12.4: Infancy and Nutrition

Skills to Develop

- Summarize nutritional requirements and dietary recommendations for infants.
- Describe the physiologic basis for lactation and the specific components of breast milk.
- Discuss the benefits and barriers related to breastfeeding.
- Examine feeding problems that parents and caregivers may face with their infants.

Diet and nutrition have a major impact on a child’s development from infancy into the adolescent years. A healthy diet not only affects growth, but also immunity, intellectual capabilities, and emotional well-being. One of the most important jobs of parenting is making sure that children receive an adequate amount of needed nutrients to provide a strong foundation for the rest of their lives.

Infancy (Birth to Age One)

The term infant is derived from the Latin word *infans*, which means “unable to speak.” Healthy infants grow steadily, but not always at an even pace. For example, during the first year of life, height increases by 50 percent, while weight triples. Physicians and other health professionals can use growth charts to track a baby’s development process. Because infants cannot stand, length is used instead of height to determine the rate of a child’s growth. Other important developmental measurements include head circumference and weight. All of these must be tracked and compared against standard measurements for an infant’s age. Nationally-accepted growth charts are based on data collected by the National Center for Health Statistics. These charts allow for tracking trends over time and comparing with other infants among percentiles within the United States. Growth charts may provide warnings that a child has a medical problem or is malnourished. Insufficient weight or height gain during infancy may indicate a condition known as failure-
to-thrive (FTT), which is characterized by poor growth. FTT can happen at any age, but in infancy, it typically occurs after six months. Some causes include poverty, lack of enough food, feeding inappropriate foods, and excessive intake of fruit juice. The greatest changes in weight and length occur during the first year of life.

**Nutritional Requirements**

Requirements for macronutrients and micronutrients on a per-kilogram basis are higher during infancy than at any other stage in the human life cycle. These needs are affected by the rapid cell division that occurs during growth, which requires energy and protein, along with the nutrients that are involved in DNA synthesis. During this period, babies are entirely dependent on their parents or other caregivers to meet these needs. For almost all infants six months or younger, breast milk is the best source to fulfill nutritional requirements. An infant may require feedings eight to twelve times a day or more in the beginning. After six months, infants can gradually begin to consume solid foods to help meet nutrient needs.

**Energy**

Energy needs relative to size are much greater in an infant than an adult because of the large surface area of its body. A baby’s resting metabolic rate is two times that of an adult. The RDA to meet energy needs changes as an infant matures and puts on more weight. The IOM uses a set of equations to calculate the total energy expenditure and resulting energy needs. For example, the equation for the first three months of life is \((89 \times \text{weight [kg]} - 100) + 175 \text{ kcal}\).

Based on these equations, the estimated energy requirement for infants from zero to six months of age is 472 to 645 kilocalories per day for boys and 438 to 593 kilocalories per day for girls (100-120 kcal per kg body weight per day). For infants ages six to twelve months, the estimated requirement is 645 to 844 kilocalories per day for boys and 593 to 768 kilocalories per day for girls. From the age one to age two, the estimated requirement rises to 844–1,050 kilocalories per day for boys and 768–997 kilocalories per day for girls.

**Macronutrients**

The dietary recommendations for infants are based on the nutritional content of human breast milk. Carbohydrates make up about 45 to 65 percent of the caloric content in breast milk, which amounts to a RDA of about 130 grams. Almost all of the carbohydrate in human milk is lactose, which infants digest and tolerate well. In fact, lactose intolerance is practically nonexistent in infants. Protein makes up about 5 to 20 percent of the caloric content of breast milk, which amounts to 13 grams per day (or 1.52 grams per kg body weight per day). Infants have a high need for protein to support growth and development, though excess protein (which is only a concern with bottle-feeding) can cause dehydration, diarrhea, fever, and acidosis in premature infants. About 30 to 40 percent of the caloric content in breast milk is made up of fat. A high-fat diet is necessary to encourage the development of neural pathways in the brain and...
other parts of the body. However, saturated fats and trans fatty acids inhibit this growth. Infants who are over the age of six months, which means they are no longer exclusively breastfed, should not consume foods that are high in these types of fats.

- **Micronutrients**

Almost all of the nutrients that infants require can be met if they consume an adequate amount of breast milk. There are a few exceptions, though. Human milk is low in vitamin D, which is needed for calcium absorption and building bone, among other things. Therefore, breastfed children often need to take a vitamin D supplement in the form of drops. Infants at the highest risk for vitamin D deficiency are those with darker skin and no exposure to sunlight. Breast milk is also low in vitamin K, which is required for blood clotting, and deficits could lead to bleeding or hemorrhagic disease. Babies are born with limited vitamin K, so supplementation may be needed initially and some states require a vitamin K injection after birth. Also, breast milk is not high in iron, but the iron in breast milk is well absorbed by infants. After four to six months, however, an infant needs an additional source of iron other than breast milk.

- **Fluids**

Infants have a high need for fluids, 1.5 milliliters per kilocalorie (150 - 170 ml per kg body weight per day) consumed compared to 1.0 milliliters per kilocalorie consumed for adults. This is because children have larger body surface area per unit of body weight and a reduced capacity for perspiration. Therefore, they are at greater risk of dehydration. However, parents or other caregivers can meet an infant’s fluid needs with breast milk or formula. As solids are introduced, parents must make sure that young children continue to drink fluids throughout the day.

- **Breastfeeding**

Figure \(\PageIndex{1}\): Anatomy of the breast.

The alveoli cells produce milk. To secrete it, they contract and push milk into the ductules and the milk sinus, which
collects the milk. When a nursing infant’s gums press on the areola and nipple, the sinuses squeeze the milk into the baby’s mouth. The nipple tissue becomes firmer with stimulation, which makes it more flexible and easier for the baby to grasp in the mouth.

After the birth of the baby, nutritional needs must be met to ensure that an infant not only survives but thrives from infancy into childhood. Breastfeeding provides the fuel a newborn needs for rapid growth and development. As a result, the WHO recommends that breastfeeding is done exclusively for the first six months of an infant’s life. New mothers must also pay careful consideration to their own nutritional requirements to help their bodies recover in the wake of the pregnancy. This is particularly true for women who breastfeed their babies, which calls for an increased need for certain nutrients.

• Lactation

Lactation is the process that makes breastfeeding possible and is the synthesis and secretion of breast milk. Early in a woman’s pregnancy, her mammary glands begin to prepare for milk production. Hormones play a major role in this, particularly during the second and third trimesters. At that point, levels of the hormone prolactin increase to stimulate the growth of the milk duct system, which initiates and maintains milk production. Levels of the hormone oxytocin also rise to promote the release of breast milk when the infant suckles, which is known as the milk ejection reflex or let-down reflex. However, levels of the hormone progesterone need to decrease for successful milk production, because progesterone inhibits milk secretion. Shortly after birth, the expulsion of the placenta triggers progesterone levels to fall, which activates lactation.

New mothers need to adjust their caloric and fluid intake to make breastfeeding possible. The RDA is 330 additional calories during the first six months of lactation and 400 additional calories during the second six months of lactation. The energy needed to support breastfeeding comes from both increased intake and from stored fat. For example, during the first six months after her baby is born, the daily caloric cost for a lactating mother is 500 calories, with 330 calories derived from increased intake and 170 calories derived from maternal fat stores. This helps explain why breastfeeding may promote weight loss in new mothers. Lactating women should also drink 3-4 liters of liquids per day (about 13 cups) to maintain milk production, according to the IOM. Carbohydrate and protein needs are higher during lactation. An additional 25 grams of protein is needed per day. Fluid needs increase to 3-4 liters while vitamins and minerals are not a concern if the woman is eating an adequate diet. A lack of nutrients will reduce the quantity in breast milk, not the quality.

As is the case during pregnancy, the RDA of nearly all vitamins and minerals increases for women who are breastfeeding their babies. The following table compares the recommended vitamins and minerals for lactating women to the levels for nonpregnant and pregnant women from Table 12.2 "Recommended Nutrient Intakes during Pregnancy". The DRI is higher is for vitamins A, E, B₁, B₂, biotin, pantothenic acid, B₆, B₁₂, choline, zinc, iodine, and selenium during lactation than pregnancy and before pregnancy. The mother may need to take an iron supplement.

Table 12.4.1: Recommended Nutrient Intakes during Lactation
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Nonpregnant Women</th>
<th>Pregnant Women</th>
<th>Lactating Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A (mcg)</td>
<td>700.0</td>
<td>770.0</td>
<td>1,300.0</td>
</tr>
<tr>
<td>Vitamin B₆ (mg)</td>
<td>1.5</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Vitamin B₁₂ (mcg)</td>
<td>2.4</td>
<td>2.6</td>
<td>2.8</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>75.0</td>
<td>85.0</td>
<td>120.0</td>
</tr>
<tr>
<td>Vitamin D (mcg)</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Vitamin E (mg)</td>
<td>15.0</td>
<td>15.0</td>
<td>19.0</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>1,000.0</td>
<td>1,000.0</td>
<td>1,000.0</td>
</tr>
<tr>
<td>Folate (mcg)</td>
<td>400.0</td>
<td>600.0</td>
<td>500.0</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>18.0</td>
<td>27.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Magnesium (mg)</td>
<td>320.0</td>
<td>360.0</td>
<td>310.0</td>
</tr>
<tr>
<td>Niacin (B₃) (mg)</td>
<td>14.0</td>
<td>18.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>700.0</td>
<td>700.0</td>
<td>700.0</td>
</tr>
<tr>
<td>Riboflavin (B₂) (mg)</td>
<td>1.1</td>
<td>1.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Thiamine (B₁) (mg)</td>
<td>1.1</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>8.0</td>
<td>11.0</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Source: Institute of Medicine, www.iom.edu.

Calcium requirements do not change during breastfeeding because of more efficient absorption, which is the case during pregnancy, too. However, the reasons for this differ. During pregnancy, there is enhanced absorption within the gastrointestinal tract. During lactation, there is enhanced retention by the kidneys. The RDA for phosphorus, fluoride, and molybdenum also remains the same.

### Components of Breast Milk

Human breast milk not only provides adequate nutrition for infants, it also helps to protect newborns from disease. In addition, breast milk is rich in cholesterol, which is needed for brain development. It is helpful to know the different types and components of breast milk, along with the nutrients they provide to enable an infant to survive and thrive. The amount of milk produced generally is determined by the infant's demand.
Colostrum

Colostrum is produced immediately after birth, prior to the start of milk production, and lasts for several days after the arrival of the baby. Colostrum is thicker than breast milk and is yellowish or creamy in color. This protein-rich liquid fulfills an infant’s nutrient needs during those early days. Although low in volume, colostrum is packed with concentrated nutrition for newborns. This special milk is high in fat-soluble vitamins, minerals, and immunoglobulins (antibodies) that pass from the mother to the baby. Immunoglobulins provide passive immunity for the newborn and protect the baby from bacterial and viral diseases. American Pregnancy Association. “Breastfeeding: Overview.” Last updated January 2012.

Bifidus factors promote the growth of friendly bacteria such as Lactobacillus, that protect against infection. Colostrum also contains lactoferrin, a protein that protects iron from digestion by harmful bacteria, and lactaherin, a protein that binds viruses responsible for infant diarrhea. Antibodies are also present that protect against intestinal infections.

• Transitional Milk

Two to four days after birth, colostrum is replaced by transitional milk. Transitional milk is a creamy liquid that lasts for approximately two weeks and includes high levels of fat, lactose, and water-soluble vitamins. It also contains more calories than colostrum. After a new mother begins to produce transitional milk, she typically notices a change in the volume and type of liquid secreted and an increase in the weight and size of her breasts. American Pregnancy Association. “Breastfeeding: Overview.” Last updated January 2012.

• Mature Milk

Mature milk is the final fluid that a new mother produces. In most women, it begins to secrete at the end of the second week post childbirth. There are two types of mature milk that appear during a feeding. Foremilk occurs at the beginning and includes water, vitamins, and protein. Hind-milk occurs after the initial release of milk and contains higher levels of fat, which is necessary for weight gain. Combined, these two types of milk ensure that a baby receives adequate nutrients to grow and develop properly. American Pregnancy Association. “Breastfeeding: Overview.” Last updated January 2012.

About 90 percent of mature milk is water, which helps an infant remain hydrated. The other 10 percent contains carbohydrates, proteins, and fats, which support energy and growth. Similar to cow’s milk, the main carbohydrate of mature breast milk is lactose. Breast milk contains vital fatty acids, such as docosahexaenoic acid (DHA) and arachidonic acid (ARA). In terms of protein, breast milk contains more whey than casein (which is the reverse of cow’s milk). Whey is much easier for infants to digest than casein. Complete protein, which means all of the essential amino acids, is also present in breast milk. Complete protein includes lactoferrin, an iron-gathering compound that helps to absorb iron into an infant’s bloodstream.

In addition, breast milk provides adequate vitamins and minerals. Although absolute amounts of some micronutrients are low, they are more efficiently absorbed by infants. Other essential components include digestive enzymes that help a baby digest the breast milk. Human milk also provides the hormones and growth factors that help a newborn to develop.
• **Diet and Milk Quality**

A mother’s diet can have a major impact on milk production and quality. As during pregnancy, lactating mothers should avoid illegal substances and cigarettes. Some legal drugs and herbal products can be harmful as well, so it is helpful to discuss them with a health-care provider. Some mothers may need to avoid certain things, such as spicy foods, that can produce gas in sensitive infants. Lactating women can drink alcohol, though they must avoid breastfeeding until the alcohol has completely cleared from their milk. Typically, this takes two to three hours for 12 ounces of beer, 5 ounces of wine, or 1.5 ounces of liquor, depending on a woman’s body weight.


• **Benefits of Breastfeeding**

Breastfeeding has a number of benefits, both for the mother and for the child. Breast milk is the ideal food and contains immunoglobulins, enzymes, immune factors, and white blood cells. As a result, breastfeeding boosts the baby’s immune system and lowers the incidence of diarrhea, along with respiratory diseases, gastrointestinal problems, and ear infections. Breastfed babies also are less likely to develop asthma and allergies, and breastfeeding lowers the risk of sudden infant death syndrome. In addition, human milk encourages the growth of healthy bacteria in an infant’s intestinal tract. All of these benefits remain in place after an infant has been weaned from breast milk. Some studies suggest other possible long-term effects. For example, breast milk may improve an infant’s intelligence and protect against Type 1 diabetes and obesity, although research is ongoing in these areas.


Breastfeeding has a number of other important benefits. It is easier for babies to digest breast milk than bottle formula, which contains proteins made from cow’s milk that require an adjustment period for infant digestive systems. Breastfed infants are sick less often than bottle-fed infants. Breastfeeding is more sustainable and results in less plastic waste and other trash. Breastfeeding can also save families money because it does not incur the same cost as purchasing formula. Other benefits include that breast milk is always ready. It does not have to be mixed, heated, or prepared. Also, breast milk is sterile and is always at the right temperature.

In addition, the skin-to-skin contact of breastfeeding promotes a close bond between mother and baby, which is an important emotional and psychological benefit. The practice also provides health benefits for the mother. Breastfeeding helps a woman’s bones stay strong, which protects against fractures later in life. Studies have also shown that breastfeeding reduces the risk of breast and ovarian cancers.


Other benefits for the mother include a low-cost feeding option, convenient way to feed their baby and a more rapid
weight loss for the mother (up to 1-2 pounds per month while lactating) targeted at the specific areas she gained weight. The quality and quantity of milk are not affected by moderate exercise. Along with bone protection, breastfeeding can reduce the risk of breast, ovarian and type II diabetes. During breastfeeding, the uterus shrinks and amenorrhea (no menstruation) occurs which conserves iron stores.

The Baby-Friendly Hospital Initiative

In 1991, the WHO and UNICEF launched the Baby-Friendly Hospital Initiative (BFHI), which works to ensure that all maternities, including hospitals and free-standing facilities, become centers of breastfeeding support. A maternity can be denoted as “baby-friendly” when it does not accept substitutes to human breast milk and has implemented ten steps to support breastfeeding. These steps include having a written policy on breastfeeding communicated to health-care staff on a routine basis, informing all new mothers about the benefits and management of breastfeeding, showing new mothers how to breastfeed their infants, and how to maintain lactation, and giving newborns no food or drink other than breast milk, unless medically indicated. Since the BFHI began, more than fifteen thousand facilities in 134 countries, from Benin to Bangladesh, have been deemed “baby friendly.” As a result, more mothers are breastfeeding their newborns and infant health has improved, in both the developed world and in developing nations.


Barriers to Breastfeeding

Although breast milk is ideal for almost all infants, there are some challenges that nursing mothers may face when starting and continuing to breastfeed their infants. These obstacles include painful engorgement or fullness in the breasts, sore and tender nipples, milk leakage that can be embarrassing, inverted nipples, infection, and inadequate storage for milk. There are societal barriers too and these include lack of comfort or confidence to breastfeed in public and lack of accommodation to breastfeed or express milk in the workplace.

One of the first challenges nursing mothers face is learning the correct technique. It may take a little time for a new mother to help her baby properly latch on to her nipples. Improper latching can result in inadequate intake, which could slow growth and development. However, International Board Certified Lactation Consultants (IBCLCs), OB nurses, and registered dietitians are all trained to help new mothers learn the proper technique. Education, the length of maternity leave, and laws to protect public breastfeeding, among other measures, can all help to facilitate breastfeeding for many lactating women and their newborns.

Contraindications to Breastfeeding

Although there are numerous benefits to breastfeeding, in some cases there are also risks that must be considered. In the developed world, a new mother with HIV should not breastfeed, because the infection can be transmitted through breast milk. These women typically have access to bottle formula that is safe and can be used as a replacement for breast milk. However, in developing nations where HIV infection rates are high and acceptable infant formula can be difficult to come by, many newborns would be deprived of the nutrients they need to develop and grow. Also, inappropriate or contaminated bottle formulas cause 1.5 million infant deaths each year. As a result, the WHO

Breastfeeding also is not recommended for women undergoing radiation or chemotherapy treatment for cancer. Additionally, if an infant is diagnosed with galactosemia, meaning an inability to process the simple sugar galactose, the child must be on a galactose-free diet, which excludes breast milk. This genetic disorder is a very rare condition, however, and only affects 1 in thirty- to sixty thousand newborns. Genetics Home Reference, a service of the US National Library of Medicine. "Galactosemia." July 9, 2012. http://ghr.nlm.nih.gov/condition/galactosemia. When breastfeeding is contraindicated for any reason, feeding a baby formula enables parents and caregivers to meet their newborn’s nutritional needs.

**Lactation Guidelines**

Babies cry for many reasons and one reason may be that they are hungry. It is a late indicator of hunger. About 10-15 minutes per breast is recommended. It is best if you allow the infant to feed on both breasts. Food flavors from the foods mom eats can appear in breast milk, for example, spicy foods. These flavors may annoy the baby. Also, mom's cow milk intake may bother the infant. Alcohol enters breast milk so it is best to avoid alcohol during lactation or wait at least 2 hours after drinking an alcoholic beverage to breastfeed. Alcohol can reduce the infant's intake of breast milk. Chemicals from cigarette smoke and caffeine also pass into milk. One should limit their caffeine-containing beverage intake to no more than 1-2 cups per day. Caffeine can cause the infant to be irritable and wakeful. Estrogen-containing oral contraceptive can reduce milk output and protein content.

**Bottle-Feeding**

Most women can and should breastfeed when given sufficient education and support. However, as discussed, a small percentage of women are unable to breastfeed their infants, while others choose not to. For parents who choose to bottle-feed, infant formula provides a balance of nutrients. However, not all formulas are the same and there are important considerations that parents and caregivers must weigh. Standard formulas use cow's milk which is very different from human milk as a base although soy-based are available too. They have 20 calories per fluid ounce, similar to breast milk, with vitamins and minerals added. Soy-based formulas are usually given to infants who develop diarrhea, constipation, vomiting, colic, or abdominal pain, or to infants with a cow’s milk protein allergy. Hypoallergenic protein hydrolysate formulas are usually given to infants who are allergic to cow’s milk and soy protein. This type of formula uses hydrolyzed protein, meaning that the protein is broken down into amino acids and small peptides, which makes it easier to digest. Preterm infant formulas are given to low birth weight infants if breast milk is unavailable. Preterm infant formulas have 24 calories per fluid ounce and are given until the infant reaches the desired weight.

Infant formula comes in three basic types:

1. Powder that requires mixing with water. This is the least expensive type of formula.
2. Concentrates, which are liquids that must be diluted with water. This type is slightly more expensive.
3. Ready-to-use liquids that can be poured directly into bottles. This is the most expensive type of formula. However, it requires the least amount of preparation. Ready-to-use formulas are also convenient for traveling.
Most babies need about 2.5 ounces of formula per pound of body weight each day. Therefore, the average infant should consume about 24 fluid ounces of breast milk or formula per day. When preparing formula, parents and caregivers should carefully follow the safety guidelines, since an infant has an immature immune system. All equipment used in formula preparation should be sterilized. Prepared, unused formula should be refrigerated to prevent bacterial growth. Parents should make sure not to use contaminated water to mix formula in order to prevent foodborne illnesses. Follow the instructions for powdered and concentrated formula carefully—formula that is over diluted would not provide adequate calories and protein, while over-concentrated formula provides too much protein and too little water which can impair kidney function.

It is important to note again that both the American Academy of Pediatrics and the WHO state that breast milk is far superior to infant formula. This table compares the advantages of giving a child breast milk to the disadvantages of using bottle formula.

Table 12.4.2: Breast Milk versus Bottle Formula

<table>
<thead>
<tr>
<th>Breast Milk</th>
<th>Bottle Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibodies and lactoferrin in breast milk protect infants.</td>
<td>Formula does not contain immunoprotective factors.</td>
</tr>
<tr>
<td>The iron in breast milk is absorbed more easily.</td>
<td>Formula contains more iron than breast milk, but it is not absorbed as easily.</td>
</tr>
<tr>
<td>The feces that babies produce do not smell because breastfed infants have different bacteria in the gut.</td>
<td>The feces that bottle-fed infants produce tends to have a foul-smelling odor.</td>
</tr>
<tr>
<td>Breast milk is always available and is always at the correct temperature.</td>
<td>Formula must be prepared, refrigerated for storage, and warmed before it is given to an infant.</td>
</tr>
<tr>
<td>Breastfed infants are less likely to have constipation.</td>
<td>Bottle-fed infants are more likely to have constipation.</td>
</tr>
<tr>
<td>Breastfeeding ostensibly is free, though purchasing a pump and bottles to express milk does require some expense.</td>
<td>Formula must be purchased and is expensive.</td>
</tr>
<tr>
<td>Breast milk contains the fatty acids DHA and ARA, which are vital for brain and vision development.</td>
<td>Some formulas contain DHA and ALA.</td>
</tr>
</tbody>
</table>


There are problems if a powdered formula is not correctly diluted with water. If it is too dilute, i.e. too much water is added, then the infant will have inadequate nutrient intake and may fail to grow as well as experience water intoxication. If the dry powder is mixed with too little water, then the infant may become dehydrated. The source of water used to make the formula should be free of contamination, for example, lead, to prevent infection or diarrhea which is common in developing countries that have poor water sanitation.

Video 12.4.1: Breastfeeding Mothers—La Leche League Canada

This video explains the benefits of breastfeeding for both mothers and infants. (click to see video)
Introducing Solid Foods

Infants should be breastfed or bottle-fed exclusively for the first six months of life according to the WHO. (The American Academy of Pediatrics recommends breast milk or bottle formula exclusively for at least the first four months, but ideally for six months.) Infants should not consume solid foods prior to six months because solids do not contain the right nutrient mix that infants need. Also, eating solids may mean drinking less breast milk or bottle formula. If that occurs, an infant may not consume the right quantities of various nutrients. If parents try to feed an infant who is too young or is not ready, their tongue will push the food out, which is called an extrusion reflex. After six months, the suck-swallow reflexes are not as strong, and infants can hold up their heads and move them around, both of which make eating solid foods more feasible.

Solid baby foods can be bought commercially or prepared from regular food using a food processor, blender, food mill, or grinder at home. Usually, an infant cereal can be offered from a spoon between four to six months. By nine months to a year, infants are able to chew soft foods and can eat solids that are well chopped or mashed.

Infants who are fed solid foods too soon are susceptible to developing food allergies. Therefore, as parents and caregivers introduce solids, they should feed their child only one new food at a time (starting with rice cereal, followed by fruits or vegetables), to help identify allergic responses or food intolerances. An iron supplement or iron-fortified cereal is also recommended at this time because iron stores are depleted by about six months.

Nutrient dense foods should be offered that are iron-rich foods like fortified cereals, pureed meat and vitamin C-rich foods that will help with iron absorption. Fruit juices should be limited to 4-6 ounces per day because they can cause diarrhea. One food should be introduced per week and it does not matter if fruit or vegetables are introduced first. Wheat cereal should be offered last.

Here are simple dietary guidelines for the last half of the infant's first year of life.

- Build up variety
- Avoid under or overfeeding
- Don't restrict fat or cholesterol
- Don't overdo fiber rich foods
- Moderate sugar and sodium intake is fine
- Focus on iron rich foods

Learning to Self-Feed

Solid foods should be introduced when the infant is physiologically, immunologically, and developmentally ready which is around 6 months. At this time starch digestion capacity has developed and the kidneys can handle the increased protein found in food. Also, fat digestion is increased with bile acid secretion. Immunologically, the gastrointestinal tract lining has closed decreasing antigen access and the gut immune system is better developed reducing the risk of infection and food allergies. Developmentally, body weight has doubled and the baby can hold their head up and sit. The extrusion reflex has diminished and the infant is interacting with their environment. They may be asking for food and can
indicate satiety by turning away and leaning back. They may be able to chew and bring the food to their mouth.

With the introduction of solid foods, young children begin to learn how to handle food and how to feed themselves. At six to seven months, infants can use their whole hand to pick up items (this is known as the palmer grasp). They can lift larger items, but picking up smaller pieces of food is difficult. At eight months, a child might be able to use a pincer grasp, which uses fingers to pick up objects. After the age of one, children slowly begin to use utensils to handle their food. Unbreakable dishes and cups are essential, since very young children may play with them or throw them when they become bored with their food.

• Feeding Problems during Infancy

Parents and caregivers should be mindful of certain diet-related problems that may arise during infancy. Certain foods are choking hazards, including foods with skins or foods that are very small, such as grapes. Other examples of potential choking hazards include raw carrots and apples, raisins, hard candy, hot dogs, gum, marshmallows, whole grapes, cherries, popcorn, raw carrots, celery, whole beans, nuts and peanut butter. These foods should be avoided.

Egg whites, chocolate, nuts and unprocessed cow’s milk should be avoided until after the first year of life. Honey, Corn syrup can contain the botulism toxin so should be avoided as well as unpasteurized juices or milk products, and raw or undercooked eggs, meat, fish poultry, and shellfish. Parents should also avoid adding salt or seasonings to an infant’s food as well as canned vegetables because the sodium can present a problem. Sugar alcohols can cause diarrhea so these foods should be avoided too. Baby desserts or concentrated sweets are not recommended.

Heating an infant’s food presents a risk of accidental injury or burns, which may occur if the food is heated unevenly or excessively. Keep in mind that an infant cannot communicate that the food is too hot. Also, parents and caregivers should never leave a baby alone at mealtime, because an infant can accidentally choke on pieces of food that are too big or have not been adequately chewed. Raw honey and corn syrup both contain spores of Clostridium botulinum. They produce a poisonous toxin in a baby’s intestines, which can cause the foodborne illness botulism. After the age of one, it is safe to give an infant honey or corn syrup. However, honey as an ingredient in food, such as in cereal, is safe for all ages because it has been adequately heat-treated.

• Overnutrition

Overnutrition during infancy is a growing problem. Overfed infants may develop dietary habits and metabolic characteristics that last a lifetime. According to the American Journal of Clinical Nutrition, the consequences of overnutrition and growth acceleration in infancy include long-term obesity, along with Type 2 diabetes and cardiovascular disease later in life. Singhal, A. et al. “Nutrition in Infancy and Long-Term Risk of Obesity: Evidence from Two Randomized Control Trials.” Am J Clin Nutr 92 (2010): 1133–44. Therefore, parents and other caregivers should restrain from overfeeding, and ideally give their infants breast milk to promote health and well-being.
Food Allergies

Food allergies impact four to six percent of young children in America. Common food allergens that can appear just before or after the first year include peanut butter, egg whites, wheat, cow's milk, and nuts. For infants, even a small amount of a dangerous food can prove to be life-threatening. If there is a family history of food allergies, it is a good idea to delay giving a child dairy products until one year of age, eggs until two years of age, and shellfish, fish, and nuts until three years of age.

However, lactating women should not make any changes to their diets. Research shows that nursing mothers who attempt to ward off allergies in their infants by eliminating certain foods may do more harm than good. According to the American Academy of Allergy, Asthma, and Immunology, mothers who avoided certain dairy products showed decreased levels in their breast milk of an immunoglobulin specific to cow’s milk. This antibody is thought to protect against the development of allergies in children. Even when an infant is at higher risk for food allergies, there is no evidence that alterations in a mother’s diet make a difference. Gever, J. “Nursing Mom’s Diet No Guard Against Baby Allergies.” Medpage Today. © 2012 Everyday Health, Inc. March 7, 2012. http://www.medpagetoday.com/MeetingCoverage/AAAAIMeeting/31527?utm_content=&utm_medium=email&utm_campaign=DailyHeadlines&utm_source=WC&eun=g330425d0r&userid=330425&email=mzimmerman@cox.net&mu_id=

Approximately one percent of formula-fed infants develop a food allergy.

Early Childhood Caries

Primary teeth are at risk for a disorder known as early childhood caries from breast milk, formula, juice, or other drinks fed through a bottle. Liquids can build up in a baby’s mouth, and the natural or added sugars lead to decay. Early childhood caries is caused not only by the kinds of liquids given to an infant but also by the frequency and length of time that fluids are given. Giving a child a bottle of juice or other sweet liquids several times each day, or letting a baby suck on a bottle longer than a mealtime, either when awake or asleep, can also cause early childhood caries. Bacteria in the mouth feed on the carbohydrate and cause teeth decay. In addition, this practice affects the development and position of the teeth and the jaw. The risk of early childhood caries continues into the toddler years as children begin to consume more foods with a high sugar content. Therefore, parents should avoid giving their children sugary snacks and beverages.

Gastroesophageal Reflux

Small amounts of spitting up during a feeding are normal. However, there is cause for concern if it is too difficult to feed an infant due to gastroesophageal reflux. This condition occurs when stomach muscles open at the wrong times and allow milk or food to back up into the esophagus. Symptoms of gastroesophageal reflux in infants include severe spitting up, projectile vomiting, arching of the back as though in pain, refusal to eat or pulling away from the breast during feedings, gagging or problems with swallowing, and slow weight gain. For most infants, making adjustments in feeding practices addresses the issue. For example, a parent can feed their baby in an upright position, wait at least an hour after eating for play time, burp more often, or give a child smaller, more frequent feedings.
Diarrhea and Constipation

Diarrhea is often caused by a gastrointestinal infection and can dehydrate an infant. It is characterized by stool frequency and consistency that deviates substantially from the norm. Diarrhea may indicate a bacterial or viral infection or food intolerance. Chronic diarrhea can cause growth failure. If an infant has had several bouts of this condition, they will need to replace lost fluids and electrolytes. A common recommendation is to give a child an oral rehydration solution. Because of the immunoprotective factors in breast milk, breastfed infants are less likely to contract gastrointestinal viral illness and experience diarrhea.

Infant constipation—which is the passage of hard, dry bowel movements, but not necessarily the absence of daily bowel movements—is another common problem. This condition frequently begins when a baby transitions from breast milk to formula or begins eating solid foods. Pediatricians can provide the best guidance for handling the problem. Common recommendations include applying a small amount of water-based lubricant to an infant’s anus to ease the passage of hard stools, and feeding an infant on solid foods pureed pears or prunes, or providing barley cereal in place of rice cereal. Mayo Clinic. “Infant and Toddler Health.” March 16, 2011. © 1998–2012 Mayo Foundation for Medical Education and Research. www.mayoclinic.com/health/infant-and-toddler-health/MY00362. Parents can also offer their child a little more water in between feedings to help alleviate the condition.

• Colic

Colic is a common problem during infancy, characterized by crankiness and crying jags. It is defined as crying that lasts longer than three hours per day for at least three days per week and for at least three weeks (which is commonly known as the “rule of 3’s”), and is not caused by a medical problem. About one-fifth of all infants develop colic, usually between the second and third weeks. Crying spells can occur around the clock but often worsen in the early evening. Also, colicky babies may have stomachs that are enlarged or distended with gas.

There is no definitive explanation for colic. Often, colic occurs when a child is unusually sensitive to stimulation. In breastfed babies, colic can be a sign of sensitivity to the mother’s diet. Lactating mothers can try to eliminate caffeine, chocolate, and any other potentially irritating foods from their meals. Medline Plus, a service of the US National Library of Medicine. “Colic and Crying.” Last updated August 2, 2011. www.nlm.nih.gov/medlineplus/ency/article/000978.htm. However, since colic usually subsides over time, any improvement that occurs with food elimination may coincide with the natural healing process.

Parents and caregivers who are feeding bottle formula to colicky babies should talk with pediatricians about replacing it with a protein hydrolysate formula. American Academy of Pediatrics. “Colic.” HealthyChildren.org. © American Academy of Pediatrics. Last updated May 12, 2011. http://www.healthychildren.org/English/ages-stages/baby/crying-colic/pages/Colic.aspx. Whether breastfeeding or bottle-feeding, it is also important not to overfeed infants, which could make them uncomfortable and more likely to have crying fits. In general, it is best to wait between two and three hours from the start of one feeding to the start of the next. If food sensitivity is the cause, colic should cease within a few days of making changes. Eventually, the problem goes away. Symptoms usually begin to dissipate after six weeks and are gone by twelve weeks. Medline Plus, a service of the US National Library of Medicine. “Colic and Crying.” Last updated August 2, 2011. www.nlm.nih.gov/medlineplus/ency/article/000978.htm.
Newborn jaundice is another potential problem during infancy. This condition can occur within a few days of birth and is characterized by yellowed skin or yellowing in the whites of the eyes, which can be harder to detect in dark-skinned babies. Jaundice typically appears on the face first, followed by the chest, abdomen, arms, and legs. This disorder is caused by elevated levels of bilirubin in a baby’s bloodstream. Bilirubin is a substance created by the breakdown of red blood cells and is removed by the liver. Jaundice develops when a newborn’s liver does not efficiently remove bilirubin from the blood. There are several types of jaundice associated with newborns:

- **Physiologic jaundice.** The most common type of newborn jaundice and can affect up to 60 percent of full-term babies in the first week of life.
- **Breast-milk jaundice.** The name for a condition that persists after physiologic jaundice subsides in otherwise healthy babies and can last for three to twelve weeks after birth. Breast-milk jaundice tends to be genetic and there is no known cause, although it may be linked to a substance in the breast milk that blocks the breakdown of bilirubin. However, that does not mean breastfeeding should be stopped. As long as bilirubin levels are monitored, the disorder rarely leads to serious complications.
- **Breastfeeding jaundice.** Occurs when an infant does not get enough milk. This may happen because a newborn does not get a good start breastfeeding, does not latch on to the mother’s breast properly, or is given other substances that interfere with breastfeeding (such as juice). Treatment includes increased feedings, with help from a lactation consultant to ensure that the baby takes in adequate amounts.

![Yellowing skin is one sign of newborn jaundice. Image used with permission (CC BY-SA 3.0; Martybugs).](https://med.libretexts.org/Courses/American_Public_University/APUS%3A_An_Introduction_to_Nutrition_(Byerley)/Text_2ed/…)

Newborn jaundice is more common in a breastfed baby and tends to last a bit longer. If jaundice is suspected, a pediatrician will run blood tests to measure the amount of bilirubin in an infant’s blood. Treatment often involves increasing the number of feedings to increase bowel movements, which helps to excrete bilirubin. Within a few weeks, as the baby begins to mature and red blood cell levels diminish, jaundice typically subsides with no lingering effects. American Pregnancy Association. "Breastfeeding and Jaundice." © 2000–2012 American Pregnancy Association. Accessed February 21, 2012. [http://www.americanpregnancy.org/firstyearoflife/breastfeedingandjaundice.htm](http://www.americanpregnancy.org/firstyearoflife/breastfeedingandjaundice.htm).
Iron Deficiency Anemia

A poor transition from breast milk, which is a poor source of iron, to solid foods can cause an iron deficiency or anemia. Remember, during the first six months of life, the infant is drawing on his/her iron stores which were accumulated in utero. By six months of age, the infant’s iron stores are low so it is important they are given iron-rich foods for their first foods. In children drinking cow's milk, milk anemia may develop if 2-3 cups of cow's milk is consumed per day. The milk displaces the iron making it unavailable for absorption.

Vegetarian Diets

For the first six months of life, infants are lactovegetarian because the consume milk. After six months, maintaining a vegan status becomes more challenging. Vegans should consult a pediatrician and a registered dietitian if they want to continue their infant as a vegan. Continued breastfeeding or formula feeding may be recommended with supplementary feeding to assure adequate iron and energy intake.

Key Takeaways

Parents and other caregivers should use growth charts to track an infant’s development and determine how to best meet their child’s nutritional needs. For the first four to six months of life, children should consume breast milk exclusively. For the next six months, solid foods should be introduced gradually into an infant’s diet as parents and caregivers continue to provide breast milk. Breast milk is ideal for infants and provides all of the nutrients they need to grow and develop. Breastfeeding provides a number of benefits for both a mother and her infant. For babies, breast milk boosts the immune system to protect against disease. For mothers, breastfeeding has several health benefits, such as reducing the risk of breast cancer and ovarian cancer. For both, breastfeeding promotes an emotional bond between mother and child. Some problems related to food and nutrition that may occur during infancy include overnutrition, early childhood caries, gastroesophageal reflux, diarrhea, constipation, and colic.

Discussion Starter

1. Why do some women choose to breastfeed their infants? Why do others decline to breastfeed? Discuss this crucial decision that parents make in the first stages of an infant’s life and the possible consequences of each choice.