish the gut microbiome and support gut health
- 3 Identify foods and beverages that support gut health



Gut Health

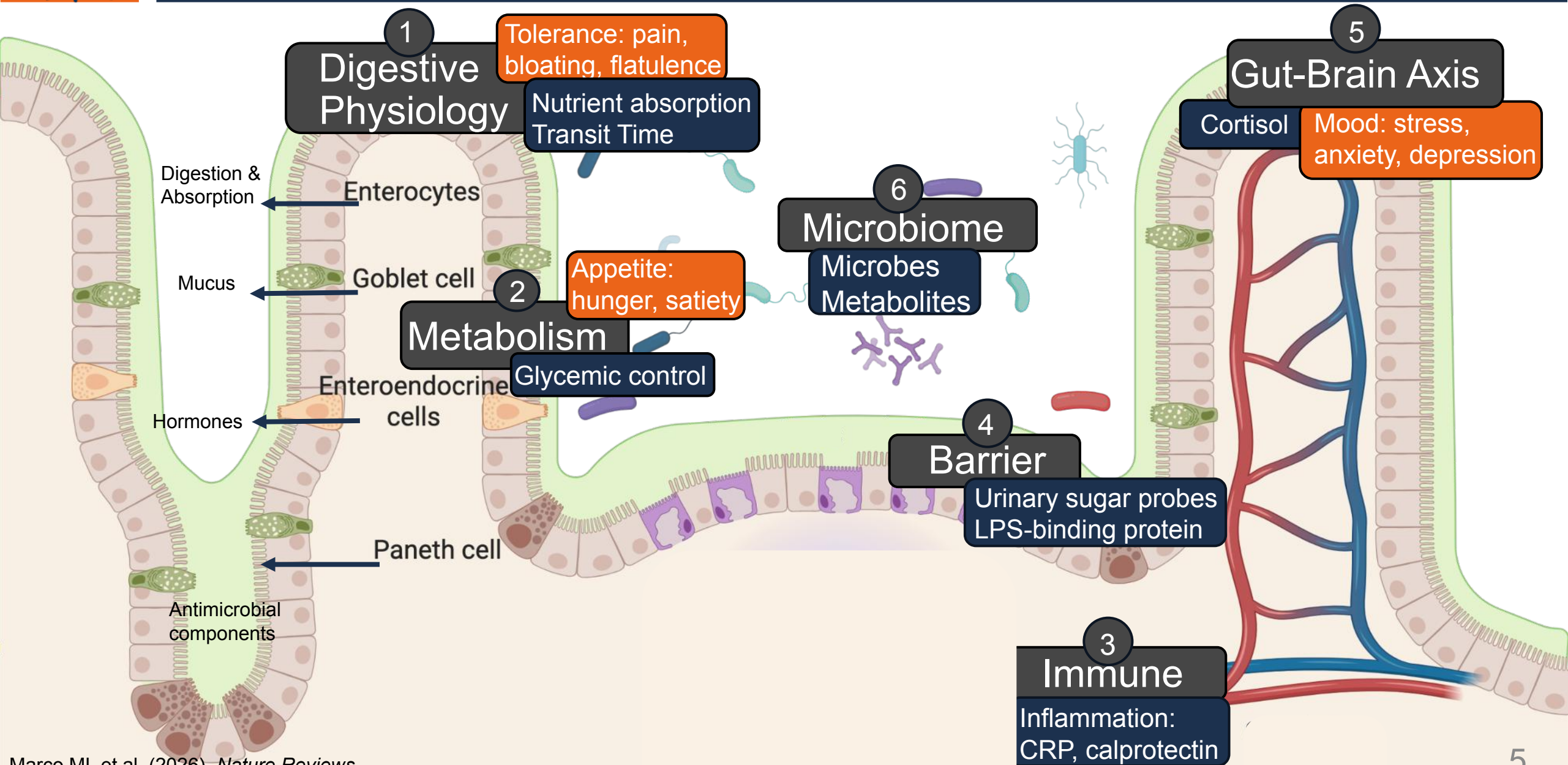


“A state of normal gastrointestinal function without active gastrointestinal disease and gut-related symptoms that affect quality of life.”

Combines an individual’s **subjective experience** of gastrointestinal activity with **objective measures** of gut function.



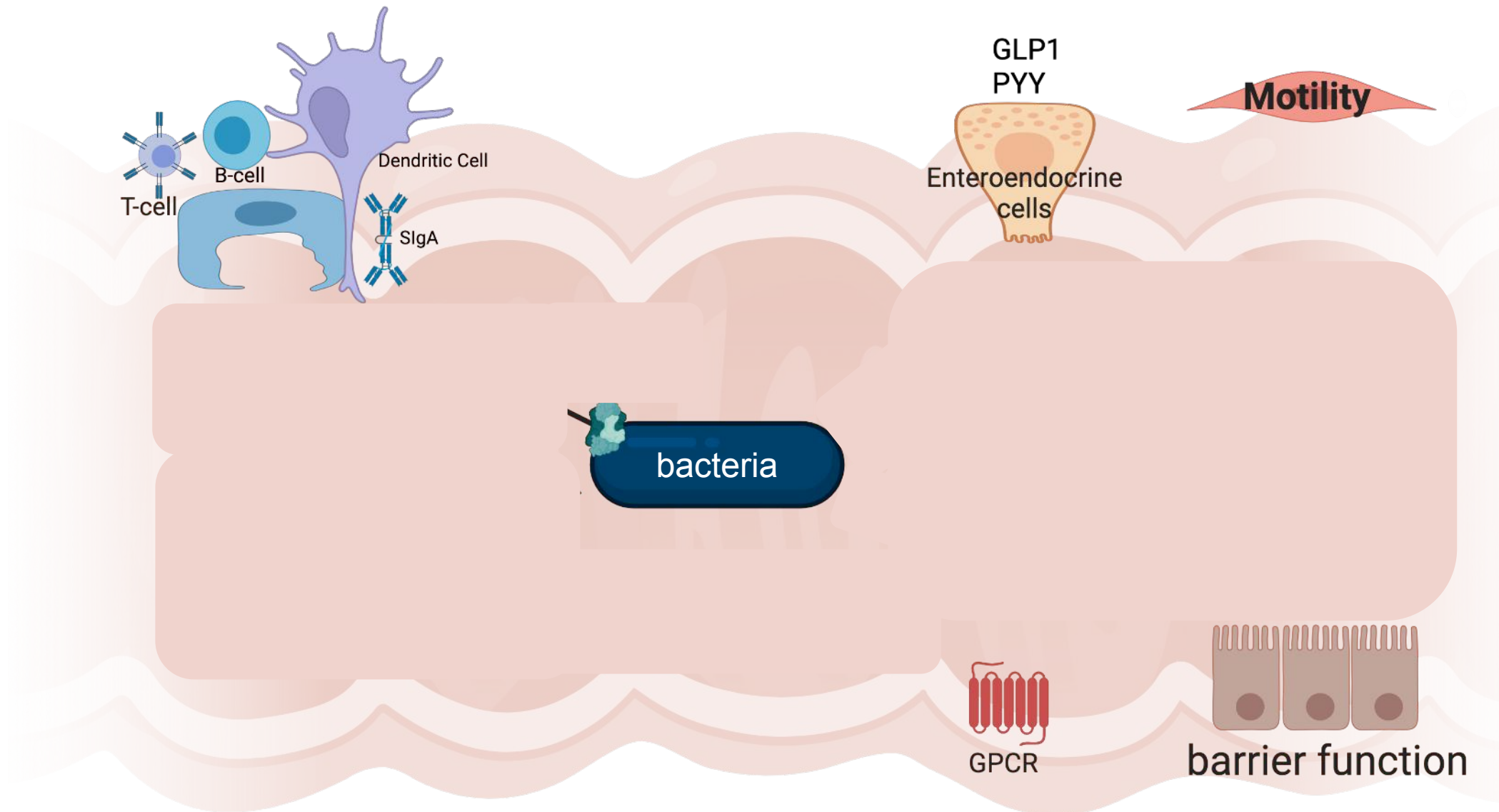
Gut Health: Six Functional Domains





Gut Microbiome Functions

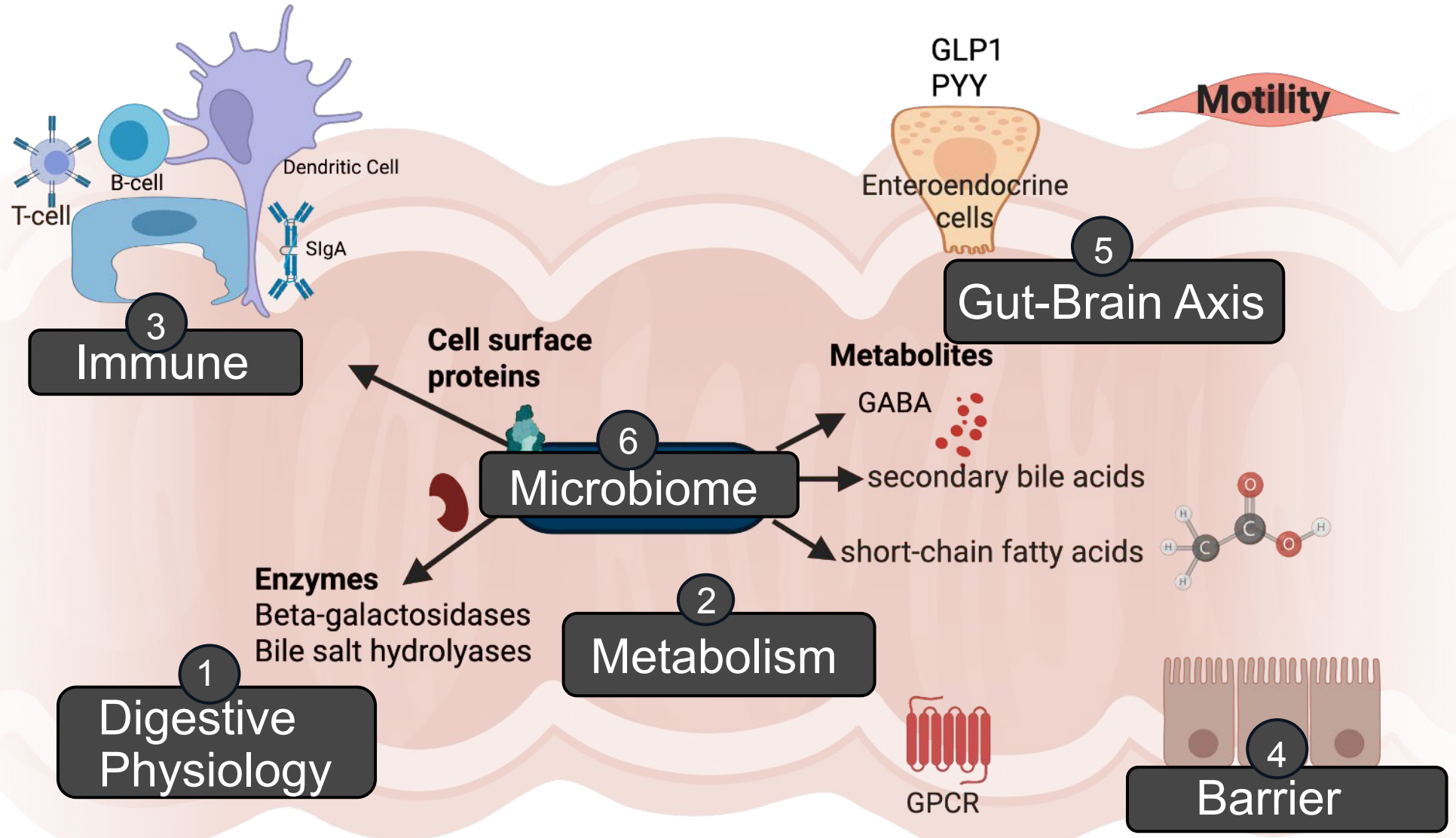
The microbiome contributes to health through **immune**, **metabolic**, and **endocrine** functions.





Gut Microbiome & Gut Health

The gut microbiome is a key domain of gut health





Microbiome Science

There is **no** definition of a “*healthy microbiome*”

- Microbial phenotypes are **predictive** of health outcomes
 - ▣ Diversity, Resilience, Resistance¹
 - ▣ Health-associated core keystones (HACK) index²
 - ▣ *Roseburia* spp. (*Roseburia inulinivorans*, *Roseburia intestinalis*, *Roseburia hominis*, *Roseburia faecis*)
 - ▣ *Eubacterium* spp. (*Eubacterium eligens*, *Eubacterium rectale*, *Eubacterium ramulus*)
 - ▣ *Alistipes* spp. (*Alistipes shahii*, *Alistipes putredinis*)
 - ▣ *Ruminococcus bromii*
 - ▣ *Faecalibacterium prausnitzii*
 - ▣ *Bacteroides uniformis*
 - ▣ *Bifidobacterium* and *Lactobacillus* spp.^{1,2,3}

1. Joos R., et al (2025). Examining the healthy human microbiome concept. *Nature Reviews Microbiology*. 23: 192-205

2. Goel A., et al (2025). Toward a health-associated core keystone index for the human gut microbiome. *Cell Reports*, 44(3) 115378

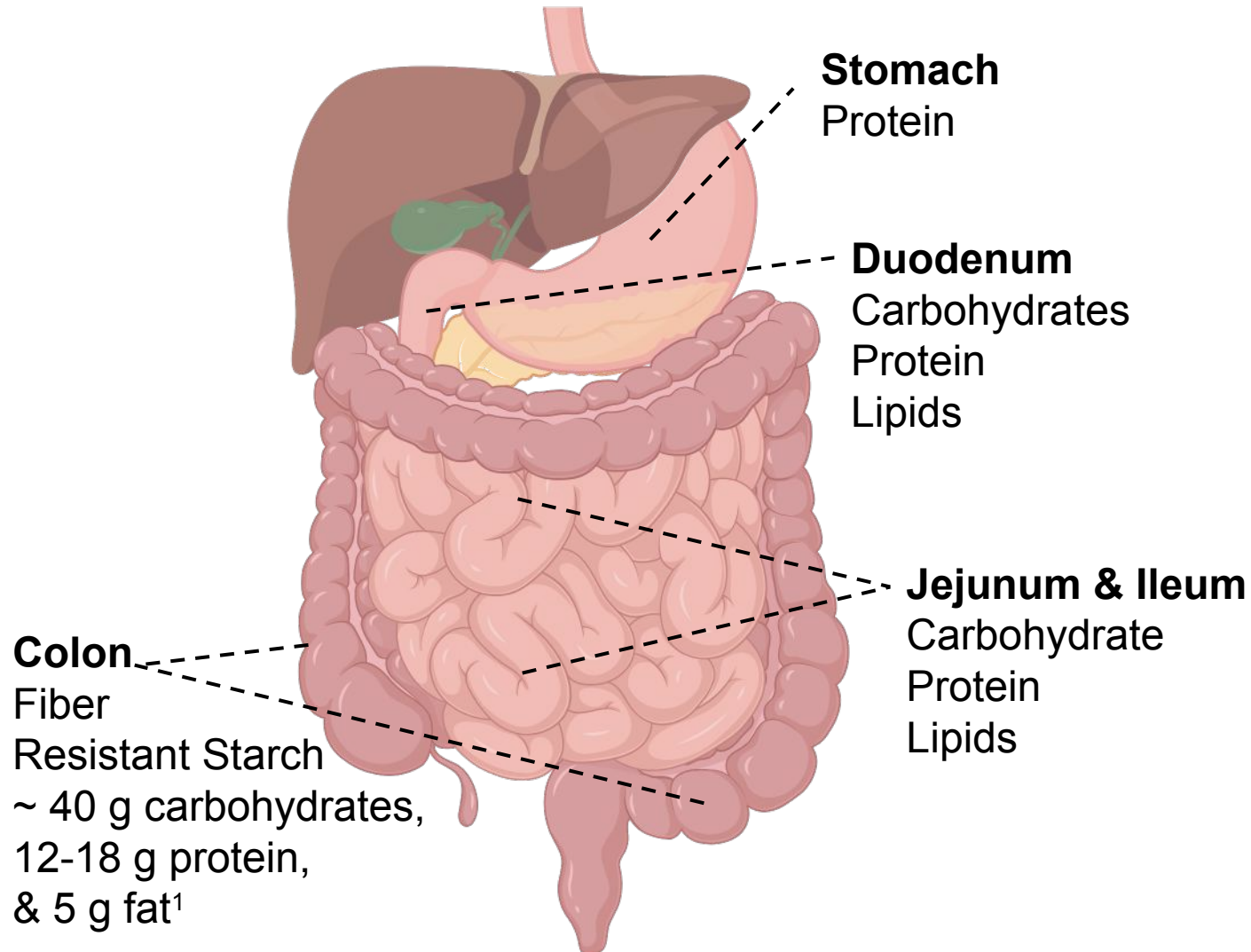
3. Hughes RL, et al (2022). The prebiotic potential of inulin-type fructans: a systematic review. *Advances in Nutrition*. 13: 492-529



Nutrition & Microbiota



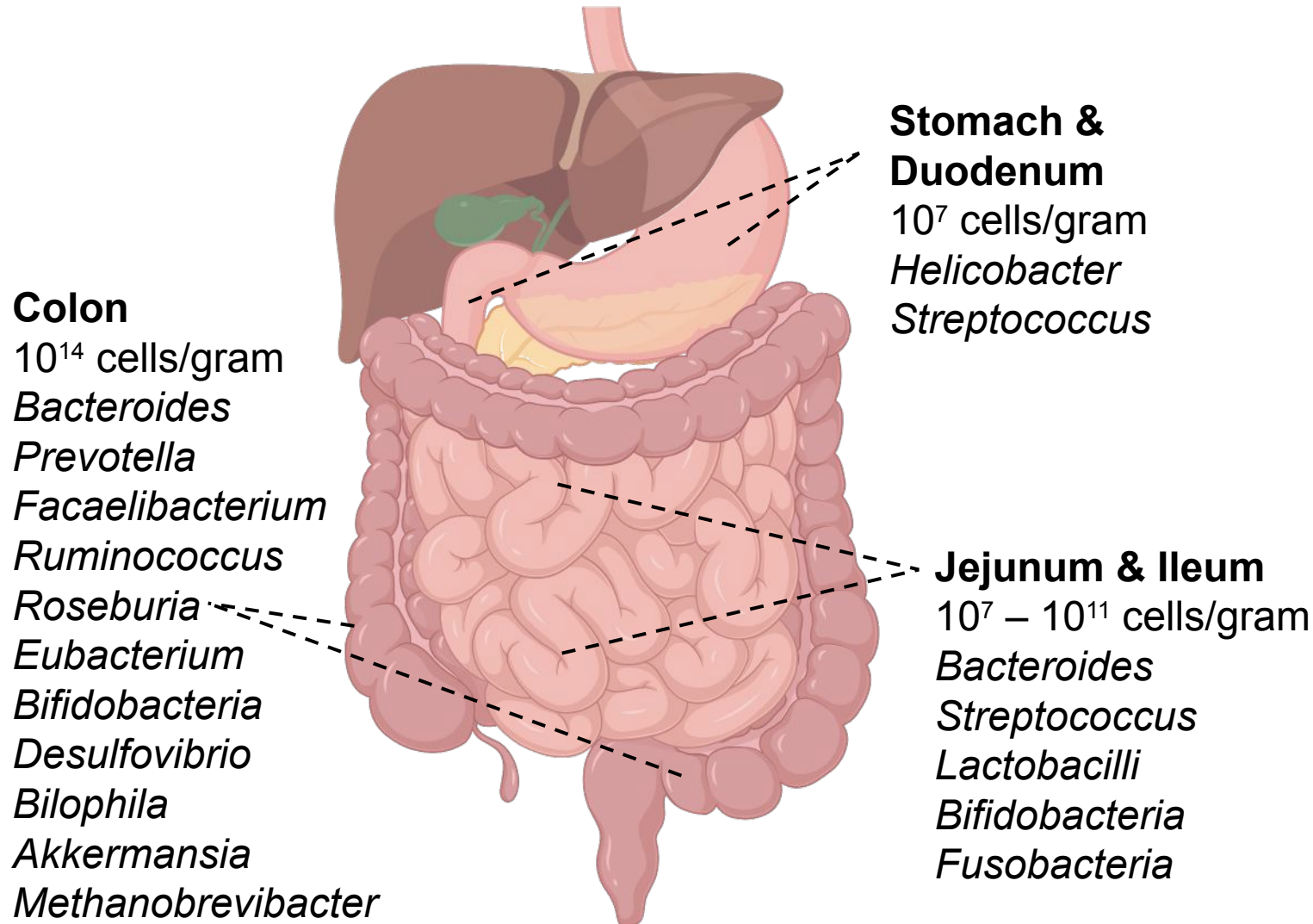
Diet, Gut Microbiota, & Health



□ Diet impacts *gut health*.



Diet, Gut Microbiota, & Health



- Diet impacts **gut health**.
- Diet provides **nutrients** for gut microbiota.
- Diet provides a source of **microbes**.



Supporting Gut Health



Prioritize plants to provide energy
for gut microbes



Choose fermented foods with
friendly microbes and metabolites



Prioritize Plants:

Fiber, Resistant Starch & Prebiotics





Diet & Gut Microbiota

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



Nutrition Facts

Calories 228

% Daily Value*

Total Fat 4g 6%

Saturated Fat 2g 10%

Trans Fat 0g

Cholesterol 0mg 0%

Sodium 120mg 5%

Total Carbohydrate 44g 15%

Dietary Fiber 8g 33%

Total Sugars 12g

Includes 10g Added Sugars 20%

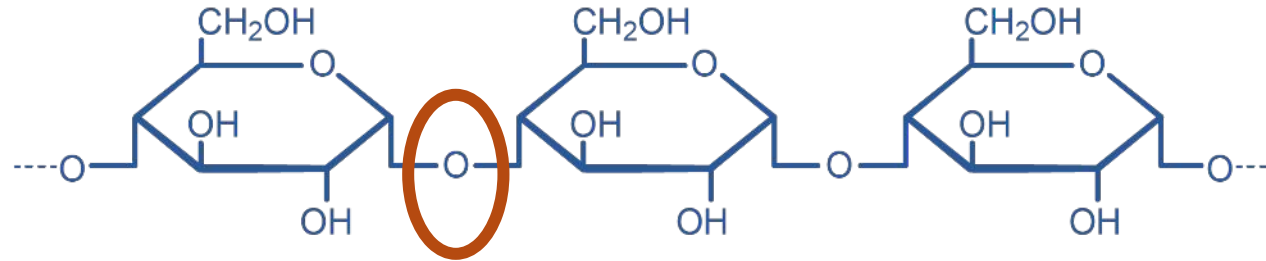
Protein 4g

Vit. D 0mcg 0% Calcium 40mg 3%

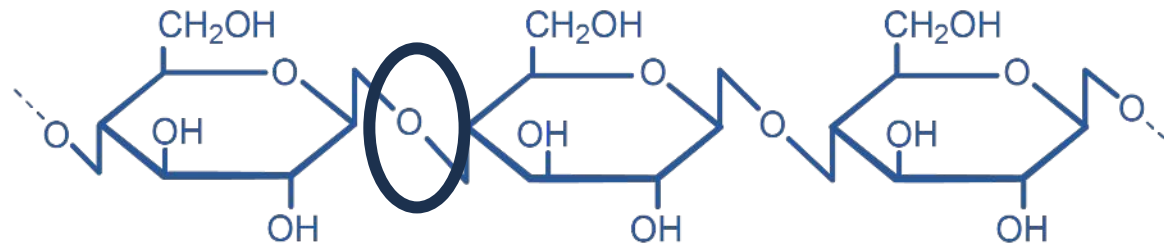
Iron 0.8mg 4% Potassium 30mg 0%



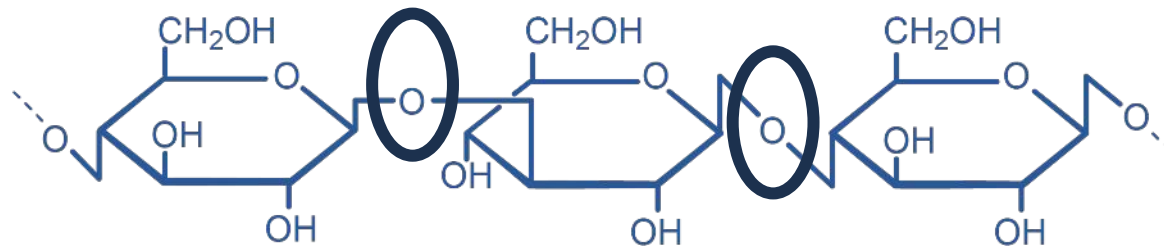
Fiber: Nutrients for Gut Microbes



Amylose: α -1,4 glucosidic bonds



Cellulose: β -1,4 glucosidic bonds



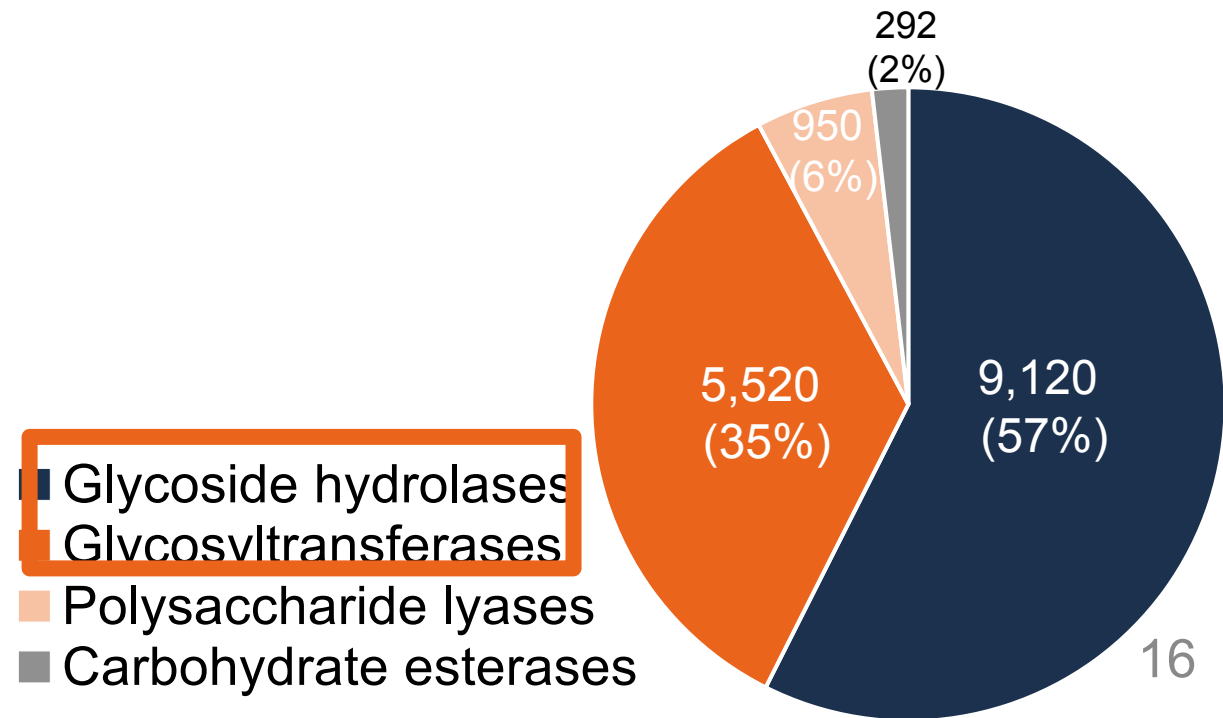
β -Glucan: mixed β -1,3 and β -1,4 glucosidic bonds



Enzymatic Breakdown of Fiber

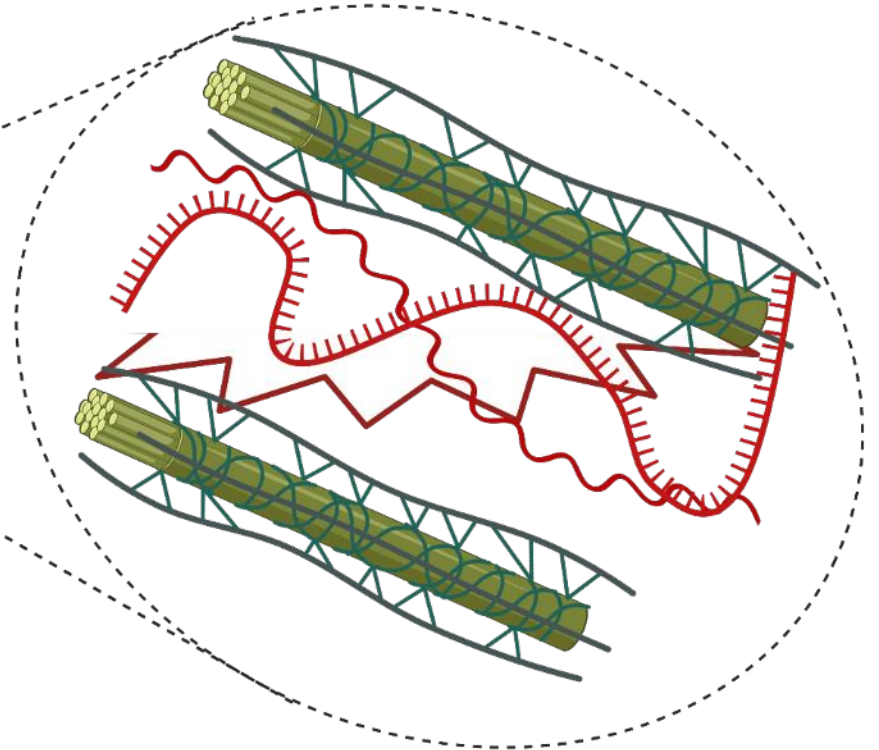
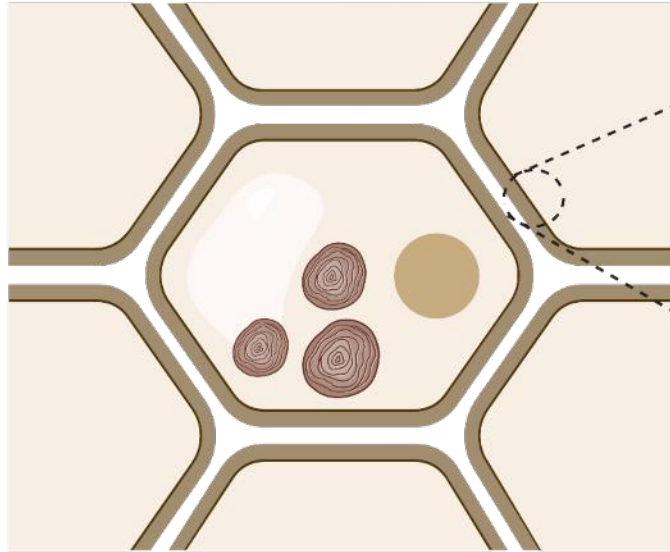
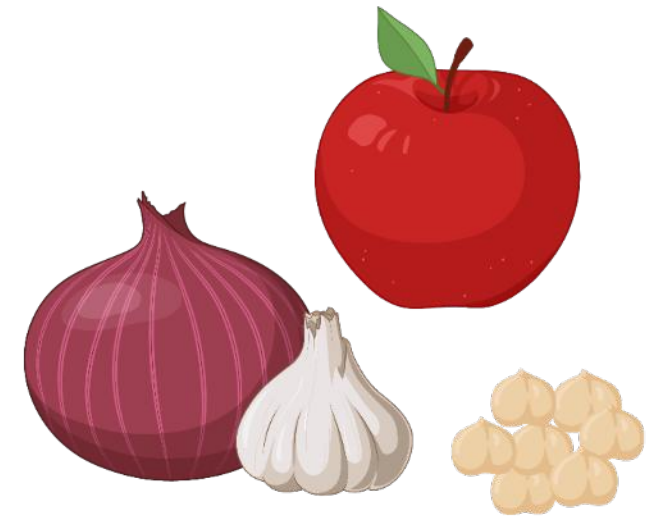
CAZymes: Carbohydrate-Active enZymes

- ▣ ~16,000 CAZyme genes in the *human gut microbiome*
 - ▣ ~9,000 genes encode enzymes that cleave glycosidic bonds
- ▣ 16 carbohydrate enzyme genes in the *human genome*

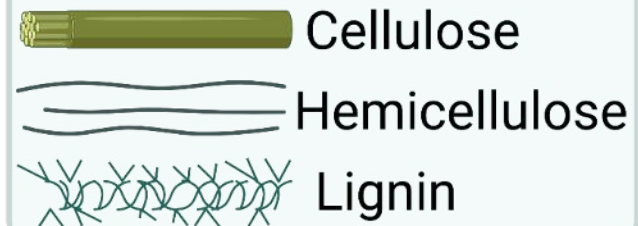




Fiber



Insoluble Fibers

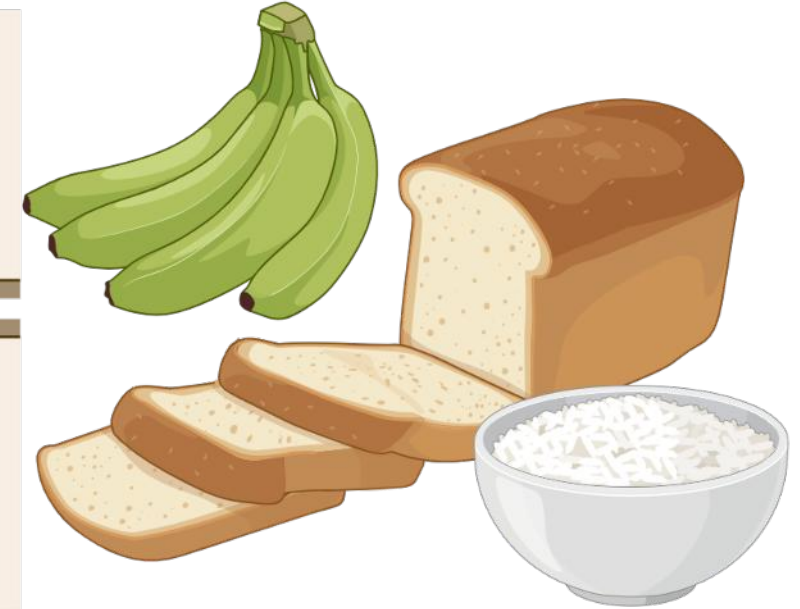
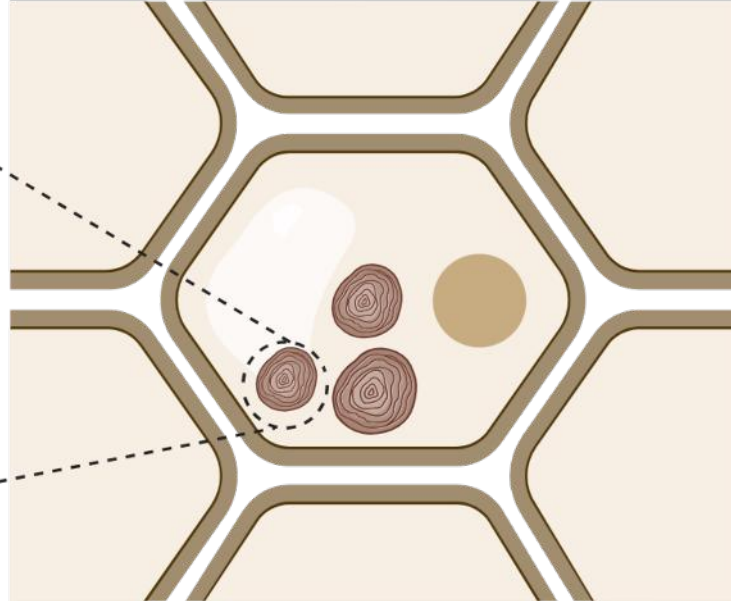
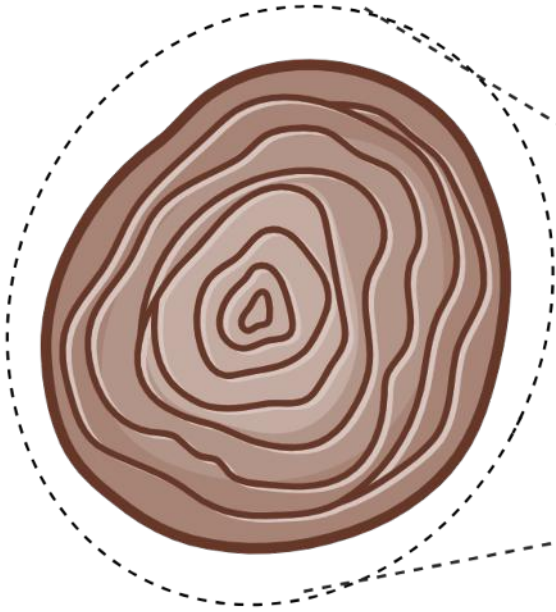


Soluble Fibers





Resistant Starch



Resistant Starch

- RS1: Physically inaccessible
- RS2: Granular
- RS3: Retrograded
- RS4: Chemically modified
- RS5: Starch-lipid complexes

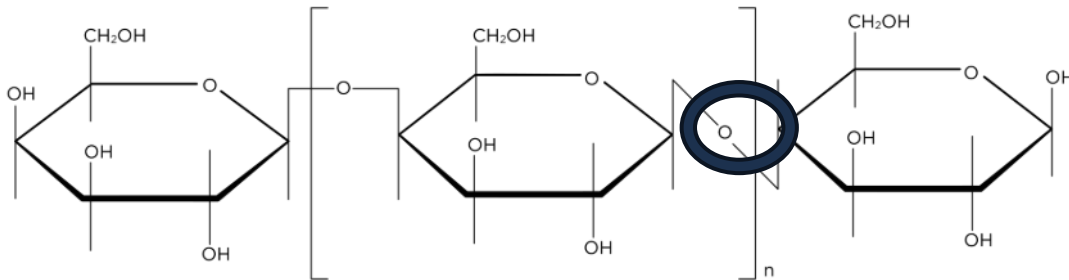


Prebiotics

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

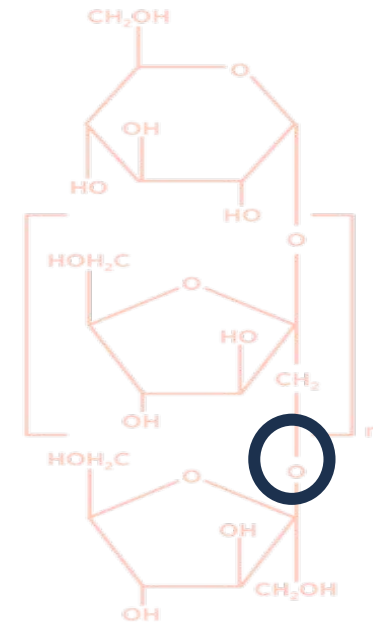
Galactooligosaccharides

- Chickpeas
- Lentil
- Faba bean
- Soybeans



Inulin-Type Fructans

- Artichoke
- Garlic
- Onion
- Leeks



Gibson, G. R (2017). *Nature Reviews Gastroenterology & Hepatology*.

Kalala G (2018). *J Food Sci and Nutr*. 69(6): 682-689

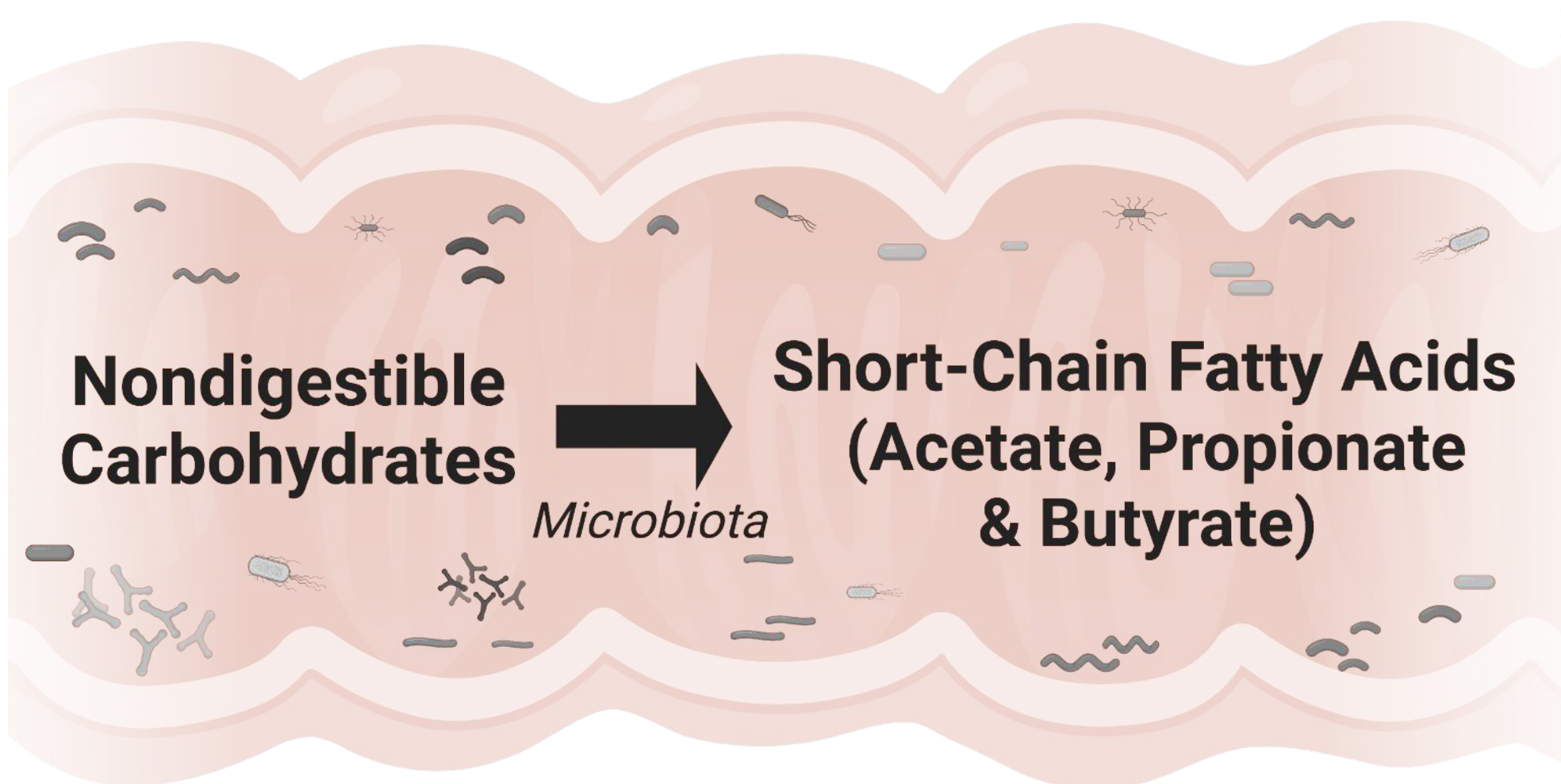
Moshfegh AJ (1999) *J Nutr*. 129, 1407S-1411S.

Njoumi S et al. (2019). *Int J of Food Sci and Nutr*



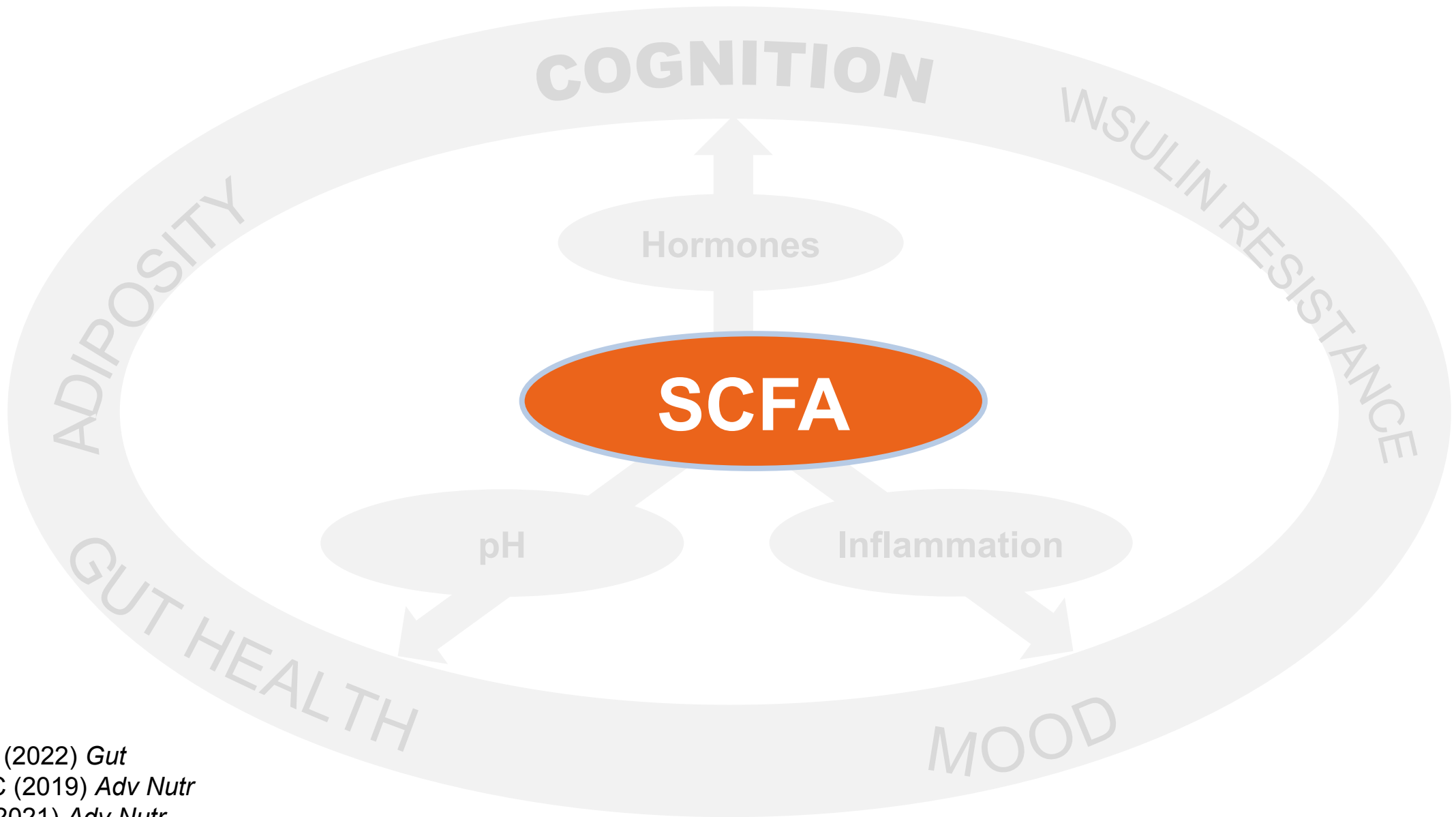
Nourishing Gut Microbes

Microbes Ferment Fiber, Resistant Starch, & Prebiotics



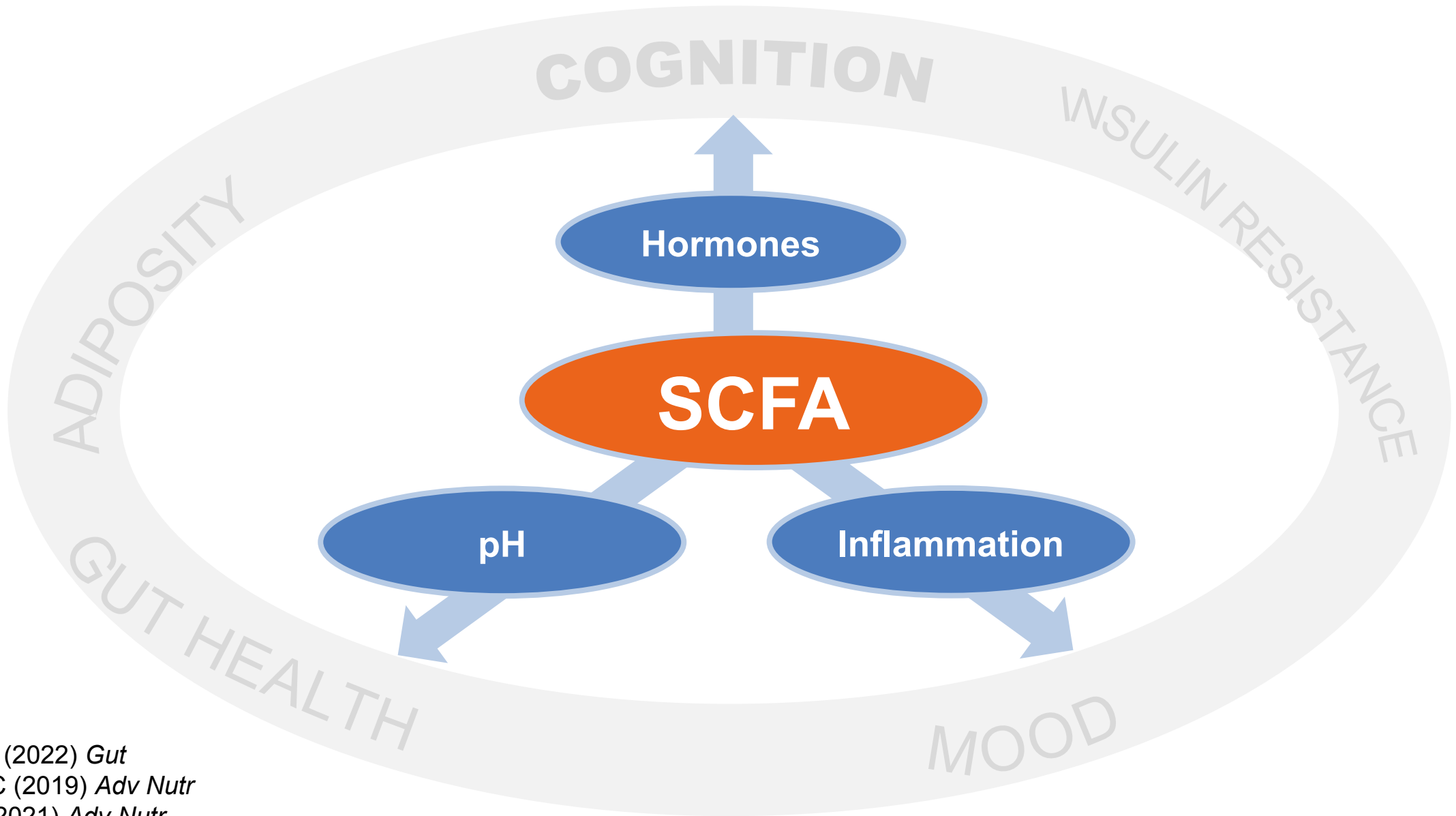


Microbial Metabolites Affect Health



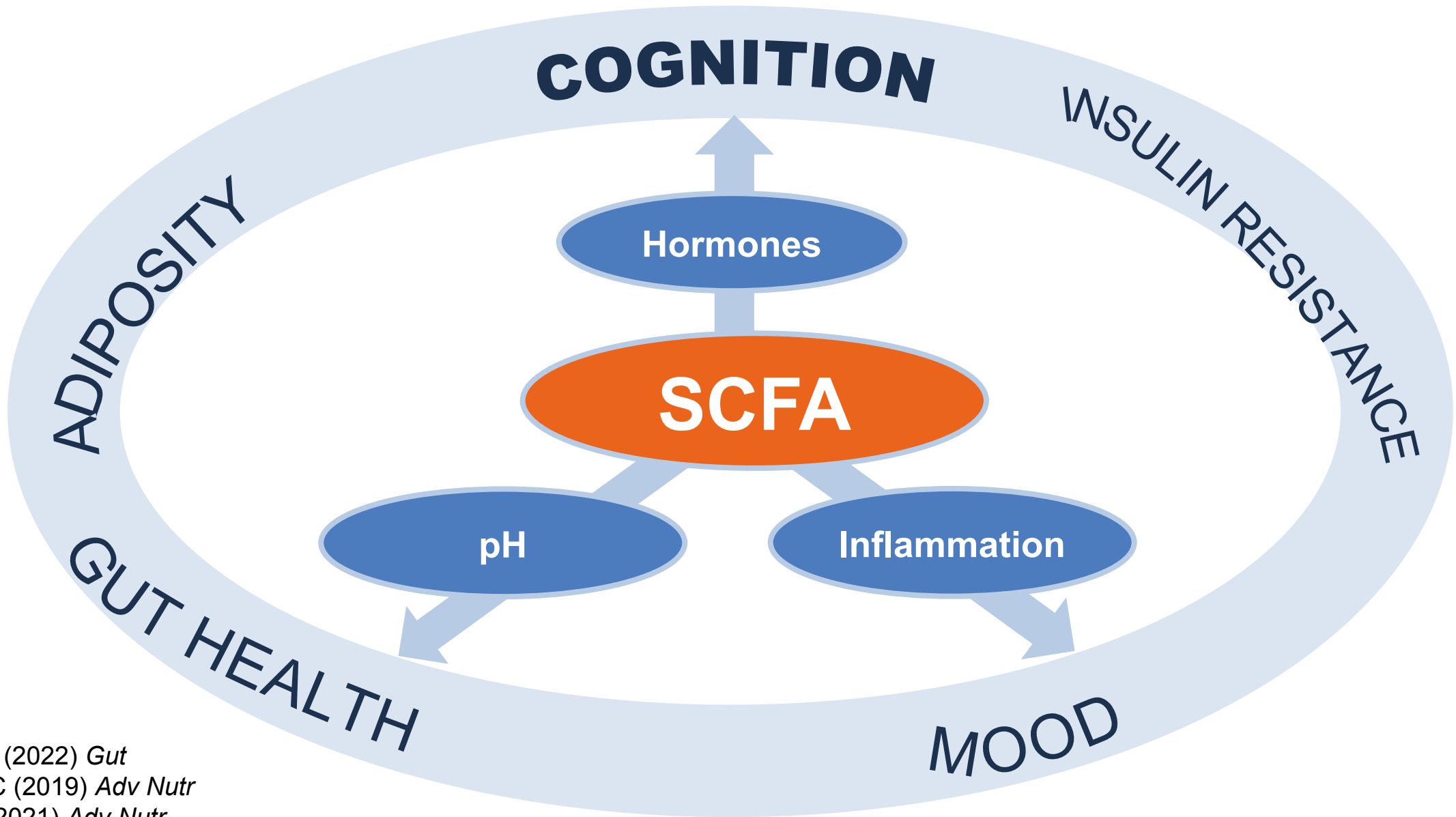


Microbial Metabolites Affect Health





Microbial Metabolites Affect Health

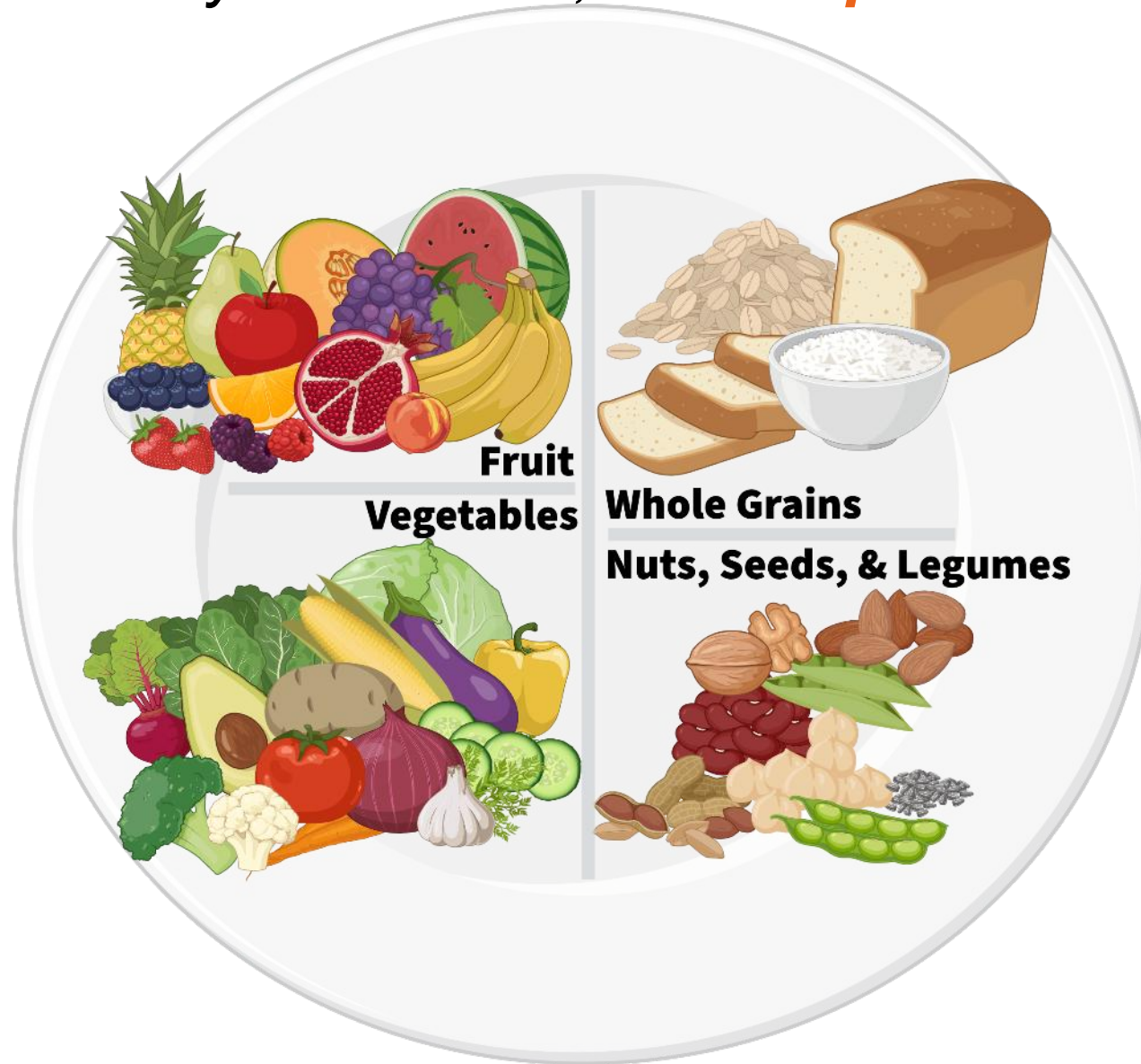




Practical Application: Prioritize Plants



*Eat an array of different, colorful **plants** to support gut health*





Choose Fermented Foods





Fermentation

Fermentation: metabolic processes in which microorganisms convert food components into other substances



Grapes



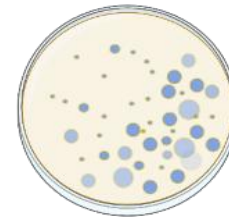
Saccharomyces
(Yeast)



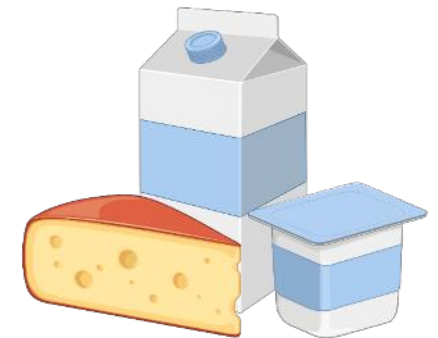
Wine



Milk



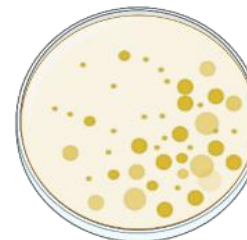
Lactic Acid
Bacteria



Yogurt, Kefir, Cheese



Apple



Acetic Acid
Bacteria



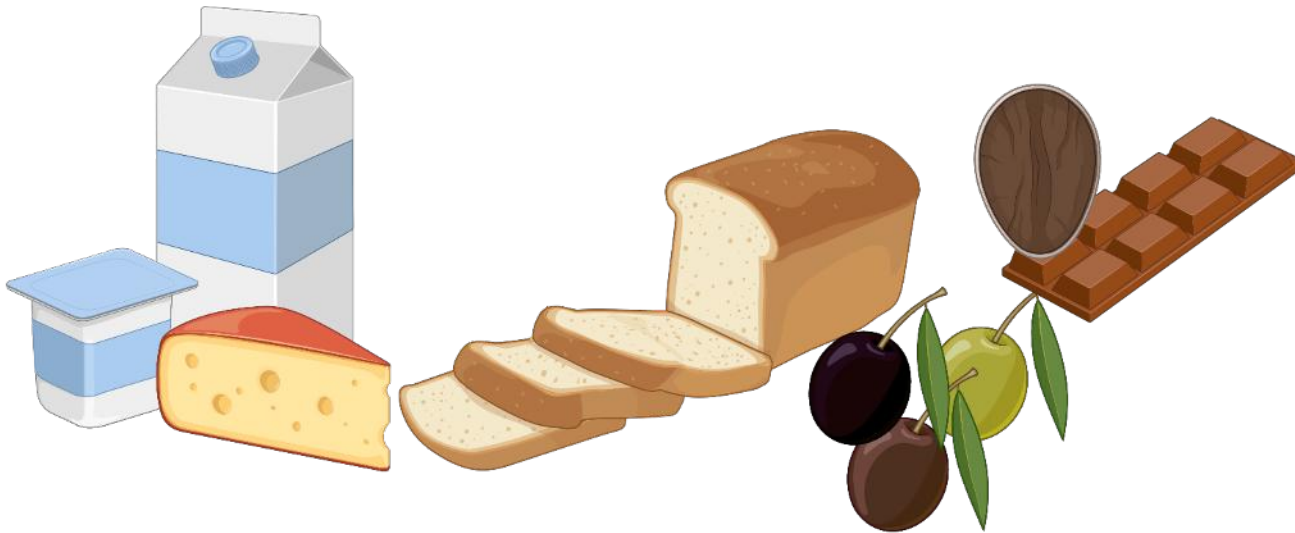
Apple Cider Vinegar



Fermented Foods

Fermented Foods— foods made through **desired microbial growth** and enzymatic conversions of food components.¹

Most food and beverages require lactic acid bacteria, acetic acid bacteria, bacilli or other bacteria, yeasts, or filamentous fungi.



Common microbes

Streptococcus
Lactobacillaceae
Lactococcus
Saccharomyces



Fermented vs. Not Fermented

Fermented		Not Fermented
<i>Live microorganisms present</i>	<i>Live microorganisms absent</i>	<i>No microorganisms</i>
Yogurt Sour cream Kefir Most cheeses Miso Natto Tempeh Fermented vegetables Salami, pepperoni, fermented sausages Fermented cereals, boza, bushera Most kombuchas	<i>Heated (Baked, Pasteurized)</i> Bread Shelf-stable vegetables Sausage Soy sauce Vinegar <i>Filtered</i> Wine, most beers, distilled spirits <i>Roasted</i> Coffee Chocolate beans	Chemically-leavened bread Fresh sausage Vegetables pickled in brine or vinegar Chemically-produced soy sauce Non-fermented cured meats and fish



Fermented Foods: Benefits

Inhibit pathogens
and food spoilage
microbes

Improve food
aroma, taste
and texture

Improve
digestibility

May be as
source of live
microbes

Health
benefits

Increase
vitamin and
bioactives in
foods

Remove/reduce
toxic substances
or anti-nutrients
in foods



Probiotics: Definition

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

Probiotics ≠ Fermented Foods

Fermented Foods— *foods made through **desired microbial growth** and enzymatic conversions of food components.*²

1. Hill, C et al. (2014). The International Scientific Association for Probiotics and Prebiotics consensus statement on the scope and appropriate use of the term probiotic *Nature Reviews Gastroenterology & Hepatology*. 11(8), 506-514.

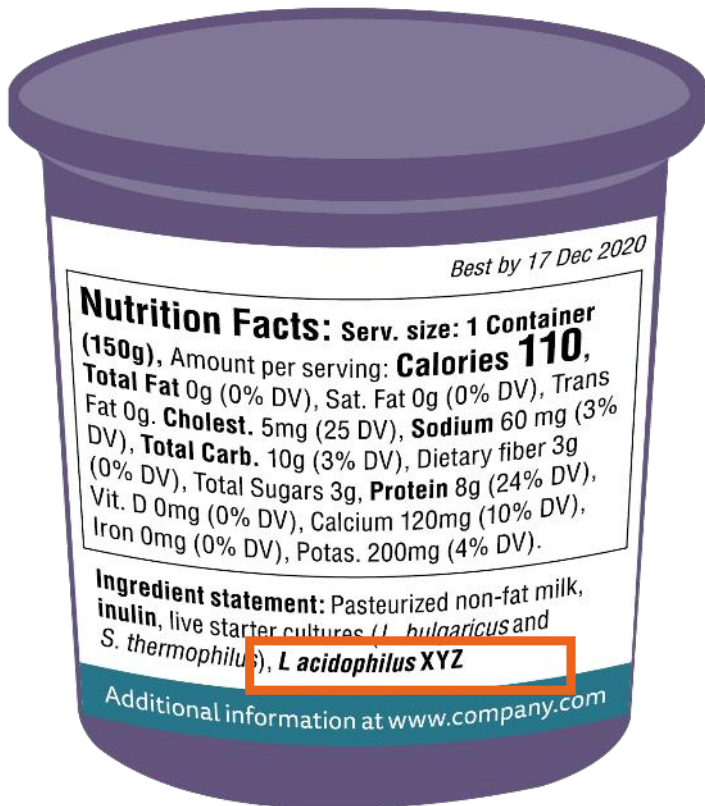
2. Marco M et al. (2021). *Nature Reviews Gastroenterology & Hepatology*. 18(3), 196-208



Probiotics

□ Food

- ▣ Fermented milk drinks
- ▣ Yogurt



Most commonly studied

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



Probiotics: Strain-Specific Health Benefits

Clinical Guide to Probiotic Products Available in USA

Applications, Dosage Forms and Clinical Evidence to Date - 12th Edition, 2026

Introduction Adult Health Vaginal Health Pediatric Health Functional Foods **References** About

Find the appropriate probiotic:

Adult Health

Womens Health

Pediatric Health

Functional Foods

Helping you select
right probiotic
supported by evidence

250 publications

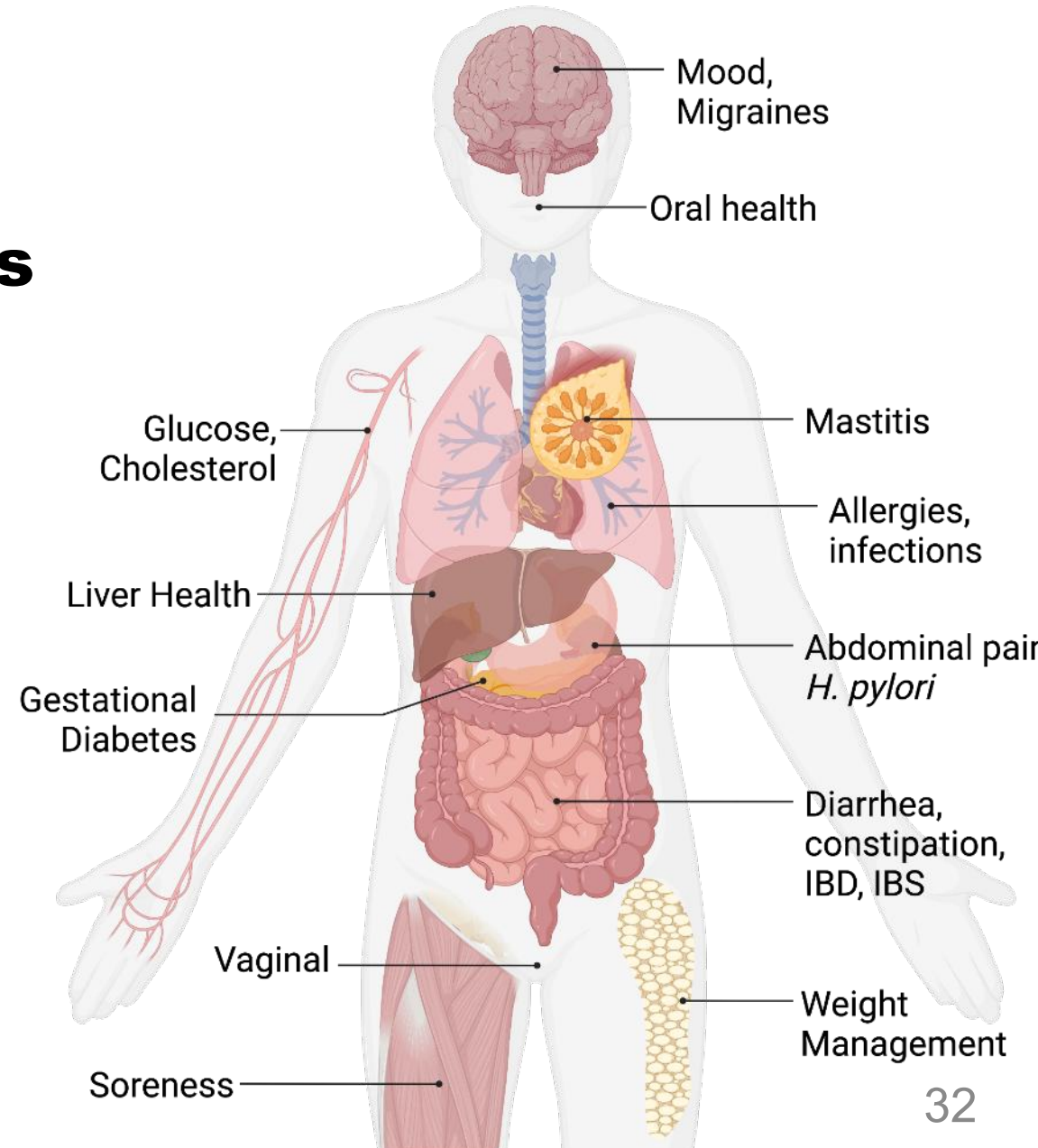
Evidence Evaluation

Level I: At least 1 appropriately designed trial with power calculation for outcome

Level II: Well-designed controlled trials w/o randomization, cohort or case-controlled

Level III: Expert opinions

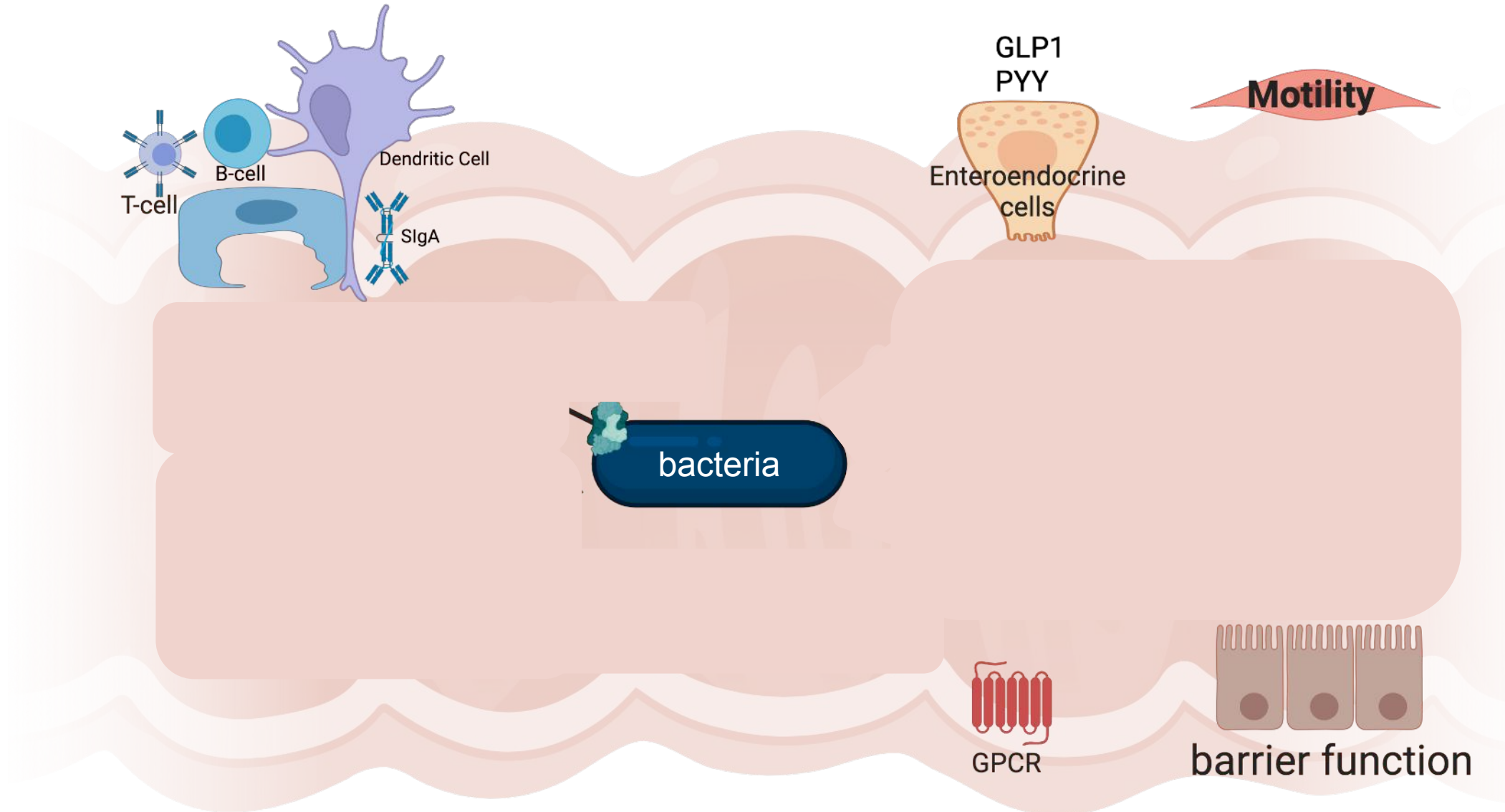
Clinical Guide to Probiotic Products 2026 (<http://usprobioticguide.com/>)





Microbes & Metabolites affect Health

Immune, Metabolic, and Endocrine Effects





Practical Application: Choose Fermented Foods



*Eating **fermented foods** provides a source of friendly microbes and metabolites to support gut health*



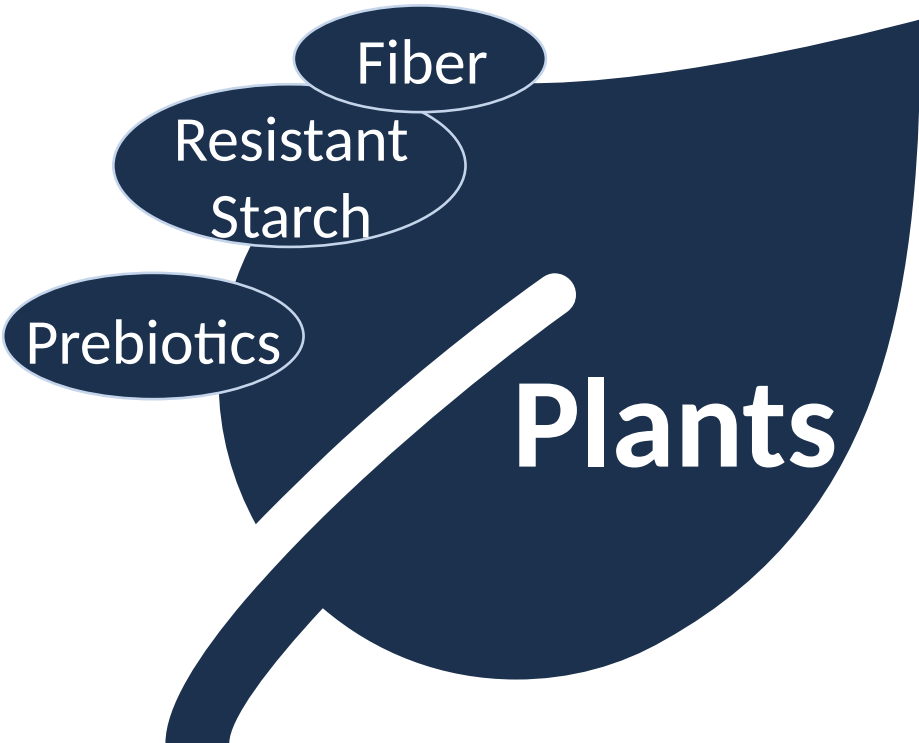


Summary & Conclusions

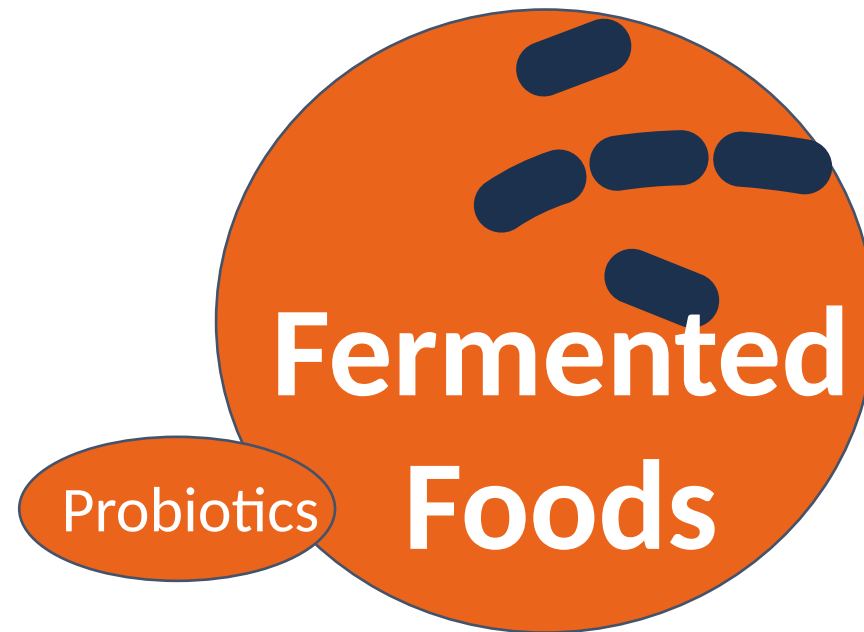


Food shapes the microbiome & gut health

Prioritize plants to provide energy for gut microbes



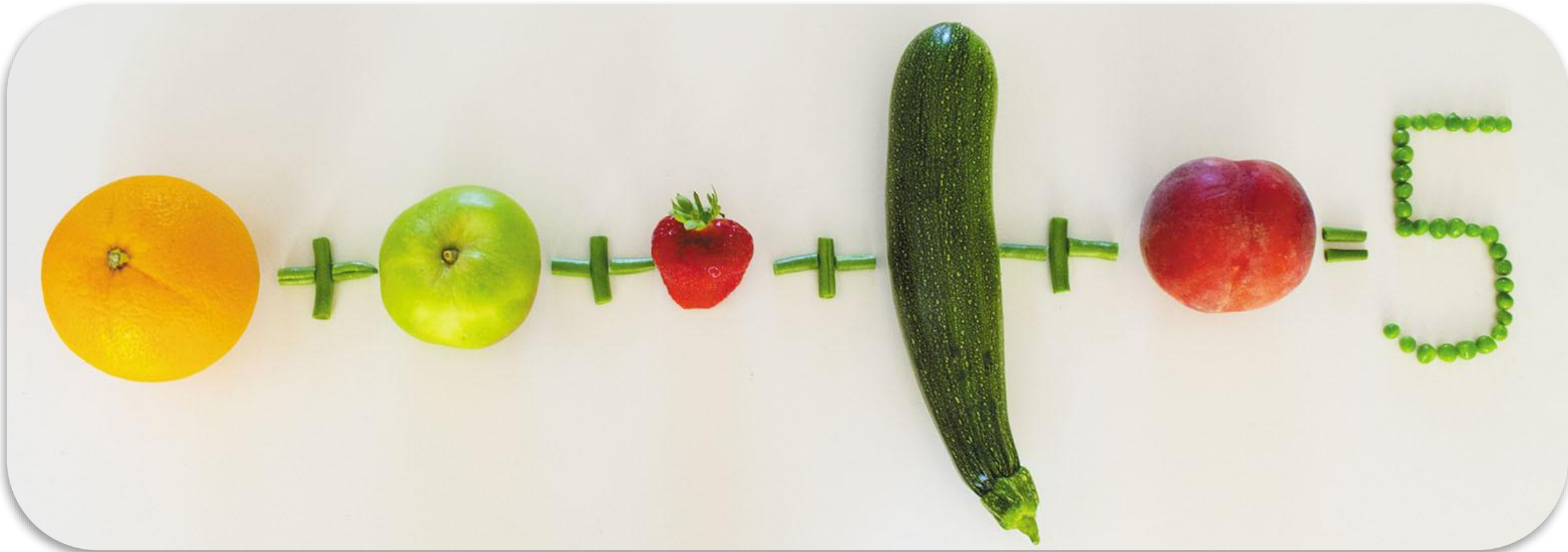
Choose fermented foods with friendly microbes and metabolites





Practical Application: Prioritize Plants

Aim for **five** a day: Eating an array of different, colorful plants supports a more **diverse gut microbiota** and health.





Practical Application: Choose Fermented Foods

- For live microbes, stick to the refrigerated aisles.
- Consider food swaps
- Explore different cultural cuisines
- For more information: International Scientific Association for Probiotics and Prebiotics (ISAPP)





Practical Application: Visual Cues & Goals

Gut Health Menu Icons



Key Takeaways

1

Gut health is vital for health and wellness.

2

Prioritize plants to provide energy for gut microbes.

3

Choose **fermented foods** with friendly microbes and metabolites.

Discussion



Nutrition & Human
Microbiome Laboratory

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