

Formula Feeding

Despite efforts to promote exclusive breastfeeding through 6 mo., <50% of women continue to breastfeed at 6 mo. Most women make their infant feeding choices early in pregnancy.

1. Parental preference is the most common reason for using infant formula.
2. Infant formula is indicated for infants whose intake of breast milk is contraindicated for infant factors (e.g., inborn errors of metabolism) and maternal factors.
3. Infant formula is used as a supplement to support inadequate weight gain in breastfed infants.

Technique:

Comfortable position for infant and caregiver.

Unhurried.

Free from distraction.

The infant should be hungry, awake, warm, and dry.

bottle milk is warmed to body temp.

Nipple holes should be at size that milk will drop slowly.

Eructation of air swallowed during feeding is important for avoiding regurgitation and abdominal discomfort. spitting up occurs more often in artificially fed than in breast fed infant.

Feeding last 5-25 m.

Most formulas in the following forms:

- Ready-to-use formulas -- do not need to add water; are convenient, but cost more.
- Concentrated liquid formulas -- need to be mixed with water, cost less.
- Powdered formulas -- must be mixed with water, cost the least.

Ready-to-feed products generally provide 19-20 kcal/30 mL (1 oz) and approximately 67 kcal/dL. Concentrated liquid products, when diluted according to instructions, provide a preparation with the same concentration. Powder formulas when mixed according to instructions will result in similar caloric density.

For all types = [20 kcal/30 mL (1 oz)]

Formula feedings should be ad libitum, with the goal of achieving growth and development to the child's genetic potential. The usual intake to allow a weight gain of 25-30 g/day will be **140-200 mL/kg/day in the 1st 3 mo.** of life. The rate of weight gain declines from 3-12 mo. of age

Although infant formulas are manufactured in adherence to good manufacturing practices and are regulated by the U.S. Food and Drug Administration (FDA), there are potential safety issues.

Ready-to-feed and concentrated liquid formulas are commercially sterile, but powder preparations are not.

Although the number of bacterial colony-forming units per gram (CFU/g) of powder formula is generally lower than allowable limits, outbreaks of infections with *Cronobacter sakazakii* (previously *Enterobacter sakazakii*) have been documented, especially in premature infants. The powder preparations can contain other coliform bacteria but have not been linked to disease in healthy term infants.

Care must be taken in following the mixing instructions to avoid over- or under dilution, to use boiled or sterilized water, and to use the specific scoops provided by the manufacturer because scoop sizes vary. Water that has been boiled should be allowed to cool fully to prevent degradation of heat-labile nutrients, specifically vitamin C.

Well water should be tested regularly for bacteria and toxin contamination. Municipal water can contain variable concentrations of fluoride, and if the concentrations are high, bottled water that is de-fluoridated should be used to avoid toxicity.

Comparison of human milk and cow's milk

Water: Relative amount of water and solid in human and cow's milk about the same.

Calories: Vary slightly and it is 20 kcal/oz.

Protein: Human milk contains 1-1.5%. Cow's milk contains 1.8-3%.

Carbohydrate: Human milk contains 6.5-7% lactose. Cow's milk contains 4.5%.

10% of carbohydrate in human milk consists of polysaccharide and glycoprotein.

In both, CHO represents the most abundant macronutrient. Human milk oligosaccharides (HMO) which act as prebiotics are unique to breast milk

Fat: Fat is the main source of energy (50%) of calories. Fat globules 10-15 times bigger than that of cow milk. Human milk contains lipase enzyme so 92% of triglycerides are digested and absorbed. Essential F.A is lighter in breast milk than cow milk, it is important for growth. Cholesterol in human milk is higher and it is important for CNS myelination and needed in early life to ensure proper development of enzyme system for metabolism.

Regarding qualitative difference, human milk contains twice as much of the more absorbable olein.

Minerals: Cow's milk formula contains much more of all minerals except iron (Breast milk iron although it is low but is better, rapid absorbed, is in ferrous form), copper than human milk.

Calcium: phosphate ratio is 1.5:1 unlike cow milk where ratio is 1:1. High phosphate content in cow milk 7 times leads to impairment of Ca absorption and later convulsions.

Vitamins:

Human milk enriched with enzymes, hormones, and coagulation factors. It contains vitamin binders like lactoferrin. Vitamins contain varies with maternal intake.

-cow's milk is low in C, breast milk contains adequate VC

-cow's milk contains more (K, B2, B6, B12) than human milk, they are synthesized by the gut flora, so no need to add such vitamins.

-cow's milk had 5 times the amounts of E in human milk.

-cow's milk had double amount of A, D in human milk.

-Both contain same adequate amount of A, B complex.

Digestibility: Stomach empties more rapidly after human milk than cow's milk.

Bacterial content: Human milk, uncontaminated by bacteria. Tubercle, typhoid, bacilli, herpes, hepatitis B, rubella, Mumps, HIV, CMV, may found at time in milk of women infected with these. Cow's milk regularly contaminated but in most case by bacteria that are not harmful to human. Certain bacteria that may not affect older children may cause diarrhea in infant.

| components | BREAST MILK | STANDARD FORMULA |
|---------------|-------------|------------------|
| protein | 1.1 per dl | 1.5 per dl |
| Fat | 4 per dl | 3.6 per dl |
| carbohydrates | 7.2 per dl | 6.9-7.2 per dl |

Types of formula feeding:

1. Substitutive (no breast milk).
2. Breast and formula:
 - Complementary: in each feed uses breast and formula.
 - Supplementary: one feed breast milk and the other is by formula.

Formula Ingredients and Components

Formulas are made of 6 basic components - protein, fat, carbohydrate, vitamins, minerals, and other nutrients such as probiotics and prebiotics.

What makes one brand of formula different from the next is the specific combination of [carbohydrates, fats, and proteins] it uses, as well as any additional ingredients.

Protein

Formulas are commonly differentiated by the type of proteins they contain.

These include [cow milk protein, soy protein, partially hydrolyzed, extensively hydrolyzed, amino acid-based formulas].

1. Cow's Milk Protein–Based Formulas

Intact cow's milk protein–based formulas contain a protein concentration considerably higher than in mature breast milk. This increased concentration is designed to meet the needs of the youngest infants, but leads to excess protein intake for older infants. In contrast, breast milk content varies over time to match protein needs at various ages. The whey: casein ratio varies in infant formula from 18: 82 to 60: 40; one manufacturer markets a formula that is 100% whey. Whey in formula consists of : β -globulin (mainly) which is the main allergen in cow's milk allergy , α -lactalbumin, small amounts of lactoferrin, Ig, lysozyme. The predominant whey protein is β -globulin in cow's milk while α -lactalbumin represent the major whey in human milk.

The primary source of fat in cow's milk protein–based infant formulas is plant or a mixture of plant and animal oils. Fat provides 40–50% of the energy in cow's milk–based formulas. Fat blends are better absorbed than dairy fat and provide saturated, monounsaturated, and polyunsaturated fatty acids (PUFAs). All infant formulas are supplemented with long-chain PUFAs, docosahexaenoic acid (DHA), and arachidonic acid (ARA) at varying concentrations. ARA and DHA are found at varying concentrations in human milk and vary by geographic region and maternal diet.

Lactose is the major carbohydrate in breast milk and in standard cow's milk– based formulas for term infants. Formulas for term infants may also contain modified starch or other complex carbohydrates.

Indications for use: Typically, first line replacement for breast milk/donor milk

Contraindications: Cow milk protein allergy/intolerance and certain metabolic conditions including galactosemia

2.Soy protein: approximately 10-14% of infants with an allergy to cow milk protein will also have allergy to soy protein. There have been theoretical concerns about high levels of dietary soy isoflavones adversely affecting human development, reproduction, or endocrine function but the current evidence does not demonstrate these negative outcomes.

- Indications for use: Galactosemia, hereditary lactase deficiency, IgE mediated allergy to cow milk, vegan, secondary lactose intolerance related to acute gastroenteritis.
- Contraindications: Not designed or recommended for preterm infants who weigh <1800 g.

Soy protein–based formulas on the market are all free of cow's milk–based protein and lactose. Carbohydrates are provided by sucrose, corn syrup solids, and maltodextrins to provide 67 kcal/dL. They meet the vitamin,

mineral, and electrolyte guidelines from the AAP and the FDA for feeding term infants. The protein is a soy isolate supplemented with L -methionine, L -carnitine, and taurine

The oils used in both cow's milk and soy formula include soy, palm, sunflower, olein, safflower, and coconut. DHA and ARA are also added.

Soy protein-based formulas have no advantage over cow's milk protein-based formulas as a supplement for the breastfed infant, unless the infant has one of the indications noted previously, and are not recommended for preterm infants. The routine use of soy protein-based formula has no proven value in the prevention or management of infantile colic, fussiness, or atopic disease. Infants with documented cow's milk protein-induced enteropathy or enterocolitis often are also sensitive to soy protein. They should be provided formula derived from extensively hydrolyzed protein or synthetic amino acids.

3. Partially hydrolyzed protein. containing oligopeptides with a molecular weight of <5000 Daltons (range 3,000-10,000 Da). Cow milk proteins (whey and/or casein) are broken into portions, making them somewhat easier to digest. Partially hydrolyzed infant formulas are not considered “hypoallergenic” by the FDA, but in many infants with cow milk protein allergy, partially hydrolyzed formula may be well tolerated and more palatable than extensively hydrolyzed formula.

- **Indications for use:** May be tolerated by some infants with cow milk protein intolerance. Insufficient evidence for use in prevention of asthma, eczema, food allergies, and rhinitis, although possibly helpful to prevent eczema in infants at high risk.
- **Contraindications:** Milk allergy

4. Extensively hydrolyzed protein. containing peptides with a molecular weight <3000 Da.

Through a heat and enzymatic process, casein is broken into small portions (peptides and amino acids), which are then generally not recognized by the body as an allergen. Taste and cost can be a limiting factor for use.

Indications for use: Infants diagnosed with allergy to cow milk protein, with significant protein-induced enteropathy or enterocolitis or failure to thrive. These formulas are lactose free and can include medium-chain triglycerides, making them useful in infants with gastrointestinal malabsorption as a consequence of cystic fibrosis, short gut syndrome, prolonged diarrhea, and hepato-biliary disease.

carbohydrate

Lactose is the main carbohydrate in human milk as well as in many formulas. It breaks down to [glucose and galactose]. Almost all infants are able to tolerate lactose, even when they have cow milk protein allergy. Corn maltodextrin is sometimes used as a secondary source of carbohydrate in formula. Complex carbohydrates (starches), are used in some formulas as thickeners to help with gastro-esophageal reflux.

Alternatives to lactose : These include sucrose, corn syrups, tapioca starch, maltodextrin, and other modified starches. Reduced lactose formulas exist as well. **Indications for use:** Congenital lactase deficiency, which is rare, and lactose intolerance (not a common infant condition)

Added starch. Typically contains added rice starch **Indications for use:** Gastro-esophageal reflux

Electrolytes, Minerals, and Vitamins

These include major and trace (FDA-regulated) minerals and vitamins.

- **Iron:** Quantities vary in different types of formulas to adjust for absorption. Standard infant formulas contain 10-12 mg/L. Low-iron formulas contain 4-6 mg/L and are not routinely recommended. Caregivers may be concerned that the iron upsets their infant's stomach or causes constipation, but no scientific evidence demonstrates this effect. **Indications for use of low-iron formulas:** Neonatal hemochromatosis (rare), impaired renal function

Aluminum: Although the aluminum content of human milk is 4-65 ng/mL, soy protein-based formula is 600-1300 ng/mL. Because aluminum competes with calcium for absorption, increased amounts of dietary aluminum from isolated soy protein-based formula may contribute to the reduced skeletal mineralization (osteopenia) observed in preterm infants and infants with intrauterine growth retardation. Term infants with normal renal function do not seem to be at substantial risk of developing aluminum toxicity from soy protein-based formulas.

Formula stages in the first year

Stage 1 formula : used in the 1st six months of life .The protein is predominantly whey. It exclusively will meet babies' nutritional needs until the appropriate introduction of complementary feeding.

Stage 2 formula (follow on): it intended to be fed alongside appropriate complementary feeding. The protein is more of casien type . It contains the same ingredients as stage 1 formulas, except they generally have higher levels of iron and vitamin D. Some stage 2 formulas also contain starch and/or maltodextrin.

Stage 3 formula (toddler follow on formula): It has fewer calories and fat than Stages 1 and 2 but has more iron than Stage 2. Used from age of 12 months.

Milk types should not be used in infant feeding???

1. Raw milk is not suitable for feeding in infancy. It contains too many proteins and electrolytes. Inadequate iron and vitamins.
2. Un modified cow's milk powder slowly digested/ easily contaminated.
3. Dried skim milk; nonfat skim milk 0.5%, half skim milk 1.5%, both available. Not used in the first 2y of life. Its high protein and mineral content in proportion to calories may cause severe dehydration.

CALORIE REQUARIED: For full term infant 80-120 kcal/kg for first few months and 100 kcal/kg by 1y.

FLUID REQUIRMENT: Ist 6m 130-190 mL/kg/24h And increase during hot weather.

NUMBER OF FEEDING DAILY:

| | |
|-------|-----|
| 1w-1m | 6-8 |
| 1-3m | 5-6 |
| 3-7m | 4-5 |
| 4-9m | 3-4 |
| 8-12m | 3 |

QUANTITY OF FORMULA:

| | |
|------------------------------------|-----------|
| 1 st -2 nd w | 60-90ml |
| 3w-2m | 120-150ml |
| 2-3m | 150-180ml |
| 3-4m | 180-210ml |
| 5-12m | 210-240ml |

sterilization:

there are several recommended ways to sterilize bottles , One is not necessary superior to the others, including

- 1-Boiling.
- 2-Microwaveable bottle sterilizers.
- 3- Electrical steamer sterilizers.

Preparation

How to mix powder formula & water to prepare a bottle

There are a few key points to remember:

- Water first, then powder. Always add the powder to the water that is in the bottle, not the other way around.
- Boil the water when needed. For infants under 3 months of age, those who were born prematurely and those who have a weakened immune system, hot water should be used to prepare formula to kill any microbes. To do this, boil the water and let it cool for about 5 minutes. Then, add it to a clean bottle and add the formula based on the instructions on the container.
- Cool formula to body temperature. If you are going to use the formula you prepared immediately, be sure to cool the formula to body temperature before feeding your baby. Run the prepared, capped bottle under cool water or place it into an ice bath.
- Test the formula temperature to make sure it is not too hot before feeding it to your baby.

Test warmed water in advance to make sure it is not too hot for your baby. The easiest way to test the temperature is to shake a few drops on the inside of your wrist.

- Prepared formula must be discarded within 1 hour after feeding it from the bottle to your baby.

Prepared formula that has not been fed to your baby may be stored in the refrigerator for 24 hours to prevent bacterial contamination

Parents should be instructed to use proper handwashing techniques when preparing formula and feedings for the infant. Guidance on formula storage should also be given. Powder formula should be stored in a cool, dry place; once opened, cans should be covered with the original plastic cap or aluminum foil, and the powdered product can be used within 4 wk.

Once prepared, all bottles, regardless of type of formula, should be used within 24 hr.

Formula should be used within 2 hr of removal from the refrigerator, and once a feeding has started, that formula should be used within 1 hr or be discarded. Prepared formula stored in the refrigerator should be warmed by placing the container in warm water for about 5 min.

Formula should *not* be heated in a microwave because it can heat unevenly and result in burns, despite appearing to be at the right temperature when tested.

What are the recommendations for giving water during infancy?

| 0-6 months Exclusively breastfed | 0-6 months Formula fed | 6-12 months All infants |
|---|---|--|
| No additional water needed | Might need extra water during hot weather. Use cooled, boiled water. | Introduce a small cup for sipping water at mealtimes. Use non boiled water. |

Why additional water is not recommended for exclusively breastfed infants under 6 months of age?

Fully breastfed babies do not need any water until they have started eating solid foods . This is because the composition of breastmilk changes to meet the infant’s needs, including for water which is a component of breastmilk. During hot weather, a breastfed infant may want to feed little and often to satisfy their thirst. A breastfeeding mother may therefore want to drink more fluids than usual during hot weather.

Type of water

For babies under 6 months: non boiled water (straight from the mains tap in the kitchen) should not be used as it is not sterile. The NHS advises to boil the tap water first and then let it cool down. Bottled water is also not recommended as it may contain too much salt (sodium) or sulphate. If parents/carers have to use bottled water, they should be advised to check the label to make sure the sodium level is less than 200 mg per litre. The sulphate content should not be higher than 250 mg per litre . Filtered water can be given to babies under 6 months, but as for tap water, it should also be boiled and cooled first.

Weaning

Between 6 and 12 mo. of age, after they become accustomed to solid foods and liquids by bottle and/or cup, most infants decrease the volume and frequency of breast-feeding.

As the infant demands less milk, the mother's supply gradually diminishes without causing discomfort from engorgement.

Weaning can be initiated when mutually desired by the mother and infant by substituting formula by bottle or cup for part and, subsequently, all of a breast-feeding. Breast-feeding is eventually replaced with formula-feeding, at which time the infant is weaned completely.

These changes should be made gradually and should be a pleasant experience, not a conflict, for both the mother and the infant.

Weaning should be gradual to prevent GIT upset. Neither start at summer nor at convalescent period of any disease. Should not started if child is under weight to avoid GIT upset.

AIM

- 1.The child cannot tolerate more than liter/day, so this increasing need for energy more solid foods should be added.
- 2.With growth, babies required more food items such as minerals and vitamins, that cannot be supplied by milk.
- 3.To train GIT digest starch, and other solid foods.
- 4.To induce independence using spoon and cup, by himself.

Principle of weaning:

Begin at 6 mo. of age

Avoid foods with high allergenic potential (cow's milk, eggs, fish, nuts, soybeans).

At the proper age, encourage a cup rather than a bottle.

Introduce 1 food at a time.

Energy density should exceed that of breast milk.

Iron-containing foods (meat, iron-supplemented cereals) are required.

-Zinc intake should be encouraged with foods such as meat, dairy products, wheat, and rice.

Phytate intake should be low to enhance mineral absorption.

-Breast milk should continue to 12 mo; formula or cow's milk is then substituted.

-Give no more than 24 oz/day of cow's milk

Fluids other than breast milk, formula, and water should be discouraged.

-Give no more than 4–6 oz/day of fruit juices. No soda.

VITAMINS:

* Formula milks are usually fortified.

*400 IU/day of vitamin D should be added early if formula not fortified.

*Low birth weight infant and black infant need supplementation.

IRON: need [2mg/kg/day]. Total [15mg/day] beginning at 6w of age to prevent iron deficiency.

Calories:

*Egg yolk, cereals, meats, have **greater** caloric density than milk.

*Vegetable and fruits have energy value **similar or lower** than that of milk

CEREALS: Excellent for infants. Contain iron, B complex.

FRUITS: Have mild laxative. Raw ripe banana is readily digested and enjoyed by most infants.

VEGETABLES: good source of iron and other minerals and B complex vitamins. Add at 7m of age.

MEATS, EGGS, STARCHY FOODS:

*Egg and starchy food usually introduced during second 6m of life.

*Potatoes, rice, bread introduce they are not included in the diet until the more essential foods mentioned earlier are being taken regularly.

*Meat used initially by 6m of age.