

Some medications pass directly into human milk, and some prescribed medications may preclude breastfeeding. Women taking prescription or over-the-counter medicines or herbal supplements should discuss the effects of these products on breast milk with their health care providers.

Key Concepts: Health benefits and convenience are key advantages of breastfeeding. For the infant, breastfeeding has been linked to reduced incidence of many infectious diseases as well as other conditions. For a mother, breastfeeding speeds recovery of normal uterine size and may reduce her disease risk. Although breastfeeding is the preferred method of infant feeding, there are times when breastfeeding is contraindicated. These situations should be identified and discussed as part of prenatal care.

Resources for Pregnant and Lactating Women and Their Children

Many agencies support research and education programs that promote the health of pregnant and breastfeeding women and their children. You may be familiar with the March of Dimes and its efforts to reduce birth defects and prematurity through optimal nutrition during pregnancy. La Leche League is a voluntary health and education organization that offers programs and educational materials to help breastfeeding mothers learn about the benefits and practice of breastfeeding.

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a much-acclaimed program of the Food and Nutrition Service of the U.S. Department of Agriculture (USDA). WIC provides food assistance, nutrition education, and referrals to health care services for low-income pregnant, postpartum, and breastfeeding women, as well as infants and children up to the age of 5. Compared with at-risk women and children who are eligible for WIC but do not participate in the program, WIC participants have significantly fewer problems such as low-birth-weight infants.⁵⁰

WIC services include intensive breastfeeding education and support. Over the first six months of life, breastfed infants enrolled in WIC use about \$500 less in WIC and Medicaid services than do formula-fed infants enrolled in WIC, according to a study conducted in Colorado.⁵¹ Continued promotion of breastfeeding by WIC and other public health programs can have both health and economic benefits. Periodically, WIC participants are required to bring their infants into the local WIC office. These visits give WIC staff an opportunity to evaluate the infant's growth and provide the caregiver with additional nutrition education.

Infancy

Infancy is the period of a child's life between birth and 1 year. Because of the rapid growth that occurs during this time, nutritional needs are higher per unit of body weight than at any other time in the life cycle. Despite the critical importance of nutrition at this stage, feeding an infant is a fairly simple process. Human milk provides all of the nutrients an infant needs and is the model for infant formulas. By 4 to 6 months, the infant's physical development and physiological maturation signal readiness for the addition of "solid" foods to the diet.

Human infants need love as much as they need food. Without love and nurturing, a baby can fail to thrive even if she is offered all of the right nutrients. If an infant is not nourished emotionally, nutrition recommendations and requirements become meaningless.⁵²

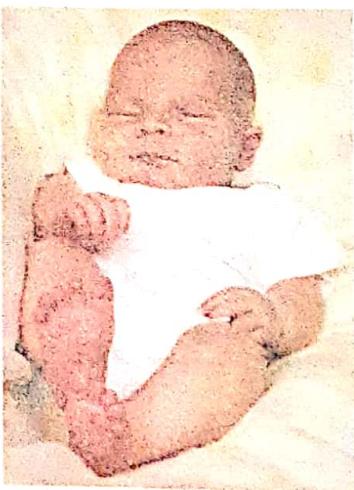
Quick Bites

Breastfeeding to Control Blood Pressure?

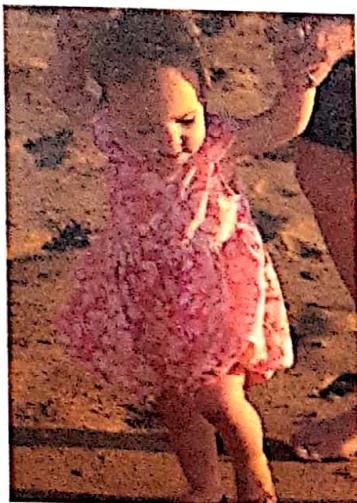
Oxytocin, the hormone produced while breastfeeding, can lower the blood pressure of nursing mothers. Research shows that breastfeeding mothers had lower blood pressures after nursing than did bottle-feeding mothers. When asked to discuss stressful events, nursing mothers also showed smaller increases in blood pressure than the bottle-feeders showed. Mothers often claim that they feel relaxed during breastfeeding, which may account for the difference in blood pressure.

Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) A USDA program that provides federal grants to states for supplemental foods, health care referrals, and nutrition education for low-income pregnant, breastfeeding, and non-breastfeeding postpartum women, and to infants and children at nutritional risk.

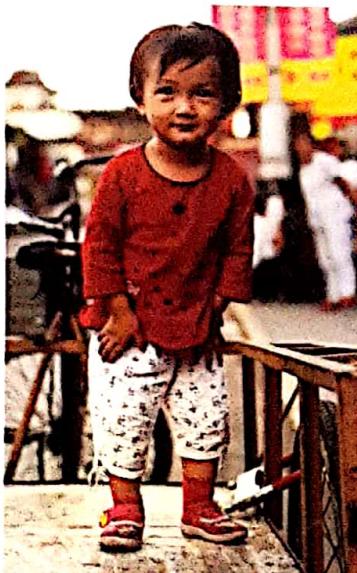
Infancy The period between birth and 12 months of age.



(a)



(b)



(c)

Figure 15.13 Different stages of infancy. (a) Newborn. (b) 4 to 6 months. (c) 12 months.

Infant Growth and Development

Birth weight is the best predictor of the child's health in the first year of life; however, it is important to correlate weight with gestational age. The risk profile of an infant who has a low birth weight because of prematurity is different from that of a full-term baby with a low birth weight.

Immediately after birth, an infant loses about 6 percent of his body weight. This is normal and expected. By 10 to 14 days, the infant should return to his birth weight. Over the next 12 months, his growth will be phenomenal. By the age of 4 to 6 months, a healthy infant will have doubled his birth weight. By his first birthday, the infant will have tripled his birth weight and increased his length by about 50 percent. The infant's body proportions change too, so that by age 1 he is looking less like a baby and more like a toddler. (See Figure 15.13.)

Length (used instead of height because infants can't stand) and head circumference are more sensitive measures than weight for assessing a baby's growth and nutritional status. Weight alone reflects just recent nutritional intake. Head circumference measures brain growth and development. Chronic malnutrition can limit this growth and is reflected in inadequate gains in head size. Regular measurements of head circumference, therefore, can verify proper growth. Head circumference measurements are useful in infants and children up to age 2.

Growth Charts

During routine checkups throughout infancy (and during childhood and adolescence), health care practitioners measure weight, length or height, and head circumference and plot these values on growth charts. (See Figure 15.14.) Charts for weight-for-age, length- (or height-) for-age, head circumference-for-age, weight-for-length, and BMI-for-age are available for boys and girls, and for two age ranges: birth to 36 months, and 2 to 20 years. (See Appendix I.) Health care practitioners use growth charts to show the growth of an individual baby over time. These charts also allow comparison of one child's growth with that of children in the general population.

Key Concepts: A typical infant doubles her birth weight by age 4 to 6 months and triples it by 12 months. Infant length increases about 50 percent during the first year. Health care practitioners use growth charts to follow and assess an infant's growth in weight, length, and head circumference.

Energy and Nutrient Needs of Infancy

How do you suppose scientists determine the nutrient needs of newborns and young infants? Studies with babies as subjects are rare—the logistical and ethical questions are daunting! So how else can we know what babies need? It's simple: We just look at breast milk—the food designed especially

gestational age Age of the fetus measured from the first day of the mother's last menstrual period until birth.

prematurity Birth before 37 weeks of gestation.

full-term baby A baby delivered during the normal period of human gestation, between 38 and 41 weeks.

toddler A child between 12 and 36 months of age.

head circumference Measurement of the largest part of the infant's head (just above the eyebrows and ears); used to determine brain growth.

growth charts Charts that plot the weight, length, and head circumference of infants and children as they grow.

for babies. The composition of human milk is the gold standard by which infant nutrient needs are determined. Babies who are not breastfed are given infant formula. In the United States, most infant formulas have a base of modified cow's milk or soy protein. To assure that formula meets all of an infant's nutrient needs, federal regulations require that the formula's composition complies with nutritional standards.

Energy

An infant's energy need is the amount of energy she requires for basal functions such as respiration and metabolism, in addition to growth and activity. An infant's basal energy needs, relative to her size, are about twice that of an adult. The amount of energy an infant needs for activity varies throughout the first year of life, increasing as the child becomes more mobile. (See Figure 15.15.) In general, a newborn requires about 100 kilocalories per kilogram of body weight.⁵³ Table 15.8 lists the specific equations for calculating infants' estimated energy requirements (EER).

The appropriate balance of energy sources (carbohydrate, fat, and protein) is different for infants than for adults. (See Figure 15.16.) The best diet for infants (as modeled by human milk) is high in fat and moderate in carbohydrate. Infants have high calorie needs but can consume only a small amount at any one time. An infant's stomach is quite small; a newborn can consume only about 1 to 2 ounces of liquid at a feeding. Because fat is the most concentrated source of calories, a high-fat diet supplies adequate calories in a smaller volume. A high-fat diet also is necessary for normal brain growth, which continues until about 18 to 24 months of age. Figure 15.17 shows the primary functions of energy-yielding nutrients in infants, which we discuss in the next sections.

Protein

Protein needs during infancy are higher than at any other time in the life cycle. In fact, protein needs (measured in grams per kilogram of body weight) during the first six months of life are nearly twice as high as an adult's needs. Table 15.9 lists the protein recommendations for infants.

Nine indispensable amino acids are required in infancy. Deficiency in any of them can retard growth. During times of stress, such as illness, three conditionally indispensable amino acids—cysteine, tyrosine, and taurine—may become indispensable to an infant. In addition, these nutrients may be indispensable for premature infants and for babies who suffer from

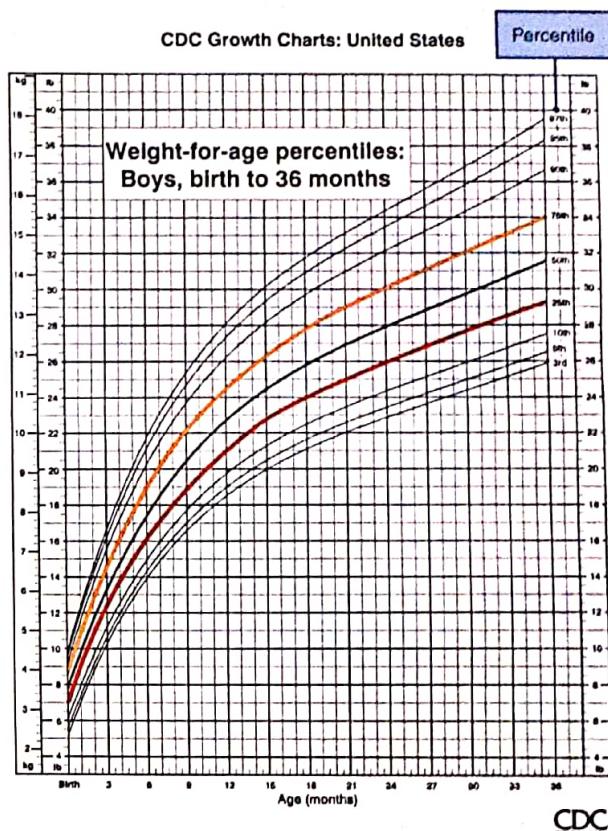


Figure 15.14 Growth chart. The CDC (Centers for Disease Control and Prevention) has complete sets of growth charts available on the Internet at www.cdc.gov/growthcharts. See Appendix I for full-scale samples of growth charts for boys and girls aged 2 to 20 years.

Source: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

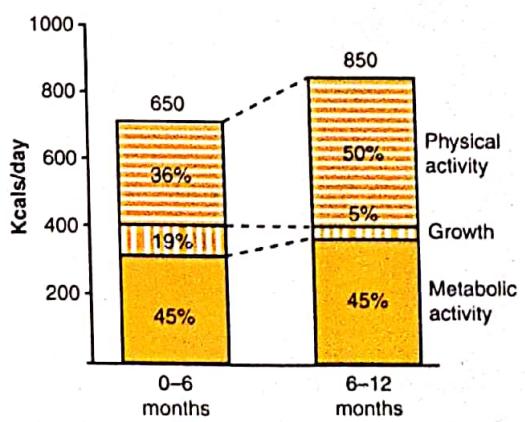


Figure 15.15 Allocation of energy expenditure. During the second six months, infants increase their energy expenditure for physical activity.

Source: Adapted from Foman SJ, Bell EF. Energy. In: Foman SJ, ed. *Nutrition of Normal Infants*. St. Louis: Mosby, 1993.

Table 15.8 Estimated Energy Requirement (EER) During Infancy

Age (mo)	EER Equation
0-3	(89 × wt [kg] – 100) + 175 kcal/day
4-6	(89 × wt [kg] – 100) + 56 kcal/day
7-12	(89 × wt [kg] – 100) + 22 kcal/day

Source: Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*. Washington, DC: National Academies Press, 2005. Reprinted with permission from the National Academy of Sciences.

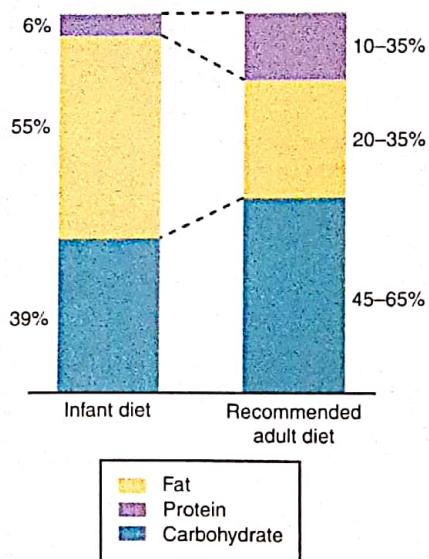


Figure 15.16 Percentages of energy-yielding nutrients in infant and adult diets.

The best diets for infants are high in fat and moderate in carbohydrate. Infants need a high-fat diet for normal brain growth and to provide adequate calories in a smaller volume.

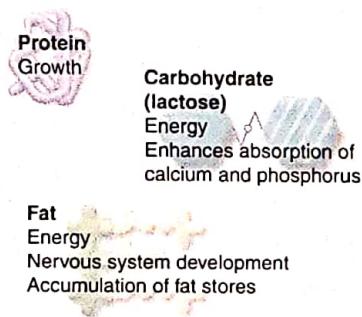


Figure 15.17 Primary functions of energy-yielding nutrients for infants.

To support growth, protein needs (per kg body weight) are higher in infancy than in any other life stage.

Table 15.9 Protein AI or RDA for Infants

Age (mo)	g/kg	g/d*
0–6	1.52	9
7–12	1.2	11

* The values for grams per day are based on reference weights of infants. Needs of individual infants vary.

Source: Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*. Washington, DC: National Academies Press, 2005. Reprinted with permission from the National Academy of Sciences.

certain inborn errors of metabolism. The carnitine and glycine content of human milk suggests that these amino acids are required in higher amounts during infancy as well. Both human milk and infant formula provide complete protein with all the indispensable amino acids.

One of the major differences between human milk and the milk of other mammals (such as cows) is the amount and type of protein that each contains. The main types of proteins in any milk are casein (phosphorus-containing proteins) and whey proteins. Human milk has larger amounts of the whey protein alpha-lactalbumin, for example. This protein contains all of the indispensable amino acids infants need, and human babies easily digest and absorb it. Cow's milk, in contrast, contains larger amounts of casein, a large protein that forms hard curds in the infant's stomach. Infants cannot digest or absorb casein easily, and too much may cause intestinal blood loss. The protein content of human milk is lower than that of unmodified cow's milk. This level is appropriate for the neonate, whose kidneys and GI tract are still immature. Indeed, excessive protein may disturb an infant's fragile hydration status, which is one reason that regular cow's milk is inappropriate for infants.

Carbohydrate and Fat

Carbohydrates and triglycerides are the major energy sources for infants. This allows protein to be used primarily for growth and not as an energy source. Nearly all of the carbohydrate in human milk and in the infant formulas made from cow's milk is lactose. Infants digest lactose easily and tolerate it well.

Triglycerides are the major energy source in human milk, providing about 50 to 55 percent of the calories. Fats in milk also enhance a baby's sense of fullness between feedings. Experts recommend that infants get at least 30 grams of fat per day.⁵⁴ Breast milk is rich in essential fatty acids: the omega-6 fatty acid arachidonic acid (ARA) and two long-chain omega-3 fatty acids, eicosapentaenoic acid and docosahexaenoic acid. These fatty acids have roles in neurological development, so some researchers have suggested that they should be considered provisionally essential for human infants.⁵⁵ The Food and Nutrition Board has set an AI for newborns (0 to 6 months of age) of 4.4 grams per day of linoleic acid and 0.5 gram per day of alpha-linolenic acid.⁵⁶ Infants also need cholesterol for brain development. Human milk is rich in cholesterol, containing about 20 to 30 milligrams per 100 milliliters.⁵⁷

Water

Because water as a percentage of body weight is higher in babies than adults, infants have higher fluid needs. The AI for water during infancy is 0.7 liter per day in the first six months (assumed to be from human milk) and 0.8 liter per day from 7 months to 1 year of age. Human milk fulfills not only the nutrient needs of the neonate, but also the fluid requirements. Properly prepared formula accomplishes the same task. During the first four to six months, supplemental water is not necessary for healthy infants who are exclusively breastfed or who receive properly mixed formula. This is true even in hot, humid weather.⁵⁸ Once solid foods are introduced, a baby's water needs change, and additional water may be required.

Vitamins and Minerals

Human milk provides the amounts of vitamins and minerals that human babies need. Therefore, the micronutrient composition of human milk is the reference point for designing infant formula. As long as an infant is

receiving adequate calories from breast milk or infant formula, nearly all vitamin and mineral needs also are being met. Human milk is lower in a few nutrients (e.g., iron and vitamin D), but infants absorb these nutrients more efficiently from breast milk than from formula. This section focuses on a few vitamins and minerals that may be of concern for infants. (See Figure 15.18.)

Vitamin D. Vitamin D is a key nutrient for calcium absorption and mineralization of bone. Human milk is low in vitamin D; however, inadequate vitamin D usually is not a problem because breastfed infants absorb it well and can make enough vitamin D from exposure to sunlight. It may be a concern, though, for infants who are not exposed to sunlight, as well as for those with darkly pigmented skin. These babies make less vitamin D from the same amount of sunlight exposure than do lighter-skinned infants. If a breastfed baby does not get adequate sunlight exposure and if the baby's mother is deficient in vitamin D, the infant's risk is especially high. The American Academy of Pediatrics (AAP) recommends that all breastfed infants receive a daily supplement of 5 micrograms (200 IU) of vitamin D.⁵⁹

Vitamin K. Vitamin K is necessary for the production of prothrombin, a substance needed for blood to clot. Although intestinal bacteria synthesize vitamin K, the gut is sterile at birth. Because babies are born with minimal stores of vitamin K, it is recommended that a single dose of vitamin K be given at birth. Both human milk and infant formula provide adequate vitamin K; as feeding begins, helpful bacteria begin to flourish in the infant's intestinal tract.

Vitamin B₁₂. Vitamin B₁₂ is essential for cell division and normal folate metabolism. Mothers who include meat, fish, and dairy products in their diets produce milk that is adequate in vitamin B₁₂. This may not be true of strict vegetarians, whose diet—and milk—may be deficient in vitamin B₁₂. Breastfed infants of vegan mothers may need a vitamin B₁₂ supplement.

Iron. Iron is essential for growth and development, and iron-deficiency anemia is the most common nutritional deficiency in the United States. Human milk is not a rich source of iron, but it does not need to be. Approximately 50 percent of the iron in breast milk is absorbed, compared with only 4 percent of the iron in infant formula. If the mother has consumed an iron-rich diet during pregnancy, the fetus builds up large enough iron stores during gestation to meet most of its iron needs for the first few months of life. These stores begin to diminish during the fourth month of life. By the age of 6 months, a breastfed infant needs an additional iron source. Iron-fortified infant cereals can meet this need. For formula-fed babies, iron supplementation is needed from birth. The AAP therefore recommends iron-fortified formula for all formula-fed babies.⁶⁰

Fluoride. Human milk is low in fluoride, a mineral important for dental health. Current research has led the American Dental Association and the AAP to recommend fluoride supplements for breastfed infants after the age of 6 months.⁶¹ If the local water supply has adequate fluoride and the formula is mixed with tap water, formula-fed infants do not need fluoride supplements. If the water used to mix formula has inadequate fluoride, fluoride supplements are indicated. Fluoridation policies and the fluoride content of tap water vary among municipalities.

Inborn errors of metabolism Any kind of biological defect (e.g., PKU) that prevents proper metabolism of a specific nutrient.

alpha-lactalbumin Primary protein in human milk.

neonate An infant from birth to 28 days.

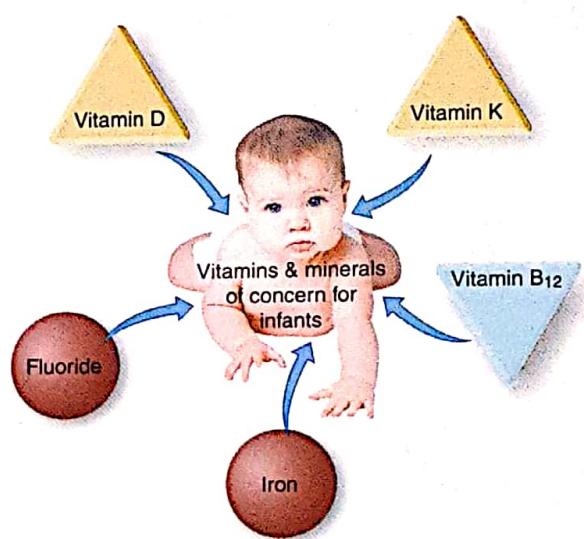
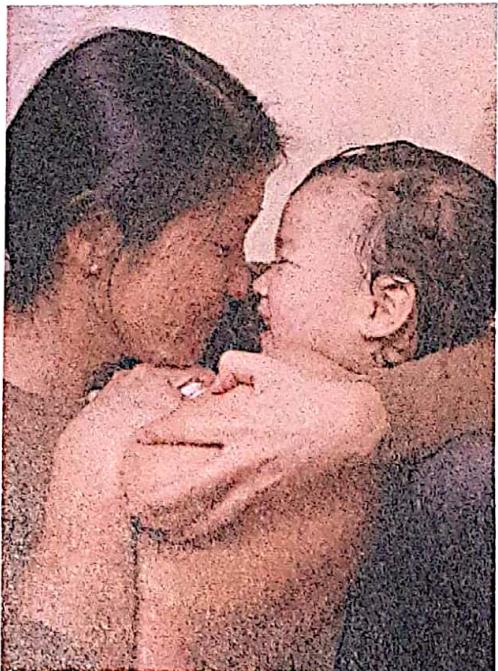


Figure 15.18

Micronutrients of concern during Infancy. Infants who lack sun exposure can become deficient in vitamin D. A dose of vitamin K usually is given to babies at birth to ensure a sufficient supply. Because vegan mothers can have breast milk deficient in vitamin B₁₂, their babies may need a B₁₂ supplement. By the age of 6 months, breastfed infants need additional iron. Formula-fed infants should consume iron-fortified formula. Human milk is low in fluoride.



Key Concepts: Energy and nutrient needs for infancy are estimated based on the composition of human milk. Because of their rapid growth and development, infants have high energy and nutrient needs per kilogram of body weight. Caregivers must give special attention to vitamin D, iron, and fluoride to ensure that the infant obtains enough. If breast milk or formula (properly mixed) are meeting energy needs, the fluid needs of the infant also are being met.

Newborn Breastfeeding

The AAP has identified breastfeeding as the ideal method of feeding to achieve optimal growth and development⁶² and recommends that breastfeeding begin as soon after birth as possible and continue at least through the first 12 months of life.⁶³ Feedings should occur at least every two to three hours, for a total of 8 to 12 feedings per day. Duration of feedings is guided by the infant's behavior and may last from 10 to 15 minutes per breast. Hospitals should provide every opportunity for breastfeeding to begin before the baby goes home. Nurses or lactation consultants should be available to offer professional breastfeeding support to new mothers. The AAP recommends that no supplements of formula or water be given to breastfed neonates unless medically indicated.

Alternative Feeding: Infant Formula

Women may decide not to breastfeed or to breastfeed only briefly. Their infants need infant formulas designed to provide adequate nutrition.

Standard Infant Formulas

Standard infant formulas have cow's milk as a base. In making infant formula, manufacturers first remove the milk fat and replace it with vegetable oils. Infant formula is fortified with all essential vitamins and minerals according to guidelines established by the AAP and enforced by the Food and Drug Administration. Infant formulas are available with or without added iron, but because of the decreased bioavailability of iron in infant formulas and the infant's high needs, the AAP recommends using only iron-fortified formulas.

Although formula manufacturers try to mimic the composition of human milk, formula remains an imperfect copy. For example, *alpha-linolenic acid*, an essential *omega-3* fatty acid, is missing from many formulas. However, several brands of infant formula now contain three fatty acids that are prevalent in human milk: arachidonic acid (ARA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). Some studies show that supplemental ARA and EPA may benefit infants' visual function and cognitive development.⁶⁴ Human milk also contains more cholesterol than infant formulas.

Soy-Based Formulas

Formula-fed infants who develop vomiting, diarrhea, constipation, abdominal pain, or colic are frequently switched to soy-based formulas. In these formulas, soy is the source of protein. To compensate for the inferior digestibility of soy protein, soy formulas contain more protein than formulas based on cow's milk. Soy formulas are lactose free and iron fortified. Corn syrup and sucrose are the carbohydrate sources.

Other Types of Formula

Special formulas are available for infants who are allergic to both cow's milk and soy protein, those who are premature, and those who have rare defects in metabolic pathways. These special formulas often have their protein content modified in either its digestibility or its amino acid composition. Many

Lactation consultants Health professionals trained to specialize in education about and promotion of breastfeeding; may be certified as an International Board Certified Lactation Consultant (IBCLC).

Quick Bites

What's a Biberon?

Many people consider Dr. Nils Rosen von Rosenstein to be the father of pediatrics. In his 1764 textbook, he describes a "biberon," a leather nipple used for artificial infant feeding. He also describes 14 types of infant diarrhea.

special formulas contain medium-chain triglycerides as the major fat source. This type of fat is very well digested and absorbed. These special formulas are expensive and often taste bad, but they are essential for many infants.

Formula Preparation

Formulas come in three forms: ready-to-feed, concentrate, and powdered. Although the ready-to-feed version is the most convenient, it is also the most expensive. As the name implies, the formula can be poured directly from the can into a bottle and fed to the baby. Liquid concentrate formula is mixed with an equal amount of water before feeding. Powdered formula also is mixed with water and is the least expensive.

When using infant formulas, principles of food safety must be observed. Infants have immature immune systems and may develop infections from improperly prepared or stored formula. If not fed to the infant immediately, prepared formula should be refrigerated immediately and kept in the refrigerator until needed. If formula is not used within 48 hours, it should be discarded. For at least the first few months, the AAP recommends sterilizing all equipment used for feeding.

Improperly mixed formula is another danger, whether it is a result of ignorance in following instructions or of economics. Some caregivers on limited budgets might purposefully overdilute formula to make it last longer. This deprives the infant of necessary calories and protein and provides too much water. Other caregivers might overconcentrate the formula in the misguided belief that this might encourage faster growth. Overconcentrated formula provides too much protein and too little water and may cause problems with an infant's kidney function and hydration.

Breast Milk or Formula: How Much Is Enough?

It is fairly simple to use DRI values and breast milk or formula composition to estimate an infant's needs based on body weight. For example, a newborn who weighs 7 pounds, 11 ounces (3.5 kg) requires approximately 390 kilocalories and 5 grams of protein each day. This amount is provided by approximately 600 milliliters (~20 oz) of breast milk or infant formula.

It's easy to keep track of how much formula an infant has consumed, but what about the breastfed baby? Although you can't see how much breast milk a nursing infant is consuming, there are other ways to tell that a baby is getting enough to eat. An adequately fed newborn will breastfeed 8 to 12 times, wet at least six diapers, and have at least three loose stools each day in the first week of life. The newborn will also regain its birth weight within the first two weeks. Normal growth, regular elimination patterns, and a satisfied demeanor are the best indicators that a baby is getting enough to eat.

Feeding Technique

Feeding should take place in a loving and warm environment. A breastfeeding mother holds her baby close, at a distance that encourages mother-baby eye contact. (See Figure 15.19.) During bottle-feeding, the caregiver needs to hold the baby close and make eye contact. Propping the bottle against a pillow or other object, so that the baby can feed alone, should be avoided.

Babies swallow air while feeding, whether at the breast or with a bottle, and they need to be burped. Babies generally need to be burped after 15 minutes or 2 to 3 ounces of formula. Just as the infant sends signals of readiness for feeding, she also signals fullness. Fullness cues include fussiness, playfulness, sleep, or just turning away. Parents need to learn these cues and respond to them.



Quick Bites

But the Breast Milk Looks Weak...

Mature breast milk looks similar to nonfat milk—thin, pale, and bluish. Not to worry! This appearance is normal and breast milk always contains the right amount of nutrients for the baby. It is never too weak.

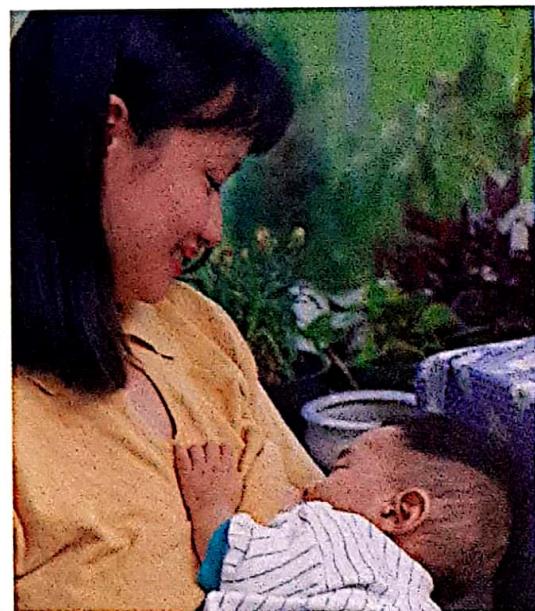


Figure 15.19

Breastfeeding. Breastfeeding nurtures an infant emotionally as well as physically. This intensely rewarding time helps to bond a mother and her child.

Quick Bites**Ancient Baby Bottle**

The earliest infant feeding vessel ever discovered is Egyptian and dates from 2000 B.C.E. Art found in the ruins of the palace of King Sardanapalus of Nineveh, who died in 888 B.C.E., depicts a mother holding a modern-looking baby bottle.

Key Concepts: Human milk provides all necessary nutrients for growth and development and enhances the immune system of the maturing infant. Infants who are not breastfed receive infant formula, which should be fortified with iron. Careful preparation and storage of the formula ensures proper nutrient composition and food safety. Formula feedings should nourish the baby emotionally as well as nutritionally.

Introduction of Solid Foods into the Infant's Diet

Based on an infant's physiological needs (e.g., depletion of iron stores) and physical development (e.g., the ability to sit up), solid foods, also called **complementary foods**, are introduced. To say that we are introducing *solid* foods is a bit of a misnomer; we are really referring to pureed and liquefied cereals, fruits, vegetables, and meats that are added to the infant's diet of breast milk or infant formula. According to the American Academy of Pediatrics, complementary foods are not needed in diets of infants fed either breast milk or iron-fortified infant formula before the age of 6 months.⁶⁵

Physiological Indicators of Infant Readiness for Solid Foods

Before a baby reaches 6 months of age, solid food is not necessary for nutrition; in fact, early introduction of supplemental foods can be detrimental. By the age of 6 months, however, an infant is physiologically ready to expand his diet. For example, at this age a baby has increased levels of digestive enzymes, so that foods other than human milk or formula can be digested with ease. In addition, the infant is more able to maintain adequate hydration by the age of 6 months. Before this age, adding cereals or other solid foods to the diet can negatively affect an infant's hydration. It is probably no coincidence that the iron stores acquired in the mother's womb become depleted at the same time the baby is physiologically ready to expand his diet. However, solid food is a supplement to, not a replacement for, human milk or formula at this time.



complementary foods Any foods or liquids other than breast milk or infant formula fed to an infant.

extrusion reflex A young infant's response when a spoon is put in its mouth; the tongue is thrust forward, indicating that the baby is not ready for spoon feeding.

Developmental Readiness for Solid Foods

If you attempt to spoon-feed a very young infant (e.g., at 3 weeks of age), the infant's tongue will push the spoon and food right back out. This **extrusion reflex** is a sign that the infant is not ready for solid foods. By 6 months of age, the infant will no longer push the food out and is capable of transferring food from the front of the mouth to the back, an ability necessary for swallowing solid foods. Also, the infant can purposefully bring her hand to her mouth, an ability necessary for self-feeding. In addition, if the baby is able to control her head and neck while sitting with minimal support, she is ready to be fed solids.

Start Healthy Feeding Guidelines

The *Start Healthy Feeding Guidelines for Infants and Toddlers* are science-based, practical guidelines for feeding healthy babies for the first two years.⁶⁶ The *Dietary Guidelines for Americans* and MyPyramid provide guidance for healthy Americans 2 years old and over. The *Start Healthy Feeding Guidelines* were designed to answer parents' and caregivers' questions, such as "When is my baby ready for complementary foods? What foods should I feed my baby? How do I feed these foods?"⁶⁷ The appropriate age for introduction of complementary foods balances physiological and developmental readiness with nutritional requirements for growth and development. Figure 15.20 summarizes the *Start Healthy Feeding Guidelines*.

Signs of readiness for the introduction of infant cereals and thin, pureed foods include the ability to sit with support and the ability to take food from a spoon and move it forward and backward in the mouth with the

Development Stage	Newborn	Head Up	Supported Sitter	Independent Sitter	Crawler	Beginning to Walk	Independent Toddler
Physical Skills							
Eating Skills	<ul style="list-style-type: none"> Needs head support 	<ul style="list-style-type: none"> More skillful head control with support emerging 	<ul style="list-style-type: none"> Sits with help or support On tummy, pushes up on arms with straight elbows 	<ul style="list-style-type: none"> Sits independently Can pick up and hold small object in hand Leans toward food or spoon 	<ul style="list-style-type: none"> Learns to crawl May pull self to stand 	<ul style="list-style-type: none"> Pulls self to stand Stands alone Takes early steps 	<ul style="list-style-type: none"> Walks well alone Runs
Baby's Hunger & Fullness Cues	<ul style="list-style-type: none"> Baby establishes a suck-swallow-breathe pattern during breast or bottle feeding 	<ul style="list-style-type: none"> Breastfeeds or bottle feeds Tongue moves forward and back to suck 	<ul style="list-style-type: none"> May push food out of mouth with tongue, which gradually decreases with age Moves pureed food forward and backward in mouth with tongue to swallow Recognizes spoon and holds mouth open as spoon approaches 	<ul style="list-style-type: none"> Learns to keep thick purees in mouth Pulls head downward and presses upper lip to draw food from spoon Tries to rake foods toward self into fist Can transfer food from one hand to the other Can drink from a cup held by feeder 	<ul style="list-style-type: none"> Learns to move tongue from side to side to transfer food around mouth and push food to the side of the mouth so food can be mashed Begins to use jaw and tongue to mash food Plays with spoon at mealtime, may bring it to mouth, but does not use it for self-feeding yet Can feed self finger foods Holds cup independently Holds small foods between thumb and first finger 	<ul style="list-style-type: none"> Feeds self easily with fingers Can drink from a straw Can hold cup with two hands and take swallows More skillful at chewing Dips spoon in food rather than scooping Demands to spoon-feed self Bites through a variety of textures 	<ul style="list-style-type: none"> Chews and swallows firmer foods skillfully Learns to use a fork for spearing Uses spoon with less spilling Can hold cup in one hand and set it down skillfully
Appropriate Foods & Textures	<ul style="list-style-type: none"> Breastmilk or infant formula 	<ul style="list-style-type: none"> Breastmilk or infant formula 	<ul style="list-style-type: none"> Breastmilk or infant formula Infant cereals Thin pureed foods 	<ul style="list-style-type: none"> Breastmilk or infant formula Infant cereals Thin pureed baby foods Thicker pureed baby foods Soft mashed foods without lumps 100% Juice 	<ul style="list-style-type: none"> Breastmilk or infant formula 100% Juice Infant cereals Pureed foods Ground or soft mashed foods with tiny soft noticeable lumps Foods with soft texture Crunchy foods that dissolve (such as baby biscuits or crackers) Increase variety of flavors offered 	<ul style="list-style-type: none"> Breastmilk or infant formula or whole milk 100% Juice Coarsely chopped foods Toddler foods Bite-sized pieces of food Becomes efficient at eating foods of varying textures and taking controlled bites of soft solids, hard solids, or crunchy foods by 2 years 	<ul style="list-style-type: none"> Whole milk 100% Juice Coarsely chopped foods Toddler foods Bite-sized pieces of food Becomes efficient at eating foods of varying textures and taking controlled bites of soft solids, hard solids, or crunchy foods by 2 years

Figure 15.20

The Start Healthy Feeding Guidelines. Summary of physical and eating skills, hunger and fullness cues, and appropriate food textures for children 0 to 24 months of age.

Source: Butte N, Dwyer J, et al. The Start Healthy Feeding Guidelines for Infants and Toddlers. *J Am Diet Assoc.* 2004;104:442–454. Copyright © 2004, with permission from The American Dietetic Association.

tongue. As the infant's body control improves and he can sit independently, he will also develop the ability to pick up and hold objects in his hand. He will be able to take in thicker pureed foods and soft mashed foods without lumps.

Babies who can crawl are also likely to be ready to self-feed finger foods such as baby biscuits or crackers. Babies at this stage can hold small foods between the thumb and first finger, and also hold a cup (preferably one with a cap and spout) independently. A baby is able to participate in the feeding process, and as her dexterity improves, she will be able to pick up small pieces of food. It is important that caregivers monitor the child's eating to make sure the youngster does not choke on food or on nonfood items.

At the end of the first year, when a baby is standing alone and beginning to walk, his diet can expand even further, with bite-size pieces of table foods and a wider variety of textures. Self-feeding with his fingers is much easier, and he desires to self-feed with a spoon as well—a messy but developmentally appropriate thing to do. Most table foods are appropriate for the child at this stage.

There is no scientific evidence to support introduction of complementary foods in any particular order; cultural practices play a large role in determining which foods are introduced first. Introducing a source of iron, such as an iron-fortified infant cereal or pureed meats, is necessary because iron stores developed in pregnancy are declining. No matter what food is introduced first, new foods should be introduced one at a time, at intervals of about one week, to see how well the infant tolerates each food and to be on the lookout for allergic reactions. Throughout the first year, breast milk or infant formula still forms the major portion of the infant's diet. Ideally, however, the child will have been introduced to a variety of foods by his or her first birthday.

Parents and caregivers should take care that complementary foods be soft in texture to avoid the risk of choking. Delaying—until age 1—the introduction of common food allergens, particularly cow's milk, egg whites, and wheat, can prevent food allergies for many infants. In addition to its allergic potential, whole cow's milk provides too much protein and too little iron, is low in essential fatty acids, may impair kidney function and lead to dehydration, and has been linked to development of insulin-dependent diabetes mellitus.⁶⁸ In families with a strong history of allergies, introduction of eggs should be delayed until age 2, and peanuts, tree nuts, fish, and shellfish should not be introduced before age 3.

Along with observing the infant's developmental readiness for complementary foods, parents and caregivers need to be alert to an infant's hunger and satiety cues. The suggestions in Table 15.10 can help new parents establish a healthy feeding relationship with their child.

Various caregivers may be involved in a child's nutrition. In today's society, it is inappropriate to assume that the caregiver is solely the mother, father, grandparent, or even a relative of the child. Many children spend the majority of their feeding time in a child-care setting. Nutrition education and training for child-care workers enhances the likelihood of proper feeding practices in these settings.⁶⁹

Key Concepts: An infant's physiological needs and developmental readiness usually indicate the appropriate time to introduce solid foods. Semisolid and solid foods should be introduced slowly to check for food intolerances or allergic reactions. The caregiver should choose foods that meet the child's nutritional needs and suit his or her developmental capabilities.

Table 15.10 How to Feed Solid Foods

- Feed your baby when she is hungry and wants to eat, but work toward regular feeding times.
- Put her in her highchair, perhaps propped up with a couple of pillows.
- Have her sit up straight and face you. She'll be able to swallow better and will be less likely to choke.
- Sit right in front of her.
- Hold the spoonful of food about 12 inches away from her face. It may be easier to start out with a long-handled baby spoon.
- Wait for her to pay attention and open her mouth before you try to feed her.
- Feed as slowly or as fast as she wants to eat.
- Let her touch her food.
- Respect her caution. It will take a while for her to get used to the spoon and the flavors of the foods.
- Talk to her, keep her company, but don't be exciting or entertaining.
- Stop feeding as soon as she shows you she is done.

Source: Satter E. *Child of Mine: Feeding with Love and Good Sense*. Boulder, CO: Bull Publishing, 2000.

Feeding Problems During Infancy

Colic

The term *colic* refers to continuous crying and distress in a healthy infant that appears to be due to abdominal cramping and discomfort. Infants with colic usually cry for hours, despite efforts to comfort them. In some cases, a change in formula or a change in the breastfeeding mother's diet provides some relief; however, diet (of either mother or infant) is not considered a cause of colic.⁷⁰ Most often, colic goes away on its own, usually by the age of 3 to 4 months.

Early Childhood Caries

Decay in the primary teeth, known as early childhood caries, and sometimes called "baby bottle tooth decay" (see Figure 15.21) can result if baby teeth are bathed too long in milk, formula, or juice, which nourish decay-producing bacteria. Other factors, such as inadequate development of tooth enamel, also contribute.⁷¹ The problem is often associated with routinely putting a baby to bed with a bottle, so that the baby's teeth are awash in formula or juice for much or all of the night. Children with early childhood caries are more susceptible to caries in the permanent teeth and the possibility of life-long dental problems.⁷²

Iron-Deficiency Anemia: Milk Anemia

Human milk and cow's milk both are low in iron. As discussed earlier, this is usually not a problem—the iron in breast milk is well absorbed, and regular cow's milk is not recommended for babies younger than 1 year. Iron deficiency may develop in older infants who do not eat enough iron-rich foods.

Gastroesophageal Reflux

Gastroesophageal reflux is the regurgitation of the stomach contents into the esophagus after a feeding. This type of spitting up occurs in 3 percent of newborns, usually males, and typically disappears within 12 to 18 months. Concern is warranted if reflux makes a child difficult to feed or results in coughing, choking, or frequent vomiting. Adding cereal to bottle feedings is *not* recommended for a baby who has reflux.

Diarrhea

Stool patterns vary from infant to infant, as well as in the same infant over time. Healthy, thriving breastfed infants may have up to 12 stools per day—or only 1 per week. Formula-fed infants usually have 1 to 7 bowel movements per day. Diarrhea—the frequent passage of loose, watery stools—can rapidly dehydrate an infant. Infants with diarrhea require increased fluids, and caregivers should consult the child's pediatrician for specific advice about how to meet this need.

Failure to Thrive

Full-term infants who experience poor growth in the absence of disease or physical defect suffer from **failure to thrive (FTT)**. (See Figure 15.22.) Although this can occur at any age, in infancy it usually occurs in the second half of the first year. Common causes include poverty and a resulting shortage of food, inappropriate foods in an infant's diet, improper formula preparation, or excessive consumption of fruit juice or fruit drinks. (See the FYI feature "Fruit Juices and Drinks.") In addition, well-meaning parents may introduce low-fat or nonfat milk in an attempt to prevent obesity.

gastroesophageal reflux A backflow of stomach contents into the esophagus, accompanied by a burning pain because of the acidity of the gastric juices.

failure to thrive (FTT) Abnormally low gains in length (height) and weight during infancy and childhood; may result from physical problems or poor feeding, but many affected children have no apparent disease or defect.



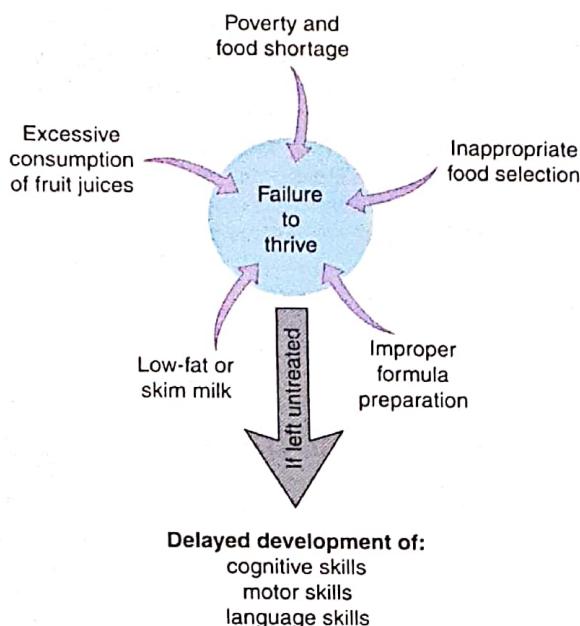
Figure 15.21

Early childhood caries. A baby routinely put to bed with a bottle can develop extensive tooth decay.

Quick Bites

Pumping Iron

The use of cow's milk for children younger than 1 year is a common cause of iron deficiency. Cow's milk is low in iron, and drinking cow's milk can cause intestinal bleeding in infants. The amount of iron in breast milk is low, but this iron is highly bioavailable. Breast milk also contains proteins that bind iron, thereby inhibiting the growth of diarrhea-causing bacteria that feed on iron. If formula is used, the AAP recommends that it be iron fortified.

**Figure 15.22**

Failure to thrive. Failure to thrive can result from many different causes. If untreated, the effects are lifelong.

Babies need a high-fat diet to support normal growth and brain development. As stated, regular cow's milk should not be introduced before age 1. Low-fat milks are inappropriate for children younger than 2 years.

Untreated, FTT can delay cognitive, motor, and language development. Studies indicate, however, that intensive intervention can correct FTT and allow resumption of a normal growth pattern. Such intervention includes nutrition education for caregivers, maintenance of food records by the caregiver, frequent weight checks of the infant, and perhaps social service intervention for the family.

Although there is nothing complex about the nutrient needs and food choices appropriate for babies, it is important for caregivers to receive some education about proper feeding. Some of the practices we learn from friends, parents, and other family members, or remember from our own childhood, are inappropriate for babies. Studies show that even people who receive nutrition education in the WIC program introduce solid foods much too early and feed infants sweetened tea, soft drinks, and other inappropriate foods. Newborns don't come with instructions, but caregivers can always turn to a pediatrician or registered dietitian for answers to feeding questions.



Fruit Juices and Drinks

FOR YOUR INFORMATION

Fruit juices are popular beverages for children aged 6 months to 5 years. Juices do have benefits to the diet. They are refreshing and sweet, accessible and affordable, more healthful than soft drinks, and provide energy, water, and selected minerals and vitamins.¹ A glass of 100 percent fruit juice counts as one fruit serving. If juice is being used as a source of vitamin C, drinking just 3 to 6 fluid ounces per day meets vitamin C intake recommendations.

Fruit juices vary greatly in fiber, pectin, sorbitol, and carbohydrate composition. White grape juice is probably the easiest to digest (it contains similar amounts of glucose and fructose and no sorbitol). Apple and pear juice, while more popular, are less well absorbed due to higher amounts of sorbitol and fructose.²

Fruit juice consumption can be a factor in obesity, if excess juice is consumed on top of a well-rounded diet. Paradoxically, fruit juice consumption also can be a factor in failure to thrive. Failure to thrive may result if fruit juices replace other food sources (particularly milk), or if high amounts of sorbitol and fructose cause diarrhea and malabsorption.³

The vast array of juice drinks and fruit beverages available in the marketplace makes it difficult for parents to find nutritious choices. At best, these beverages contain added vitamin C and, in some cases, vitamin A and calcium. However, beverages that are less than 100 percent fruit juice are more like soft drinks than fruits and, as such, should be severely limited in the diets of young children.

To keep intake of fruit juices to a healthy level,

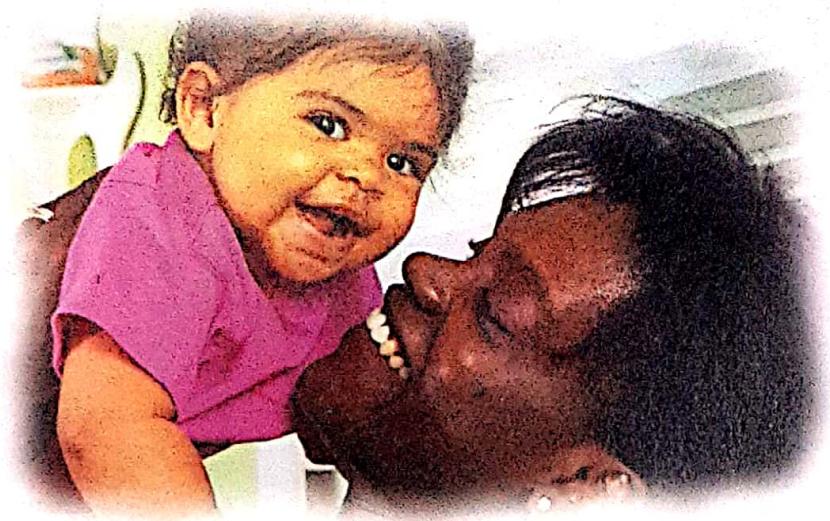
- Limit consumption of fruit juice to 12 fluid ounces per day and ideally no more than 3 to 6 fluid ounces per day
- Encourage caregivers to offer fruit rather than juice to children
- Dilute fruit juice with water
- Delay introduction of juices in the diet until the child can drink from a cup, thus avoiding using juice in bottles

1 Lifshitz F. Weaning foods...the role of fruit juice in the diets of infants and children. *J Am Coll Nutr.* 1996;15(suppl): 15-35.

2 Ibid.

3 Nobugrot T, Chasalow F, Lifshitz F. Carbohydrate absorption from one serving of fruit juice in young children: age and carbohydrate composition effects. *J Am Coll Nutr.* 1997;16: 152-158.

Key Concepts: Feeding-related problems of infancy include colic, early childhood caries, nursing bottle tooth decay, iron-deficiency anemia, gastroesophageal reflux, diarrhea, and failure to thrive. Usually minor adjustments in food choices or feeding techniques solve these problems; however, caregivers may need the guidance of a pediatrician or registered dietitian.



Label [to] Table

A pregnant woman requires more nutrients than usual. The RDA for both iron and folate increases by 50 percent during pregnancy. Iron, especially, is difficult to get in this quantity from the diet. Enriched grains and fortified foods, such as cereals, make it easier to obtain these essential nutrients. Let's take a look at the Nutrition Facts label from a popular breakfast cereal.

Take a look at how much folic acid a 1-cup serving of this breakfast cereal contains—50% DV (DV = 400 micrograms). The DV for folate is the same as the RDA for nonpregnant women; for pregnancy, the RDA increases to 600 micrograms. If orange juice accompanies the cereal, another 15% DV (60 µg) is added for a 1-cup serving. So, these two foods provide a substantial amount of the folate that a pregnant woman would need.

Iron also is extremely important for pregnancy because of its role in growth and its importance as blood volume increases during pregnancy. One serving of this breakfast cereal provides almost half of the DV of 18 milligrams (45 percent of 18 milligrams equals 8 milligrams). However, during pregnancy, the RDA for iron is 27 milligrams. So, one serving of this cereal provides nearly one-third of the iron needed each day—a good start. Having orange juice with the cereal will enhance iron absorption.

Nutrition Facts		
Serving Size: 1 cup (30g)	with 1/2 cup skim milk	
Amount Per Serving	Cheerios	with 1/2 cup skim milk
Calories	110	150
Calories from Fat	15	20
Total Fat 2g	3%	3%
Saturated Fat 0g	0%	3%
Trans Fat 0g		
Polyunsaturated Fat 0.5g		
Monounsaturated Fat 0.5g		
Cholesterol 0g	0%	1%
Sodium 280mg	12%	15%
Total Carbohydrate 22g	7%	9%
Dietary Fiber 0g	11%	11%
Sugars 1g		
Protein 3g		
Vitamin A	10%	15%
Vitamin C	10%	10%
Calcium	4%	20%
Iron	45%	45%
Vitamin D	10%	25%
Thiamin	25%	30%
Riboflavin	25%	35%
Niacin	25%	25%
Vitamin B ₆	25%	25%
Folic Acid	50%	50%
Vitamin B ₁₂	25%	35%
Phosphorus	10%	25%