ARTICLE SUMMARY

- Infant formula lacks many key substances for development and growth. If a key nutrient is missing or not available, the body cannot adequately accomplish the task.
- Infant formula is primarily composed of sugar or lactose, dried skim milk and refined vegetable oil which can include genetically modified components. Organic formula is made of basically the same ingredients but they are not genetically modified. Soy-based formula is made of soy protein, sugar and refined oils.
- Breast milk from a well-nourished mother is composed of hundreds of substances—over one hundred fats alone.
- Infant formula contains double the amount of protein that breast milk does, which promotes insulin resistance and adiposity.
- There have been over twenty infant formula recalls since 1980 involving ingredients, pollution with pathogens, adulteration with foreign substances like glass, lack of required nutrients, foul smells, etc.
- Rocket fuel, phthalates, melamine, and high levels of heavy metals have been found in infant formula.
- There is no FDA regulation of infant formula; proof of safety is left to the manufacturers.
- Additives to infant formula, such as iron, DHA, ARA and laboratory-made folic acid are all problematic.
- Heat damages the protein in formulas forming advanced glycation end products as well as compromising the nutritional value.

Modern-day infant formula is the ultimate refined food, a product of science, composed of highly processed ingredients such as sugar, nonfat dried milk, vegetable oils and a list of synthetic nutrients. But it is convenient: just open, mix with water, heat and serve. And all can be done at home, much like preparing a can of condensed soup. A dubious added bonus is that with the “science” of infant formula there is no work or worry. You don’t have to think about it. One size fits all.

Infant formulas may be convenient but they have a very dark side. Even though some pediatricians think commercial formula is equivalent to breast milk, they are sorely mistaken. A simple review of the medical literature emphasizes the inadequacy of infant formula in infant nutrition. Formulas are much higher in protein than breast milk, a fact which has been significantly linked to childhood obesity. Formula is calorie-dense and increases insulin levels.

Trends in the use of infant formula over the last century have tracked an increase in allergic reactions, diabetes type 1 and type 2, and other chronic diseases among those children fed infant formula. Commercial formulas contain GM (genetically modified) ingredients and synthetically derived nutrients; they lack vitally necessary cholesterol but include mostly polyunsaturated fats which could include trans fats, toxic by-products as a result of
heating and chemical additions, and many other substances not found in breast milk. “Formula-fed babies are sicker, sick more often, and are more likely to die in infancy or childhood. Studies for a white American population show that bottle-fed infants were fourteen times more likely to be hospitalized than breast-fed infants. Compared to breastfed babies, formula-fed babies have a doubled overall infant death risk, and four-fold risk of Sudden Infant Death Syndrome (SIDS).” Bottle-fed infants and children have more frequent and more severe upper respiratory infections, wheezing, pneumonia and influenza. They have more diarrhea, more gastrointestinal infections and constipation.²

Formula-fed babies suffer more jaw misalignment and are more likely to need orthodontic work as they get older. Speech problems are more likely to develop because of weak facial muscles and tongue thrust problems which develop among bottle-fed babies. Formula-fed babies tend to become mouth breathers who snore and develop sleep apnea.²

Formula-fed infants also tend to have more dental decay—so-called “baby bottle caries” when habitually put to bed with a bottle—along with periodontal disease and TMJ problems.³⁻⁴ Most infants in the U.S. today rely on infant formula for some portion of their nutrition. An estimated one million infants in the United States are fed formula from birth every year.⁵ Today infant formulas are made by drug companies not mothers. Drug companies hold patents on their products and fiercely protect many “trade secrets.”

But unlike drugs, infant formulas are considered by law to be food,
and food is considered inherently safe. There are few regulations
governing infant formulas and the Food and Drug Administration
(FDA), the government organization responsible for overseeing
infant formulas, has left the burden of proof of their safety up to the
manufacturers.\(^5\)

The FDA does not approve infant formulas before they can be
marketed. Surprisingly no government agency is charged with this
responsibility. However, all formulas marketed in the United States
must meet federal nutrient requirements. Infant formula
manufacturers are required to register with the FDA and provide the
agency with a notification prior to marketing a new formula or
adding a new ingredient. But these were not always the rules.\(^5\)

**EXPERIMENTATION ON HUMAN INFANTS**

In her book, Breastfeeding: A Guide for the Medical Profession,
now in its seventh edition, the prominent pediatrician Dr. Ruth
Lawrence called infant formula “one of the largest human
experiments in history.” Formulas were concocted, ingredients
came and went, and there were no randomized clinical trials or
experiments of any kind before the formulas were tried on real live
babies. Not much has changed today. The “scientific” formula label
you see today is a result of years of guesswork.\(^6\)

Infant formula and breast milk are unique in comparison to almost
all other foods in that they are often the sole source of nutrition in
the vulnerable and rapidly growing and developing child.
“Inadequate nutrition in infancy has the potential to result in serious
and irreversible adverse effects.”\(^7\) In contrast to breast milk,
formulas do not change in composition in response to the infant’s ever-changing needs.⁶

Food is a programming system: the new science of epigenetics and nutrigenomics has taught us that food contains information that speaks to our genes, not just provides calories for energy, and what we eat programs our body with messages which ultimately lead to health or disease. Leading neurologist Dr. David Perlmutter and functional medicine specialist Dr. Mark Hyman believe that “Every time you take a bite of food you talk to your genes. The very food you eat is changing your DNA right now.”⁸ If this is so, what are the devitalized, spray-dried, nonfat milk, GM sugar and glucose solids in baby formula telling your baby’s genes every day? In the 1800s breastfeeding of infants was understood to be the “gold standard” of nutrition, and a baby who was bottle-fed was regarded with pity because of the high mortality rate associated with this inferior method. But ideas were already changing: by 1883 there were twenty-seven patented brands of powdered infant formula which were added to cow’s milk, including the first marketed formula of the putative genius Justus von Liebig in 1869. Henry Nestlé’s formula, introduced in 1870, was made of “good Swiss milk,” sugar, wheat flour, and malt. The use of these formulas was associated with a high death rate in the summer months when milk spoiled easily. Public health movements providing better care for cows improved the quality of milk, while milk clinics for infants were set up. By 1912 many homes had an icebox.⁹

PROBLEMS

Many babies fed formula developed vitamin deficiency diseases
such as rickets and scurvy before doctors and manufacturers figured out that the baby’s diet should be supplemented with orange juice and cod liver oil. Pundits of the day believed that boiled or sterilized milk caused scurvy and was to be avoided. But physicians showed that boiling could reduce the clumping of casein curds in the infant stomach, apparently making cow’s milk more digestible, thus justifying the practice. Cow’s milk for use in infant formula was usually boiled in Europe.⁹

In the early 1920s cane sugar became scarce and expensive. Dr. William M. Mariott introduced Karo corn syrup, and it became the carbohydrate of choice for over twenty years. The Evaporated Milk Association funded Mariott’s work and not surprisingly, in 1929 he published the first study purporting to show the superiority of that product to cow’s milk and even breast milk. Other untrustworthy researchers followed with the same fraudulent results.

In 1934 Carnation irradiated their milk, using a process Henry Steenbock patented for developing vitamin D in the product. Dried milk was also deemed an excellent source of infant nutrition. *Mothers and Medicine: A Social History of Infant Feeding*, 1890-1950 by Rima D. Apple provides a fascinating and well-documented account of the shady history of the infant formula industry.¹⁰

Although formulas containing powdered milk have been around for almost a century, they became widely used during World War II and the post-war years. In the 1950s and 1960s, infant formula feeding was considered the norm and breastfeeding rates plummeted.
Infant formulas in the 1950s were fraught with problems including an excessive quantity of substances requiring excretion by the kidneys and excessive sodium in the blood serum which caused dehydration for some infants. Low iron content and high intake of iron inhibitors caused iron deficiency and increased intestinal blood loss. Intake of fatty acids was low. The formulas lacked vitamin C so scurvy was a continuing problem, even though leading pediatricians advised the use of orange juice.\textsuperscript{11}

The two types of concentrated commercially prepared liquid formulas mostly in use during the 1960s were similar to evaporated milk formula with added vitamins (Lactum, Mead Johnston) and a product with a lower protein content with added vegetable oils and vitamins (Similac and SMA).\textsuperscript{12}

By 1970, nearly all of the locally based commercial formula services had ceased to exist. Few hospitals prepared their own formulas in-house as had formerly been the norm and most newborn nurseries used commercially prepared, ready-to-feed formulas.\textsuperscript{13}

In the 1970s, a marked resurgence in breastfeeding took place world-wide. The movement toward increased breastfeeding seemed to arise from the general public rather than from the prompting of health professionals, and may have been in part associated with negative publicity directed against the formula industry. In addition new scientific evidence illuminated the benefits of breastfeeding and sparked campaigns to promote the practice.\textsuperscript{14}
Ironically, an increased use of powdered formulas after 1971 coincided with the surge in breastfeeding because pediatricians of the time advocated introducing cow’s milk at a later age and feeding formula instead to older babies. The percentage of infants fed formulas after four months of age continued to increase. About 20 percent of six-month-old infants were formula-fed in 1971 and 50 percent were formula-fed in 1980.¹⁰

Despite the persistent claim of formula manufacturers that sound “science” was behind the development of infant formula, the “science” was in fact not well developed at all, and much experimentation fell to trial and error. When babies became ill, didn’t develop properly, or even died from consuming a formula, the problem was isolated and the “Band-Aid” applied: the missing ingredient was added or the offending substance was removed.¹⁰

**NEW STANDARDS**

Manufacturers often add new ingredients to infant formulas in an attempt to mimic the composition or performance of human milk. However, the addition of these ingredients is not without risks due to a range of complex issues, such as bioavailability, the potential for toxicity, and the practice of feeding formula and human milk within the same feeding or on the same day.¹⁵

Shockingly, a review of the information on infant formula regulation and overview shows the FDA dragging its feet for many years in implementing recommendations of professional task forces.¹⁸ Several meetings of the Food Advisory Committee on Infant Formula took place from 1996-2002, but the FDA took no action on
any recommendations until September 2014 when the agency published the final rule regarding standards for manufacturers of infant formula. These set in place federally enforceable requirements for the safety and quality of infant formula. The requirements include current good manufacturing practices specifically designed for infant formula, including required testing for the harmful pathogens Salmonella, Cronobacter, and *E. sakazakii*. Further, manufacturers must demonstrate that the infant formulas they produce support normal physical growth, and the formulas must be tested for nutrient content in the final product stage, before entering the market, and at the end of the products’ shelf life.

The new rules are rudimentary, however, and in the end “toothless” as they do not apply to formulas manufactured for infants with unusual medical conditions, special dietary needs such as galactosemia, and for babies who are born prematurely. This oversight excludes many infant formula products which will not fall under this regulation, such as soy-based formulas.¹⁹

These new standards are based on the first Infant Formula Law (1980), which was passed after more than twenty to fifty thousand infants were exposed to a chloride-deficient soy formula and thirty children were diagnosed with hypochloremic metabolic acidosis because of chloride deficiency. These infants developed loss of appetite, failure to gain weight, muscular weakness, vomiting, severe metabolic alkalosis and slowed growth in head circumference. Brain growth is vulnerable to chloride deficiency. In a follow-up of this group of infants four to nine years later, distinct
cognitive impairments had emerged including “language disorder, problems with word finding, visual disturbances, attention deficient disorder with repetitive behaviors, and withdrawal and over-focusing as seen in autism.”

By law, the FDA requires that all formulas contain the following nutritional constituents: protein; fat; vitamins C, A, D, E, K, B₁, B₂, B₃, B₆, and B₁₂; niacin; folic acid; pantothenic acid; calcium; phosphorous; magnesium; iron; zinc; manganese; copper; iodine; sodium; potassium; and chloride. Selenium, a trace mineral essential for brain growth and thyroid health, was belatedly added to this list in 2015.

THE BASE FOR INFANT FORMULA
Most formulas use cow’s milk as their base ingredient, but some adjustments must be made to bring the composition closer to that of breast milk. Human breast milk is 3.8 percent fat, 1.0 percent protein, and 7.0 percent lactose, while cow’s milk is 3.7 percent fat, 3.4 percent protein and 4.8 percent lactose.

Cow’s milk also has higher levels of phosphorus and calcium and lower levels of iron, zinc, niacin, and ascorbic acid than human milk. Formulas based on goat milk (Kabrita) and other animal milks are also commercially available, as well as a vegan formula (Coopers), along with soy milk formulas, and others.

INFANT FORMULA INGREDIENTS
All infant formulas, both organic and conventional, contain basically the same highly processed ingredients such as sugars, vegetable
fats, processed proteins, synthetic vitamins, minerals, nucleotides, and DHA and ARA (see Table 1). The main ingredients include:

1. Carbohydrate, in the form of lactose, corn maltodextrin, maltodextrin(-ose), sugar;
2. Protein as non-fat milk, casein hydolysate, whey protein concentrate, soy protein isolate;
3. Fat as soy oil, coconut oil, palm olein, high oleic safflower oil, high oleic sunflower oil, “other medium-chain fatty acids”;
4. Synthetic arachadonic acid (ARA) and docsahexanoic acid (DHA);
5. Synthetic vitamins A, E, D, K, B₁-B₃, B₅, B₆, C, folic acid, biotin, choline; the carotenoids lycopene, lutein;
6. Minerals in inorganic form: potassium, calcium, iron, magnesium, chloride, zinc, copper, manganese, selenium;
7. Synthetic preservatives: beta carotene and ascorbyl palmitate to prevent rancidity in the DHA and ARA oils;
8. Synthetic amino acids: taurine, L-carnitine and L-methionine (in soy formula);
9. Nucleotides: cytidine 5’-monophosphate, disodium guanosine 5’-monophosphate, disodium uridine 5’-monophosphate, adenosine 5’-monophosphate;
10. Probiotic or prebiotic substances as oligosaccharides, fructooligosaccharides (fos), polydextrose.

Other common additions are carrageenan and salt.²⁷

The synthetic ingredients in infant formula are produced with toxic chemicals. Lutein is a hexane extract from marigolds; lycopene is
produced with toxic toluene; taurine is processed with sulfuric acid and aziridine; L-carnitine and L-methionine are discussed in depth below; nucleotides are derived from chemically treated yeast; the fatty acids ARA and DHA are present in the synthetic forms of ARASCO and DHASCO, to be discussed below.28

AMINO ACIDS AND NUCLEOTIDES

Taurine is an amino acid that is plentiful in breast milk in a free form for easy absorption. It plays an important role in the development of the central nervous system and is credited with growth of the brain, as it is necessary for myelination. It also protects cells in the brain and eye against toxins or oxidants. The human infant, unlike adults, cannot synthesize taurine from cysteine and methionine precursors. Even adults rely somewhat on dietary sources of taurine. Low in cow’s milk, taurine was added to infant formula in 1984. But the taurine in infant formula is produced synthetically; one processing method includes the use of sulfuric acid, a toxic and carcinogenic substance, and another technique involves aziridine, listed as a hazardous air pollutant by the Environmental Protection Agency.29

L-carnitine production involves epichlorhydrin, listed as a 2-B material (possible human carcinogen) by the International Agency for Research on Cancer. For this reason it was rejected for use in organic foods by the National Organic Standards Board. The bioavailability of oral carnitine supplements is only about 14–18 percent of the administered dose. In contrast, the bioavailability of L-carnitine from food in omnivores is about 54–72 percent.30

FDA regulations on the nutrient requirements of infant formula (21
CFR 107.100(a)) do not require the addition of L-carnitine.\(^{31}\)

L-methionine is required in soy-based infant formula to meet basic amino acid requirements. Given its incompatibility with organic principles, synthetic L-methionine is prohibited in European organic foods. For that reason, organic soy-based infant formula does not exist in Europe. The synthetic version of L-methionine used in infant formula is produced with materials including acrolein, an EPA hazardous air pollutant, and hydrogen cyanide, described by the Centers for Disease Control and Prevention as a “systemic chemical asphyxiant” and “chemical warfare agent. . . used commercially for fumigation, electroplating, mining, chemical synthesis, and the production of synthetic fibers, plastics, dyes, and pesticides.”\(^{32}\)

Nucleotides, the building blocks of nucleic acids like DNA and RNA, are produced from hydrolyzed yeast. The yeast undergoes multiple chemical changes in order to allow extraction of nucleotides, including heating to denature proteins, cell wall proteolysis, enzymatic hydrolysis, and dehydration. A Chinese biotech company (Dalian Zhen-Ao Bio-Tech) and a Japanese company supply most of the infant formula nucleotides.\(^{33}\)

**FATTY ACIDS: DHA AND ARA**

Martek Bioscience Corporation, a Dutch conglomerate, makes the fatty acids DHA and ARA from a strain of genetically modified algae through induced mutations with the use of radiation and harsh chemicals. The algae are fermented in tanks containing corn syrup, ethanol and other ingredients and then immersed in a bath of hexane, a petrochemical solvent which is a known neurotoxin.
according to the CDC. If used in infant formulas it is micro-encapsulated, which is also prohibited in organic standards. It is also preserved with synthetic ingredients prohibited in organic standards like mannitol, modified starch, glucose syrup solids, ascorbyl palmitate, and beta carotene. DHASCO, the artifically produced DHA, is used extensively in omega-3 supplements and foods. The natural source of DHA is fish or fish liver oil.\(^\text{34}\)

**PROTEIN IN INFANT FORMULA**

The present protein concentrations in infant formula are twice as high as that in human milk. Too much protein results in the formation of high blood urea and ammonia, which must be eliminated in the urine, and a higher mineral and ash content than the infant requires. Thus the formula-fed infant has a two-thirds higher renal solute load and higher urine specific gravity than the breastfed counterpart. The kidneys of formula-fed infants are taxed working overtime to eliminate the solutes.\(^\text{35}\)

Formula feeding of human and rhesus monkey infants accelerates weight gain in early infancy and results in increased serum concentrations of branched-chain amino acids (BCAAs). Milk-derived BCAAs stimulate the secretion of insulin and IGF-1 growth factor. The European Childhood Obesity Trial Study Group confirmed that early high-protein feeding predicts obesity. Fat mass is higher in formula-fed infants than in children breastfed at twelve months.\(^\text{35}\)

Whey alpha-lactalbumin is the major protein in breast milk, which is important in lactose formation, and is rich in tryptophan (TRP), the
essential amino acid that serves as a precursor for the neurotransmitters serotonin and melatonin. These regulate many neurobehavioral effects such as appetite, satiation, mood, pain perception, and the sleep-wake cycle. Breast milk contains no beta-lactoglobulin, the dominant whey protein in cow’s milk and thus in formula.36

The infant’s daily need for TRP is relatively high compared to children ten to twelve years of age and adults. To meet infant requirements the concentration of protein in formula must be higher than in breast milk: more than 15 grams per liter in formula versus 9-11 grams in breast milk. Despite these higher added levels, studies report that the TRP levels in formula-fed infants are still low. Low levels of TRP in infancy may be related to the development of behavioral disorders like ADHD.36

Underscoring the crucial importance of adequate levels of this amino acid in infant nutrition is the fact that the metabolites of TRP are unique among amino acids. TRP with tetrabiopterin (BH4) and dioxygen as cofactors is converted to 5- hydroxytryptophan (5-HP) which readily crosses the blood-brain barrier. 5-HP is then converted to serotonin which is further metabolized in the pineal gland to melatonin.

The pathway of TRP that leads to B3 (niacin) formation requires B1 (thiamine), B2 (riboflavin) and B6 (pyridoxine). Niacin is necessary to prevent pellagra.36 With unenriched whey in formula, babies are at risk of insufficient TRP for serotonin synthesis in the brain.

Excessive protein intake represents a useless metabolic load to the
infant, but if the protein amount is reduced in infant formulas more toward the standard value of human milk, this causes a reduction in the tryptophan and taurine concentrations in the serum of formula-fed infants, even when they contain excess whey protein. Recently, whey sources with elevated concentrations of alpha-lactalbumin have become available, which has permitted the development of formulas with increased concentrations of this protein and decreased concentrations of betalactoglobulin. Human milk is high in TRP and provides optimal conditions for the availability of serotonin, the body’s feel-good chemical.\textsuperscript{36}

The U.S. Dietary Guidelines recommend lowfat or skim milk for children older than two years of age. In 2013, Mark DeBoer, associate professor of pediatrics at the University of Virginia and his colleagues fed toddlers and children between the ages of two and four one percent and skim milk, and found that children who drank milk which has a higher amount of protein than whole fat milk, gained more weight and had a higher body mass index than those who drank whole milk or even 2 percent milk. “Children drinking 1 percent or skim milk at both two and four years were more likely to become overweight/obese between those time points.” It was indeed the higher amount of protein in the milk that caused the weight gain, not fat.\textsuperscript{37}

**COW’S MILK HYDROSYLATE FORMULA**

Protein hydrosylate formulas based on casein or whey are considered hypoallergenic. They were first introduced in the 1940s and are recommended for babies who have food allergies and colic because of supposed protein sensitivity. Similac Alimentum,
Enfamil Nutramigen, and Enfamil Pregestimil are specific brands. These formulas are more expensive than others on the market.49 These formulas are extensively processed with heat and chemicals to break down the protein to some extent. The result is a product with “a very sour and bitter taste and an unpleasant sulfur smell.”49 Even so, these formulas have some intact proteins, which can trigger an allergic response; 10-30 percent of allergic babies cannot tolerate these formulas.49

In studies of babies using this formula compared to breastfed babies, iron status was lower, and amounts of amino acids excessive. Infants had significantly higher serum urea nitrogen than did all other groups. Plasma threonine, valine, phenylalanine, methionine, and tryptophan were significantly higher in the hydrolysate formula groups than in the breastfed group. Plasma tyrosine was significantly lower.50

Atopic dermatitis continues to be a problem in formula-fed babies and rates have been continually increasing. The FDA recently stated that “Partially hydrolyzed formulas should not be fed to infants who are allergic to milk or to infants with existing milk allergy symptoms.”51

SODIUM IN INFANT FORMULA

Higher sodium concentrations in infant formulas require a greater water intake for excretion and produce increased thirst. The increased thirst in the formula-fed infant is often interpreted as hunger by the mother and the infant is fed more formula. The infant fed artificial formula needs a greater water intake in order to excrete
the increased amount of substances produced from metabolizing infant formula. In the past, however, mothers feeding infant formula did not give additional water and infant kidneys were compromised. Could this early exposure to high sodium levels set the stage for hypertension in later life?

**FATS IN INFANT FORMULA**

Popular books on baby and infant care and scientific articles of the past sixty years have claimed that the fats necessary for brain growth are the long-chain polyunsaturated fats like DHA and that saturated fats must be avoided at all cost. This disastrous misinformation is based on the radical change in government dietary policy promulgated by Ancel Keys, a scientist who rose to become a leading authority on heart disease, cholesterol and saturated fats in the 1950s. His misguided recommendations were adopted and found their way into every home as researchers, dietitians, and health personnel jumped on his anti-saturated fat bandwagon. Babies were harmed by this restriction of saturated fats as these same dangerous theories found their way into the recipes for commercial infant formula.

In keeping with this lowfat theme, babies also were the subjects in experimental research when pediatricians and researchers in the 1960s and 1970s recommended skim milk for infants beginning at four to six months of age. The advice didn't work out so well—for the babies. A small amount of safflower oil and fat-soluble vitamins was then added. The infants drank enormous quantities of the milk and ate a lot of cereal. They gained in length at a normal rate but had slow or no weight gain. They also lost fat as shown in skinfold...
thickness because they were using stored fat to make up for the loss of fat in the diet. The researchers concluded that this diet was “likely to be seriously detrimental to the infants.”

Saturated fats are essential for the newborn and children in periods of rapid growth. They provide a diverse range of molecular function and actions within cells and tissues beyond providing simple energy. Fatty acids are required for membrane synthesis, modifications of proteins and carbohydrates, construction of various structural elements in cells and tissues, production of signaling compounds, and for oxidative fuel. Saturated fats are so important that the body has a mechanism to synthesize them from acetate in the absence of sufficient dietary fat. Feeding a lowfat diet results in membrane fragility which can disrupt cell signaling and many functions of the cell. This condition can be remedied by a high fat diet. The body has a control mechanism for the production of saturated fat—when they are plentiful in the diet, new synthesis is inhibited.

In fact, cells produce a remarkable diversity of saturated fatty acids under particular conditions, and although not all of their functions are known, they are clearly not simply interchangeable. Saturated fatty acids have been suggested as being the preferred fuel for the heart.

Baby formula today is high in polyunsaturated oils, which can quickly become rancid. They also may contain trans fats from the deodorizing process. GM crops can be sources of the oils. Fats undergo further processing when converted to a powdered form.
Consequently some baby formulas contain the preservatives ascorbyl palmitate and beta carotenes to prevent oxidation of fats.

High-oleic safflower or sunflower oil is commonly used in infant formulas. Safflower oil itself is a relatively inexpensive oil, mainly produced by Cargill, Archer Daniels Midland, and BASF (a German chemical company), but it is high in the polyunsaturated fatty acid (PUFA) linoleic acid, which makes up about 55-77 percent of the oil. Safflower oil has been linked with the development of heart disease. But the hybridized high-oleic safflower oil contains only 12-16 percent linoleic with 70-80 percent as oleic acid, a monounsaturated fat (MUFA). Hybrids are not genetically modified but radiation and toxic chemicals are used to produce them. PUFAs are highly subject to rancidity and were partly hydrogenated in the past to preserve shelf life. The label on current infant formulas does not indicate whether the PUFAs in the product are hydrogenated. Because PUFAs are so prone to oxidation, increasing the MUFA would give the product a longer shelf life.68

Coconut oil is another fat used in infant formula. It is a unique plant fat, which is high in saturated fats the infant desperately needs to grow and develop. Saturated fats like coconut oil are usually not subject to oxidation. However animal sources of saturated fats, which give a wider range of the various saturated fatty acids found abundantly in the breast milk of a well-nourished mother, are still missing from infant formula.66

Soybean oil, another common oil used in infant formula, contains 34 percent PUFA with 24 percent MUFA. Most soybean oil in the
U.S. is a product of GM soy beans. It is extracted from the beans with high heat and hexane, and the deodorization process may result in trans fats in the oil. In the past most soybean oils were partially hydrogenated to preserve their shelf life. But recently the U.S. government recognized trans fats as harmful substances, especially damaging to the heart. Soybean oil is reputed to contain omega-3 fatty acids but these fats are very sensitive to heat and quickly become rancid and therefore harmful.\textsuperscript{69}

Another prominent fat used in formulas is palm olein, which is not the same as saturated palm oil. It is added to provide palmitic acid at a level similar to that found in breast milk. However, palmitic acid from palm olein is chemically different from that in breast milk and is poorly absorbed. The fat reacts with calcium to form insoluble soaps and causes constipation.\textsuperscript{70}

In randomized double-blind prospective trials palm olein has been found to hinder bone mineralization and development in infants because of reduced calcium absorption. In formulas where palm olein is used and most of the calcium is added in the form of calcium salts as in soy-based and casein hydrolysate formulas, incidence of hard stools and constipation are increased.\textsuperscript{70}

For many years, the FDA did not allow canola oil in infant formula, but today the FDA regards canola oil as GRAS (generally regarded as safe) for use in them. The multinational company, Danone, applied to the FDA in 2013 to use canola as a source of fat in infant formulas to be sold in the U.S. In a letter responding to Danone’s application, the FDA had no questions regarding the inclusion of
canola oil as a source of fat in infant formulas at levels up to 31 percent of the total fat blend. Danone claimed in its petition that canola oil has a higher alpha linoleic acid (ALA) content than soy (11 percent versus 8 percent) and less saturated fat (7 percent versus 15 percent) than soybean oil, offering a “healthier” fat profile overall.\(^7\) Canola oil is mostly produced from GM seed, is processed at high heat, extracted with the neurotoxin hexane, and contains trans fats and other rancid products.\(^2\)

**DHA AND ARA**

DHA (decosahexanoic acid) is the central focus of advertising for infant formulas and almost all formulas contain this synthetic ingredient. Abbott Laboratories now is using OptiGRO™, a blend of DHA, lutein and vitamin E, as their main calling card while Mead Johnston offers “choline and DHA” for its importance in “brain and eye development.”\(^4\)

DHA is the most abundant omega-3 fatty acid in the brain making up about 40-50 percent of the polyunsaturated fatty acids (PUFAs). In addition, 50 percent of the weight of a neuron’s plasma membrane is composed of DHA. About 40 percent of the retina is made of DHA. It is also very important component in the skin, sperm and testicles. It can be derived directly from human milk but amounts vary widely dependent on dietary intake. Babies cannot synthesize it from the vegetable source, alpha linoleic acid (ALA), and this reaction is slow or non-existent in humans for many reasons. Professionals recommend 300 mg per day of DHA for pregnant and lactating women. The average consumption of DHA among U.S. and Canadian women is between 45 mg and 115 mg
per day while Japanese women consume the highest amounts. DHA is found primarily in fish and fish oil. Because of presumed health benefits, synthetic DHA is now added to baby formula.74

ARA (arachidonic acid) is a polyunsaturated fatty acid naturally synthesized by the body from linoleic acid. The work of Susan Carlson and colleagues established the importance of ARA levels for growth in the infant. She also found that babies whose formula was supplemented with fish oil but not ARA had slower growth rate than those on conventional formulas and that when DHA was added to infant formula, levels of ARA decreased due to competition in the enzyme available needed to make both conversions.75

In 2004 the FDA accepted the claim made by Martek Biosciences Corp for inclusion of ARASCO and DHASCO into infant formula. ARASCO is artificially produced ARA from Mortierella alpina oil and DHASCO is produced from Crypthecodinium cohnii oil. These ingredients are extracted from algae and soil fungus with hexane—a neurotoxic, petroleum-based solvent. The National Organic Standards Board stated that hexane-extracted algal oil and fungal oil should not be allowed in organic foods—but the USDA has failed to act, and hexane-extracted DHA and ARA remain in organic infant formula.76

When the C. cohnii and M. alpina oils first appeared in infant formula, FDA received dozens of reports from physicians and parents who noticed diarrhea, vomiting and other gastrointestinal distress in infants given formula with these oils—symptoms that
disappeared when the infant was switched to the exact same formula without these novel additives.77

Three of the most prominent and respected independent scientists in the field of infant formula science stated in 2010 that the scientific evidence supporting the addition of DHA and ARA to infant formula is “recognized by most investigators and Key Opinion Leaders in the field to be weak,” and that “this field of research has been driven to an extent by enthusiasm and vested interest.”76 The World Health Organization’s Director of Nutrition for Health and Development wrote a letter in 2011 to members of the European Parliament to let them know that no solid evidence existed to confirm that adding DHA to infant formula would provide important clinical benefits.76

PREBIOTIC SUBSTANCES
Oligosaccharides are the third largest component in human milk. In an attempt to emulate human milk properties, formula companies add specific prebiotics such as galactooligosaccharides (GOS) to some of their products to stimulate the growth of beneficial bacteria. Polydextrose, made from glucose, is a common GOS. A 2008 Chinese study found that supplementation with low levels of GOS “seemed to improve stool frequency, decrease fecal pH, and stimulate intestinal bifidobacteria and lactobacilli up to levels as found in breastfed infants.” The fructooligosaccharides (FOS) inulin and pectin hydrosylate have also been tried as prebiotics in infant formula studies.

Another possible property of prebiotics is the potential to prevent
allergic response or food hypersensitivity. A Cochrane Database Review in 2007 determined that “there is insufficient evidence to determine the role of prebiotic supplementation of infant formula for prevention of allergic disease and food reduction in eczema in infants.”

CONTAMINANTS IN FORMULA

A study in 2014 from the U.K. found that aluminum concentrations in infant formula were too high. Researchers from Keele University in England published two articles on aluminum contamination in ready-to-drink and powdered formulas and found that some brands contain over one hundred times more aluminum than breast milk. Aluminum was highest in products that contain an aluminum seal between the cap and the product. “Soy is a significant source of aluminum contamination in infant formula,” said the authors. Other sources of aluminum are additives such as calcium and phosphorus salts as well as the infant formula manufacturing process itself. The authors say that “despite their 2010 publication of the aluminum content of fifteen well-known infant formula products, manufacturers have not yet addressed the problem.”

In 2013, two infants with kidney problems died of aluminum intoxication, and powdered formula was the source. “Brain and bone disease caused by high levels of aluminum in the body have been seen in children with kidney disease. Bone disease has also been seen in children taking some medicines containing aluminum. In these children, the bone damage is caused by aluminum in the stomach preventing the absorption of phosphate, a chemical compound required for healthy bones.”
The CDC has not determined whether aluminum causes birth defects in humans. In the U.S., substantial amounts of aluminum are found in drinking water. Babies get a double dose of aluminum if fed soy formula made with tap water.

Aluminum is also found in vaccines. According to researchers, “experimental research. . . . clearly shows that aluminum adjuvants have a potential to induce serious immunological disorders in humans. In particular, aluminum in adjuvant form carries a risk for autoimmunity, long-term brain inflammation and associated neurological complications and may thus have profound and widespread adverse health consequences. In our opinion, the possibility that vaccine benefits may have been overrated and the risk of potential adverse effects underestimated, has not been rigorously evaluated in the medical and scientific community.”

In the first U.S. study of urinary arsenic in babies, Dartmouth College researchers found that formula-fed infants had higher arsenic levels than breastfed infants, and that breast milk itself contained very low arsenic concentrations. Arsenic is found in rice products like rice syrup, rice milk and rice baby cereal, as well as in apple and grape juice.

**BISPHENOL A**

The European Safety Authority (EFSA) has determined that canned commercial formulas are a significant source of the chemical bisphenol A (BPA). Formula cans are lined with BPA. It is also part of the composition of polycarbonate baby bottles. BPA is a hormone disruptor and is linked with early puberty in girls, attention deficit
disorder, ADHD and urogenital abnormalities in boys. BPA has also been found in breast milk.\(^{87}\)

**CLOSTRIDIUM DIFFICILE**

Formula-fed infants have high levels of the pathogen *C. difficile* in their gut bacteria. *C. difficile* is a bacterium whose growth is linked to use of antibiotics. The substance p-Cresol, formed via anaerobic metabolism of the essential amino acid tyrosine by bacteria such as *C. difficile*, is a highly toxic carcinogen, which also causes adverse effects on the central nervous system, the cardiovascular system, lungs, kidney and liver. *C. difficile* is a well-established causal factor in colitis and inflammatory bowel disease.\(^{88}\)

In a recent case-control study, children with autism were found to be significantly more likely to have been formula-fed rather than breastfed. The study did not distinguish if children were fed organic or conventional formulas, but we know that non-organic soy formula is contaminated with glyphosate, and this could be a contributing factor to the incidence of both autism and *C. difficile* overgrowth.\(^{88}\)

According to Dr. David Perlmutter, children with autism have higher levels of propionic acid (PPA) in their blood which is toxic to the brain. Clostridia species produce large amounts PPA which also weakens tight junctions in the intestines allowing access to the bloodstream. PPA directly alters the brain’s ability to use energy and depletes the brain of antioxidants, neurotransmitters, and omega-3 fats.\(^{89}\)

**HOMEMADE FORMULAS**

Throughout human history, women who could not nurse their
babies have turned to other methods of feeding infants, which included animal milk and pre-masticated foodstuffs. Women in the countryside worked outdoors during certain times of the year, and the portable infant was taken with them as the milk source was also portable and readily available. However, when the Industrial Revolution called women to work in droves in urban factory settings, this natural, sensible arrangement was no longer possible and early weaning or feeding of alternative foods became a harsh reality.¹⁰

In the countryside breast milk substitutes were prepared with whole milk or “top milk” (cream) which made a more digestible offering. A home recipe from 1908 contained instructions to obtain the milk both morning and evening and then let it stand for several hours to ladle off the top cream. This recipe included more fresh cream, cow’s milk, limewater (a calcium supplement), brown sugar and boiled water.⁹⁰

From the 1930s or early 1940s, most home-made formulas fed to infants in the United States were prepared with evaporated milk. A typical evaporated milk formula, from around 1949, included one can (13 fl oz) evaporated milk, 19 fl oz water, and 1 oz corn syrup (Karo) or sucrose. If cow’s milk was used it was pasteurized and homogenized. Bottles and nipples were thoroughly sterilized.⁹¹

**RAW MILK AND INFANT FEEDING**

In the 1920s and 1930s Dr. Weston Price documented his use of raw milk to improve the diets of sickly children during the Great Depression years and showed it was indeed safe, wholesome and
healthy. Dr. Francis Pottenger, Jr. showed the benefits of raw milk in his research with cats. His cats receiving raw milk flourished while those receiving heated milk suffered from underdeveloped chests; were infected with ticks, fleas and lice; and had irregular crowded teeth with protruding faces and narrower and smaller skulls. Cat mothers fed heated milk experienced difficult deliveries. The resulting offspring were sterile. Dr. Pottenger also was concerned with differences in the development of the jaw and facial muscles between formula-fed and breastfed infants.  

In May 1945 Coronet magazine published “Raw Milk Can Kill,” a seemingly factual article about a town called Crossroads, USA where many died from undulant fever contracted from consuming raw milk. The article was entirely fabricated—there was no town called Crossroads—but generated a furor aimed at pasteurizing all milk. To add fuel to the fire, in August 1946, The Readers Digest reprinted the story. This carefully planned campaign played a role in the mandatory pasteurization laws instituted in 1948, soon after these articles were published.  

RAW MILK FORMULAS  
Despite this deliberately planned scandal over the purported dangers of raw milk, Adele Davis, the most popular nutritionist of the 1940s-1970s, advocated “certified raw milk” as the best milk to use in formulas for babies who couldn’t nurse. In her bestselling book, Let’s Raise Healthy Children, she published several infant formulas using raw milk. Mrs. Davis also recommended supplementary cod liver oil drops.  

She disdained commercial formulas and referred to children who
were fed these formulas as “fatties in training,” remarking on the tendency of formula-fed babies to be overweight, a condition which she said could persist into adulthood. Apparently she was right as current research strongly implicates commercial formulas in the risk of obesity and diabetes.\(^94\)

During her career as a dietitian, Mrs. Davis worked in public schools and for obstetricians. She appeared on many major TV programs, on the lecture circuit, and as lecturer at many college campuses. She supported free speech on food safety and food freedoms. In 1972 Time magazine called her “the high priestess of a new nutrition religion” and “the Oracle.” Her books sold over one million copies. Adele was a great admirer of Dr. Pottenger and Dr. Price, discussed their work in detail, and praised them lavishly in her book on child care.\(^95\)

Around 1999 Dr. Mary Enig and Sally Fallon Morell of the Weston A. Price Foundation developed a raw milk formula for babies using fresh cow’s milk or goat’s milk, and a liver-based formula for those babies who could not tolerate animal milks.\(^96\) These formulas are still very much in use today and a boon to parents who are determined not to feed their babies commercial formula. They are promoted and supported by popular health pundit Dr. Joseph Mercola.\(^97\)

A full description of the three formulas can be found in *The Nourishing Traditions Book of Baby and Child Care*, and in *Nourishing Traditions*. Sarah Pope, the Healthy Home Economist, presents a comprehensive video on preparation of these formulas.
WHAT’S MISSING IN INFANT FORMULA?
In contrast to formula where every drop is identical, breast milk from a well-nourished mother is an intricate and ever-changing composition of ingredients prepared by the mother herself for her developing infant: customized nutrition at its best. Scientists have not yet discovered all the many substances in breast milk—they have barely scratched the surface. Breast milk is not just food but “represents a most sophisticated signaling system of mammalian evolution promoting a regulatory network for species-specific, postnatal growth and metabolic programming.” Scientists studying the “message” in mother’s milk see it as nothing less than a program for life.

Research indicates that “specific micro-constituents of milk, alone and in concert, contribute to neurobiological, cognitive, somatic, metabolic, and immune development in infants among mothers within species.”

Drs. Katie Hinde and J. Bruce German, known for their work in decoding the constituents in mammalian breast milk, in their 2012 article called human milk “the Rosetta Stone of food and nourishment…reflecting…the most elegant and compelling example…of 200 million years of symbiotic co-evolution between producer and consumer.”

The authors underscore one of many ways in which human milk is unique: “Human milk includes highly selective oligosaccharides that
support the growth of only a very unique group of intestinal bacteria \((\text{Bifidobacterium longum v. infantis})\) that co-evolved with mammals” which guide “the development and phenotype of a bacterial ecosystem” which aids “infant digestive, metabolic, and immunological functions.” These oligosaccharides are not digested by the infant or by simple bacteria but are the primary food source for \(B.\ longum\), which are critical for health and nutrition as they modulate immune responses in the intestine and participate in the bioconversion of digested nutrients. They also serve as competitive inhibitors of the establishment of pathogenic bacteria implicated in chronic infant diarrhea, a leading cause of childhood mortality worldwide.\(^{100}\)

Lactoferrin and lysozyme are unique immune constituents with anti-bacterial properties that are found in higher concentrations in human milk than in cow’s milk, which indicates that these substances are highly important for the infant. In an attempt to replicate these immune components, Chinese researchers inserted human DNA into transgenic cloned cows which produced human-type lactoferrin and lysozyme in the milk. The implications of such genetic grotesqueries are unknown.\(^{100}\)

Food preferences can be learned through breast milk and appetite is formed, in part, through the foods consumed during early development. When mothers eat garlic, for example, infants drink more breast milk.\(^{101}\)

Dr. Hinde and Dr. German are convinced that “The period of breastfeeding, by shaping healthy food preferences and healthy
growth trajectories, is a potentially critical period for combating future obesity and dealing with our changing environments. Lifestyle modifications in adulthood, once neurobiological and metabolic pathways are well-established, are likely to have a much smaller and more transient effect on phenotype.”¹⁰⁰ If this is so, appetite and food preferences of the formula-fed infant will be based on products of conventional agriculture such as sugar, vegetable oils, damaged proteins, GMOs and synthetic ingredients, and linked to the development of inflammation, obesity, chronic disease and premature death.

LACTOSE
Lactose, a disaccharide composed of glucose and galactose, is the main carbohydrate in breast milk and unique to the mammary gland. The amount of lactose in human milk is independent of the mother’s consumption of lactose and seems to be fixed. Bovine milk has a much lower amount of lactose and to approximate breast milk, it must be added to formula, although some formulas use maltodextrin, (made from rice, corn, potatoes, sugar or glucose syrup solids) instead of lactose. Lactose is a natural component of whey.¹⁰²

Lactose plays a major role in milk synthesis and draws water into the milk, forming a liquid. It is needed to absorb calcium and up-regulates innate immunity, leading to protection of the baby’s gut against pathogens.¹⁰³

FATS
Fats are the main source of energy and carriers of fat-soluble
vitamins which provide essential omega-3 and omega-6 fatty acids. In human milk and most formulas, 50 percent of calories are supplied by fats, most of which is in the form of triglycerides of saturated and unsaturated origin. While two hundred fatty acids have been identified in human milk lipids, with fifty metabolically active, the major fatty acids are palmitic, stearic, oleic, and linoleic with medium-chain fatty acids also present. Palmitic acid, the major saturated fat in breast milk, makes up 17-25 percent of fatty acids.

The fatty acid composition of human milk fat varies with the mother’s diet, particularly the omega-6 (linoleic acid) and omega-3 (alphalinolenic acid and DHA) fatty acids. It also varies widely within and among different populations. Levels of linoleic acid have increased over the last century in step with the increase in omega-6-rich processed vegetable oils in the diet. 104

Lactating women who are on high-carbohydrate, lowfat diets, women who are malnourished, and those with infections or metabolic disorders may see a decrease in their milk fat levels. 105

In addition to DHA and ARA, breast milk contains the other long-chain fatty acid eicosapentanoic acid (EPA), which is found at almost the same levels as ARA “thus giving some legitimacy to the notion that big-brained mammals need it.” Both dietary DHA and EPA reduce plasma ARA acid concentrations. Formula manufacturers have chosen not to add EPA to infant formula. 106

In 2010 Du Pont developed “a clean and sustainable source of EPA” through fermentation using metabolically engineered (that is,
genetically engineered) strains of the oleaginous yeast Yarrowia lipolytica, sold as New Harvest EPA oil in GM Nutrition stores. The New Harvest website is no longer active and the project seems to be abandoned as a supplement but we may see this genetically modified EPA product sooner than later. In 2011 the FDA had no problem with DuPont’s petition for GRAS status for the GM yeast in producing EPA for use in a wide variety of foods, even chewing gum, but thankfully not yet infant formula.107

**CHOLESTEROL: ESSENTIAL COMPONENT**

Breastfed babies receive large amounts of cholesterol from the milk of well-fed mothers, which ensures healthy brain growth. Cholesterol requirements for growth alone are 36-64 mg/day, excluding requirements for the brain, nervous system, and skin. This component is quite low or missing in formulas and formula-fed babies, especially those fed soy formula, and these infants must make their own cholesterol for use in brain and body.

In a study by Dr. Charles Wong, breastfed babies receiving higher intakes of cholesterol through breast milk had a 3.3 fold lower cholesterol turnover; that is, their bodies made less cholesterol than babies on cow-based and soy-based formulas. Those babies fed soy formula had the highest cholesterol synthesis as they were not receiving it in their formula so their bodies up-regulated the process to supply it. Dr. Wong concluded that children and adults who were breastfed milk from a well-nourished mother may not have to make as much cholesterol as those children and adults who were missing it in early life.108

Cholesterol is an essential component of cell membranes and is
required for growth, replication and maintenance. The central nervous system (CNS) contains 23 percent of the total body cholesterol. Two cholesterol pools exist in the brain: 70 percent is found in the myelin sheath, and 30 percent in the neurons and glial cells.\textsuperscript{109} This sterol is important for brain function in numerous ways: it forms nerve synapses; enables neurotransmitter, opioid and receptor signaling; helps the transport of amino acids; and performs many other tasks. Cholesterol also plays an important role in the dopamine transporter (DAT) function, an important regulatory component in maintaining dopamine homeostasis in the brain, which is the primary target for drugs like Ritalin (methylphenidate), prescribed for ADHD. Dopamine is a major neurotransmitter in the brain in charge of the reward mechanism and many other essential functions.\textsuperscript{110} Low levels of cholesterol in nerve cell membrane directly result in a decrease in the number of serotonin receptors, resulting in an overall reduction of serotonergic transmission in the brain.\textsuperscript{111} Cholesterol is also the activator for the oxytocin receptor in the brain and in the absence of cholesterol, this receptor inactivates. Lack of oxytocin in autistic children is involved with their inability to recognize voices, faces, and other visual cues. Many autistic children on the spectrum have low cholesterol levels. Oxytocin is also responsible for the “let down” response for the milk to start flowing from the breast and for the new mother’s attachment to her baby.\textsuperscript{112}

Is this lack of cholesterol in infant formula tied to compromised brain development and behavioral problems in childhood? When babies have to make cholesterol at such a young age, can they produce enough to adequately support brain function and does this
process program the infant for higher cholesterol levels in adulthood?

**HUMAN MILK LIPASE**

Lipases are enzymes needed for the breakdown and digestion of fats. In newborns pancreatic lipase is not fully developed but a lipase specific to breast milk is available to the breastfed baby. Bile salt–dependent lipase (BSDL), also known as carboxyl ester lipase (CEL), is an enzyme of the mammary gland which can completely hydrolyze triglycerides, phospholipids, cholesterol and lipid–soluble vitamins and release long chain polyunsaturated fatty acids, which makes BSDL highly desirable for neonatal digestion. Breastfed infants absorb fat better than formula-fed infants due to the presence of BSDL in human milk, which is not present in formulas made from soy or processed cow’s milk. Studies show that the BSDL remains active in the infant’s gastrointestinal tract and therefore contributes significantly to fat digestion and digestion of vitamin A (retinol esters).¹¹³

The lipase activity is lost on pasteurization and fat absorption from the milk is reduced by as much as one-third in preterm infants. When preterm infants were fed their mothers’ milk they gained significantly more in length and weight than when fed pasteurized milk.¹¹⁴

**THE RISE OF FORMULA FEEDING**

In the nineteenth and early twentieth centuries, the old and honorable tradition of the wet nurse was the preferred alternative when an infant’s mother was unable to provide milk for her child.
With time, however, a campaign was launched to discredit wet nursing in general. The unmarried status of some of these mothers offended the moral code of influential social groups. Rumors circulated that the women were of low morals and carried venereal diseases. Besides, most modern families did not have the means or the inclination to have a strange woman move into their homes. Gradually, by persuasive advertising and other clever tactics, the formula industry got the attention of mothers everywhere.10

The formula manufacturers' main slogan in those days was that their formulas were “scientific” and thereby certain to contain all the ingredients that the baby needed to grow and be healthy. At that time infant mortality was high and breast milk and cow’s milk were named as culprits. Further, putative experts claimed that mother’s milk was not adequate to support the child.

Sigmund Freud theorized that infants experienced suckling as sexual pleasure. Mothers were scandalized and to head off the development of infantile incestuous desire, breastfeeding, holding, fondling and cuddling were all abandoned. Virtuous mothers instead propped their babies up in high chairs with bottles.

Physicians weren’t much interested in birth and breastfeeding until the development of the specialties of obstetrics and pediatrics at the beginning of the twentieth century. At first, formula manufacturers sold their products directly to the public. But later pediatricians became intensely involved in artificial infant feeding, developing and selling their own formulas and writing their own prescriptions. In the 1920s and 1930s, the American Academy of
Pediatrics (AAP) even pressured formula manufacturers to sell their products without directions, instructing the buyer to get the directions from their doctors. If the companies did not comply, they did not receive the coveted AAP “seal of approval,” which was very influential among the customer base of new mothers. At one point formula preparation became so complicated that it was made in the hospital pharmacy.\textsuperscript{10}

Women growing up during these times were acculturated in the infallibility of the new science and technology. They experienced medicalized pregnancies and hospital births where medical technology was on display via monitoring, measuring and assessing. Bottle feeding became part and parcel of this process. More and more women giving birth in hospitals were handed a bottle of formula when leaving with their babies. “Medical knowledge superseded and de-legitimized other sources of knowledge generated from the woman’s bodily experiences.”\textsuperscript{117}

Although it is certainly the ultimate convenience food for babies, breastfeeding is not an exact science. The milk comes directly from the mother’s nipple to the infant’s mouth. There is no milk level to watch gradually decreasing as there is when the infant feeds from a bottle. Is the milk adequate? Is it nutritious enough? With breastfeeding, there was no way of knowing; with bottle feeding everything could be measured.

Even with mothers who intended to breast feed, the bottle was not far away. Fiona Dykes explains that the most common reason given by women for discontinuing breastfeeding was that breast milk was
inadequate for nourishing baby exclusively, and the perception that mothers had “insufficient milk” because “baby seemed hungry.” Indeed physicians had contributed to this thinking by advising mothers to give babies a bottle occasionally and to wean their babies early to the bottle.\(^{117}\)

In addition, lactation failure was a growing phenomenon in the U.S. starting at the beginning of the last century when women claimed that they had no milk. Journalists declared an “epidemic of lactation failure,” which dovetailed nicely with the growing success of artificial infant formula available on the market.\(^{118}\)

About five percent of women cannot produce sufficient milk because of medical conditions such as hypothyroidism or inadequate development of breast tissue, exposure to toxins at a critical period of development, medications, low prolactin levels and other reasons.\(^{119}\)

Mothers cite lack of interest and support by those on the front lines—medical personnel, midwives, home visitors and lactation consultants—as reasons not to continue breastfeeding early on in the process.\(^{117}\)

For mothers the ultimate measure of quality of milk and the central focus of progress of the infant has been weight gain, and indeed this is the focus of doctor’s visits. Weight gain was set as a major indicator of growth because it is easier to measure. However, length is considered a better standard.\(^{120}\)

The growth of breastfed infants in affluent populations differs from
that of formula-fed ones. After birth, babies normally lose a small amount of weight: five percent for formula-fed and seven percent for breastfed, with up to a ten percent maximum in the first week of life, before starting to gain. Most formula-fed but not most breastfed infants have exceeded their birth weights by the age of eight days. With breastfeeding this weight loss might seem slower to catch up. Breastfed infants generally are leaner than formula-fed ones after four months of age and gain less than formula-fed infants during the first year of life.\textsuperscript{120}

The physiologic reason for slower weight gain is that breastfed infants self-regulate their energy intake at a lower level than that observed in formula-fed infants. This lower activity may be related to the lower body temperature and metabolic rate of breastfed infants. It also may be associated with the different endocrine environment of breastfed as compared with formula-fed infants which could be affected by the marked differences in protein content of human milk and infant formula.\textsuperscript{120} However normal it may be, this weight loss is alarming for mothers who want to see a healthy, thriving baby, especially when weight is by consensus the major measure of progress, and these mothers are easily persuaded by family or medical personnel to take up the bottle.\textsuperscript{120}

I discussed this topic with a sixty-year-old European mother of two adult children who had breastfed her babies over one year—no bottles. She told me that she learned about her babies’ initial weight loss and what it meant from her mother and neighbors who naturally supplied their knowledge and shared experiences. Because of this she was not alarmed when her baby lost weight
and was slow to gain, and she continued to breastfeed without
doubt or worry.\textsuperscript{121} But mothers today have no reference group to
turn to because it is unlikely that their own mothers breastfed them.

A family member shared a story of her disappointing
breastfeeding experience in 1990. She really wanted to breastfeed
and despite an adequate amount of breast milk, her baby was not
thriving—at an initial doctor visit she was not gaining weight
according to the growth charts. She also had colic. Her mother told
her that her milk was “no good” and that she needed to bottle-feed.
This didn’t go well as she tried one formula after the other. The
child, now an adult, continues to experience
gastrointestinal difficulties.\textsuperscript{122}

Up until 2006, the only growth charts in use in the U.S. were
based on the growth of formula-fed infants, thus ignoring the
different growth patterns of the normal breastfed infant. Formula-fed
infants are heavier and weigh more early in life than breastfed
infants. The World Health Organization (WHO) growth standards for
breastfed babies came into use at that time and are now
recommended for one- to two-year-olds. The WHO standards
establish growth of the breastfed infant as the norm for growth and
breastfeeding as the recommended standard for infant feeding.\textsuperscript{120}

Generations of breastfed babies and mothers trying to breastfeed
were subjected to the bottle-based growth charts. Consequently
doctors, not familiar with the normal weight gain patterns
of breastfed babies, evaluated an infant’s physical growth by
standards set by bottle-fed infants. Who knows how many mothers
were distressed needlessly when their infants were misdiagnosed with failure to thrive and put on a bottle because their baby was not heavy enough compared to bottle-fed babies?\textsuperscript{120}

Researchers have found that ineffective feeding practices may actually cause an insufficiency of breast milk. A mother’s lack of confidence in the efficacy of the lactation process can lead to a self-fulfilling prophecy whereby milk flow and transfer to the baby is undermined. The mother may then interpret this as representing insufficient milk, making her highly likely to resort to formula, with the result that her milk volume actually diminishes.\textsuperscript{123}

The themes of science, insufficient milk, hungry baby and low weight gain formed a strong basis on which the infant formula industry continues to build. Particularly potent were the messages suggesting that when breast milk was insufficient, infant formula was there to ensure optimum growth and health.\textsuperscript{124}

The science myth was enhanced by medical doctors who in general did not support breastfeeding. There is a well-documented history of collusion between doctors and the infant formula industry. Formula companies openly give hundreds of thousands of dollars to medical professionals. Physicians and nurses in the U.S. routinely receive gifts, office supplies, meals, a year’s supply of free infant formula for themselves or a relative, and even pricey vacations from the infant-formula marketing representatives. They also supply massive amounts of free formula to hospitals. The companies sponsor medical seminars and research studies. Some major medical centers may use more than a quarter of a million
dollars in “free” formula every year. What these hospitals fail to realize is that in essence they are providing free advertising for the formula companies. In fact, some pediatric residency programs are largely underwritten by infant-formula manufacturers, an allegation verified by the National Association of Breastfeeding Advocacy and the International Lactation Consultants Association.\textsuperscript{10}

This strategy works. More than 70 percent of surveyed pediatricians recently reported to the AAP that they recommend a particular brand of infant formula to their patients. Many medical professionals do not inform their patients of the impact these infant feeding choices may have, “due in large part to their own ignorance of the facts.” Doctors and nurses have little exposure to the recent literature or clinical practice in this area. And with successful breastfeeding, the involvement of a doctor is naturally minimal.\textsuperscript{125}

A recent AAP survey revealed that about 45 percent of pediatricians see formula-feeding and breastfeeding as equally acceptable methods for feeding an infant and that “nearly equal proportions of pediatricians agree and disagree as to whether formula-fed babies are just as healthy in the long run as breastfed babies (34 percent vs. 38 percent); 27 percent are undecided.”\textsuperscript{125}

**MATERNITY LEAVE**

Maternity leave during the first several months is critical after the birth of the baby to help support breastfeeding, yet the amount of time a working woman is allowed in the U.S. is shamefully brief compared to other countries. The U.S. is one of only three
countries in the world that does not guarantee paid maternity leave. American women must take vacation or sick days to cover maternity leave. Only 60 percent of all workers are covered by the Family and Medical Leave Act, which allows employees of companies with more than fifty employees to take an unpaid job-protected leave of up to twelve weeks, but this requires at least one year of employment (twenty-five hours or more per week).\textsuperscript{126}

Four states have publicly funded paid maternity leaves: California, New Jersey, Massachusetts and Rhode Island. California offers six weeks paid at 55 percent of salary. New Jersey offers six weeks at two-thirds of salary and Rhode Island pays four weeks at 60 percent. Tech companies offering paid maternity leave include Google, Facebook, Apple, Yahoo, Instagram, Reddit and Twitter.\textsuperscript{127}

In contrast, Slovenia, Germany, Austria and more than one hundred seventy other countries provide generous maternity-childbirth benefits that are not available to mothers in the U.S. The family financial benefits may include both a maternity and parental allowance, assistance payments upon the birth of a child, child benefit or allowance payments up to age five, and a “large family” allowance payment. Maternity leave can consist of twenty-eight to fifty days \textit{before} giving birth with parental leave of four months up to two years after the birth. A midwife or nurse makes home visits at least every day after the birth for a week or more to help with child care and breastfeeding, and at least once a week thereafter for a period of six weeks.\textsuperscript{125}

\textbf{OTHER SOLUTIONS}
More and more women are selling their breast milk online to other mothers who can’t breastfeed. In the past year, somewhere around fifty-five thousand women sold their excess breast milk online, up from thirteen thousand in 2011. No contamination issues have been reported. The FDA does not regulate online breast milk sales but advocates caution in purchasing milk from strangers. Four main internet sites sell breast milk, “Human Milk 4 Human Babies,” “Eats on Feets,” “Only the Breast,” and “Milk Share.”

Joseph A. Ladapo, assistant professor of medicine at New York University School of Medicine supports this form of sharing: “Some parents (including this author) go to considerable lengths to provide their infants with human breast milk because of the body of evidence supporting its health benefits.”

Breast milk donated to milk banks is not an option. It is pasteurized and reserved for pre-term and sick babies.

CONCLUSION
The health and welfare of generations of Americans have been severely compromised through the use of infant formulas. Autism rates are rampant and rising yearly. Diabetes, obesity and heart disease rates have skyrocketed. Many American children develop ADHD, OCD, and other behavioral “diseases” and take dangerous medications. Some breastfeeding mothers have followed the SAD (Standard American Diet) advice and their children are deprived of vital nutrients necessary for growth of the brain and body. Advances in infant formula technology over the years as a result of research, new knowledge, needs of mothers and infants, and the “Band-Aid”
approach have improved the quality of infant formulas but these formulas are still woefully lacking in nutrients and myriad co-factors compared to the breast milk of a well-nourished mother.

Lack of support for breastfeeding is often cited as the main reason that more mothers do not breastfeed. Most women who have children work outside the home. With a new baby, mothers need a great deal of help to cope with just routine matters of everyday life, especially when there are other children in the family. Continuing breastfeeding requires a good deal of planning and most mothers have to return to work within a short period of time.

Rather than developing financial and social support for breastfeeding mothers, granting extended and paid pregnancy and maternity leave, and investing in our collective future by improving the diets of young families, governments and institutions are instead funding transgenic research to try to replicate the unique components of breast milk for commercial formulas, developing GMOs, and looking for new ways to market excess GM soy and corn.

It is just as important to support the mother and family socially and financially as to provide basic knowledge earlier in life, knowledge that the breastfeeding mother needs to know how to produce milk that will nourish her infant. This means a healthy omnivorous diet before pregnancy and throughout breastfeeding with access to pasture-raised clean and healthy foods, knowledge of food preparation techniques, and elimination of sugars, artificial sweeteners, junk and refined foods.
Programs such as “Cooking Kids” in Slovenia, where all young students can learn the value of cooking techniques, reading recipes, traditional foods, and gardening is one way to provide such a path. The “Cooking Kids” model could be easily adapted to cultures willing to recognize the value of basic nutritional principles, traditional foods and their preparation. The Weston A. Price Foundation financially supports this program.¹²⁹

Those families who want to breastfeed are developing their own community breast milk-sharing networks. WAPF chapter leaders are taking the lead throughout the county in providing families in diverse communities with this important information. There remains much work to be done in educating mothers, families, grandparents, and neighbors everywhere about the right to breastfeed their child and how to produce the best possible quality breast milk for our children.

SIDEBARS

INFANT FORMULA RECALLS

There have been over twenty infant formula recalls since 1982. Hazards discovered in formula include:

1. Deficiencies in protein, iron, vitamins A, D, C, B₆, folate, copper, linoleic acid;
2. Contamination with metal, glass, polyvinyl chloride, chlorine, beetle parts, hard plastic, perchlorate (rocket fuel);
3. Contamination with E. sakazakii;
4. Elevated levels of lead, arsenic;
5. Excessive magnesium, vitamins A, D;
6. Incorrect preparation instructions, no label, no instructions, mislabeled;
7. Insufficient processing, peeling can liner, curdling, foul smell;

In 2000, CDC researchers found perchlorate in fifteen brands of powdered infant formula including Similac and Enfamil, two manufacturers that cornered 87 percent of the infant formula market. E. sakazakii is a bacterium that may cause necrotizing enterocolitis among infected infants. Clusters of E. sakazakii infections have been reported in a variety of locations over the past several years among infants fed milk-based powdered infant formula products.16 Melamine and phthalates have also been found in infant formula.17

MAJOR INFANT FORMULA MANUFACTURERS

Three leading brands dominate the infant formula market:
• The most popular formula in the U.S. is the Similac brand, made by Abbott Laboratories, cornering about 43 percent of the market.25 Similac was the first conventional brand to market a GMO-free product in 2015.
• Enfamil, made by Mead Johnson Nutrition, enjoys a 40 percent market share.
• The Gerber Good Start line is made by Nestlé and earns a 15 percent share of the formula market.26
All of these companies contributed sizable amounts to the campaign in California (Proposition 37) to defeat the measure which would require labeling of GMOs. Abbott: $334,500; Mead Johnson: $800,000 and Nestlé: $1,461,600.\(^{26}\) What do they have to hide?

**CONTROVERSIAL INGREDIENT IN ORGANIC INFANT FORMULAS**

Carrageenan, an extract of red seaweed, appears in some organic infant formulas, even though the National Organic Standards Board (NOSB) voted to prohibit it. The Secretary of Agriculture’s decision to disregard the NOSB’s decision reveals the lobbying power and influence of the infant formula industry. Carrageenan is prohibited in both conventional and organic formula in the European Union. The science linking carrageenan to intestinal inflammation is disturbing enough, but what adds insult to injury is that its addition to infant formula is entirely unnecessary. Carrageenan contributes no nutritional value or flavor to formula, or other food, but is added solely to stabilize ready-to-feed formula. Adding carrageenan means parents or caregivers do not have to shake the product before feeding it to the baby. The simple alternative to adding carrageenan is to put a “shake well” label on the bottle. Earth’s Best and Similac Organic ready-to-feed formula, the only liquid organic formulas on the market, both contain carrageenan.\(^{28}\)

**PASSIVE IMMUNITY, VACCINATION AND GCMAF**

A mother can give the gift of immunity to her child in two ways. The first is through breastfeeding when the mother passes specific antibodies, secretory immunoglobulin A (sIgA), to the infant. These
antibodies are the first line of defense for the epithelial tissues that line the cavities and surfaces of blood vessels and organs throughout the body. As a component of the immune system, sIgA blocks pathogens from attaching to intestinal epithelial cells, prevents them and antigens such as toxins from gaining access to the intestinal epithelium, and even controls bacterial colony formation. It also may be involved in the establishment of the newborn’s microbiome. In studies, sIgA, in concentrations at or below those found in human milk, inhibited the binding of Clostridium difficile toxin A to the brush border of intestinal cells.¹

The production of sIgA is very important because the infant does not begin to make her own sIgA until several months of age, and at one year her levels are only 20 percent of adult levels.² The production of sIgA is exclusive to breastfed infants; formula-fed infants do not acquire this protection from formula.

The maternal diet can help to “boost” the secretory sIgA levels transferred to milk, at least in the animal kingdom. In studies, the milk of nursing mice given a fermented milk kefir had increased levels of IgA antibodies.¹

Through these processes the baby learns how to interface with the environment from information passed through the breast milk. Breastfeeding can be viewed as an important part of the immune system maturation process.¹

The second way that a mother transfers immunity to her child is through maternal antibodies called immunoglobulin G (IgG), which
pass through the placenta. IgG is the major antibody in the blood and extracellular fluids, and it binds viruses, bacteria and fungi to protect the body from infection.

The beneficial Bifidobacteria and DNA from many other bacteria present in the mother’s gut also pass into the breast milk through a specific connection. Because of this factor, it is important for mothers to have a healthy microbiome before pregnancy, eat plenty of lacto-fermented foods, and avoid antibiotics, artificial sweeteners, oral contraceptives and other substances that damage the friendly bacteria. For those who are lactose-intolerant and cannot ingest yogurt, kefir and other dairy products, raw sauerkraut, pickles and other mixtures, as well as kombucha, water kefir and other products containing probiotic bacteria can be consumed.

Surprisingly, the baby’s antibodies are stronger than an adult’s. The antibodies that mothers pass to babies can inhibit the formation of vaccine responses throughout the first year of life. “This effect is usually overcome by secondary responses to booster immunization,” say researchers. In fact published research papers show that science is working to squelch this response. Dr. Stefan Niewiesk from Ohio State University suggests that the infant’s response to the mother’s natural antibodies “can be partially overcome by injection of a vaccine-specific monoclonal IgM antibody. IgM stimulates the Bcell directly through cross-linking the BCR via complement protein C3d and antigen to the complement receptor 2 (CR2) signaling complex.”

Studies have shown prolonged protection against illness in...
breastfed infants including:

- Haemophilus influenzae type b (Hib), infection is enhanced by breastfeeding up to ten years after lactation;
- Diarrhea even if solid foods had been introduced during the breastfeeding;
- Respiratory tract infections for nearly seven years compared with those not breastfed;
- Otitis media up to the age of three years.  

Colostrum is the first milk produced immediately after birth up to four days until regular breast milk begins. It is a source of fats, proteins, sugars and micronutrients in the form of vitamins and minerals and a very rich source of secretory IgA, IgG, lactoferrin and other immune substances that grant protection to the newborn. Colostrum establishes the immune system and confers growth and protective factors. It is full of leukocytes, macrophages, polymorphonuclear neutrophils and lymphocytes, which enhance the immature infant’s immune system.

Macrophages are phagocytic cells that are an important part of the immune system. They increase in numbers in response to an infection. These cells recognize, engulf and destroy pathogens, cancer cells and foreign substances, release cytokines, help remove cellular debris and clear away cells that have undergone apoptosis (cell death).

GcMAF, glycoprotein macrophage activating factor, a protein that is made and released into the bloodstream by T cells and B cells, is
important in activating macrophage activity. It has other important physiological functions that include involvement in vitamin D transport and storage, other immune functions, and brain communication and development. GcMAF docks into the surface receptors of macrophages to activate them.\textsuperscript{11}

The precursor for forming GcMAF is vitamin D-binding protein (DBP) which is a glycoprotein (containing sugars). In order to make GcMAF from vitamin D-binding protein, two steps are needed, each catalyzed by a specific enzyme (betagalactosidase and sialidase), which remove these sugars from the molecule. Sialidases interact with sialic acid in various natural substances, including glycoproteins.\textsuperscript{11}

Human milk, including milk from mothers of preterm infants, is a rich source of sugar-bound sialic acid. Relatively small amounts, if any, are found in infant formulas. Sialic acid is highest in colostrum and decreases over time. In animal studies, sialic acid supplementation is associated with increases of gangliosides in the brain and improved learning ability.\textsuperscript{12} The role of sialic acid in breast milk is currently unknown but it may play a role in the activity of GcMAF.

Nagalase, an enzyme made by viruses and cancer cells to cloak their activities from the immune system, disables GcMAF in vivo, resulting in immunosuppression. In the absence of GcMAF, cancers and HIV and other viruses can grow unimpeded.\textsuperscript{11}

In 1990 Dr. Nabuto Yamamoto demonstrated that administration of
GcMAF bypasses the nagalase blockade and re-activates the macrophages, and that it is involved in killing cancer cells, inhibiting their further growth and returning the cancer state to normal. Administration of GcMAF rebuilds a depressed immune system, activates white blood cells, and increases the neuronal activity in the brain. It also leads to increased energy production at the mitochondrial level, reducing symptoms of chronic fatigue syndrome, and improves human neuronal metabolic activity.  

Dr. Marco Ruggiero, a medical doctor, professor of molecular biology and scientific director of Immuno Biotech, found that colostrum contains GcMAF. Along with his team at the University of Florence, he is researching reversing cancer, autism, autoimmune disease and other diseases based on this special molecule and claims cures in this field. Scientists at Immuno Biotech have published sixteen peer-reviewed research papers in 2013 alone, showing evidence that GcMAF rebuilds a depressed immune system.

Ruggiero has been working to produce a food product, starting with a colostrum-enriched yogurt-like product inoculated with probiotic bacteria and vitamin D. He says that when the yogurt arrives in the gut where there are the highest number of microphages in the GALT (gut associated lymph tissue), the immune system of the gastrointestinal tract, it activates the macrophages. Dr. Ruggerio explains that he can basically recreate the primal mammal microbiome using colostrum and other substances like vitamin D, oleic acid and probiotic bacteria.

In 2013 Immuno Biotech introduced “GOleic,” combining colostrum
containing the GcMAF molecule with oleic acid, which can be taken orally in yogurt and also under the tongue, proving effective ways to administer GcMAF to younger children with autism. Dr. Ruggerio stressed the fact that changing the diet and lifestyle is a very important part of the treatment: “Daily vitamin D$_3$, removing sugar and carbohydrates from the diet, decreasing stress, exercise, eating meat and fish are all essential components to beating cancer.”$^{13-14}$ Again we see the importance of adequate levels of vitamin D$_3$ in the body.

Physicians like Dr. Thomas Cowan have discussed the fact that vaccines and other factors can weaken and debilitate the cell-mediated immune system, which eventually leads to the formation of cancer. Dr. Cowan outlined the use of GcMAF in cancer therapy at the 2013 Weston A. Price Conference in his presentation “The Holistic Treatment of Cancer, Part II,” which is available on MP3-CD ROM through Fleetwood.$^{15}$

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**DESTRUCTION OF AMINO ACIDS IN PROCESSING AND HEAT TREATMENT**

Proteins in infant formula are prone to glycation reactions during processing. To ensure safety and extend shelf life, ingredients are blended, pasteurized, homogenized, concentrated, heat sterilized, spray dried and canned up to 130-140°C, which leads to major changes in the compositions of the infant formula. Glycation is the reaction of sugars with amines, amino acids, peptides and proteins at high temperatures, which initially form Amadori products, the first step in a process called the Maillard reaction (MR). Amadori products are degraded via various pathways leading eventually to advanced glycation end products (AGEs). Human milk contains small amounts of these products compared to infant
Heating results in a decrease in the availability of amino acids, mainly lysine, by up to 50 percent. The lysine and lactose react to form lactulosyllysine (LL), an early-stage AGE, which blocks the uptake of the essential amino acid lysine, resulting in loss of absorption, digestibility and nutritional value. LL can break down into furosine (FUR) and the two AGEs N-carboxymethyllysine (CML) and oxalic acid monoalkylamide (OMA), which also can be produced when omega-3 DHA reacts with lysine. Infant formulas may contain CML levels one-hundred-fold higher than human milk. Studies have shown levels of furosine from 932 to 1550 milligrams per 100 grams of protein in infant formulas versus no furosine in breast milk.

Both the high lactose content and the supplementation with whey proteins promote MRs. Supplemental whey powders can already be highly damaged before they are added to the formula. Whey protein used in infant formulas, protein powders and other products are also subjected to thermal processing. During heating, many chemical reactions take place that can drastically decrease the favorable nutritional properties of whey.

In whey-added formulas, lysine becomes significantly even more degraded. Liquid formulas have six times more lysine loss than powders. To compensate for this loss, formula companies add higher protein concentrations in the formula, about twice that of human milk. But increasing protein leads to higher production of AGEs.
Iron and ascorbic acid increase hydroxyl radical formation, lysine glycation and tryptophan oxidation. Vitamin C itself can oxidize to dehydroascorbic acid. Important minerals like zinc, iron and copper can form complexes with MRPs.⁴²

Many MRPs are toxic substances, accumulating in the liver, kidneys and pancreas, causing pathological changes in these organs in laboratory animals. Arginine, methionine, tryptophan and histidine are also similarly affected. MRPs also limit the digestibility of proteins by blocking the availability of a peptide bond for trypsin and carboxypeptidase, and are inhibitors of digestive enzymes.³⁹

The most prevalent protein oxidation product generated during milk processing is methionine sulfoxide, which is formed by oxidation of methionine. Methionine sulfoxide levels can be as high as 64 percent of total methionine in whey protein concentrate and calcium caseinate. Methionine is an essential amino acid and a source of methyl groups for a number of methylation reactions, as well as a source for cysteine required for synthesis of glutathione, the most important antioxidant made by the body. If most of the methionine is oxidized, it is not available for use by the infant.⁴³

Cysteine and tryptophan also can become oxidized. Tryptophan is oxidized to N-formylkynurenine (NFK). NFK is a metabolite of tryptophan associated with tics.⁴⁴

What happens to these products? Except for LL and fructosyllysine, which are bound into peptides, most of the other MRPs are probably fermented by the gut microbiota.⁴⁵ What changes these
substances cause in the microbiota is not known.

A diet high in AGEs shows development of inflammation mediators and decreased insulin sensitivity in animals and humans. Experimental studies show that AGEs themselves may start the insulin resistance process in muscles and decrease the insulin content in the pancreas. Higher protein content, lower concentrations of long chain polyunsaturated fatty acids, and presumably the lack of insulin-sensitizing hormones, as well as numerous other biologically active substances in infant formulas in comparison with breast milk, are thought to play a pathophysiological role in formula feeding associated decreased insulin sensitivity. Recently, it has been suggested that food-derived AGEs in AGE-rich infant formulas might precondition infants to insulin resistance via induction of inflammation and oxidative stress.46

Recognized as dangerous by the EPA and FDA, acrylamide, identified in 2002, is a known carcinogen and human neurotoxicant formed in food as a result of a heat-induced reaction between two naturally occurring ingredients, the amino acid asparagine and sugars. The FDA detected acrylamide in two out of twelve brands of infant formula they tested: Enfamil Milk-Based Infant Formula with Iron (powdered) and Similac Infant Formula with Iron. Babies may be more sensitive to the neurotoxic impact of acrylamide because of their immature nervous systems. Early epidemiological studies have found an association between acrylamide intake and the occurrence of tumors.47

The consumption of MRPs has increased in recent decades along
with evidence that these substances may participate in pathological processes such as cataract formation, diabetes, degenerative diseases, atherosclerosis and chronic renal failure. The amount of AGES in formula may exceed that in breast milk up to six-hundred-seventy-fold. In addition to toxic AGES and MRPs, “a significant decrease of nutritive value of infant formulas occurs during their production, relative to the nutritive value declared by the manufacturers.” It is unknown whether manufacturers prepare nutritional labeling on the basis of ingredients before or after processing. Thermal processing takes a huge toll on the nutritional content of the formulas as well as creating harmful substances which are not present before production.48

**SOY-BASED INFANT FORMULA**

The most damaging and experimental artificial formula on the market is soy-based formula. Approximately 20–25 percent of infants in the U.S. now receive some soy-based formula during their first year, but no data exist regarding how many are exclusively fed soy formula.52 The current position of the American Academy of Pediatrics (AAP) is that there is “no conclusive evidence from animal, adult human, or infant populations that dietary soy isoflavones may adversely affect human development, reproduction, or endocrine function.” On the other hand the AAP also clearly advises that breast milk is the best food for babies and that soy-based formula must only be used in the case of galactosemia, a life-threatening condition in which the infant cannot tolerate lactose.52

In 2014 the Center for Food Safety, a national advocacy
organization, purchased soy-based infant formulas in order to test for the presence of GM (genetically modified) ingredients. Similac Soy Isomil and Enfamil Prosobee Powder Soy Infant Formula both tested positive for GM soy, which is genetically engineered for resistance to Monsanto’s herbicide Roundup and its active ingredient glyphosate. “I think most moms purchasing infant formula have no idea they are feeding their baby a product that has been genetically engineered to survive exposure to high levels of chemical pesticides,” said Aurora Paulsen, with the Center’s Portland office. Farmers spray Roundup on their soy crops several times during the growing season. Glyphosate is a systemic herbicide, which means that it is absorbed through the foliage and relocated internally throughout the plant structure, including the soy beans. It cannot, therefore, be “washed off.”

Soy-fed infants receive large amounts of phytoestrogens, which are estrogen-like compounds. The infant consuming soy formula has blood levels of these compounds thirteen thousand to twenty-two thousand times higher than children on milk-based formula or, according to toxicologist Michael Fitzpatrick, the equivalent of five to six birth control pills a day. Experiments with animals show many hormonal abnormalities in those fed soy-based formulas.

The late Dr. Mary Enig, past President of the Maryland Nutritionists Association and co-founder of the Weston A. Price Foundation, reviewed the literature and found that high levels of phytoestrogens in soy formula have been implicated in increasingly earlier sexual maturity in girls and delayed or slowed sexual development in boys.
Problems with nutritional deficiencies in babies resulting from soy formula feeding were never pre-determined but only addressed after the babies suffered harm. The first soy formulas made in 1929 and later were made with soy flour and caused major digestive troubles. In 1960 a formula with soy protein isolate was introduced.\textsuperscript{54}

Soy protein isolate is 90 percent protein; it is high in arginine, aspartic acid, glutamic acid, and leucine, and low in methionine, tryptophan and cysteine.\textsuperscript{56} It contains no lactose and only polyunsaturated fatty acids (PUFA) in the form of linoleic acid, and a small amount of linolenic acid. It is high in sodium, phosphorus and manganese and low in magnesium and iron.\textsuperscript{56} High manganese levels have been implicated in behavioral problems in children. Soy protein isolate is also contaminated with high amounts fluoride, aluminum and cadmium.\textsuperscript{54}

Soy protein is low in tryptophan and thermal processing further destroys and/or degrades tryptophan as well. Neither the brain nor the body can make this essential amino acid—it must come from the diet. The soy-fed infant brain is starving for tryptophan needed to make the neurotransmitter serotonin. This pattern of low levels of serotonin may come into play years later. In many studies, persons who display aggressive behaviors, who attempt violent suicide, commit impulsive murders, those with ADHD, and depression show low levels of serotonin.\textsuperscript{57-58}

Soy proteins contain anti-nutrients that are not totally removed by processing. The following harmful substances can be found in
soy-based formula:

• Lectins are sugar-binding proteins that adhere to intestinal cells causing inflammation and toxicity. They are resistant to digestive enzymes and the cooking process. Associated with leaky gut, they invade the blood and are suspected of causing disease. Many lectins are powerful allergens. They also may inhibit leptin, a hormone made by adipose cells which inhibits hunger and this dysregulation may be one of the ways that feeding infant formula encourages obesity and weight gain in infants and later in life.59
• Protease inhibitors are substances that inactivate some key digestive enzymes like trypsin and chymotrypsin and are associated with pancreatitis and pancreatic enlargement.
• Phytic acid compounds in plants bind tightly with minerals and are a leading cause of poor growth, immune system dysfunction, iron and zinc deficiencies and other problems. Soy beans contain more phytates than other plants.
• Saponins are associated with leaky gut and inhibit important major enzymes like trypsin and chymotrypsin. Causing enlargement of thyroid, they may also be goitrogens which inhibit production of thyroid hormone.
• Oxalates are compounds in foods that prevent the proper absorption of calcium and are related to kidney stones and vulvodynia.
• Goitrogens are substances which block the synthesis of thyroid hormone causing goiter, an enlarged thyroid, or thyroid dysfunction. They are powerful endocrine disruptors. The phytoestrogens in soy are goitrogens.54

Higher levels of fluoride are reported in soy formula than in cow’s
milk formulas but reducing levels is difficult because the fluoride binds to the phytate and tricalcium phosphate in the mix. The CDC recently reported an increased prevalence of dental fluorosis—damage to the enamel of the teeth which is a sign of excessive fluoride intake—in children’s teeth in both fluoridated and non-fluoridated communities and indicated that American children were ingesting too much fluoride. Human breast milk contains virtually no fluoride, a mere four parts per billion, about two hundred fifty times less fluoride than is added to water in fluoridation programs. Infants fed formula made with fluoridated water ingest the highest fluoride dose from water of all age groups in the population. In 2007 the American Dental Association warned that parents of children under one year “should consider using water that has no or low levels of fluoride” when mixing baby formula, due to concerns about fluorosis.

Growth and bone development can become problematic in infants fed soy-based formula because of resulting low methionine levels and poor retention of calcium and/or phosphate in the infant, and the absence of lactose in the formula which is a stimulator of calcium absorption. Phytates bind minerals and make them unavailable for bone building.

A 2013 study by Cara J. Westmark at the University of Wisconsin associated soy-based infant formula with specific behaviors, particularly deficits in language, communication, social overtures, and hypersensitivity to environmental stimuli in autistic children. In 2014 she also found indications that soy-based formula was associated with increased seizure susceptibility and incidence of
neuronal disease in mice and human models.62

**INFANT FORMULA WITH IRON AND LOWERED INTELLIGENCE**

Despite the use of whole milk from various animals for centuries as a substitute for human milk, a strong trend away from early introduction of cow’s milk between 1971 and 1998 related to a number of studies reported in the 1960s-1980s showing that consumption of pasteurized cow’s milk could cause gastrointestinal blood loss in infants with related iron deficiency anemia.¹ In 1971, a policy statement recommended that iron-fortified formula be used during the first year of life. In 1976, iron-fortified formula or infant cereal was also recommended during older infancy because of feared blood loss. In 1983 the American Academy of Pediatrics (AAP) recommended the use of cow’s milk in infants older than six months of age which could replace iron-fortified formula when they consumed one third of calories from supplemental foods. But in 1992 the Academy changed its mind and recommended that cow’s milk not be used until after the first year of life because of the risk of reported large fecal blood loss and anemia associated with pasteurized cow’s milk. Blood loss did not seem to occur in babies fed cow-based formulas, only in those fed pasteurized cow’s milk.² Studies by George Fuchs in 1993 at the Louisiana State University Medical School found that infants fed whole cow’s milk are at increased risk of developing iron depletion but the iron insufficiency is not due to gastrointestinal blood loss.³

On the AAP recommendation, many more infants were fed iron-fortified formulas than ever before. From 1971 to 1991 much of this can be accounted for by the increased enrollment in the
USDA’s WIC (Women, Infants and Children) program and provision of free formulas, which began in the early 1970s. Because of the AAP position that all infants receive either breast milk or iron-fortified formula for the first year of life, WIC only distributes low-iron formula for infants who have serious medical conditions. Otherwise many of these infants would have been fed cow’s milk.  

In addition to feeding iron-fortified formula to infants over six months of age, the AAP later advocated feeding high iron (12 milligram/liter) versus low iron (2.3 mg/L) formula to infants for one year after six months of age, further increasing the use of infant formula. Iron-fortified formula can have iron levels twenty times higher than breast milk, and higher still in soy formula compared with cow-based formula. During storage, iron content can increase two milligrams per liter with total iron as high as 20 mg/L. The more iron added the less absorbed: 6 percent of ferrous sulfate is absorbed per liter when 6 mg are added; when 12 mg/L are added only 4 percent is absorbed. European manufacturers have changed to lower levels of iron because of these effects. What happens to the unabsorbed iron is unknown.  

Infants need iron primarily for growth. At birth infants of well-fed mothers have adequate iron stores which last until four months of age. Breastfed infants can develop an iron deficiency after six months depending on the diet of the mother. By this time, solids are introduced and liver and egg yolk can contribute adequate iron to the baby’s diet. Today’s medical advice to feed rice cereal as a first food is unfortunate as the iron in baby cereal is not well absorbed and extra iron can cause constipation.
When the AAP made their recommendations, they did not consider the effects of extra iron in the infant’s diet. A ten-year randomized follow-up study of almost five hundred infants found that healthy, well-nourished children fed high iron-fortified formula as infants scored an average of eleven points lower on IQ tests at ten years of age than similar children fed low-iron formula, according to the Pediatric Academic Societies and Asian Society Pediatric Research Joint Meeting. The low iron group had higher scores “on every outcome” at ten years of age. The findings were significant for spatial memory and visual motor integration and suggestive for IQ, visual perception and motor coordination compared with those in the high iron-fortified group, who scored lower on all of these measures. “The results raise the possibility that long-term development is adversely affected in iron sufficient infants who receive formula fortified with iron at the level commonly used in the United States.”

“Mother’s milk is very low in iron and formula makers have seized on this fact to promote iron-fortified formula as an improvement on Mother Nature,” says Dr. Naomi Baumslag, Clinical Professor of Pediatrics at Georgetown University Medical College and President of the Woman’s International Public Health Network. She points out that mother’s milk is low in iron for at least two reasons: low iron levels in human milk contribute to its antiviral effects and iron competes with zinc for absorption. The human infant needs a plentiful supply of zinc for the development of brain and nervous system. Iron also interferes with calcium and copper absorption. Iron-fortified soy-based formulas are especially problematic because they contain low levels of bioavailable zinc.
Mother’s milk also contains lactoferrin, an anti-infective agent which prevents iron from becoming bioavailable to pathogenic microbes in the infant intestine. Iron in formula can cause lactoferrin in breast milk to become saturated, which impairs its antibacterial effects.\textsuperscript{13}

Ascorbic acid (vitamin C) is usually added to infant formula to increase intestinal absorption of iron. However, ascorbic acid is a very potent glycating agent.\textsuperscript{14} Iron and ascorbic acid promote advanced glycation end-product (AGE) formation and tryptophan degradation in infant formula.\textsuperscript{14} AGEs induce inflammation, enhance oxidative stress, insulin resistance, kidney damage and promote atherosclerosis.\textsuperscript{15}

In the late 1960s and early 70s, iron administration in the presence of vitamin E deficiency was found to lead to hemolytic anemia in low-birth-weight infants, especially with the consumption of an infant formula that was rich in polyunsaturated fatty acids. Under these conditions, iron at the level present in iron-fortified infant formula catalyzed oxidative damage to the red blood cell membrane. Despite addition of vitamin E, iron fortification in the low birthweight infants still causes decreases in serum vitamin E.\textsuperscript{16}

“Dietary iron may result in a major change in the intestinal flora with consequences that carry important health implications.” In studies, infants fed iron-fortified formula had high counts of E.coli and clostridia, but low counts of bifidobacteria, the major beneficial microorganism in the infant gut.\textsuperscript{17} Despite these conflicting results, the AAP recommendation still stands, resulting in greater use of iron-fortified formulas and formulas in general in older infants who
would normally have received cow’s milk.\(^{18}\)

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**ALL FORMULAS, EXCEPT ORGANIC, CONTAIN GENETICALLY MODIFIED INGREDIENTS**

Similac, Enfamil, and Gerber Good Start—which combined account
for more than 90 percent of all infant formula sales in the U.S.—expose North American babies to potentially grave health risks by using genetically modified ingredients according to GMO Inside.org.  

According to pediatrician Dr. Michelle Perro, infant livers do not reach maturity for about two years and therefore are less equipped to process toxins in the body, such as the herbicides used when growing genetically modified crops. “Because of the toxic effects of herbicides, particularly glyphosate (due to its prolific usage) as well as other organophosphates and genetically engineered foods in non-organic commercial formulas, these are not an option for infant feeding. In order to ensure the health of our infants and children, there is no amount of acceptable herbicide or GMO that should be in their diets.”

Several of the ingredients likely to be genetically modified are sugar, maltodextrin, soy, and even the milk base (GM-derived bovine growth hormones). The effects of feeding GMOs to tiny infants and babies are unknown. A search of Pub Med archive at the National Library of Medicine revealed no studies.

**NUCLEOTIDES AND INFANT GROWTH RATES**

Nucleotides (adenylic acid, guanylic acid, cytidylic acid, and uridylic acid) are non-nitrogenous substances that occur naturally in breast milk. They are the building blocks of RNA and DNA necessary for cell growth and proliferation.

Nucleotides were added to baby formula in 1990. They are
commercially produced from hydrolyzed yeasts which undergo multiple chemical changes in order to allow extraction of the nucleotides, including heating to denature proteins, cell wall proteolysis, enzymatic hydrolysis and dehydration. In a random-controlled study led by Dr. Singhal and published in Pediatrics in 2010, researchers revealed that nucleotide supplementation increased weight gain and head growth in formula-fed infants. Previous randomized trials had not shown an advantage for supplementing with nucleotides. It was originally proposed that nucleotides would help infants who were small for gestational age or those with the diagnosis failure to thrive (FTT). However, controversy exists as to the benefits of faster weight gain, and the slower weight gain that occurs in breastfed infants compared with formula-fed infants may be more beneficial.85

Thirty years ago Michael Crawford, author of What We Eat Today, wrote that if a factor accelerates growth, it is deemed beneficial but “from comparative biology it is clear that animals that grow the fastest are always the least intelligent.”86

SYNTHETIC VITAMIN A IN INFANT FORMULA
Infant formula manufacturers strive to emulate the content of mother’s milk in their products. It’s an absolute necessity to add specific vitamins like vitamin A. If not, babies would suffer irreparable harm in body and brain growth. Vitamin A is absolutely vital in the health, development and maintenance of skin, vision, immune system, gene transcription, bone metabolism, antioxidant activity, and other body systems both before and after birth. The active form, retinoic acid, affects many downstream target genes.1
Natural sources of vitamin A are animal products such as liver, butter and cold water fish, which provide the “cis” form of vitamin A\(^2\) versus the cheap and artificial “trans” form, retinyl palmitate, which manufacturers put into infant formulas, refrigerated fluid milk products, and other products that are fortified with vitamin A.\(^3\) Retinyl palmitate was first made in 1942 by esterifying crystalline vitamin A with a halide.\(^4\) The natural form and the synthetic are not equivalent.\(^3\)

Poly Vi-Sol vitamin drops and other vitamin supplements for babies contain retinyl palmitate per milliliter (one serving size).\(^5\)

The activity of one International Unit of vitamin A (equivalent to a USP unit) is contained in 0.3 μg (microgram) of all trans retinol and in 0.55 μg of trans retinol palmitate. Each gram of retinyl palmitate contains approximately 9 milligrams of butylated hydroxytoluene (BHT) to retard oxidation.\(^3\) BHT is a toxic petroleum product.\(^6\) Baby formula contains the synthetic retinyl palmitate with BHT added unless indicated otherwise on the label.

According to the Federal Food, Drug, and Cosmetic Act, retinyl palmitate is recognized as safe (GRAS status) with no limitation for use in infant formula\(^7\) despite evidence that it is toxic to various cells and organs,\(^8\) is a tumor promoter,\(^9\) weakens the immune system,\(^10\) affects the nervous system and behavior,\(^11\) and has negative effects on sperm and egg production, reproduction, and development.\(^12\)

As early as 1974, a study by Stoke and Scudder reported that when
BHT was fed to pregnant mice, it reduced the cholinesterase and serotonin in the brain of their offspring to half the normal levels. BHT can damage DNA when ingested at the officially sanctioned level of daily intake.¹³

BHT is not always listed on product labels. If the product contains oil or other secondary ingredients, preservatives in those ingredients may not be listed.⁶

The vitamin A content of breast milk is influenced by diet. The breast milk content of well-nourished mothers is much higher in preformed vitamin A than those of poorly nourished mothers. The vitamin A content changes dramatically with the stage of lactation. Levels of vitamin A are many times higher in colostrum and early milk than in later, mature milk. Bilesalt-stimulated lipase in human milk assists in the absorption of preformed vitamin A. The contribution of carotenoids and beta-carotene (pre-vitamin A in vegetables) to breast milk vitamin A levels is much less than pre-formed vitamin A provided by animal products. Preformed vitamin A is a mixture of retinol and retinyl-fatty acid esters.¹⁴

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**FOLIC ACID IN INFANT FORMULA**

In a 2005 paper, Mark Lucock from the University of Newcastle,
Australia, and Zoe Yates from the University of Leeds, U.K., suggested that folic acid fortification and supplement use might be “a genetic time bomb.” They were referring to the high levels of folic acid to which the unborn are subjected, which continue after birth and have the potential for serious epigenetic effects.¹ Folic acid is added to all baby formulas.

The terms folate and folic acid (FA) are used interchangeably, but they are not one and the same and do not possess the same properties. Follates are water-soluble B vitamins occurring in foods such as organ meats and green leafy vegetables in the form L-5-MTHF (methyltetrahydrofolate) while FA, the synthetic form used in supplements and fortified foods, was synthesized in 1943 at Lederle Laboratories.²⁻³ FA is 100 percent bioavailable unlike folates in food, which are 50-80 percent available. More FA is therefore absorbed by the body for metabolism. Follates are utilized by the infant for life-supporting functions such as methylation reactions, synthesis of amino acids, and RNA and DNA replication.²⁻³

Follates and FA are metabolized differently by the body. FA metabolism requires a two-step process with the same enzyme, dihydrofolate reductase. At certain levels, occurring even at 400 micrograms (μg), which is the recommended daily allowance, this enzyme can become saturated. At this point un-metabolized folic acid (UMFA) passes into the bloodstream by passive diffusion.⁴ UMFA has been detected in the blood of the newborn’s umbilical cord in mothers who did and did not take prenatal vitamins. In 2005 M.R. Sweeney and colleagues found UMFA in the cord blood of all
the four-day-old infants they tested. Others have replicated these findings. The effects of excess UMFA on the newborn and other groups are unknown.

Pregnant women today ingest much higher levels of FA from prenatal vitamins and diet than in the pre-1990 era. Average FA exposure increased after 1998 when the U.S. and Canada, without long-term studies, instituted mandatory fortification of all commercial grain products with FA solely to prevent neural tube defects (NTDs)—structural defects, such as spina bifida, that can occur anywhere along the neuroaxis from the brain to spinal cord between seventeen to twenty-eight days after conception. The United Kingdom Standing Advisory Committee on Nutrition estimated that 370,000 to 780,000 people would be exposed to higher levels of folic acid for each potential NTD infant saved.

Studies have shown, however, that FA fortification is not successful in reducing NTDs among high-risk groups, such as obese or Hispanic women, nor in women with epilepsy taking anti-seizure medication. Most countries do not require fortification of the food supply with FA.

In addition, since 1991 the U.S. government has recommended the use of 400 μg of FA daily during pregnancy and for all women of reproductive age, and 4000 μg daily beginning one month before attempting conception and continuing through the first three months of pregnancy. The U.S. Preventive Task Force recommends 400-800 micrograms daily of FA for all women planning or capable of pregnancy.
For babies, this means higher levels of FA throughout life, not only in the uterine environment, but in infant formulas which are fortified with synthetic FA by law. Because of the rapid rise of autism rates in the 1990s after fortification with FA, some researchers have pointed the finger at this dubious public health measure as a possible cause of autism. In the United States, reported cases of autism have increased significantly since food fortification with FA.

A high FA intake continues throughout childhood with the ingestion of cereals and other grain products. Today the typical five-year-old in America has the highest blood levels of FA (780 μg/d) per day of all groups, double the proposed untested tolerable upper limit (300–400 μg/d) for children of that age. Around 10 percent of these children are consuming 1320 μg per day, which is well above the tolerable upper limit of 1000 μg per day for adults. The second highest group for FA levels is children ages six to eleven years, and the third highest concentrations occur in sixty-year-olds.

In the meantime, research has shown that FA does not prevent NTDs in all women at risk and that some groups in the population are “folic acid resistant.” It’s estimated that 30-40 percent of the population can’t efficiently convert synthetic folic acid into folate. About 10-15 percent of the population has a common genetic error called a single nucleotide polymorphism in the folate enzyme MTHFR, which could account for this resistance. People with certain MTHFR mutations do not process FA acid into 5-MTHF and need folate not FA. Certain groups have much higher levels of this error, such as U.S. Hispanics, Southern Europeans, and the
English and Irish. This genetic propensity is relatively new and some have speculated that the high levels of unmetabolized FA contribute to the problem. In Spain, for example, the prevalence of this polymorphism has reportedly doubled since the introduction in 1982 of FA supplements for women in early pregnancy.\textsuperscript{14}

The enzyme can still function with polymorphisms but its efficacy is greatly reduced. A copy of one polymorphic gene from one parent results in a 40 percent loss of function in the MTHFR enzyme, while in the case of an affected gene from each parent there is a 75 percent loss of function.\textsuperscript{15}

Pregnant women with the folate polymorphism are considered at high risk for spontaneous abortion, stillbirth, and giving birth to babies with brain lesions.\textsuperscript{16} This mutation is associated with a two-to four-fold increased risk of NTD if the mother has two copies of the defective gene (homozygous).\textsuperscript{17} In a 2010 Italian study of forty-two high-risk pregnancies in women with the folate polymorphism, in which all women were supplemented with heparin, aspirin, and FA, two women lost their babies, four were lost before delivery, and six had babies with hemorrhagic cerebral lesions.\textsuperscript{18}

Breast milk contains levels of natural folate (5-MTHF) but FA supplementation may interfere with that process. In a 2015 double-blinded randomized placebo controlled trial (the gold standard for clinical trials) of over fifty pregnant women, with one group taking 1 mg of FA daily for four weeks, Lisa Houghton and her research team found that with supplementation the red blood cell levels
increased but the levels of folate in breast milk did not change. Instead, she found un-metabolized FA in breast milk in both supplemented and non-supplemented mothers, and a down-regulation of the natural folate-binding protein needed to take the folate into the breast milk.

Another problem with synthetic FA is that high supplemental intakes mask B$_{12}$ deficiency, which is related to adverse neurological outcomes and microcytic anemia. In India, FA but not B$_{12}$ is mandatory for all pregnant women despite the high rate of vegetarianism, which can predispose the mother to low B$_{12}$ levels. It was in India, in fact, that the British researcher Dr. Lucy Wills, working with women with anemia during the 1920s and 1930s, discovered a factor in Marmite, an inexpensive British yeast product, which was first called “Wills Factor,” then later folate, which cured the women of anemia. In a 2013 Indian study, babies born of mothers with low B12 and high folic acid supplementation were small for gestational age, a risk factor for normal growth. B$_{12}$ is an emerging pregnancy and natal concern linked to NTDs, preeclampsia, placental abruption, pregnancy loss, hyperhomocysteinemia, and intrauterine growth restriction (small for gestational age).

Because the folate receptor in the brain also has an affinity for FA, at certain levels unmetabolized FA may tie up the receptor and effectively block the transport of folate needed in the brain through the brain-blood barrier. The effects of unmetabolized FA in the brain are unknown. However, a condition among some autistic children
called cerebral folate deficiency (CFD) occurs when auto-antibodies to the folate receptor prevent folate from entering the brain. The autoantibody has been found in some mothers with the MTHFR mutation who have given birth to babies with NTDs. Among many other functions, the brain uses MTHF to form tetrahydrobiopterin, a crucial cofactor in the synthesis of serotonin, norepinephrine and dopamine. Thus far no studies have examined the link between unmetabolized folic acid and CFD.

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### FACTORS IN HUMAN MILK

Human milk contains many factors not found in commercial formula, which are unique and affect nutritional status and growth and development of the infant:

- Enzymes: amylase, proteases and lipases.
- Growth factors and hormones: epidermal growth factor, erythropoietin, insulin, insulin-like growth factors I and II, lactoferrin, lipase, nerve growth factor, relaxin, transforming growth factor-

...
alpha.
• Various hormones and growth factors such as adipokines (leptin and adiponectin) as well as ghrelin, resistin, and obestin, which are thought to control food intake and energy balance and induce satiety and self-regulation of intake. Adiponectin, a circulating adipocyte protein, is associated with lower obesity. Breastfed infants are rarely obese. Breast milk also contains a unique number of anti-infective or immunological properties and other substances.\textsuperscript{115}
• The high concentration of biopterin in human milk suggests that biopterin has a vital role in fetal development. Tetrahydrobiopterin (BH4) is the essential cofactor for the breakdown of essential amino acids and in the biosynthesis of neurotransmitters. In cells it enhances the release of dopamine and serotonin. Biopterin also serves as the cofactor for production of nitric oxide enzymes. Formulas contain only trace amounts of biopterin.\textsuperscript{116}

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