

WHITEPAPER

PREBIOTICS: GOS AND FOS

Prebiotic: A non-digestible carbohydrate (primarily oligosaccharides) is metabolized by microorganisms in the gut, modulates composition and/or activity of the gut microbiota, thus having a beneficial physiological effect on the host ¹.



What are prebiotics?

Prebiotics are not digested in the small intestine, and thus reach the large intestine intact. Prebiotics are (selectively) utilized by beneficial bacteria in the large intestine. Thereby, short-chain fatty acids, such as butyrate and propionate, and lactate are produced. Which have multiple beneficial effects like supporting growth of good bacteria such as the *Bifidobacteria* and inhibit the growth of pathogens ¹⁻³.

Oligosaccharides are carbohydrates made up of 3 to 10 simple sugars (monosaccharides).

Human milk

Carbohydrates are one of the main components found in milk. The major carbohydrate in human milk is lactose, but human milk also contains high amounts of more complex carbohydrates named human milk oligosaccharides (*hMOS*). Human milk contains a high diversity of these complex oligosaccharides. The total content of oligosaccharides in human milk is around 5 – 15 g/L ^{4, 5}. *hMOS* are not digested in the small intestine, that is why oligosaccharides are also called prebiotics. By promoting the growth of the beneficial bacteria, the growth of pathogens will be inhibited, resulting in a well-balanced intestinal microbiota that helps the gut and immune system of the infant to develop in a healthy way. The prebiotic oligosaccharides in human milk can strengthen the gut barrier functioning and protect against pathogens and development of inflammatory, atopic and autoimmune diseases ⁶⁻⁸.

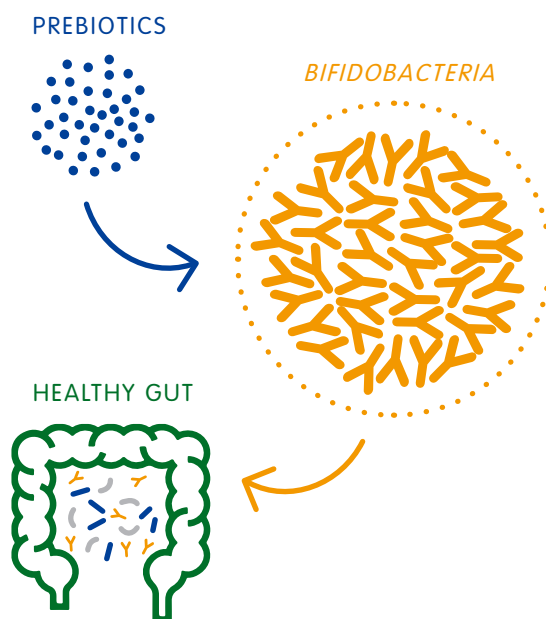


Figure 1 The *Bifidobacteria* in the gut ferment the prebiotics, resulting in growth of the beneficial bacteria and thus in a well-balanced gut microbiota ².

Prebiotics: effect on the gut microbiota

From the moment of birth, the infant's gut microbiota will develop extensively. The maturation of the digestive and immune system depends heavily on a well-balanced gut microbiota ⁹. When prebiotics are consumed in early life, this might result in a more healthy gut and immune system in infants ¹⁰. An imbalance in gut microbiota might lead to disorders including allergy, autoimmune diseases, food intolerance, irritable bowel syndrome, and in the long-term obesity and diabetes ¹¹⁻¹⁴. Moreover, the gut microbiota is associated with psychological well-being and behavior, including mood and stress response ¹⁵.

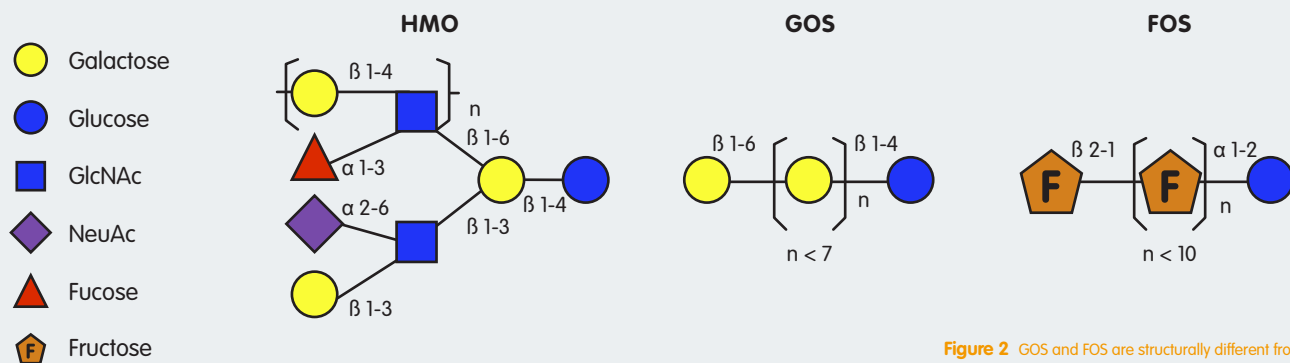


Figure 2 GOS and FOS are structurally different from hMOS.

GOS = GALACTO-OLIGOSACCHARIDES
FOS = FRUCTO-OLIGOSACCHARIDES

Prebiotics in infant formula

As human milk is the golden standard, prebiotic oligosaccharides are often added to infant formula to substitute some functions of the human milk oligosaccharides (hMOS) 10. Due to the complexity of hMOS it is challenging to produce hMOS-like structures. To resemble some functions of the hMOS, Galacto-oligosaccharides (GOS) and Fructo-oligosaccharides (FOS) are developed and currently the most common prebiotics used in infant formula. A specific mixture of prebiotic GOS/FOS in the ratio of 9:1 has been studied most extensively and might have various health benefits for the infant 3, 10, like:

- Promote the growth of beneficial microbiota (like *Bifidobacteria*)
- Lower the growth of pathogenic bacteria
- Improve stool consistency and frequency
- Improve some immune markers

GOS is an oligosaccharide offering prebiotic effects to the infants. GOS can support the growth of *Bifidobacteria* in the large intestine, which is the dominant beneficial bacterial strain found in the microbiota of breastfed infants 16, 17. Furthermore, it can reduce the growth of pathogens and help achieve a gut microbiota closer to that of breastfed infants. In several studies GOS was shown to maintain comfort in infants and showed beneficial effects on both stool consistency and frequency and the development of some immune markers 18-20. GOS is derived from lactose.

FOS is also known for its prebiotic effects and can stimulate the growth of *Bifidobacteria* 21-26. Infants who have been fed infant formula with added FOS have shown to have softer stools 22, 23. FOS can be extracted from sources like chicory roots.

There are indications that prebiotics, like GOS and FOS, may also be effective in decreasing the rate and duration of several infections in infants 27-30.

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"A well-balanced intestinal microbiota supports a more healthy gut and immune system development in infants."

Mixture of GOS/FOS (ratio 9:1): The mix of short-chain GOS and long-chain FOS in the specific ratio of 9:1 has demonstrated clinical gut and immunity benefits. This ratio was used to mimic the molecular size distribution of neutral oligosaccharides in human milk 3, 11, 31.

To offer formula-fed infants the benefits of hMOS, a mixture of oligosaccharides should be given. For this reason, Ausnutria also has the ingredient 2'-fucosyllactose (2'-FL) available besides GOS and/or FOS. If you would like to learn more about 2'-FL, please read the 2'-FL whitepaper.

Currently other single hMOS-like structures and mixtures to more resemble human milk in the future are being developed at a fast pace.



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