

# A Comparison of Human Milk and Formula



Mothers' Milk Bank  
Colorado Based. Nationwide Impact.

## HUMAN MILK

### WATER

### CARBOHYDRATES

(energy source)  
Lactose  
Oligosaccharides (see below)

### CARBOXYLIC ACID

Alpha hydroxy acid  
Lactic acid

### PROTEINS

(building muscles and bones)  
Whey protein  
Alpha-lactalbumin  
- HAMLET (Human Alpha-lactalbumin Made Lethal to Tumor Cells)  
Lactoferrin  
Many antimicrobial factors (see below)  
Casein  
Serum albumin

### NON-PROTEIN NITROGENS

Creatine  
Creatinine  
Urea  
Uric acid  
Peptides (see below)  
Amino Acids (the building blocks of proteins)  
Alanine  
Arginine  
Aspartate  
Cystine  
Glutamate  
Glycine  
Histidine  
Isoleucine  
Leucine  
Lysine  
Methionine  
Phenylalanine  
Proline  
Serine  
Taurine  
Theronine  
Tryptophan  
Tyrosine  
Valine  
Carnitine (amino acid compound necessary to make use of fatty acids as an energy source)  
Nucleotides (chemical compounds that are the structural units of RNA and DNA)  
5'-Adenosine

monophosphate (5'-AMP)  
3'5'-Cyclic adenosine monophosphate  
(3'5'-cyclic AMP)  
5'-Cytidine monophosphate (5'-CMP)  
Cytidine diphosphate choline (CDP choline)  
Guanosine diphosphate (UDP)  
Guanosine diphosphate-mannose  
3'-Uridine monophosphate (3'-UMP)  
5'-Uridine monophosphate (5'-UMP)  
Uridine diphosphate (UDP)  
Uridine diphosphate hexose (UDPH)  
Uridine diphosphate-N-acetylhexosamine (UDPAH)  
Uridine diphosphoglucuronic acid (UDPGA)  
Several more novel nucleotides of the UDP type

### FATS

Triglycerides  
Long-chain polyunsaturated fatty acids  
Docosahexaenoic acid (DHA)  
- Linoleic acid  
- Alpha-linolenic acid (ALA)  
- Eicosapentaenoic acid (EPA)  
- Conjugated linoleic acid (Rumenic acid)  
Free Fatty Acids  
Monounsaturated fatty acids  
- Oleic acid  
- Palmitoleic acid  
- Heptadecenoic acid  
Saturated fatty acids  
- Stearic  
- Palmitic acid  
- Lauric acid  
- Myristic acids  
Phospholipids  
Phosphatidylcholine  
Phosphatidylethanolamine  
Phosphatidylinositol  
Lysophosphatidylcholine  
Lysophosphatidylethanolamine  
Plasmalogens  
Sphingolipids  
Sphingomyelin  
Gangliosides  
- GM1  
- GM2  
- GM3

Glucosylceramide  
Glycosphingolipids  
Galactosylceramide  
Lactosylceramide  
Globotriaosylceramide (GB3)  
Globoside (GB4)  
Sterols  
Squalene  
Lanosterol  
Dimethylsterol  
Methosterol  
Lathosterol  
Desmosterol  
Triacylglycerol  
Cholesterol  
7-dehydrocholesterol  
Stigma-and campesterol  
7-ketocholesterol  
Sitosterol  
β-lathosterol  
Vitamin D metabolites  
Steroid hormones

### VITAMINS

Vitamin A  
Beta carotene  
Vitamin B6  
Vitamin B8 (Inositol)  
Vitamin B12  
Vitamin C  
Vitamin D  
Vitamin E  
a-Tocopherol  
Vitamin K  
Thiamine  
Riboflavin  
Niacin  
Folic acid  
Pantothenic acid  
Biotin

### MINERALS

Calcium  
Sodium  
Potassium  
Iron  
Zinc  
Chloride  
Phosphorus  
Magnesium  
Copper  
Manganese  
Iodine  
Selenium  
Choline  
Sulphur  
Chromium  
Cobalt  
Fluorine  
Nickel

### METAL

Molybdenum (essential element in many enzymes)

### GROWTH FACTORS

(aid in the maturation of the intestinal lining)  
Cytokines  
interleukin-1β (IL-1β)  
IL-2  
IL-4  
IL-6  
IL-8  
IL-10  
Granulocyte-colony stimulating factor (G-CSF)  
Macrophage-colony stimulating factor (M-CSF)  
Platelet derived growth factors (PDGF)  
Vascular endothelial growth factor (VEGF)  
Hepatocyte growth factor -α (HGF-α)  
HGF-β  
Tumor necrosis factor-α - Interferon-γ  
Epithelial growth factor (EGF)  
Transforming growth factor-α (TGF-α)  
TGF β1  
TGF-β2  
Insulin-like growth factor-I (IGF-I) (also known as somatomedin C)  
Insulin-like growth factor- II  
Nerve growth factor (NGF)  
Erythropoietin

### PEPTIDES

(combinations of amino acids)  
HMFG I (Human growth factor)  
HMFG II  
HMFG III  
Cholecystokinin (CCK)  
β-endorphins  
Parathyroid hormone (PTH)  
Parathyroid hormone-related peptide (PTHrP)  
β-defensin-1  
Calcitonin  
Gastrin  
Motilin  
Bombesin (gastric releasing peptide, also known as neuromedin B)  
Neurotensin  
Somatostatin

### HORMONES

(chemical messengers that carry signals from one cell, or group of cells, to another via the blood)  
Cortisol  
Triiodothyronine (T3)  
Thyroxine (T4)  
Thyroid stimulating hormone (TSH) (also known as thyrotropin)  
Thyroid releasing hormone (TRH)  
Prolactin  
Oxytocin  
Insulin  
Corticosterone  
Thrombopoietin  
Gonadotropin-releasing hormone (GnRH)  
Leptin (aids in regulation of food intake)  
Ghrelin (aids in regulation of food intake)  
Adiponectin  
Feedback inhibitor of lactation (FIL)  
Eicosanoids  
Prostaglandins (enzymatically derived from fatty acids)  
- PG-E1  
- PG-E2  
- PG-F2  
Leukotrienes  
Thromboxanes  
Prostacyclins

### ENZYMES

(catalysts that support chemical reactions in the body)  
Amylase  
Arylsulfatase  
Catalase  
Histaminase  
Lipase  
Lysozyme  
PAF-acetylhydrolase  
Phosphatase  
Xanthine oxidase

### ANTI-PROTEASES

(thought to bind themselves to macromolecules such as enzymes and as a result prevent allergic and anaphylactic reactions)  
a-1-antitrypsin  
a-1-antichymotrypsin

### ANTIMICROBIAL FACTORS

(are used by the immune system to identify and neutralize foreign objects, such as bacteria and viruses.)  
Leukocytes (white blood cells)  
Phagocytes  
- Basophils  
- Neutrophils  
- Eosinophils  
Macrophages  
Lymphocytes  
- B lymphocytes (also known as B cells)  
- T lymphocytes (also known as T cells)  
sIgA (Secretory immunoglobulin A) (the most important anti-infective factor)  
IgA2  
IgG  
IgD  
IgM  
IgE  
Complement C1  
Complement C2  
Complement C3  
Complement C4  
Complement C5  
Complement C6  
Complement C7  
Complement C8  
Complement C9  
Glycoproteins  
Mucins (attaches to bacteria and viruses to prevent them from clinging to mucousal tissues)  
Lactadherin  
Alpha-lactoglobulin  
Alpha-2 macroglobulin  
Lewis antigens  
Ribonuclease  
Haemagglutinin inhibitors  
Bifidus Factor (increases growth of Lactobacillus bifidus - which is a good bacteria)  
Lactoferrin (binds to iron which prevents harmful bacteria from using the iron to grow)  
Lactoperoxidase  
B12 binding protein (deprives microorganisms of vitamin B12)  
Fibronectin (makes phagocytes more aggressive, minimizes inflammation, and repairs damage caused by inflammation)  
Oligosaccharides (more than 200 different kinds!)

## FORMULA

### WATER

### CARBOHYDRATES

Lactose  
Corn maltodextrin

### PROTEIN

Partially hydrolyzed reduced minerals whey protein concentrate (from cow's milk)

### FATS

Palm olein  
Soybean oil  
Coconut oil

High oleic safflower oil (or sunflower oil)  
M. alpina oil (Fungal DHA)  
C.ohnii oil (Algal ARA)

### MINERALS

Potassium citrate  
Potassium phosphate  
Calcium chloride  
Tricalcium phosphate  
Sodium citrate  
Magnesium chloride  
Ferrous sulphate  
Zinc sulphate

Sodium chloride  
Copper sulphate  
Potassium iodide  
Manganese sulphate  
Sodium selenate

### VITAMINS

Sodium ascorbate  
Inositol  
Choline bitartrate  
Alpha-Tocopheryl acetate  
Niacinamide  
Calcium pantothenate  
Riboflavin

Vitamin A acetate  
Pyridoxine hydrochloride  
Thiamine mononitrate  
Folic acid  
Phylloquinone  
Biotin  
Vitamin D3  
Vitamin B12

### AMINO ACID

Taurine  
L-Carnitine (a combination of two different amino acids)

### ENZYME

Trypsin

### NUCLEOTIDES

Cytidine 5-monophosphate  
Disodium uridine 5-monophosphate  
Adenosine 5-monophosphate  
Disodium guanosine 5-monophosphate  
Soy Lecithin

For more information, visit [milkbankcolorado.org](http://milkbankcolorado.org)



Rocky Mountain  
Children's Health  
FOUNDATION

\*Developed as a student project for the Breastfeeding Course for Health Care Providers, Douglas College, New Westminster, BC, Canada - © 2007 by Cecily Heslett, Sherri Hedberg and Haley Rumble.

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