Progress in research on human lactation and breast milk has advanced our knowledge about the significance of breast milk for the recipient infant and the effects of various components on long-term outcomes (fig. 1).

Several growth factors (EGF, TGF-β, erythropoietin, IGFs) and cytokines (IL-1β, IL-2, IL-6, IL-7, IL-8, IL-10) are present in breast milk and their capacity to persist in the infant gut and exert their activities is likely to affect maturation of immune function, possibly affecting the development of oral tolerance. One example is TGF-β, which is present in high concentrations in colostrum and early milk, but also at biologically relevant concentrations in mature milk. TGF-β is known to affect cell growth and differentiation, but is also a potent immunoregulatory molecule. It is likely that TGF-β in breast milk is particularly important at an early age, when production of endogenous TGF-β in the intestine is very low and that TGF-β can promote IgA production in infants. TGF-β in breast milk may be involved in the prevention of atopic disease in infants [1], which is supported by the finding of an inverse correlation between TGF-β in breast milk and wheezing in infants.

Docosahexaenoic acid (DHA; C22:4 n-3) is important for brain development of infants, and as breast milk from most women is higher in DHA than infant formula, some manufacturers have supplemented their products with DHA. A study on increased DHA intake of infants leading to lower BMI and another study showing a positive correlation between breast milk DHA and eicosapentaenoic acid (EPA; C20:5 n-3) levels with developmental scores may strengthen the argument for DHA supplementation. A proper balance of polyunsaturated fatty acids (n-3/n-6 ratio) may also be of significance for allergy prevention in children. Levels of EPA and DHA as well as the n-6/n-3 ratio were
lower in breast milk from mothers of allergic children as compared to those having nonallergic children. Further, infants born to women supplemented with n-3 fatty acids during pregnancy and lactation had a lower prevalence of food allergy as well as IgE-mediated eczema than the placebo group [2]. In addition, a positive association has been found between polyunsaturated fatty acids and TGF-β2 in milk [3]. It is therefore possible that the lower levels of TGF-β2 in the breast milk may interfere with the development of the mucosal immune system of the breastfed infant.

The recent findings that specific strains of bacteria are present in breast milk [4] and act as probiotics in the early colonization of the infant gut and that human milk oligosaccharides are specific substrates for these probiotic strains may not only affect the defense against pathogens, but also affect energy utilization and development of obesity. Interestingly, bifidobacteria were found to be present in higher numbers in children maintaining normal weight than in children becoming overweight [5]. Thus, it is feasible that specific probiotic strains in breast milk not only facilitate colonization of the gut with beneficial bacteria and deter pathogens, but that they also modulate energy metabolism which in turn can affect development of obesity.

Previously neglected milk fat globule membranes (MFGM) contain several components involved in protection against infection and
may be an additional arm in the multi-faceted shield that breastfed infants have developed against bacterial and viral antagonists. MFGM components have been shown to bind to various rotavirus strains, and it has been shown that the content of lactadherin (one of the MFGM components) in breast milk was negatively correlated to symptomatic rotavirus infection in Mexican infants. Recently, Peruvian infants given MFGM proteins were shown to have a lower prevalence of diarrhea than the control group, further supporting an antimicrobial activity of this milk fraction.

All these findings have implications for development of improved infant formulas.

References