

# The Science of Mother's Milk

Most mothers are aware that breastfeeding boosts a baby's immune system, but few of us could say how. "It's something to do with antibodies," we might answer vaguely. Now there's a brand of formula on the market claiming to "naturally strengthen your baby's immune system;" it also says it is "inspired by breastmilk" and "supported by science." To understand these claims we need to delve a bit deeper into the real science of breastmilk and find out how it actually supports a baby's developing immune system.

It turns out that there is much more to the story than just antibodies, important though they are. Breastmilk contains literally thousands of different components that support the immune system in some way. Some of these components are very specific, defending against a particular pathogen (bacteria, virus, parasite), while others have a broader function, protecting the baby in many different ways. Often these various components act together, providing even more protection than each would alone.

The brand of formula in question says it contains a "unique patented mix of special prebiotics"—sugars that are naturally found in milk and which are a source of food for so-called friendly bacteria (probiotics). Having a healthy mix of friendly bacteria in the gut is important for overall health because 80 percent of the immune system is located here, and the "good" bacteria can help to push out the "bad" bacteria that can cause disease.

But prebiotics are more than just food for bacteria. There are hundreds of different types of these special sugars—properly known as "oligosaccharides"—and the milk of each animal species contains a distinctive mix. (In fact, the precise mix varies from individual to individual, so each woman has her own unique blend—though not patented, of course!) After fat and lactose, oligosaccharides form the third largest solid component in human milk (the proportion in colostrum is even higher), but they used to be dismissed by scientists as just a useless indigestible by-product of milk production. Now it is clear that they actually have a very important function.

Human milk has been found to contain 90 different oligosaccharides forming over 900 different chemical structures, each of which can block infection by preventing a particular strain of bacteria from sticking to the gut wall. (I don't know how many oligosaccharides are found in this formula with the "patented mix," but we can safely assume it does not contain 90 different types, in 900 different forms.) Unlike antibodies, they are able to protect a baby from bacteria or viruses that a mother has never been

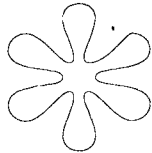


*Photo of Ayala Ochert and son Jacob*

exposed to. What is more, oligosaccharides are just one in a class of human milk components—there are others called glycoproteins and glycolipids—that work by blocking the attachment of microbes to the cells of the gut, so preventing infection.

Human milk is relatively low in protein compared to the milk of other species, yet the primary function of two of the major proteins in milk—antibodies and lactoferrin—is not nutrition but defense against infection. Most milk antibodies are made of a special form of protein called SIgA, which is particularly resistant to digestion. A mother's milk contains antibodies to pathogens that she's recently been exposed to. Chances are, the baby has been exposed to the same pathogens. These SIgA antibodies stick to microbes and stop them from attaching to and infecting cells in the gut. They also make their way into the nose and mouth, where they can defend against airborne diseases.

**Breastmilk contains literally thousands of different components that support the immune system in some way.**



While each antibody is specifically designed to target one particular pathogen, the major milk protein lactoferrin acts more broadly. It can directly kill bacteria, viruses, and fungi, and it also has an anti-inflammatory effect, which helps reduce the pain, swelling, and high temperature associated with infection. Because lactoferrin is quite resistant to digestion, it passes into the urine relatively unchanged and so helps prevent urinary tract infections. Lactoferrin also helps to encourage the growth of friendly bacteria in the infant's gut. Human milk contains particularly high levels of lactoferrin and, significantly, human lactoferrin is distinct from that found in the milk of other species.

In addition to these there are many other components that are known to play a role in supporting the immune system. The list includes alpha-lactalbumin, lysozyme, lipids, milk fat globules, nucleotides, defensins, cytokines, hormones, growth factors, anti-secretory factor, leucocytes, neutrophils, macrophages, lymphocytes, and more. The more you find out about these remarkable substances, the more apparent it becomes that mother's milk is important for babies. As the research scientist David Newburg puts it: "My thinking on milk has changed totally. I used to think of it as the best source of nutrition. Now, it's looking like milk is really designed to be protective."

A newborn baby's immature immune system relies heavily on this protection. Colostrum, the milk produced in the first days after birth, contains higher concentrations of many of these substances. The infant immune system matures during the first year, and is more mature at age two, but the immune system does not reach full maturity until the child is around six years old.

So it's reasonable to assume that mother's milk gives a useful immune boost for as long as a child is breastfeeding. But what about once they stop? Happily, the effects of breastfeeding on the immune system continue throughout life. This is because breastmilk contains components that direct the development of a child's own immune system. For example, it was found that the thymus—a central organ of the immune system—is twice as big in breastfed infants compared with formula-fed infants at four months. The size difference was also seen at ten months. Researchers attribute the growth of the thymus in breastfed infants to two components of human milk, IL-7 (a cytokine) and leptin (a hormone). Since the thymus continues to grow throughout childhood, it seems likely that breastfeeding enhances the growth of the thymus for as long as breastfeeding continues.

The main role of the thymus is in the development of the immune system. It grows steadily in early life and then abruptly stops at puberty and starts to shrink and gradually disappear during adulthood. During those early active years, bone marrow cells enter the thymus and mature into T cells, which then spread to the rest of the body. There are several different types of T cells, all vital to the proper functioning of the immune system—one sort finds and recognizes pathogens and can kill them directly; other types of T cell can instruct other cells of the immune system to kill. Yet others have the role of directing the production of antibodies. Another vital function of the thymus is to learn to recognize the body's own tissues so that the immune system doesn't attack them, as happens in autoimmune diseases like rheumatoid arthritis, type 1 diabetes, and multiple sclerosis.

Since breastfeeding is the biological norm, and since organs of the immune system like the thymus can only develop to their full potential through breastfeeding, an inevitable conclusion must be that people who were never breastfed (or those who were weaned too early) will have deficient immune systems—not just in infancy but for the rest of their lives.

From the outside, babies seem to grow well on formula—they certainly get bigger and longer. But on the inside their vital organs may struggle to grow adequately without support from mother's milk, which has evolved to meet their needs. Perhaps one brand of formula can argue that it is marginally better than another brand, but can it possibly claim to be "inspired by breastmilk" or to "strengthen the immune system"? Those are claims that the real science simply does not support.

#### Refer to

Hanson, L. A. MD, PhD. *Immunobiology of Human Milk: How Breastfeeding Protects Babies*. Pharmasoft Publishing, 2004.

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