Navigating the World of Fiber: Going Beyond Soluble & Insoluble Classifications

Venus S. Kalami, MNSP, RD, CSP
Board-Certified Specialist in Pediatric Nutrition
August 8, 2024

1

DISCLOSURES

- I received an honorarium for this presentation.
- Honoraria: Nutricia, NASPGHAN, FARE, NAP NAP
- Employee: Solid Starts Inc, Niche Noosh LLC (Founder)
- Consultant for Nutricia
- Secretary/Treasurer for NASPGHAN CPNP Executive Board (Unpaid)

None pose any conflict of interest for this presentation.

The opinions reflected in this presentation are those of the speaker and independent of Nutricia North America.

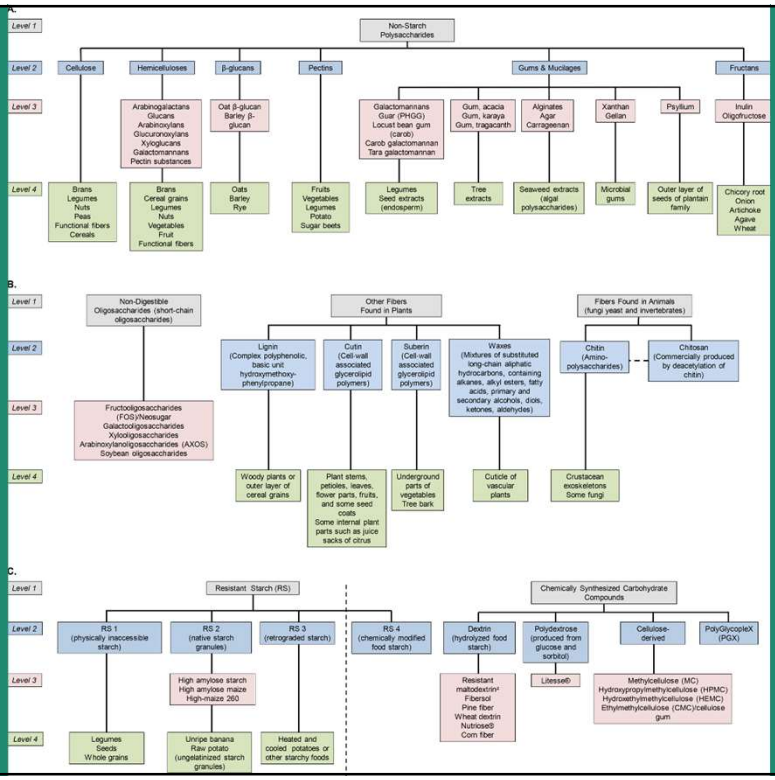
2

OBJECTIVES

- Discuss the background of fiber, its history, and classifications.
- Explain the physiological impacts of various fibers.
- Review clinical applications of various fiber classifications in patient care, including fiber in pediatric formulas.
- Distinguish between prebiotic fibers and probiotics, and their impact on the gut microbiome.

3

FIBER TYPES



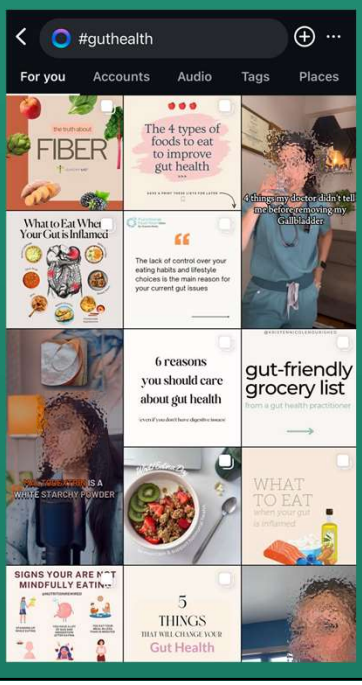
KA Livingston. PLoS ONE. 2016.

4

OBJECTIVES

- **Discuss the background of fiber, its history, and classifications.**
- Explain the physiological impacts of various fibers.
- Review clinical applications of various fiber classifications in patient care, including fiber in pediatric formulas.
- Distinguish between prebiotic fibers and probiotics, and their impact on the gut microbiome.

5

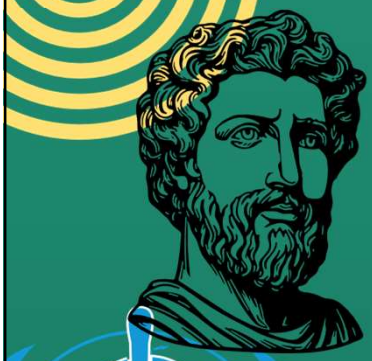


Fiber in the Wild

- Gut health has been and continues to be on trend
- Social media influencers, i.e. “gut-fluencers”
- Rise of gut-health products and functional foods
  - Prebiotic soda-like drinks
  - Protein bars with added prebiotics
  - Low sugar snacking gummies with prebiotics
  - Fiber crackers
  - And more
- Supplements: prebiotics, synbiotics, and others
- Food: fruits, vegetables, whole grains, legumes, nuts, and seeds.

6

Background & History



130 AD
- Physician Galen – foods "excite the bowels to evacuate."

1970s
- Fiber = CHO resistant to digestion with laxation-promoting properties

Decades of controversy regarding fiber definition

2009
- CODEX Alimentarius Commission & WHO developed definition

Many definitions exist to this day, often overlapping[1]

"Dietary fiber is many things to many people. It is a concept, a hypothesis, a marketer's bonanza, a unique complex of non-digestible carbohydrates, but most importantly an integral necessity of a normal functioning and healthy intestine."[2]

CHO = carbohydrate. 1. JM Jones. Nutrition Journal. 2014. 2. KA Livingston et al. PLoS ONE. 2016.

7

CODEX Alimentarius Fiber Definition

Dietary fibre = CHO polymers:[1]

- 1) with 10 or more monomeric units
- 2) which are not hydrolysed by the endogenous enzymes in the small intestine of humans and belong to the following categories:
  - Edible CHO polymers naturally occurring in the food as consumed.
  - CHO polymers, which have been obtained from food raw material by physical, enzymatic or chemical means and which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities,
  - Synthetic CHO polymers, which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities.

CHO = carbohydrate. 1. JM Jones. Nutrition Journal. 2014.

8

Visualizing Fiber

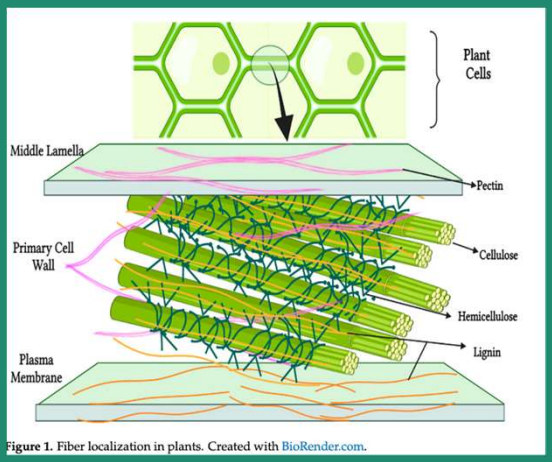


Figure 1. Fiber localization in plants. Created with BioRender.com.

KB Ionită-Mîndrican et al. Nutrients. 2022

Soluble	Insoluble
Pectin	Cellulose
Beta glucan	Hemicellulose
Galactomannan	Lignin

9

Sources of Fiber

Dietary Fiber
Intact from plant foods and crustaceans (chitin)

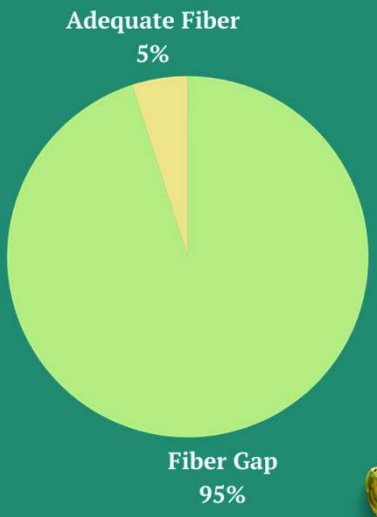
Functional Fiber
Supplemental sources (naturally and synthetically derived)

Total Fiber
Amount of fiber consumed in total

10

Fiber Consumption & The Fiber "Gap"

95%
Adults & children estimated to not consume enough fiber.[1]

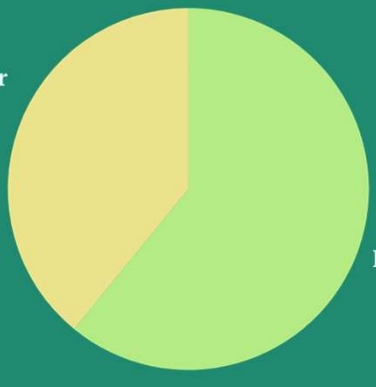


D Quagliani & P Felt-Gunderson. Am J Lifestyle Med. 2017.

11

Fiber Consumption & The Fiber "Gap"

60.9%
Children with food allergies on AAF estimated to not consume enough fiber[1]



AAF = amino acid-based formula. Robbins et al. J Allergy Clin Immunol. 2014.

12

Benefits of Fiber Consumption

Reduced risk of:

Cardiovascular diseases
(coronary heart disease, stroke, hypertension)

GI conditions
(constipation, irritable bowel syndrome, GI cancers)

Metabolic conditions
(type 2 diabetes, dyslipidemia, metabolic-dysfunction associated steatotic liver disease)

Benefits:

Cardiometabolic
(glycemic control, lipid management, blood pressure improvements)

Digestive
(increase stool bulk and softening, gut microbiome diversity, SCFA production)

Nutrition
(increased nutrient absorption; associated vitamins, minerals, phytochemicals, and antioxidants)

GI = gastrointestinal; SCFA = short-chain fatty acids

13

Fiber & Socioeconomic Status

Lower socioeconomic status
Food and nutrition security
Lower education status
Rural areas of residence

Several factors associated with low fiber intake[1-3]

Fiber = proxy for whole foods access (i.e. fruit and vegetable intake) in research

"A large body of epidemiologic data show that diet quality follows a socioeconomic gradient...If limited economic resources are causally linked to low-quality diets, some current strategies for health promotion, based on recommending high-cost foods to low-income people, may prove to be wholly ineffective."[3]

1.B Krusinka et al. Nutrients. 2017.
2.AL Mayén et al. Am J Clin Nutr. 2014.
3. N Darmon & A Drewnoski. Am J Clin Nutr. 2008.

14

Is Fiber "Essential?"

- Essential for cardiometabolic, digestive, and nutritional health.
- Not essential from a deficiency disease perspective.
- No Estimated Average Requirement (EAR) or Recommended Dietary Allowance (RDAs).
- Adequate Intake (AI) levels exist.

JB Kohn. J Acad Nutr Diet. 2016.

15

Daily Suggested Intakes for Fiber in Pediatrics

- **14 g/1000 kcal**
  Adequate Intake (AI)
- **Child's age + 5 g/day**
  American Heart Association
- **Child's age + 10 g/day**
  American Heart Association
- **19 g/1000 kcal (1-3 years)**
  Institute of Medicine
- **25 g/1000 kcal (4-8 years)**
  Institute of Medicine
- **0.5 g/kg**
  American Academy of Pediatrics

16

Fiber Intake Recommendations

Table 1

Recommendations for daily fibre intake for children

Country	Source	Year of recommendation	Daily fibre recommendation
UK	UK Scientific Advisory Committee on Nutrition[12]	2015	Age 2–5 years: 15 g/day Age 5–11 years: 20 g/day Age 11–16 years: 25 g/day Age 16–18 years: 30 g/day
EU	European Food Safety Authority[11]	2019	Age 1–3 years: 10 g/day Age 4–6 years: 14 g/day Age 7–10 years: 16 g/day Age 11–14 years: 19 g/day
USA	Williams *et al* [9]	1995	Age plus 5 g/day for those over 2 years (minimum) up to 10 g/day (maximum)
	Institute of Medicine (Institute of Medicine; Stephen *et al*)[8,10]	2005	Age 1–3 years: 19 g per 1000 kcal Age 4–8 years: 25 g per 1000 kcal

I Hojsak et al. Arch Dis Child. 2022.

17

Fiber Intake Recommendations

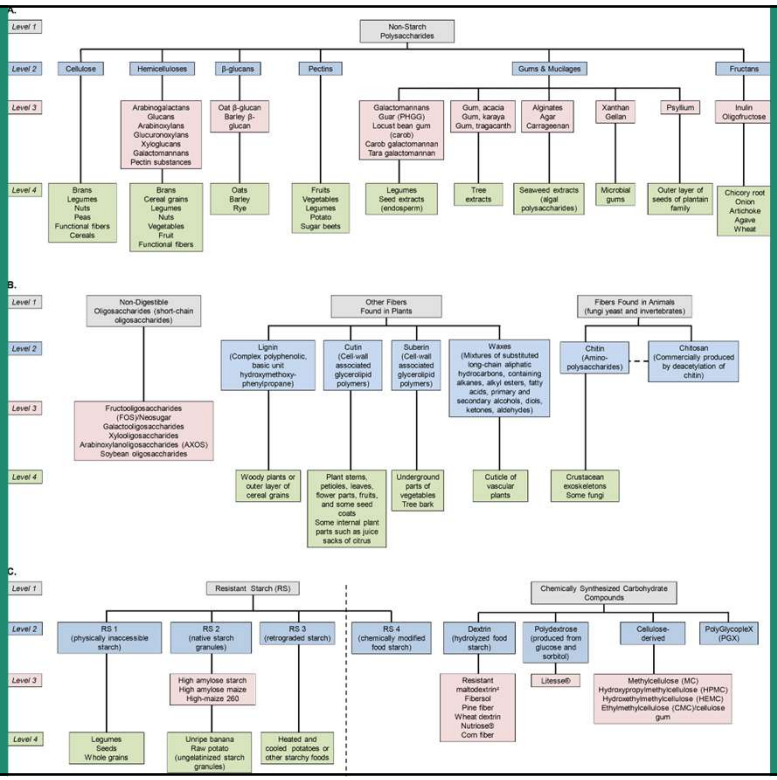
From: CODEX-aligned dietary fiber definitions help to bridge the 'fiber gap'

Country/Region		Recommended fiber intake (g/day)	Median intake (g/day)	Body issuing the requirement
US and Canada	Males	38	16.5-19.4	North America – Jointly use the IOM report from the National Academy of Sciences
	Females	25	12-15	
France	Males	30	21	*Agence française de sécurité sanitaire des aliments* (French food safety agency)
	Females	25	17	
Germany	Males	30	24	German Nutrition Society
	Females	30	21	
Japan	Males	30	17	Japanese Ministry of Health
	Females	25	17	
UK	Males	18*	15.2	UK Department of Health
	Females	18*	12.6	
FAO/WHO		>25		WHO/FAO
		>20		

JM Jones. Nutr J. 2014.

18

FIBER TYPES



KA Livingston. PLoS ONE. 2016.

19

OBJECTIVES

- Discuss the background of fiber, its history, and classifications.
- **Explain the physiological impacts of various fibers.**
- Review clinical applications of various fiber classifications in patient care, including fiber in pediatric formulas.
- Distinguish between prebiotic fibers and probiotics, and their impact on the gut microbiome.

20

Physicochemical Characteristics of Fiber:
Going Beyond Soluble and Insoluble Classifications

Solubility
Soluble vs. Insoluble

Viscosity
Water-holding capacity, viscous, non-viscous, degree of viscosity

Fermentability
Prebiotic capacity, fermentable, non-fermentable, degree of fermentability

Bulking
Large and coarse particles, aid laxation

SK Gill et al. Nat Rev Gastroenterol Hepatol. 2021.

21

Types of Fiber:

1.Insoluble, Non-Viscous, Non-Fermentable, Bulking

"Plastic Effect"
- Due to large and coarse particles

Stool Bulking
- Due to large and coarse particles
- Ex: cellulose in kale

Laxation
- Due to mechanical irritation & stimulation + intestinal lubrication
- Faster transit
- Stool bulking

JW McRorie & NM McKeown. J Acad Nutr Diet. 2017.

22

Types of Fiber:

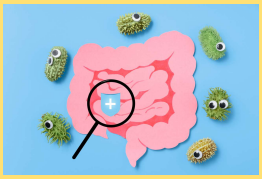
2. Soluble, Non-Viscous, Fermentable, Non-Bulking

Dissolves in Water

- No gel formation (non-viscous)

Rapidly Ferments

- Produces gas and SCFAs
- Energy uptake from SCFAs
- "Prebiotics" like GOS, FOS, and inulin



Microbiome Shifts

- Due to prebiotic nature of fiber
- Minimal impact on laxation

SCFA = short-chain fatty acids. JW McRorie & NM McKeown. J Acad Nutr Diet. 2017.

23

Types of Fiber:

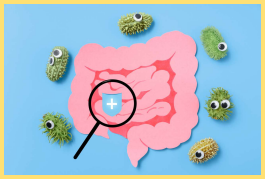
3. Soluble, Viscous, Fermentable, Non-Bulking

Dissolves in Water & Forms Gel

- Gel formation due to viscosity

Increased Chyme Viscosity

- Slowed nutrient absorption
- Better glycemic control
- Lowered serum cholesterol
- Ex: pectin, galactomannan



Readily Fermented

- Due to prebiotic nature
- SCFA production
- Minimal impact on laxation
- Gel structure broken down

JW McRorie & NM McKeown. J Acad Nutr Diet. 2017.

24

Types of Fiber:

4. Soluble, Viscous, Non-Fermentable, Bulking

Dissolves in Water & Forms Gel

- Gel formation due to viscosity

Increased Chyme Viscosity

- Slowed nutrient absorption
- Better glycemic control
- Lowered serum cholesterol

Dichotomous Stool Normalizing Effect

- Softens hard stool due to fluid retention
- Forms up liquid stool due to gelling capacity
- Gel structure retained

JW McRorie & NM McKeown. J Acad Nutr Diet. 2017.

25

Summary of Various Fates of Fiber

Decreased glucose & lipid absorption rate
Due to solubility and viscosity

Immunomodulation & hepatic cross-talk
Due to prebiotics and SCFA production

Support tight junction integrity
Due to SCFAs

Decreased bile acid reabsorption
Due to solubility and viscosity

Laxation
Due to water binding, stool bulking, and increased colonic muscular contractions

Inhibition of pathogens
Due to beneficial microbial growth, SCFAs, decreased colonic pH

SCFAs = short-chain fatty acids. SK Gill et al. Nat Rev Gastroenterol Hepatol. 2021.

26

Fiber Types

TABLE Clinically Demonstrated Health Benefits Associated With Common Fiber Supplements

	No Water-Holding Capacity			Water-Holding Capacity			
	Insoluble	Soluble, Nonviscous		Soluble Viscous	Soluble Viscous/Gel Forming		
	Wheat Bran	Wheat Dextrin	Inulin	Methylcellulose	Partially Hydrolyzed Guar Gum	β-Glucan	Psyllium
Source	Wheat	Heat/acid treated wheat	Chicory root	Chemically treated wood pulp	Guar beans	Oats, barley	Seed husk, *Plantago ovata*
Degree of fermentation	Poorly fermented	Readily fermented	Readily fermented	Nonfermented	Readily fermented	Readily fermented	Nonfermented
Cholesterol lowering					+/−[a]	+[b]	+
Improved glycemic control					+/−[a]	+[b]	+
Satiety						+[b]	+
Weight loss							+/−[c]
Constipation/ stool softener	+[d]			+/−[e]			+
Diarrhea/stool normalizer							+
Irritable bowel syndrome							+[f]

JW McRorie & NM McKeown. J Acad Nutr Diet. 2017.

27

Fiber Types

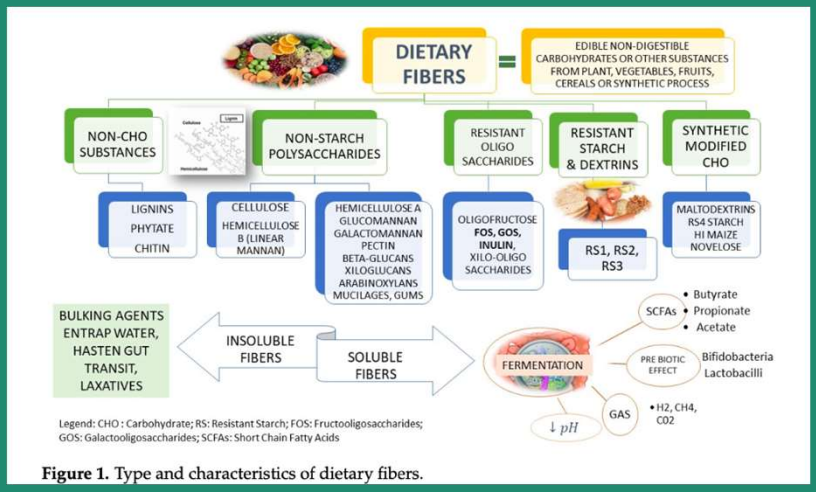


Figure 1. Type and characteristics of dietary fibers.

S Salvatore et al. Nutrient. 2023.

28

OBJECTIVES

- Discuss the background of fiber, its history, and classifications.
- Explain the physiological impacts of various fibers.
- **Review clinical applications of various fiber classifications in patient care, including fiber in pediatric formulas.**
- Distinguish between prebiotic fibers and probiotics, and their impact on the gut microbiome.

29

Fiber & Pediatric Medical Conditions

- **Constipation**
- **Dyslipidemia**
- **Irritable Bowel Syndrome** (Constipation, diarrhea, and mixed type)
- **Glycemic Control**
- **Inflammatory Bowel Disease**
- **Short Bowel Syndrome**

30

Constipation & Fiber

Most children under-consuming fiber-rich foods

Prevalence of constipation in pediatrics as high as 30% worldwide[1]

Supplements can help, but type matters

3 main mechanisms for constipation relief via fiber:

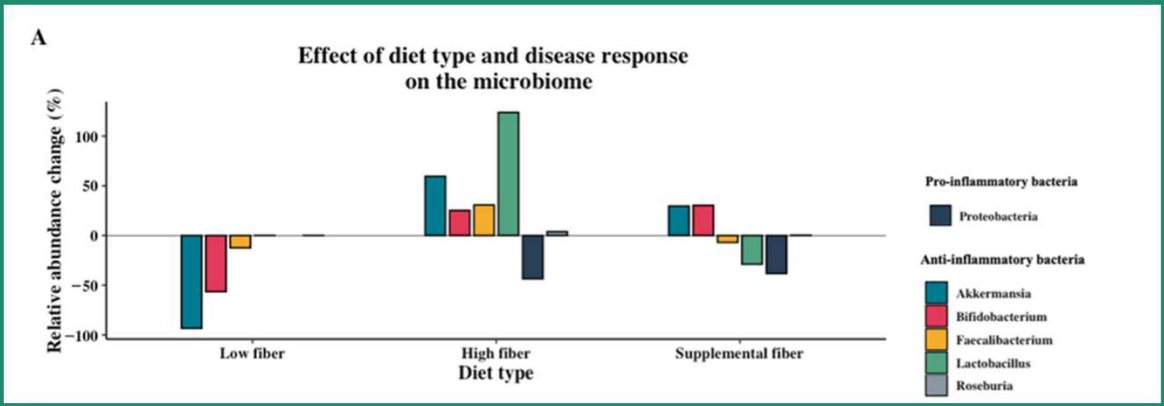
- Mechanical stimulation + irritation of colonic mucosa
- Gel-dependent, viscous, water-holding capacity
- Osmotic effect with highly fermentable fibers

Most supplements are soluble, non-viscous, readily fermentable, non-bulking (i.e. inulin, pectins, dextrins).

E Mulhem et al. Am Fam Physician. 2022.

31

Fiber: Food vs Supplement?



CA Wagenaar et al. Nutrients. 2021.

32

Fiber: Food vs. Supplement?

- Right fit
- Right patient
- Right time

- Access
- Feasibility
- Bandwidth

33

Case Study

- Pre-adolescent patient
- History of constipation, EoE, food allergies
- Referred to GI and nutrition
- Autism, sensory/textural aversions, limited diet
- How to support?

EoE = eosinophilic esophagitis

34

Fiber in Formula

- Type of Fiber
- Fluids
- Ramp Up
- Troubleshooting Intolerance

35

OBJECTIVES

- Discuss the background of fiber, its history, and classifications.
- Explain the physiological impacts of various fibers.
- Review clinical applications of various fiber classifications in patient care, including fiber in pediatric formulas.
- Distinguish between prebiotics fibers and probiotics, and their impact on the gut microbiome.

36

What are Prebiotics?

TABLE 4

Regulatory prebiotic definitions worldwide[1]

Regulatory body	Prebiotic regulatory status or definition
FDA[2]	"Complementary and alternative medicine products" are subject to FDA regulation. Prebiotics are included in the "biologically-based" group of foods, under the Center for Complementary and Integrative Health (a subset of NIH), using the 1995 definition. Manufacturers can also self-affirm GRAS status for products labeled as prebiotics (19).
EFSA[2]	FAO definition, "a nonviable food component that confers a health benefit on the host associated with modulation of the microbiota" (5, 20)
Health Canada	The phrase "prebiotic" is only allowed for products that satisfy the requirement for an approved health claim. The phrase "prebiotic" on labels is regulated as an implied health claim (Canada Food Inspection Agency).
Japan (FOSHU)	"Prebiotic" not used, but rather "foods to modify gastrointestinal conditions."[3]
Costa Rica (RTCA)	A prebiotic substance must: be preferred by ≥1 species of beneficial bacteria in the large intestine or colon, be resistant to gastric acids, be fermentable by intestinal microflora, be resistant to endogenous enzymatic hydrolysis, stimulate selectively the growth and/or activity of those bacteria that are associated with health and wellness.[4]
Colombia	A prebiotic substance must: be a preferred substance by ≥1 species of beneficial bacteria in the large intestine or colon, be resistant to gastric acids, be fermentable by the intestinal microflora, be resistant to endogenous enzymatic hydrolysis, have the ability to produce changes in the lumen of the large intestine or in the host organism showing health benefits, selectively stimulate the growth and/or activity of those bacteria that are associated with health and wellness.[4]

1. Hojsak et al. Arch Dis Child. 2022. 2. Carlson et al. Curr Dev Nutr. 2018.

37

What are Prebiotics?

The evolution of the changes in the scientific definitions of "prebiotic"[1]

Year	Definition	Reference
1995	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 and Roberfroid (1)
2003	Nondigestible substances that provide a beneficial physiologic effect on the host by selectively stimulating the favorable growth or activity of a limited number of indigenous bacteria.	Reid et al. (2) Inaugural ISAPP Meeting
2004	A selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal microflora that confers benefits upon host well-being and health.	Gibson et al. (3)
2007	A selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal microflora, that confer benefits upon host well-being and health.	Roberfroid (4) IDF/FAO Meeting
2008	A nonviable food component that confers a health benefit on the host associated with the modulation of the microbiota.	FAO Technical Meeting (5) (2007)
2010	A selectively fermented ingredient that results in specific changes in the composition and/or activity of the gastrointestinal microbiota, thus conferring benefits upon host health.	Gibson et al. (6) ISAPP 6th Annual Meeting
2015	A nondigestible compound that, through its metabolization by	Bindels et al. (7)

Open in a separate window

[1]IDF, International Dairy Federation; ISAPP, International Scientific Association for Prebiotics and Probiotics.

1. Hojsak et al. Arch Dis Child. 2022. 2. Carlson et al. Curr Dev Nutr. 2018.

38

Defining Terms

Prebiotic
Substrate that is selectively utilized by host microorganisms conferring a health benefit on the host.

Probiotics
Live microorganisms that when administered in adequate amounts, confer a health benefit on the host.

Synbiotics
Mix of live microorganisms and substrate(s) selectively utilized by host microorganisms that confers a health benefit on the host.

Gut Microbiota
All microbes inhabiting the gut (who).

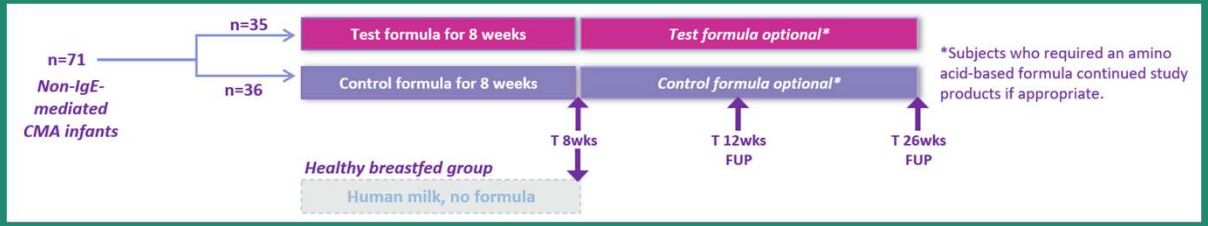
Gut Microbiome
Genome of the microbiota (what they do).

Gut Dysbiosis
Disrupted, unbalanced state of the microbiome (what is wrong).

39

Synbiotics in Formula

- Double-blind, randomized, controlled multicenter trial
- Investigated change in fecal microbiota in infants with non-IgE-CMA
- Tested AAF with added synbiotics (scFOS/lcFOS + *Bifidobacterium breve* M-16V) vs. control on AAF without synbiotics
- Healthy breastfed reference group (51 subjects)
- Formula provided for 8 weeks, option for up to 26 weeks
- Fecal testing took place at 0, 8, 12, and 26 weeks



CMA = cow milk allergy; AAF = amino acid-based formula. Fox et al. Clin Transl Allergy. 2019.

40

Synbiotics in Formula

- By week 26:
  - 71% test, 80% control continued study formula
  - Median % bifidobacteria higher in test [47.0% vs 11.8% (p<0.001)]
  - % *Eubacterium rectale/Clostridium coccoides* (ER/CC) lower in test [13.7% vs 23.6% (p=0.003)]
  - Less reports of dermatological medication use (p=0.019) and ear infections (p=0.011)

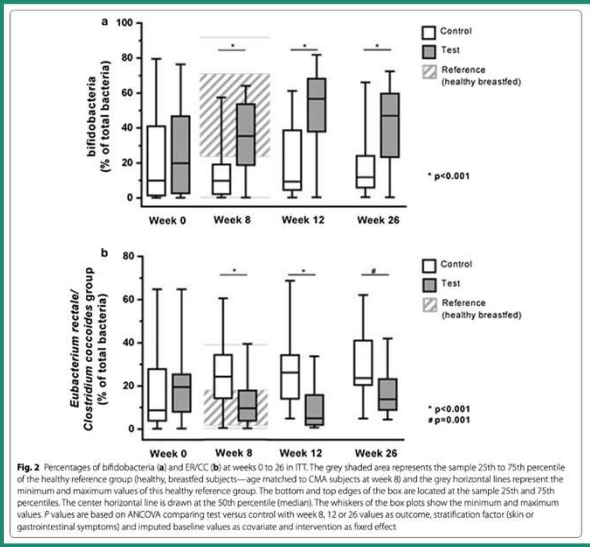
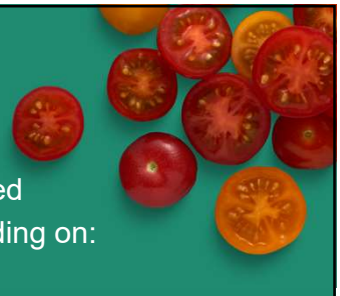


Fig. 2 Percentages of bifidobacteria (**a**) and ER/CC (**b**) at weeks 0 to 26 in ITT. The grey shaded area represents the sample 25th to 75th percentile of the healthy reference group (healthy, breastfed subjects—age matched to CMA subjects at week 8) and the grey horizontal lines represent the minimum and maximum values of this healthy reference group. The bottom and top edges of the box are located at the sample 25th and 75th percentiles. The center horizontal line is drawn at the 50th percentile (median). The whiskers of the box plots show the minimum and maximum values. *P* values are based on ANCOVA comparing test versus control with week 8, 12 or 26 values as outcome, stratification factor (skin or gastrointestinal symptoms) and imputed baseline values as covariate and intervention as fixed effect

Fox et al. Clin Transl Allergy. 2019.

41

Summary



- Fiber is characterized by its inability to be digested or absorbed
- Many types of fiber, qualities, and health benefits vary depending on:
  - ✓ solubility
  - ✓ viscosity
  - ✓ fermentability
  - ✓ bulking effects
- Important roles across body systems
- Fiber from food, more impactful on gut microbiome basis
- With supplements, form = function
- Access to fiber-rich foods and supplements determined by SES
- Fibers in formula often prebiotic form
- Synbiotics are an emerging area in gut microbiome and immunology research

SES = socioeconomic status

42

References

Darmon N, Drewnowski A. Does social class predict diet quality?. Am J Clin Nutr. 2008;87(5):1107-1117. doi:10.1093/ajcn/87.5.1107

Fox AT, Wopereis H, Van Ampting MTJ, et al. A specific synbiotic-containing amino acid-based formula in dietary management of cow's milk allergy: a randomized controlled trial. Clin Transl Allergy. 2019;9:5. Published 2019 Jan 15. doi:10.1186/s13601-019-0241-3

Gill SK, Rossi M, Bajka B, Whelan K. Dietary fibre in gastrointestinal health and disease. Nat Rev Gastroenterol Hepatol. 2021;18(2):101-116. doi:10.1038/s41575-020-00375-4

Hojsak, I., Benninga, M. A., Hauser, B., Kansu, A., Kelly, V. B., Stephen, A. M., Morais Lopez, A., Slavin, J., & Tuohy, K. (2022). Benefits of dietary fibre for children in health and disease. Archives of disease in childhood, 107(11), 973–979. https://doi.org/10.1136/archdischild-2021-323571

Holmes E, Li JV, Marchesi JR, Nicholson JK. Gut microbiota composition and activity in relation to host metabolic phenotype and disease risk. Cell Metab. 2012;16(5):559-564. doi:10.1016/j.cmet.2012.10.007

Ioniță-Mîndrican, C. B., Ziani, K., Mititelu, M., Oprea, E., Neacșu, S. M., Moroșan, E., Dumitrescu, D. E., Roșca, A. C., Drăgănescu, D., & Negrei, C. (2022). Therapeutic Benefits and Dietary Restrictions of Fiber Intake: A State of the Art Review. Nutrients, 14(13), 2641. https://doi.org/10.3390/nu14132641

Jones, Julie Miller. "CODEX-Aligned Dietary Fiber Definitions Help to Bridge the 'Fiber Gap.'" Nutrition Journal 13, no. 1 (December 2014): 34.https://doi.org/10.1186/1475-2891-13-34.

Kohn JB. Is Dietary Fiber Considered an Essential Nutrient?. J Acad Nutr Diet. 2016;116(2):360. doi:10.1016/j.jand.2015.12.004

Korczak, Renee, Alison Kamil, Lisa Fleige, Sharon M. Donovan, and Joanne L. Slavin. "Dietary Fiber and Digestive Health in Children." Nutrition Reviews 75, no. 4 (April 2017): 241–59. https://doi.org/10.1093/nutrit/nuw068.

Krusinska, B., Kowalkowska, J., Wadolowska, L., Wuenstel, J. W., Slowinska, M. A., & Niedzwiedzka, E. (2017). Fibre-Related Dietary Patterns: Socioeconomic Barriers to Adequate Fibre Intake in Polish Adolescents. A Short Report. Nutrients, 9(6), 590. https://doi.org/10.3390/nu9060590

43

References

Livingston, Kara A., Mei Chung, Caleigh M. Sawicki, Barbara J. Lyle, Ding Ding Wang, Susan B. Roberts, and Nicola M. McKeown. "Development of a Publicly Available, Comprehensive Database of Fiber and Health Outcomes: Rationale and Methods." Edited by Lamberto Manzoli. PLOS ONE 11, no. 6 (June 27, 2016): e0156961. https://doi.org/10.1371/journal.pone.0156961.

Mayén AL, Marques-Vidal P, Paccaud F, Bovet P, Stringhini S. Socioeconomic determinants of dietary patterns in low- and middle-income countries: a systematic review. Am J Clin Nutr. 2014;100(6):1520-1531. doi:10.3945/ajcn.114.089029

McRorie, Johnson W., and Nicola M. McKeown. "Understanding the Physics of Functional Fibers in the Gastrointestinal Tract: An Evidence-Based Approach to Resolving Enduring Misconceptions about Insoluble and Soluble Fiber." Journal of the Academy of Nutrition and Dietetics 117, no. 2 (February 2017): 251–64. https://doi.org/10.1016/j.jand.2016.09.021.

Mulhem E, Khondoker F, Kandiah S. Constipation in Children and Adolescents: Evaluation and Treatment. Am Fam Physician. 2022;105(5):469-478.

Pourabedin M, Zhao X. Prebiotics and gut microbiota in chickens. FEMS Microbiol Lett. 2015;362(15):fnv122. doi:10.1093/femsle/fnv122

Quagliani, Diane, and Patricia Felt-Gunderson. "Closing America's Fiber Intake Gap: Communication Strategies From a Food and Fiber Summit." American Journal of Lifestyle Medicine 11, no. 1 (2017): 6.

Salvatore, S., Battigaglia, M. S., Murone, E., Dozio, E., Pensabene, L., & Agosti, M. (2023). Dietary Fibers in Healthy Children and in Pediatric Gastrointestinal Disorders: A Practical Guide. Nutrients, 15(9), 2208. https://doi.org/10.3390/nu15092208

Robbins KA, Guerrerio AL, Hauck SA, et al. Growth and nutrition in children with food allergy requiring amino acid-based nutritional formulas. J Allergy Clin Immunol. 2014;134(6):1463-1466.e5. doi:10.1016/j.jaci.2014.08.053

Wagenaar CA, van de Put M, Bisschops M, et al. The Effect of Dietary Interventions on Chronic Inflammatory Diseases in Relation to the Microbiome: A Systematic Review. Nutrients. 2021;13(9):3208. Published 2021 Sep 15. doi:10.3390/nu13093208

44

How to obtain your certificate of attendance

1. Please provide feedback through the survey:

Aim your smartphone camera at this → QR code

OR
access the survey at:
surveymonkey.com/r/navigatingfiberrec

2. To receive your certificate of attendance:

Detailed instructions on how to obtain your certificate are included at the end of the above survey.

For questions about this webinar, please email: NutritionServices@nutricia.com or call: **1-800-365-7354**

45

Let's Connect!

venuskalamird.com

vkalami@gmail.com

linkedin.com/in/venuskalami

46