Infants receive valuable assistance from their mothers’ breast milk to combat infection and disease during the critical neonatal period when their immune systems are not yet fully functional. While breast milk contains a myriad of biologically active molecules, one in particular, lactoferrin, has recently received extensive attention from research scientists, health practitioners, and the general public.

Why all the interest? Well, to begin with, anecdotal evidence of healing attributed to lactoferrin when taken as a nutritional supplement is plentiful. Some accounts with respect to cancer, immune deficiency and other afflictions are described as nothing short of miraculous. From a more scientific perspective, basic research on the molecular, cellular, and physiological properties of lactoferrin has increased tremendously in the past few years as the results of each new study generate further interest and excitement. So great is the promise of this protein — discovered over 30 years ago — that research is being encouraged by the National Institutes of Health. Here, I describe biological characteristics and properties of lactoferrin as revealed in recent scientific studies and include a sampling of the therapeutic “miracles” attributed to it.

The name lactoferrin is derived from its affinity to bind with iron (lacto = milk; ferrin = iron). In fact, lactoferrin binds iron over a hundredfold more strongly than transferrin, the major iron transport protein in the body. The highest known concentrations of lactoferrin are found in human colostrum, or “first milk,” where levels measure as much as 7 grams/liter. Mature human milk contains considerably less — about 1 gram/liter. A similar pattern exists in bovine (cow) milk, but the levels are not as high as in human milk. Lactoferrin is also found in neutrophils (a type of leukocyte or white blood cell), and, to a lesser extent, in the secretions of tear glands, salivary glands and the prostate gland.

Lactoferrin is a protein molecule comprised of a single strand of amino acids. For reasons not completely understood, lactoferrin, compared to other proteins, is remarkably resistant to degradation — a trait that may prolong functional activity following oral ingestion. The lactoferrin molecule is also characterized by the existence of distinct functional domains. For example, one region has ribonuclease activity, i.e., the ability to break bonds within nucleic acid molecules such as ribonucleic acid (RNA). Another region is responsible for lactoferrin’s iron-binding properties. Both the ribonuclease activity and iron-binding capacities of lactoferrin have been implicated in the antimicrobial effects of lactoferrin, described below.

The locations of receptors for a biologically active substance in different tissues often provide clues as to its actions, or at least the site of its actions. Receptors to which lactoferrin presumably binds in the course of its biological effects have been found in intestinal tissues, in the brain, on the surface of several types of white blood cells, on blood platelets, and on certain bacteria. Evidence described recently in the scientific journal Nature, suggests that lactoferrin can bind to regions of DNA in the cell nucleus and directly influence the activity of genes that code for the cell’s proteins.
Role In Immune System
A strong case can be made for lactoferrins central role in the immune system. The biological actions of lactoferrin under various experimental conditions are wide-ranging and include: inhibition of the survival or growth of many different pathogenic organisms; activation or stimulation of a variety of immune system cells; regulation of normal cell growth; and inhibition of abnormal tumor growth and spread of cancer cells in laboratory animals.

Physiological concentrations of lactoferrin are capable of killing or inhibiting the growth of a wide spectrum of infectious organisms including bacteria, viruses, parasites and fungi. One mechanism probably involved in at least some of the anti-microbial effects of lactoferrin is that, by strongly binding iron, lactoferrin deprives foreign organisms of essential iron. Interestingly, “friendly” bacteria, i.e., those that have beneficial effects in the gastrointestinal tract (e.g. Lactobacillus acidophilus, Lactobacillus bifidus and Lactobacillus G.G., may be resistant to such effects by virtue of the fact that they are less dependent on exogenous sources of iron. Other proposed mechanisms for lactoferrin’s antimicrobial actions relate to the ability of lactoferrin to interfere with the carbohydrate metabolism of invading organisms or lactoferrin’s ribonuclease activity, which may interfere with the organism’s ability to synthesize RNA essential for microbial protein synthesis. Fortunately, lactoferrin does not appear to adversely interfere with these processes in the human host’s cells.

Bacterial Inhibition
Examples of specific bacteria inhibited by lactoferrin include: Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, and Helicobacter pylori, all of which are capable of causing serious illness. Helicobacter pylori has recently been identified as a primary culprit in the development of stomach ulcers. While many studies have involved observations of lactoferrin’s effects on microbial growth in a laboratory dish or test tube, recent research in Japan has demonstrated that, when administered orally to mice, bovine-derived lactoferrin causes a marked reduction in the proliferation of intestinal bacteria, including several strains of the pathogenic bacterium, Clostridium. Furthermore, when administered to laboratory animals, lactoferrin also decreases the number of bacteria that translocate, or pass through, the cell lining of the intestines. Translocation of bacteria through the intestinal epithelium is a means by which bacteria can gain access to the blood and lymphatic system, and, if they are not checked by the body’s immune system, infections and illness ensue.

Antiviral Effects
Potent antiviral effects have been described for lactoferrin. Human cytomegalovirus, human herpes simplex virus-1, and human immunodeficiency virus (HIV, the virus responsible for AIDS) all have been inhibited by lactoferrin in laboratory experiments. Viral infections are believed to be involved in the etiology of certain types of leukemia. In an experimental model in which mice are infected with a virus that produces conditions similar to leukemia, mice given lactoferrin fared significantly better than control mice in terms of the degree of illness.

Antifungal and Antiparasite
As mentioned previously, lactoferrin also inhibits several species of fungi and certain
parasites. Fungi inhibited by lactoferrin include Candida albicans, the form of yeast normally present to some extent in all individuals, but responsible for “yeast infections,” or aggressive fungal overgrowth. The mechanism by which lactoferrin inhibits some parasites may be via stimulation of the process of phagocytosis, whereby immune cells engulf and digest foreign organisms.

**Antimicrobial Functions**
Lactoferrin present in gland secretions may serve an antimicrobial function. Saliva, for example, aids in the prevention of dental cavities by virtue of antibacterial properties attributed to lactoferrin and antimicrobial enzymes like lysozyme and peroxidase. Insufficient amounts of lactoferrin in some secretions also appear to correlate with certain health problems. Low concentrations of lactoferrin present in lacrimal secretions of some patients with acquired immune deficiency syndrome (AIDS) may contribute to ocular dry syndrome, a condition characterized by eye tissue deterioration and insufficient tear secretion.

**Immunosupportive**
Lactoferrin affects the proliferation, maturation and activation of several types of immune cells. Evidence suggests lactoferrin regulates the maturation and activation of neutrophils and macrophages, the immune cells primarily responsible for phagocytosis. Neutrophils secrete lactoferrin during inflammation. Lactoferrin also affects, in a number of ways, the maturation and function of lymphocytes, another major class of immune cells that includes cells responsible for antibody secretion and cells that directly attack foreign organisms. One notable study demonstrated that lactoferrin prevents fatal cytomegalovirus infections in mice. It does this by augmenting the action of lymphocytes called natural killer T-cells that attack and destroy the viruses. Without lactoferrin, test mice succumbed to the viral infection.

**Cytokines**
At the biochemical level, lactoferrin appears to modulate immune function through chemical called cytokines. Cytokines belong to a broad class of molecules that interactions between various cells in the body. Cytokines that specifically interactions between white blood cells, or leukocytes, are called interleukins. Recent lactoferrin research has focused on the ability of lactoferrin to regulate release or actions of interleukins and other cytokines.

**Maternal Immune Suppression**
An appealing theory on lactoferrin and immune function has been put forth (see ref. 3) that relates to the natural immune suppression that occurs in women during pregnancy. Immune suppression at this time is believed to help avoid maternal rejection of the fetus. According to this theory, increased lactoferrin production in the mother at the time of birth may be a major factor in restoration of maternal immune function and at same time help to prevent infection in the newborn via breast milk. Unfortunately, the natural immune suppression that occurs during pregnancy may manifest itself abnormally at other times — the consequence being immune deficiency and disease (e.g. AIDS). Reasoning follows that, if lactoferrin is an essential immune system regulatory protein, as evidence suggests, then deficiencies in production of lactoferrin during both
childhood and adulthood alike could be responsible for various health problems associated with a dysfunctional immune system. Anecdotal evidence indicates that lactoferrin is beneficial in some AIDS cases.

**Cancer Inhibition**
With respect to cancer, lactoferrin has been shown to inhibit the growth of some solid tumors and inhibit experimental metastasis, or spread of cancer cells, in laboratory mice. Research conducted in Japan studied the effects of bovine-derived lactoferrin in mice that were inoculated with cancer-like cells intended as a model for either skin cancer or leukemia. The cancer cells used in these experiments are known to be highly metastatic, i.e., they easily spread from a solid tumor site to invade other organs and tissues. When lactoferrin was administered just after tumor formation, the growth of tumor cells was suppressed and the spread of the cancer cells to the lungs and liver was significantly less than in control animals that did not receive lactoferrin.

**Angiogenesis Suppression**
Several possibilities have been described for how lactoferrin carries out its anticancer effects. Japanese researchers have speculated that lactoferrin's iron-binding capacity may be involved in the anticancer mechanism. Others think lactoferrin acts directly on the cancer cells themselves, as suggested by demonstrations that human lactoferrin binds to cell receptors on the surface of certain cancer cells. Still other evidence suggests that lactoferrin acts indirectly through stimulation of the killer T-lymphocytes which then attack the cancer cells. Finally, lactoferrin also appears to suppress tumor-induced angiogenesis, or blood vessel formation. Consequently, such suppression deprives the tumor of nutrients needed to sustain its growth.

**Anecdotal Evidence**
In vitro and animal experiments strongly support the argument that lactoferrin is part of an ongoing defense against tumors. But does it act similarly in humans? The actions of lactoferrin in humans are based largely on anecdotal evidence, i.e., reports that have not been documented according to scientific standards. Nevertheless, anecdotal accounts of results following lactoferrin administration to humans with serious illnesses, under the supervision of health practitioners, suggest that lactoferrin may be responsible for significant improvements in human health. In one example, a seriously ill patient with lung cancer was given lactoferrin by her prominent New York City physician, who specializes in treating the terminally ill. Despite the poor prognosis, this woman experienced a startling revitalization within weeks of first taking lactoferrin, resulting in weight gain and increased muscle strength.

Another remarkable turnaround following the addition of lactoferrin as a dietary supplement involves Gerry H. McAnulty, who suffered from scleroderma, a poorly understood and severely disabling fibrotic disease of the skin and internal organs. I talked to Ms. McAnulty prior to writing this article, and the change in her condition that she attributes, in part, to lactoferrin could easily be described by the spiritually unchallenged as a miracle. She feels she would not be alive today were it not for lactoferrin. Her renewed vigor has inspired her to become actively involved in women’s health education issues.
Numerous other dramatic effects of lactoferrin taken as a nutritional supplement have been described. I recently was informed of a case in which an individual suffering from impotence was able to achieve an erection for the first time in years after taking lactoferrin! The problem, of course, with interpreting these testimonials is that it is difficult, if not impossible, to determine what precisely was responsible for the dramatic recovery or effect. A combination of treatments, psychological factors, or interactions between therapeutic agents could be responsible. Or the events that transpire may be a natural course of the illness or condition.

**Conclusion**
Lactoferrin is an exciting new supplement that may contribute to an increased likelihood of a positive outcome when used to support the body’s recovery from disease. Lactoferrin appears to be safe and, in fact, is presently being considered for addition to infant formulas to more closely equate to breast milk. Lactoferrin’s overwhelming margin of safety, along with a rapidly accumulating body of clinical data and anecdotal accounts of its effects when taken by humans, suggests significant benefit when lactoferrin is used as a nutritional supplement in a wide range of infectious and life-threatening illnesses.

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