A Comparison of Human Milk and Formula

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
Sulpher
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) HMGF I (Human growth factor) HMGF II
HMGF 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
Arysulfatase
Catalase
Histaminase
Lipase
Lysozyme
PAF-acetylhydrolase
Phosphatase
Xanthine oxidase

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

ANTIMOCROBIAL 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
- Eoisinophils
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.cohnii 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