Nutricia considers breastfeeding and human milk as inspiration to continue to develop advanced innovations in maternal and infant nutrition. Key areas for Nutricia include Immune, Gut Health and Growth & Metabolism. We share our expertise and knowledge with healthcare professionals and academics to enable them to educate and support mothers on infant and maternal nutrition. The goal is to help mums to be successful in their breastfeeding journey.

THE COMPOSITION OF BREAST MILK AND ITS HEALTH BENEFITS ARE OUR INSPIRATION TO SUPPORT BREASTFEEDING AND TO DEVELOP INNOVATIVE NUTRITIONAL SOLUTIONS

GUT HEALTH

Bifidobacteria are highly significant in the gut microbiota of breastfed infants [1–3]. An important health-promoting and protective property of Bifidobacteria is their capability to lower the pH of the gut by the production of acids (i.e. acetate), which prevents growth of pathogenic microbes. Also, Bifidobacteria have been shown to *stimulate the development* of the *immune system* and *produce digestive enzymes* and essential *vitamins*. Interestingly, human milk contains even living bacteria, including Bifidobacteria, Lactobacillus and Streptococcus [4, 32]. Living bacteria produce metabolites (*postbiotics*), which can be beneficial to the human host [33].

Human milk oligosaccharides (HMOS) are the source for the prebiotic effect of human milk. They are present in high numbers and have an extremely complex composition consisting of short- and long-chain structures. Adding *prebiotic* oligosaccharides and *probiotic* bacteria is an effective way to increase the numbers of Bifidobacteria and other beneficial bacteria in the intestine of formula-fed infants [5,6]. We have developed a patented mixture of prebiotics, with similar function to human milk oligosaccharides, consisting of *short-chain galacto-oligosaccharides* and *long-chain fructo-oligosaccharides (scGOS/lcFOS) (9:1).* The health benefits, including gut health and reduced risks of allergy, of scGOS/lcFOS (9:1) are validated with almost 20 years of research and more than 30 studies published in >55 *scientific publications.*

IMMUNE

Human milk is rich in tailor-made *immunological factors*, such as immunoglobulins, lactoferrin, cytokines, HMOS and long-chain poly-unsaturated fatty acids (LcPUFAs) [7]. The immune system is of *critical importance* for infants to further develop and mature. Breastfeeding, starting with colostrum the first few days, plays an important role in both providing *passive* as well as *active* support. Therefore, the period of breastfeeding can be considered be a key phase for *training* the infant's *immune system*. We believe that training the immune system can help build *immune training*, which is a state where an individual's

'Inspired by the ratio of short to long chain oligosacchardies in human milk, our scGOS/lcFOS (9:1) are validated by almost **20 years of research and more than 30 studies'**

immune system is resilient, having an inbuilt capacity to adapt to challenges by establishing, maintaining and regulating an appropriate immune response.

ALLERGY

Human milk contains a diverse range of *proteins* and *peptides*, associated with the education of infant's immune system. Risk factors for allergies include family history of allergy, being born by C-section, exposure to pollution and the use of antibiotics.
We discovered that specific *sequences of peptides* are *more potent* in *inducing tolerance* compared to other peptides with similar sizes [8]. To support immune training, intact allergens should ideally be avoided in at risk infants. However peptide epitopes are essential for the training of the immune system. Therefore we focus on the importance of these specific peptides in tolerance induction in order to better understand how to best support immune fitness.

In addition, we discovered that to create an *optimal gut microbial ecosystem*, modulation of the early microbiome is crucial. Therefore, we have further developed our patented prebiotic concept (scGOS/lcFOS 9:1) with the addition of probiotic *B. breve M-16V*. This synbiotic concept positively influences *cows' milk sensitivity, immune functions, asthma* and *digestive & colon health* [9–13]. The probiotic *Bifidobacterium breve specie* is a commonly isolated bifidobacterial species in human milk and a natural species in the infant gut [13]. Our unique prebiotics, in a 9:1 short- to long-chain ratio are combined with the probiotic *Bifidobacterium breve* M-16V strain, selected for its safe use in infants and demonstrated by our research to have the best anti-allergenic effect.

PRETERM HEALTH

Human milk is the preferred feeding for preterm infants [19,20]. However, preterm infants have higher nutritional requirements than term infants and additional *nutritional support* is required for appropriate growth and development [21,22]. Human milk for preterm infants needs to be *fortified* to meet their high nutritional needs. This has *positive* long lasting effects on their health and reduces *risk of diseases* [23–26]. We provide *tailored nutritional* concepts to support human milk feeding and meet the increased nutritional needs of preterm infants.

BREAST COMFORT

Up to *33%* of breastfeeding women *suffer* from mastitis and related symptoms, and *1 out of 4* women *stop* breastfeeding due to mastitis [14,15]. The leading cause of mastitis is believed to be a *dysbiosis* of the human milk microbiota [16]. We have discovered that human milk contains *probiotic bacteria* and that these probiotics can help to restore the balance of microbiota in the breast. we have researched 2 probiotic strains (*Lactobacillus salivarius CECT5713* and *Lactobacillus salivarius PS2*) to manage early symptoms of mastitis and the prevention of mastitis [15–17]. Clinically proven benefits of these strains in lactating women include the *reduction in pain scores, decreased level of pathogenic bacteria, reduction in recurrent episodes* and *prevention* of *infectious mastitis* in a susceptible population [14,16,17]. Lactobacillus are also natural occuring in human milk [18].

GROWTH AND METABOLISM

The micro and macro-nutrients within human milk have an impact on an infants metabolism. *Digestion*, *absorption* and subsequent metabolic reactions are crucial for the growing infant. The right nutrition and functional components with anti-oxidant and anti-inflammatory effects deliver protection and metabolism in an optimal way. Especially the lipids within human milk and certain *long-chain poly-unsaturated fatty acids (LcPUFAs)*, which are important for *brain* and *immune* functions play an essential role. We are *pioneers* in the area of lipids and human milk research. Already in 1983, we found that LcPUFAs are specifically distributed in form of *polar* and *non-polar lipids*, which are part of the very complex *3D-architecture* of milk fat

'**Preterm care**: We provide tailored nutritional concepts to support human milk feeding **when every drop counts**'

'We try to decipher the **personal**, **cultural**, **sociological**, **psychological** and **physiological** context of infant feeding'

globules. We proved that the lipid form is important for the functional benefits of LCPUFAs. Inspired by this research we introduced LCPUFAS in to infant and maternal nutrition.

BREASTFEEDING SCIENCE

Breastfeeding plays an important role beyond nutrition in the social and cognitive development of the child and the wellbeing of mother and child. Into we work to decipher the *personal*, *cultural*, *sociological*, *psychological* and *physiological* context of infant feeding. Understanding the *interplay* between these factors is key for providing *optimal solutions* for mothers and children. There is ample evidence that the dose and duration of breastfeeding has benefits for immune, growth and metabolism. Furthermore, breastfeeding may help the *social and cognitive development* of the child and the wellbeing of mother and child [27–29]. A first step is to understand the motives and barriers of women concerning breastfeeding. For example, it is suggested that interpreting an infant's signals concerning hunger and satiety may be difficult and can cause the feeding situation to be suboptimal or even to stop. In order to support a healthy feeding interaction between mother and infant, we conduct studies to understand these *feeding signals* [30,31].

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