

APPENDIX 1

SUPPLEMENTS TO CHAPTER 2

Section 2.2 Components of human milk and vitamin supplements

Carbohydrates

Oligosaccharides

Human **Oligosaccharides** can modulate epithelial and cellular immune responses, reducing the risk of necrotizing enterocolitis and providing necrotising enterocolitis, and providing infants with sialic acid as a nutrient potentially essential for the development of the brain and cognition.

Lipids

The total quantity of **Lipids** contained in human milk is stable, but the type of lipids vary greatly and depend largely on the mother's diet, particularly during pregnancy. Human milk contains fatty acids, including long-chain polyunsaturated fatty acids and essential unsaturated fatty acids and the essential fatty acids linoleic acid and alpha linoleic acid, the latter two being involved in the development of the central the central nervous and immune systems, and in children's growth. In comparison milk, which is used to make commercial infant formula, contains mainly high-fat medium-chain fatty acids, and very few long-chain amino acids or essential fatty acids. This difference in the types of fat found in human and bovine milk could explain why studies describe a difference in neurological function and cognitive abilities in people who have not been breastfed.

The hormones in human milk

A growth factor that mimics the effect of insulin, called **Insulin-Like Growth Factor**, or IGFI, is present in large quantities in colostrum. factor, or IGFI, but its presence rapidly diminishes in mature milk. It is often referred to as growth hormone.

Cortisol is present in colostrum in large quantities, with levels declining rapidly over the following days. Cortisol may be useful in fluids and salts in the baby's digestive system. It may also play a role in the growth of the pancreas, and may occur during periods of maternal stress.

Leptin, a hormone that regulates appetite, food intake and energy metabolism, is present in human milk. Its presence in human milk could explain, at least in part, the lower risk of obesity in children who have been breastfed.

Cholecystokinin is a gastrointestinal hormone that improves digestion, sedation (relaxation), and provides a feeling of satiety and well-being. Infants' levels of this hormone rise at the same time as their mothers', immediately after feeding and between 30 and 60 minutes after feeding.

Vitamins

Vitamin A

The presence of this vitamin in milk depends on its level in the mother's blood serum, and can vary with the mother's diet. **Vitamin A** deficiency in breastfed babies can result from abrupt weaning, chronic exposure to tobacco smoke or a low intake of food rich in fat or vitamin A by the mother. Such deficiency is not without consequences can lead to blindness and, in extreme cases, death.

Vitamin C

The antioxidant capacity and **Vitamin C** levels of infants fed commercial are well below recommended levels.

Vitamin E

No supplement is required for either mother or child. If the mother smoked cigarettes during pregnancy, she and her baby would be under oxidative stress. During breastfeeding, the mother's **vitamin E** should be used to protect her baby from oxidative stressors, leaving less of it in her milk for her baby. The commercial infant formulas and cigarette smoke both cause pro-oxidative both cause harmful prooxidant effects in children. [Ajouter "1" en exposant pour la référence à mettre en bas de page :](#)

Schwarz KB et al. (1997) Prooxidant effects of maternal smoking and formula in newborn infants. https://www.canada.ca/fr/santecanada/services/alimentsnutrition/saine_alimentation/apportsnutritionnelsreference/tableaux/valeursreference_relatives_vitamines_tableauxapportsnutritionnelsreference2005.html

The living cells in human milk

Phagocytes

Macrophages are a type of **Phagocyte** found in large numbers in human milk. They engulf and absorb pathogens. These increase significantly during breast inflammation and could play a role in protecting the breast tissue. Macrophages release IgA antibodies, which are highly protective of breastfed babies because, unlike other IgA antibodies do not cause inflammation. However, we know that inflammation can potentially damage healthy tissues as well as microbes. Macrophages also produce lactoferrin and lysozyme, which degrade phagocytised particles.

Another type of phagocyte, called **Neutrophils**, are brief-lived but are very effective, as these immune cells are the first to arrive at an inflamed site of inflammation, such as mastitis.

Lymphocytes

Lymphocytes mainly comprise T and B cells. They are cellular and humoral immunity. These processes are important in destroying viruses, for example, because the cells within which replicating viruses are protected from the action of antibodies. Babies fed commercial infant formulas have different types of lymphocytes.

T cells are special immune components that can be activated as memory T cells which are the key to active immunity. While antibodies are stable for only a few weeks, memory cells can live for years offering long-term protection to the breastfed infants.

Stem cells

While regenerative medicine typically uses cord blood or amniotic fluid to treat conditions such as Parkinson's and diabetes, this discovery makes it possible to work with a much less invasive source of **Stem Cells** by using mother's milk. These cells could potentially be used to treat a wide range of health problems. The stem cells in human milk range from 10,000 to 13 million cells per mL, so a breastfed child ingests several thousand viable stem cells with each feed. Research has made it possible to observe and measure dynamic changes and differences in the number of stem cells levels in colostrum, transitional and mature milk. It has been suggested that the number may be affected by the maturation of the mammary gland at different stages of lactation, and that stem cell population changes at these times could be consistent with the changing needs of the baby at different stages of growth and development. The fact that the baby swallows live stem cells suggests that it may receive greater benefits than expected on the basis of current data.

Section 2.3 Human milk and the development of intestinal flora and the immune system

The intestinal physiology of infants is composed of intestinal epithelial (IECs) that cover the intestines like a skin. These cells are covered by a layer of mucus, and it is in this space that innate and adaptive innate and adaptive immunities must work together to protect the infant from the assaults it encounters. In other words, this is where the immunoglobulins from human milk (polymeric immunoglobulins) attach themselves to non-functional antibodies to form IgAs, which are the functional antibodies.

Insufficient antibodies for up to two years

After translocation of IgAs from the intestinal epithelial cells (IEC), they enter the intestinal mucus layer, where they help to maintain the separation between the microbiota and the epithelial surface.

Section 2.4 Effects on the health of breastfed children

The **Peptides** in human milk, these pieces of protein, have been shown to have immunomodulatory, antioxidant, antimicrobial and probiotic properties, as well as having a function similar to that of opiates, which are powerful anti-painkillers. These peptides could offer benefits to both mother and child, such as preventing mastitis and gastrointestinal infections.

There are a multitude of modulatory components in human milk, including antigens cytokines, immunoglobulins (Ig), polyunsaturated fatty acids and chemokines. It contains white blood cells or leukocytes, including macrophages, neutrophil granulocytes and

lymphocytes. There are immune stimulating proteins and glycoproteins such as lactoferrin and IgAs and, finally, other components such as hormones, growth factors and endogenous peptides. These immunogenic activities of the human milk proteome are essential for the establishment of innate immunity and the development of adaptive immunity in the breastfed child.