

A Practical Guide to Understanding Prebiotics



WHAT ARE PREBIOTICS?

Prebiotics are dietary substances resistant to digestion and selectively fermented in the large intestines to promote specific changes in the composition and activity of beneficial gastrointestinal microflora^{1,2}. Oligosaccharide prebiotics in particular, can stimulate the growth of *Lactobacillus* and *Bifidobacterium*³, which have been associated with the health and well-being of the host¹⁻³.

What types of prebiotics are available?

Common prebiotics (non-digestible carbohydrates) can be grouped into the categories listed^{1,4}

- 1** Human milk oligosaccharides (HMO)
- 2** Lactulose
- 3** Galacto-oligosaccharides (GOS)
- 4** Inulin-type prebiotics or inulin-type fructans
 - which includes inulin, fructo-oligosaccharides (FOS) and oligofructose (OF)
 - Inulin-type prebiotics are members of a larger group called ‘fructans’. Fructans are primarily polymers of fructose units, with a specific bonding profile between the sugars²
 - These prebiotics can be broken down into broad subgroups based on degree of polymerization².

Please refer to the table below ^{1,2,4,12}

Type	Natural food source	Manufacture method	Degree of polymerization	Usage in food products
HMO	Human milk ⁵	A large variety found in human milk, complex to mimic ⁶	Large structural diversity ⁷	Addition to infant formula being explored ⁵
Lactulose	Only formed during heat treatment by isomerization of lactose ⁸	Polymerizing one unit of fructose with one unit of galactose ¹	Disaccharide ¹	Used as a drug for treatment of constipation and hepatic encephalopathy ¹
GOS	Produced from lactose ⁹	Enzymatic transgalactosylation of lactose ⁷	2–8 ^{4,7}	Added in milk formula and infant foods, beverages, meal replacers, fermented milks, and confectionery products ¹⁰
Inulin-type prebiotics	Naturally in plants such as root vegetables including burdock, chicory, leeks, onions ¹	Extraction from chicory roots, contains FOS molecules ^{11,12}	11-65 ¹¹	Added in milk formula and infant foods, beverages, yogurts, biscuits, dietary supplements ⁹
		Enzymatic synthesis from sucrose ²	2-6 ^{4,7}	
		Enzymatic synthesis from sucrose ²	7-60 (average 25) ^{4,7}	
		Enzymatic partial hydrolysis of inulin ^{1,2}	< 10 (average 4) ²	

Please note the above table was collated from different authors who defined types of prebiotics, however terms are not universal and uses have been inconsistent across papers.



The metabolism of prebiotics⁴:

- Non-digestible carbohydrates are fermented in the colon to short chain fatty acids (SCFA – mainly acetate, propionate and butyrate), metabolites and gases such as hydrogen and carbon dioxide
- Beneficial effects can be related to the **metabolism of Bifidobacteria**, with their end products from fermentation:
 - > Bifidobacteria have the capacity to produce vitamins and antioxidants
 - > SCFA reduces the gastrointestinal pH to **suppress the growth of pathogens, consequently supporting immunity**, while also contributing energy

Prebiotic effects and potential health benefits:

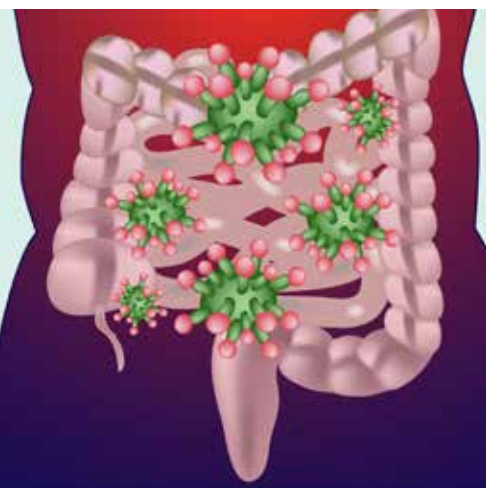
Supplementation in infant formula was associated with:

- Change of gut microbiota profile, especially increasing fecal concentration of Bifidobacteria⁴
- Improved stool quality and frequency^{4,13}
- Reduced risk of gastro-enteritis⁴
- Reduced risk of certain allergic reactions and types of infections, as suggested by preliminary data^{4,13}

Intake in adults was associated with:

- Ability to modulate certain immunological biomarkers, affecting immune activities⁴
- Improved pathogenesis of irritable bowel disease (IBD) with changes in gut microbiota composition⁴
- Reduction in colon cancer risk and increased calcium absorption, as suggested by preliminary evidence^{1,4}

There should be further studies to help confirm the health benefits listed above and the relevant clinical significance^{4,13}.



How much prebiotics do we need?

- Individual response to an identical dose of prebiotics can be variable. It is suggested **bifidogenic effects may be influenced by the existing gut flora**². For example, the growth of a strain of bacteria that was previously present in a low number might be greater after supplementation, than if it was present in a high number.
- There is currently no consensus on a recommended intake for prebiotics, however there is some evidence suggesting a **minimum dose of 2.5 g inulin-type prebiotics daily is needed to produce a bifidogenic effect in adults**, with a dose-response relationship up to 10 g per day².
- For infants, recommendations on dosages are currently unavailable, but existing scientific research suggests **administration of prebiotic-supplemented formula to healthy infants does not raise safety concerns** in terms of growth and adverse effects¹³.

References: 1. Guarner F et al. World Gastroenterology Organisation global guidelines: probiotics and prebiotics October 2011. *J Clin Gastroenterol.* 2012;46(6):468-481. 2. Kelly G. Inulin Type Prebiotics – A Review: Part 1. *Altern Med Rev.* 2008;13(4):315-329. 3. Shoaf K et al. Prebiotic galactooligosaccharides reduce adherence of enteropathogenic Escherichia coli to tissue culture cells. *Infect Immun.* 2006;74(12):6920-6928. 4. Roberfroid M et al. Prebiotic effects: metabolic and health benefits. *Br J Nutr.* 2010;104(S2):S1-63. 5. Moreno FJ and Sanz ML. Food oligosaccharides: Production, analysis and bioactivity. New York: John Wiley & Sons; 2014. 6. Arslanoglu S. Early dietary intervention with a mixture of prebiotic oligosaccharides reduces the incidence of allergic manifestations and infections during the first two years of life. *J Nutr.* 2008;138(6):1091-1095. 7. Boehm G and Moro G. Structure and functional aspects of prebiotics used in infant nutrition. *J Nutr.* 2008;138(9):1818S-1828S. 8. Luzzana M et al. Milk lactose and lactulose determination by the differential pH technique. *Le Lait.* 2003;83:409-416. 9. Nitiynen L et al. Galacto-oligosaccharides and bowel function. *Scand J Food Nutr.* 2007;51(2):62-66. 10. Torres D et al. Galactooligosaccharides: Production, properties, applications and significance as prebiotics. *Compr Rev Food Sci F.* 2010;9:438-454. 11. Macfarlane S et al. Review article: prebiotics in the gastrointestinal tract. *Aliment Pharmacol Ther.* 2006;24(5):701-714. 12. Thomas DW et al. Probiotics and prebiotics in pediatrics. *Pediatrics.* 2010;126(6):1217-1231. 13. Braegger C et al. Supplementation of infant formula with probiotics and/or prebiotics: A systematic review and comment by the ESPGHAN Committee on Nutrition. *J Pediatr Gastroenterol Nutr.* 2011;52(2):238-250.