# Technical Bulletin
## Human Milk Oligosaccharides (HMOs)

### HMOs Overview

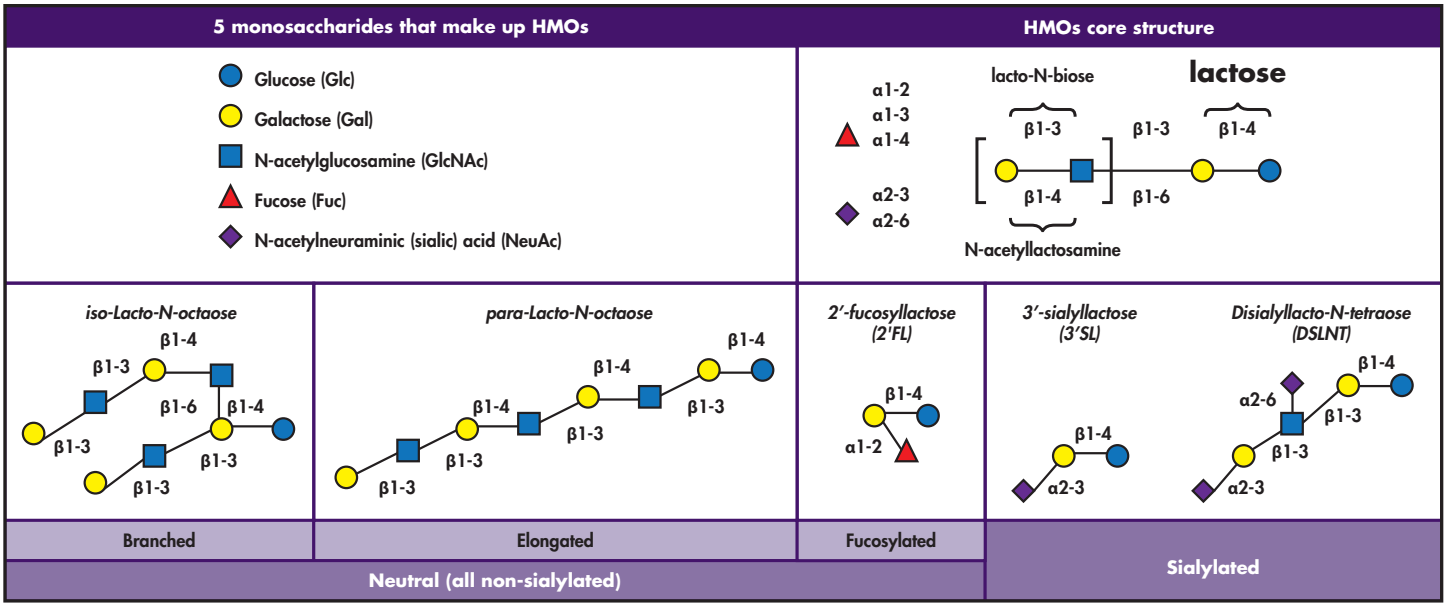
Human milk contains many diverse and naturally occurring bioactive substances, including human milk oligosaccharides (HMOs). HMOs were discovered as a prebiotic "bifidus factor" that serves as a metabolic substrate for *Bifidobacterium* spp. and shapes intestinal microbiota composition, with health benefits for the breast-fed neonate.[1] In modulating the microbiome, HMOs counteract dysbiosis in the infant's intestine, which leads to the prevention of coinciding diseases.

Approximately 200 different HMOs with unique structures have been identified to date.[2] Human milk contains higher amounts and more complex structures of soluble oligosaccharides than any other mammalian milk.[3]

HMOs are a family of structurally diverse sugars that are highly abundant in and unique to human milk. They constitute the third-most-abundant component in human milk, following lactose and lipids.[4] HMOs are more abundant than protein in human milk.[5]

HMOs can be made up of a combination of 5 monosaccharides: glucose (Glc), galactose (Gal), N-acetylglucosamine (GlcNAc), fucose (Fuc), and sialic acid (Sia). For all HMOs, the structural backbone is lactose, a disaccharide consisting of glucose and galactose. Lactose can be elongated by the addition of either lacto-N-biose or N-acetyl-lactosamine, which are disaccharide units consisting of Gal and GlcNAc. The monosaccharide fucose or sialic acid can be added to lactose or to the elongated oligosaccharide chain. All HMOs containing sialic acid are known as sialylated (acidic) HMOs, and all others are known as neutral HMOs.[1]

### Figure 1: HMOs Structure Combinations




Note. Modified from Bode L. Human milk oligosaccharides: every baby needs a sugar mama. Glycobiology. 2012;22(9):1147-1162. doi:10.1093/glycob/cws074

The structural complexity of HMOs encountered in human milk, particularly the larger HMOs, makes them extremely difficult to synthesize. As human milk is ingested, HMOs pass through the stomach and the small intestine intact, landing in the large intestine (where a significant percentage of the immune system resides), and they are primarily digested by beneficial bacteria.[1]

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## HMOs Functions

The great diversity of HMOs suggests different biological functions and mechanisms by which they may influence the infant's microbiome and immune maturation and their susceptibility to infections.[4] HMOs functions include the following:

- Enhance and sustain growth of beneficial gut bacteria such as Bifidobacteriaceae family[3]
- Prophylactically bind harmful bacteria, viruses, and toxins to allow for their excretion[3]
- Improve intestinal epithelial barrier function by supporting beneficial bacteria[3]
- Support maturation and regulation of the immune system[6]
- May function as a supplementary source of sialic acid for brain development[7]

## HMOs in Prolacta Bioscience Products

Prolacta's 100% human milk-based neonatal nutritional products are the FIRST and ONLY to contain a wide spectrum of HMOs.[8] The immunity, prebiotic, and gut maturation benefits that HMOs promote may have a role in the health outcomes attributed to an exclusive human milk diet (EHMD), of which Prolacta's neonatal nutritional products are a part.[2]

Prolacta Bioscience conducted a study to examine the concentration and variety of HMOs present before and after pasteurization. The data are consistent with previous research and demonstrate that HMOs are unaffected by pasteurization at temperatures used in most traditional pasteurization methods.[8,9]

Analyses performed by Prolacta Bioscience have shown that there is a wide spectrum of HMOs found in both Prolact HM® donor milk and Prolact+ H²MF® fortifiers.[9] This is due, at least in part, to Prolacta Bioscience's use of large starting pools, which include hundreds of donors, thus allowing for representation of all the HMOs structures.

**Table 1: HMOs found in Prolact HM donor milk and Prolact+ fortifiers**

| HMOs (neutral) | Pre-pasteurization | Post-pasteurization |
|---|---|---|
| 3FL | √ | √ |
| LNDFH | √ | √ |
| 2'FL | √ | √ |
| LNFP | √ | √ |
| LNT | √ | √ |
| HMOs (acidic) | | |
| 6'SL | √ | √ |
| LSTc | √ | √ |
| 3'SL | √ | √ |
| LSTb | √ | √ |
| DSLNT | √ | √ |

**Table 1** is representative of HMOs found in Prolact HM donor milk and Prolact+ fortifiers before and after pasteurization; these represent the most abundant HMOs in human milk. The choice of HMOs measured was dictated by the limited availability of characterized HMOs. Inclusion or exclusion of HMOs in the list, therefore, does not relate to bioactivity.

Neither parenteral nutrition nor formula naturally contains HMOs. There are 1 to 2 synthetic and plant-based oligosaccharides that are added to some preterm and term infant formula products to mimic the role of HMOs as prebiotics. Differences in oligosaccharide composition, abundance, and function between human milk and formula remain profound.[2]

Many of the benefits in terms of health outcomes for premature infants receiving an exclusive human milk diet can be tied back in part to the anti-infective, anti-inflammatory, and gut maturation activities of HMOs.[6]

The source of an HMO has to be human milk. The "HM" in "HMOs" stands for Human Milk. Anything else is simply a synthetic oligosaccharide.


**References**

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