

First update, July 2007

Chapter 2: Carbohydrates: Cummings & Mann

Chapter 31: Infant feeding: Secker & Zlotkin

Update of paragraphs 2.10.5 (prebiotics) and 31.1 (value of breastfeeding)

HUMAN MILK OLIGOSACCHARIDES (HMOs)

Although they are missed out of our 3rd edition of Essentials – and are barely mentioned in the other current nutrition textbooks - HMOs are a fascinating example of the impact of nutrition, and a topic of growing importance. They belong between prebiotics on page 30 in the Carbohydrates chapter and “breast milk provides immunological protection” on page 456 in Infant Feeding.

Lactose is not the only carbohydrate in human milk. There are more (total) oligosaccharides than (total) protein. HMOs are the third major component, after lactose and lipids.

There are over 100 different oligosaccharides in human milk, all made up of five monosaccharides: galactose and glucose (lactose) is always present at one end and fucose, N-acetylglucosamine (GlcNAc) and sialic acid. They contain between 3 and 9 of these sugar residues.

Human milk contains 10 times more oligosaccharides than cows' milk and formulas based on cows' milk which have only a few different types of oligosaccharide.

HMOs are mostly not digested in the baby's small intestine. They pass on to the colon, the equivalent of dietary fibres in breast milk. Here they are fermented and the resulting lower pH favours growth of bifidobacteria, which are the dominant and beneficial colonic flora in breast-fed babies. HMOs containing GlcNAc particularly promote bifidobacteria.

Micro-organisms and their toxins gain entry to cells by attaching to specific sugars on the cell surface. Oligosaccharides in human milk include particular sugars that can act as “decoys” for major pathogenic bacteria and bacterial toxins and so prevent their access to

the body. HMOs have been shown to include receptors for E coli, E coli toxin, campylobacter, rotavirus and strep pneumoniae.

About half these HMOs contain sialic acid. It is always at one end, where some of it is digested off and absorbed. It is an important constituent in the brain. When the brain is growing rapidly it appears the endogenous synthesis rate of sialic acid is suboptimal. Brains of babies who died of SIDS contain more sialic acid if they have been breast-fed.

It is impossible to reproduce the complexity of all the individual HMOs, to add them to infant formulas. But a mixture of 90% galactose oligosaccharide and 10% fructose oligosaccharide, approved for feeding to formula-fed infants, acts as a prebiotic. It promoted bifidobacteria and lactobacilli and reduced pathogens in the large intestine and the pattern of blood lymphocyte types indicated a reduced tendency to formation of IgE and allergic reactions.

Further reading

- Newburg DS & Street JM (1997) Bioactive materials in human milk : milk sugars sweeten the argument for breast-feeding. *Nutrition Today*, 32 : 191-201.
- Wang B & Brand-Miller (2003) The role and potential of sialic acid in human nutrition. *European J Clin Nutrition*, 57 : 1351-1369.
- Fanaro S, Boehm G, Garssen J, et al. (2005) Galacto- oligosaccharides as prebiotics in infant formulas : a review. *Acta Paediatrica*, 94 (Suppl 449) : 22-26.