Life Cycle Nutrition: Mother and Infant

DO YOU EVER . . .

• Think that men’s lifestyle habits cannot affect a future pregnancy?
• Wonder how much alcohol it takes to harm a developing fetus?
• Consider breast milk and formula to be about the same?
• Wonder how infants can thrive on only breast milk or formula?

Keep reading . . .

Learning Objectives

To find learning objective topics in this chapter, look for text headings with a corresponding “LO” number above the heading. After completing this chapter, you should be able to accomplish the following:

LO 13.1 Explain why a nutritionally adequate diet is important long before a pregnancy is established.

LO 13.2 Identify the special nutritional needs of a pregnant teenager as compared to a pregnant adult.

LO 13.3 Evaluate the statement that “no level of alcoholic beverage intake is safe or advisable during pregnancy.”

LO 13.4 Describe the impacts of gestational diabetes and preeclampsia on the health of a mother and her unborn child.

LO 13.5 Discuss the nutrition and health benefits of breastfeeding to both the mother and the child.

LO 13.6 Discuss some relationships between childhood obesity and chronic diseases.

LO 13.7 Develop a healthy eating and activity plan to help an obese child improve his or her short-term and long-term health overall.
All people need the same nutrients, but in differing amounts throughout life. This chapter is the first of two on life’s changing nutrient needs. It focuses on the two life stages that might be the most important to an individual’s life-long health—pregnancy and infancy.

LO 13.1, 13.2

Pregnancy: The Impact of Nutrition on the Future

People normally think of nutrition as personal, affecting them alone. For the woman who is pregnant, or who soon will be, however, nutrition choices today profoundly affect the health of her future child and the adult that the child will one day become. The nutrient demands of pregnancy are extraordinary.

Preparing for Pregnancy

Before she becomes pregnant, a woman must establish eating habits that will optimally nourish both the growing fetus and herself. She must be well nourished at the outset because early in pregnancy the embryo undergoes rapid and significant developmental changes that depend on good nutrition.

Fathers-to-be are also wise to examine their eating and drinking habits. For example, a sedentary lifestyle and consuming too few fruits and vegetables may affect men’s fertility (and the fertility of their children), and men who drink too much alcohol or encounter other toxins in the weeks before conception can sustain damage to their sperm’s genetic material. When both partners adopt healthy habits, they will be better prepared to meet the demands of parenting that lie ahead.

Prepregnancy Weight

Before pregnancy, all women, but underweight women in particular, should strive for an appropriate body weight. A woman who starts out underweight and who fails to gain sufficiently during pregnancy is very likely to bear a baby with a dangerously low birthweight. (A later section comes back to the needed gains in pregnancy.) Infant birthweight is the most potent single indicator of an infant’s future health. A low-birthweight baby, defined as one who weighs less than 5½ pounds (2,500 grams), is nearly 40 times more likely to die in the first year of life than a normal-weight baby. To prevent low birthweight, underweight women are advised to gain weight before becoming pregnant and to strive to gain adequately thereafter.

When nutrient supplies during pregnancy fail to meet demands, the fetus may adapt to the sparse conditions in ways that may make obesity or chronic diseases more likely in later life. Low birthweight is also associated with lower adult IQ and other brain impairments, short stature, and educational disadvantages. Nutrient deficiency coupled with low birthweight is the underlying cause of more than half of all the deaths worldwide of children under 5 years of age. In the United States, the infant mortality rate in 2006 was just under 7.0 deaths per 1,000 live births. This rate, though higher than that of some other developed countries, represents a significant decline over the last two decades and is a tribute to public health efforts aimed at reducing infant deaths (see Figure 13-1).

Low birthweight may also reflect heredity, disease conditions, smoking, and drug (including alcohol) use during pregnancy. Even with optimal nutrition and health during pregnancy, some women give birth to small infants for unknown reasons. But poor nutrition is the major factor in low birthweight—and an avoidable one, as later sections make clear.

Obese women are also urged to strive for healthy weights before pregnancy. The infant of an obese mother may be larger than normal and may be large even if born prematurely. The large early baby may not be recognized as premature and thus may

*Reference notes are found in Appendix F.
not receive the special medical care required. The baby of an obese mother may be twice as likely to be born with a neural tube defect, too. The vitamin folate may play a role, but a more likely explanation seems to be poor blood glucose control. Obese women themselves are likely to suffer gestational diabetes, hypertension, and complications during and infections after the birth. In addition, both overweight and obese women have a greater risk of giving birth to infants with heart defects and other abnormalities. The obese woman who strives for a healthier pre-pregnancy body weight helps protect both herself and her future child.

A Healthy Placenta and Other Organs A woman’s nutrition before pregnancy is crucial because it determines whether her uterus will be able to support the growth of a healthy placenta during the first month of gestation. The placenta is both a supply depot and a waste-removal system for the fetus. If the placenta works perfectly, the fetus wants for nothing; if it doesn’t, no alternative source of sustenance is available, and the fetus will fail to thrive. Figure 13-2 shows the placenta, a mass of tissue in which maternal and fetal blood vessels intertwine and exchange materials. The two bloods never mix, but the barrier between them is notably thin. Nutrients and oxygen move across this thin barrier from the mother’s blood into the fetus’s blood, and wastes move out of the fetal blood to be excreted by the mother. Thus, by way of the placenta, the mother’s digestive tract, respiratory system, and kidneys serve the needs of the fetus as well as her own. The fetus has these organ systems, but they do not yet function. The umbilical cord is like a pipeline that conducts fetal blood to and from the placenta. The amniotic sac surrounds and cradles the fetus, which floats inside its cushioning fluids.

The placenta is a highly metabolic organ that actively gathers up hormones, nutrients, and protein molecules such as antibodies and transfers them into the fetal bloodstream. The placenta also produces a broad range of hormones that act in

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**Figure 13-1** Infant Mortality Decline Over Time

The graph shows infant deaths per 1,000 live births.


**Figure 13-2** Animated! The Placenta

The placenta is composed of spongy tissue in which fetal blood and maternal blood flow side by side, each in its own vessels. The maternal blood transfers oxygen and nutrients to the fetus’s blood and picks up fetal wastes to be excreted by the mother. The placenta performs the nutritive, respiratory, and excretory functions that the fetus’s digestive system, lungs, and kidneys will provide after birth.
many ways to maintain pregnancy and prepare the mother’s breasts for lactation. Is it any wonder that a healthy placenta is essential for the developing fetus? If the mother’s nutrient stores are inadequate during placental development, no amount of nutrients later on in pregnancy can make up for the lack. If the placenta fails to form or function properly, the fetus will not receive optimal nourishment. After getting such a poor start on life, the child may be ill equipped, even as an adult, to store sufficient nutrients, and a girl may later be unable to grow an adequate placenta or bear healthy full-term infants. For this and other reasons, a woman’s poor nutrition during her early pregnancy could affect her grandchild as well as her child.

KEY POINT Adequate nutrition before pregnancy establishes physical readiness and nutrient stores to support fetal growth. Both underweight and overweight women should strive for appropriate body weights before pregnancy. Newborns who weigh less than 5½ pounds face greater health risks than normal-weight babies. The healthy development of the placenta depends on adequate nutrition before pregnancy.

The Events of Pregnancy
The newly fertilized ovum is called a zygote. It begins as a single cell and rapidly divides into many cells during the days after fertilization. Within two weeks, the cluster of cells embeds itself in the uterine wall in a process known as implantation, and the placenta begins to grow inside the uterus. Minimal growth in size takes place at this time, but it is a crucial period in development. Adverse influences such as smoking, drug abuse, and malnutrition at this time lead to failure to implant or to abnormalities such as neural tube defects that can cause loss of the developing embryo, often before the woman knows she is pregnant.

The Embryo and Fetus During the next six weeks, the embryo registers astonishing physical changes (see Figure 13-3). At eight weeks, the fetus has a complete

CONCEPT LINK 13-1
The interactions between the maternal nutrition and the genes may also affect a future grandchild’s health; see Controversy 11, page 440.

uterus (YOO-ter-us) the womb, the muscular organ within which the infant develops before birth.
placenta (pla-SEN-tuh) the organ of pregnancy in which maternal and fetal blood circulate in close proximity and exchange nutrients and oxygen (flowing into the fetus) and wastes (picked up by the mother’s blood).
gestation the period of about 40 weeks (three trimesters) from conception to birth; the term of a pregnancy.
umbilical (um-BIL-ih-cul) cord the rope-like structure through which the fetus’s veins and arteries reach the placenta; the route of nourishment and oxygen into the fetus and the route of waste disposal from the fetus.
amniotic (AM-nee-OTT-ic) sac the “bag of waters” in the uterus in which the fetus floats.
lactation production and secretion of breast milk for the purpose of nourishing an infant.
ovum the egg, produced by the mother, that unites with a sperm from the father to produce a new individual.
zygote (ZYE-goat) the product of the union of ovum and sperm; a fertilized ovum.
implantation the stage of development, during the first two weeks after conception, in which the fertilized egg (fertilized ovum, or zygote) embeds itself in the wall of the uterus and begins to develop.

Figure 13-3 Stages of Embryonic and Fetal Development

1. A newly fertilized ovum, called a zygote, is about the size of the period at the end of this sentence. Less than 1 week after fertilization, the zygote has rapidly divided many times and becomes ready for implantation.
2. After implantation, the placenta develops and begins to provide nourishment to the developing embryo. An embryo 5 weeks after fertilization is about ½ inch long.
3. A fetus after 11 weeks of development is just over an inch long. Notice the umbilical cord and blood vessels connecting the fetus with the placenta.
4. A newborn infant after 9 months of development measures close to 20 inches in length. The average birthweight is about 7½ pounds. From 8 weeks to term, this infant grew 20 times longer and 50 times heavier.
central nervous system, a beating heart, a fully formed digestive system, well-defined fingers and toes, and the beginnings of facial features.

In the last seven months of pregnancy, the fetal period, the fetus grows 50 times heavier and 20 times longer. Critical periods of cell division and development occur in organ after organ. The amniotic sac fills with fluid, and the mother’s body changes. The uterus and its supporting muscles increase in size, the breasts may become tender and full, the nipples may darken in preparation for lactation, and the mother’s blood volume increases by half to accommodate the added load of materials it must carry. Gestation lasts approximately 40 weeks and ends with the birth of the infant. The 40 or so weeks of pregnancy are divided into thirds, each of which is called a trimester.

<table>
<thead>
<tr>
<th><strong>TABLE 13-1</strong> High-Risk Pregnancy Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Prepregnancy BMI either &lt;18.5 or ≥25</td>
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<tr>
<td>- Insufficient or excessive pregnancy weight gain</td>
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<tr>
<td>- Nutrient deficiencies or toxicities; eating disorders</td>
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<tr>
<td>- Poverty, lack of family support, low level of education, limited food available</td>
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<tr>
<td>- Smoking, alcohol, or other drug use</td>
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<tr>
<td>- Age, especially 15 years or younger or 35 years or older</td>
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<tr>
<td>- Many previous pregnancies (3 or more to mothers under age 20; 4 or more to mothers age 20 or older)</td>
</tr>
<tr>
<td>- Short or long intervals between pregnancies (&lt;18 months or &gt;59 months)</td>
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<tr>
<td>- Previous history of problems such as low- or high-birthweight infants</td>
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<tr>
<td>- Twins or triplets</td>
</tr>
<tr>
<td>- Pregnancy-related hypertension or gestational diabetes</td>
</tr>
<tr>
<td>- Diabetes; heart, respiratory, and kidney disease; certain genetic disorders; special diets and medications</td>
</tr>
</tbody>
</table>

A Note About Critical Periods  Each organ and tissue type grows with its own characteristic pattern and timing. The development of each takes place only at a certain time—the critical period. Whatever nutrients and other environmental conditions are necessary during this period must be supplied on time if the organ is to reach its full potential. If the development of an organ is limited during a critical period, recovery is impossible. For example, the fetus’s heart and brain are well developed at 14 weeks; the lungs, 10 weeks later. Therefore, early malnutrition impairs the heart and brain; later malnutrition impairs the lungs.

The effects of malnutrition during critical periods of pregnancy are seen in defects of the nervous system of the embryo (explained later), in the child’s poor dental health, and in the adolescent’s and adult’s vulnerability to infections and possibly higher risks of diabetes, hypertension, stroke, or heart disease.\(^{14}\) The effects of malnutrition during critical periods are irreversible: abundant and nourishing food, fed after the critical time, cannot remedy harm already done.

Table 13-1 identifies characteristics of a high-risk pregnancy. The more factors that apply, the higher the risk. All pregnant women, especially those in high-risk categories, need prenatal medical care, including dietary advice.

**KEY POINT** Implantation, fetal development, and critical periods depend on maternal nutrition before and during pregnancy.

**Increased Need for Nutrients**

During pregnancy a woman’s nutrient needs increase more for certain nutrients than for others. Figure 13-4 shows the percentage increase in nutrient intakes recommended for pregnant women compared to nonpregnant women. To meet the high nutrient demands of pregnancy, a woman must make careful food choices, but her body will also do its part by maximizing nutrient absorption and minimizing losses.

**Energy, Carbohydrate, Protein, and Fat**  Energy needs vary with the progression of pregnancy. In the first trimester, the pregnant woman needs no additional energy, but her energy needs rise as pregnancy progresses. She requires an additional 340 daily calories during the second trimester and an extra 450 calories each day during the third trimester.\(^{15}\) Well-nourished pregnant women meet these demands for more energy in several ways: some eat more food, some reduce their activity, and some store less of their food energy as fat. A woman can easily meet the need for extra calories by selecting more nutrient-dense foods from the five food groups. Table 2-2 (on page 44) provided suggested eating patterns for several calorie levels, and Table 13-2 offers a sample menu for pregnant and lactating women.

Ample carbohydrate (ideally, 175 grams or more per day and certainly no less than 135 grams) is necessary to fuel the fetal brain and spare the protein needed for fetal growth. Whole-grain breads and cereals, dark green and other vegetables, legumes, and citrus and other fruit provide carbohydrates, nutrients, and phytochemicals, along with fiber to help alleviate the constipation that many pregnant women experience.

The protein DRI recommendation for pregnancy is an additional 25 grams per day higher than for nonpregnant women. Most women in the United States, however,
The increased need for iron in pregnancy cannot be met by diet or by existing stores. Therefore, iron supplements are recommended during the 2nd and 3rd trimesters.

Values for other nutrients are listed on the inside front cover, pages A and B.

Energy allowance during pregnancy is for 2nd trimester; energy allowance during the 3rd trimester is slightly higher; no additional allowance is provided during the 1st trimester. Energy allowance during lactation is for the first 6 months; energy allowance during the second 6 months is slightly higher.

### Table 13-2: Daily Food Choices for Pregnancy (2nd and 3rd Trimesters) and Lactation

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Amounts</th>
<th>SAMPLE MENU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits</td>
<td>2 c</td>
<td>Breakfast</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 whole-wheat English muffin</td>
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<tr>
<td></td>
<td></td>
<td>2 tbs peanut butter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 c low-fat vanilla yogurt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>½ c fresh strawberries</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 c orange juice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dinner</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chicken cacciatore</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 oz chicken</td>
</tr>
<tr>
<td></td>
<td></td>
<td>½ c stewed tomatoes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 c rice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>½ c summer squash</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1½ c salad (spinach, mushrooms, carrots)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 lbs salad dressing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 slice Italian bread</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 tsp soft margarine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 c low-fat milk</td>
</tr>
<tr>
<td>Vegetables</td>
<td>3 c</td>
<td>½ c cranberry juice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 oz pretzels</td>
</tr>
<tr>
<td>Grains</td>
<td>8 oz</td>
<td>Lunch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sandwich (tuna salad on whole-wheat bread)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>½ carrot (sticks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 c low-fat milk</td>
</tr>
<tr>
<td>Protein Foods</td>
<td>6½ oz</td>
<td>Midmorning snack</td>
</tr>
<tr>
<td></td>
<td></td>
<td>½ c cranberry juice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 oz pretzels</td>
</tr>
<tr>
<td>Milk</td>
<td>3 c</td>
<td>Fruits 2 c</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vegetables 3 c</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grains 8 oz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Protein Foods 6½ oz</td>
</tr>
</tbody>
</table>

Note: This sample meal plan provides about 2,500 calories (55% from carbohydrate, 20% from protein, and 25% from fat) and meets most of the vitamin and mineral needs of pregnant and lactating women.
CONCEPT LINK 13-2
To read about vegetarian diets during pregnancy, see Controversy 6 (page 219).

CONCEPT LINK 13-3
Good food sources of the essential fatty acids were listed in Table 5-6 (page 169).

KEY POINT Pregnancy brings physiological adjustments that demand increased intakes of energy and nutrients. A balanced diet that includes more nutrient-dense foods from the five food groups can help to meet these needs.

Of Special Interest: Folate and Vitamin B₁₂ Two vitamins famous for their roles in cell reproduction—folate and vitamin B₁₂—are needed in increased amounts during pregnancy. New cells are laid down at a tremendous pace as the fetus grows and develops. At the same time, the number of the mother’s red blood cells must rise because her blood volume increases, a function requiring more cell division and therefore more vitamins. To accommodate these needs, the recommendation for folate during pregnancy increases from 400 to 600 micrograms a day.

As described in Chapter 7, folate plays an important role in preventing neural tube defects. To review, the early weeks of pregnancy are a critical period for the formation and closure of the neural tube that will later develop to form the brain and spinal cord. By the time a woman suspects she is pregnant, usually around the sixth week of pregnancy, the embryo’s neural tube normally has closed. A neural tube defect (NTD) occurs when the tube fails to close properly. In the United States, an estimated 2,500 infants with NTDs are born each year. In the worst cases, when the neural tube fails to close properly and brain development fails, an invariably fatal defect known as anencephaly occurs.

In a more common NTD, spina bifida, the spinal cord and backbone do not develop normally (see Figure 13-5). The membranes covering the spinal cord, and sometimes the cord itself, may protrude from the spine as a sac. Spina bifida often produces paralysis in varying degrees, depending on the extent of spinal cord damage. Mild cases may not be noticed. Moderate cases may involve curvature of the spine, muscle weakness, mental handicaps, and other ills; severe cases can result in death.

To reduce the risk of neural tube defects, women who are capable of becoming pregnant should obtain 400 micrograms of folic acid daily from supplements, fortified foods, or both, in addition to eating folate-rich foods (see Table 13-3). The DRI committee recommends intake of synthetic folate, folic acid, in supplements and fortified foods because it is better absorbed than the folate naturally present in foods. Foods that naturally contain folate are still important, however, because they contribute to folate intakes while providing other needed vitamins, minerals, fiber, and phytochemicals.

The enrichment of grain products (cereal, grits, pasta, rice, bread, and the like) sold commercially in the United States with folic acid has improved folate status in women of childbearing age and lowered the number of neural tube defects that occur each year. Researchers expect to see declines in some other birth defects (cleft lip and cleft palate) and miscarriages as well. A safety concern arises, however. The pregnant woman also needs a greater amount of vitamin B₁₂ to assist folate in the manufacture of new cells. Because high intakes of folate complicate the diagnosis of a vitamin B₁₂ deficiency, quantities of 1 milligram of folate or more...
require a prescription. Most over-the-counter multivitamin supplements contain 400 micrograms of folate; supplements for pregnant women usually contain at least 800 micrograms.

People who exclude all animal products from the diet need vitamin B<sub>12</sub>-fortified foods or supplements. Limited research suggests that low vitamin B<sub>12</sub> during pregnancy may act synergistically with low folate status to increase the risk of NTD.  

Spina bifida, a common neural tube defect, occurs when the vertebrae of the spine fail to close around the spinal cord, leaving it unprotected. The B vitamin folate helps prevent spina bifida and other neural tube defects.

### Table 13-3 Rich Folate Sources<sup>a</sup>

<table>
<thead>
<tr>
<th>Natural Folate Sources</th>
<th>Fortified Folate Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver (3 oz) 221 µg</td>
<td>Multi-Grain Cheerios Plus cereal (1 c) 400 µg&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lentils (½ c) 179 µg</td>
<td>Product 19 cereal (1 c) 400 µg&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Chickpeas or pinto beans (½ c) 145 µg</td>
<td>Total cereal (1 c) 400 µg&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Asparagus (½ c) 134 µg</td>
<td>Pasta, cooked (1 c) 110 µg</td>
</tr>
<tr>
<td>Spinach (1 c raw) 58 µg</td>
<td>Rice, cooked (1 c) 134 µg</td>
</tr>
<tr>
<td>Avocado (½ c) 105 µg</td>
<td>Bagel (1 small whole) 75 µg</td>
</tr>
<tr>
<td>Orange juice (1 c) 74 µg</td>
<td>Waffles, frozen (2) 36 µg</td>
</tr>
<tr>
<td>Beets (½ c) 68 µg</td>
<td>Bread, white (1 slice) 28 µg</td>
</tr>
</tbody>
</table>

<sup>a</sup>Folate amounts for these and thousands of other foods are listed in the Table of Food Composition in Appendix A.

<sup>b</sup>Folate in cereals varies; read the Nutrition Facts panel of the label.

**CONCEPT LINK 13-4**

Chapter 7 described how excessive folate intakes can mask symptoms of vitamin B<sub>12</sub> deficiency (page 254).
KEY POINT Due to their key roles in cell reproduction, folate and vitamin B\textsubscript{12} are needed in large amounts during pregnancy. Folate plays an important role in preventing neural tube defects.

**Vitamin D and Calcium** Vitamin D and the minerals involved in building the skeleton—calcium, phosphorus, and magnesium—are in great demand during pregnancy. Insufficient intakes may produce abnormal fetal bone development.

Vitamin D plays a vital role in calcium absorption and utilization. Consequently, severe maternal vitamin D deficiency interferes with normal calcium metabolism, which, in rare cases, may cause rickets in the infant.\textsuperscript{23} Regular exposure to sunlight and consumption of vitamin D-fortified milk are usually sufficient to support normal calcium metabolism. The vitamin D in prenatal supplements ensures that intakes during pregnancy are adequate.\textsuperscript{24}

Intestinal absorption of calcium doubles early in pregnancy, and the mineral is stored in the mother’s bones. Later, when fetal bones begin to calcify, the mother’s bone calcium stores are mobilized, and there is a dramatic shift of calcium across the placenta. In the final weeks of pregnancy, more than 300 milligrams of calcium a day are transferred to the fetus. Recommendations to ensure an adequate calcium intake during pregnancy are aimed at conserving the mother’s bone mass while supplying fetal needs.\textsuperscript{25}

Typically, young women in this country take in too little calcium. It is of particular importance for pregnant women under age 25, whose own bones are still actively depositing minerals, to strive to meet the DRI recommendation for calcium by increasing their intakes of milk, cheese, yogurt, and other calcium-rich foods. Less preferred, but still acceptable, is a daily supplement of 600 milligrams of calcium. The DRI recommendation for calcium intake is the same for nonpregnant and pregnant women in the same age group. Women who exclude milk products need calcium-fortified foods such as soy milk, orange juice, and cereals. Read the labels: contents vary and products fortified with both calcium and vitamin D are recommended.

**Iron** A pregnant woman needs iron to help increase her blood volume and to provide for placental and fetal needs. The developing fetus draws heavily on the mother’s iron stores to accumulate a sufficient supply to carry it through the first four to six months of life.\textsuperscript{26} Even a woman with inadequate iron stores transfers a significant amount of iron to the fetus, suggesting that the iron needs of the fetus take priority over those of the mother. In addition, blood losses are inevitable at birth, especially during a delivery by cesarean section, further draining the mother’s iron supply.

During pregnancy, the body makes several adaptations to help meet the exceptionally high need for iron. Menstruation, the major route of iron loss in women, ceases, and absorption of iron increases up to threefold. Without sufficient intake, though, iron stores quickly dwindle.

Few women enter pregnancy with adequate iron stores. Women who enter pregnancy with iron-deficiency anemia have a greater-than-normal risk of delivering low-birthweight or preterm infants.\textsuperscript{27} All women not taking supplemental iron are urged to do so, particularly during the second and third trimesters of pregnancy. When a low hemoglobin or hematocrit is confirmed by a repeat test, more than the standard iron dose of 30 milligrams may be prescribed. To enhance iron absorption, the supplement should be taken between meals and with liquids other than milk, coffee, or tea, which inhibit iron absorption.

**Zinc** Zinc is vital for protein synthesis and cell development during pregnancy. Typical zinc intakes of pregnant women are lower than recommendations, but fortunately, zinc absorption increases when intakes are low.\textsuperscript{28} Large doses of iron can interfere with zinc absorption and metabolism, but most prenatal supplements supply the right balance of these minerals for pregnancy. Zinc is abundant in protein-rich foods such as shellfish, meat, and nuts, and routine zinc supplementation during pregnancy is not advised.\textsuperscript{29}
KEY POINT Severe maternal vitamin D deficiency interferes with normal calcium metabolism in the fetus. All pregnant women, but especially those who are under 25 years of age, need to pay special attention to ensure adequate calcium intakes. A daily iron supplement is recommended for all pregnant women during the second and third trimesters. Iron interferes with zinc absorption, so women need a balanced intake.

Prenatal Supplements Physicians often recommend daily prenatal multivitamin-mineral supplements for pregnant women that typically provide more folate, iron, and calcium than regular supplements (see Figure 13-6). Women who do not eat adequately need them urgently, as do women in high-risk groups: women carrying twins or triplets, and those who smoke cigarettes, drink alcohol, or abuse drugs. For multiple births, prenatal supplements may be of some help in reducing the risks of preterm delivery, low birthweights, and birth defects. Supplements cannot prevent the vast majority of fetal harm from tobacco, alcohol, and drugs, however, as later sections explain.

KEY POINT Women most likely to benefit from multivitamin-mineral supplements during pregnancy include those who do not eat adequately, those carrying twins or triplets, and those who smoke cigarettes, drink alcohol, or abuse drugs.

Food Assistance Programs

Women of limited financial means may eat diets too low in calcium, iron, vitamins A and C, and protein. Often, they and their children need help in obtaining food and benefit from nutrition counseling. At the federal level, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides vouchers redeemable for nutritious foods, along with nutrition education and referrals to health and social services to low-income pregnant and lactating women and their children. For infants given infant formula, WIC also provides iron-fortified formula. WIC encourages mothers to breastfeed their infants, however, and offers incentives to those who do.

More than 9 million people—most of them infants and young children—receive WIC benefits each month. Participation in the WIC program benefits both the nutrient status and the growth and development of infants and children. WIC participation during pregnancy can effectively reduce infant mortality, low birthweight, and maternal and newborn medical costs. The Supplemental Nutrition Assistance Program (formerly, the Food Stamp Program) can also help to stretch the low-income pregnant woman’s grocery dollars. In addition, any communities and organizations such as the American Dietetic Association and local hospitals provide educational services and materials, including nutrition, food budgeting, and shopping information.

KEY POINT Food assistance programs such as WIC can provide nutritious food for pregnant women of limited financial means.

How Much Weight Should a Woman Gain During Pregnancy?

Women must gain weight during pregnancy—fetal and maternal well-being depends on it. Ideally, a woman will have begun her pregnancy at a healthy weight, but even more importantly, she will gain within the recommended weight range for her prepregnancy body mass index (BMI), as shown in Table 13-4. Even obese women are urged to gain during pregnancy. Pregnancy weight gains within the

Example of a Prenatal Supplement Label

Notice that vitamin A is reduced to guard against birth defects, while extra amounts of folate, iron, and other nutrients are provided to meet the specific needs of pregnant women.

Prenatal Vitamins

* To provide certain key nutrients for pregnancy, lactation, and growth, WIC offers vouchers for:
  * baby foods
  * eggs, dried beans, tuna fish, peanut butter
  * fruit, vegetables, and their juices
  * iron-fortified cereals
  * milk and cheese
  * soy-based beverages and tofu
  * whole-wheat bread, and other whole-grain products
  * iron-fortified formula for infants who are not breastfed.

Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) a USDA program offering low-income pregnant and lactating women and those with infants or preschool children coupons redeemable for specific foods that supply the nutrients deemed most necessary for growth and development. For more information, visit www.usda.gov/FoodandNutrition.
recommended ranges are associated with fewer surgical births, a greater number of healthy birthweights, and other positive outcomes for both mothers and infants, but many U.S. women exceed the recommended ranges—only a few fall short. To improve pregnancy outcomes, researchers and health-care providers are placing greater emphasis on preventing excessive weight gains during pregnancy than in the past.

Weight loss during pregnancy is not recommended. Ideally, overweight women will achieve a healthy body weight before becoming pregnant, avoid excessive weight gain during pregnancy, and postpone weight loss until after childbirth.

The ideal weight-gain pattern for a woman who begins pregnancy at a healthy weight is 3½ pounds during the first trimester and 1 pound per week thereafter. If a woman gains more than is recommended early in pregnancy, she should not restrict her energy intake later on in order to lose weight. Also, any sudden, large weight gain is a danger signal, however, because it may indicate the onset of preeclampsia (see the section titled “Troubleshooting”).

The weight the pregnant woman puts on is nearly all lean tissue: placenta, uterus, blood, milk-producing glands, and the fetus itself (see Figure 13-7). The fat she gains is needed later for lactation. Physical activity can help a pregnant woman cope with the extra weight, as a later section explains.

Weight Loss After Pregnancy
The pregnant woman loses some weight at delivery. In the following weeks she loses more as her blood volume returns to normal and she gets rid of accumulated fluids. The typical woman does not, however, return to her prepregnancy weight. In general, the more weight a woman gains beyond the needs of pregnancy, the more she retains—mostly as body fat. Even without excessive gain, most women tend to retain a few pounds with each pregnancy. When those few pounds become 7 or more and BMI increases by a unit or more, complications such as diabetes and hypertension in future pregnancies as well as chronic diseases later in life can increase—even for women who are not overweight. Women who achieve a healthy weight prior to the first pregnancy and maintain it between pregnancies best avoid the cumulative weight gain that threatens health later on.

**KEY POINT** Weight gain is essential for a healthy pregnancy. A woman’s prepregnancy BMI, her own nutrient needs, and the number of fetuses she is carrying help to determine appropriate weight gain.
Should Pregnant Women Be Physically Active?

An active, physically fit woman experiencing a normal pregnancy can and should continue to exercise throughout pregnancy, adjusting the intensity and duration as the pregnancy progresses. Staying active during the course of a normal, healthy pregnancy improves the fitness of the mother-to-be, facilitates labor, helps to prevent or manage gestational diabetes, and reduces psychological stress. Women who remain active during pregnancy report fewer discomforts throughout their pregnancies and retain habits that help in losing excess weight and regaining fitness after the birth.

Pregnant women should choose “low-impact” activities and avoid sports in which they might fall or be hit by other people or objects (for some suggestions, see the Think Fitness feature). Pregnant women with medical conditions or pregnancy complications should undergo a thorough evaluation by their health-care professional before engaging in physical activity. A few more guidelines are offered in Figure 13-8. Several of the guidelines are aimed at preventing excessively high internal body temperature.
and dehydration, both of which can harm fetal development. To this end, the pregnant woman should also stay out of saunas, steam rooms, and hot whirlpools.

**KEY POINT** Physically fit women can continue to be physically active throughout pregnancy. Pregnant women should be cautious in their choice of activities.

### Teen Pregnancy

Each year in the United States, more than 400,000 infants are born to teenage mothers. A pregnant adolescent presents a special case of intense nutrient needs. Young teenage girls have a hard enough time meeting nutrient needs for their own rapid growth and development, let alone those of pregnancy. Many teens enter pregnancy with deficiencies of vitamins B₁₂ and D, folate, and iron that can impair fetal growth. Pregnant adolescents are less likely to receive early prenatal care and are more likely to smoke during pregnancy—two factors that predict low birthweight and infant death. The rates of stillbirths, preterm births, and low-birthweight infants are high when either parent is a teen. Adequate nutrition and appropriate weight gain during pregnancy are indispensable components of prenatal care for teenagers and can substantially improve the outlook for both mother and infant.

To support the needs of both mother and fetus, a pregnant teenager with a normal BMI is encouraged to gain about 35 pounds. However, concerns about obesity have focused attention on proper weight gain advice for pregnant adolescents. Grown women who gave birth during their adolescent years often have higher body weights, BMIs, and body fat than women who bore their children later in life.

Meanwhile, pregnant and lactating teenagers can follow the eating pattern presented in Table 2-2 (page 44), making sure to choose a calorie level high enough to support adequate, but not excessive, weight gain.

**KEY POINT** Of all the population groups, pregnant teenage girls have the highest nutrient needs and an increased likelihood of having problem pregnancies.

### Why Do Some Women Crave Pickles and Ice Cream While Others Can’t Keep Anything Down?

Does pregnancy give a woman the right to demand pickles and ice cream at 2 a.m.? Perhaps so, but not for nutrition’s sake. Food cravings and aversions during preg-
nancy are common but do not seem to reflect real physiological needs. In other words, a woman who craves pickles is not in need of salt. Food cravings and aversions that arise during pregnancy are probably due to hormone-induced changes in taste and sensitivities to smells, and they quickly disappear after the birth.

Some pregnant women develop cravings for nonfood items such as laundry starch, clay, soil, or ice—a practice known as pica. Pica may be practiced for cultural reasons that reflect a society’s folklore; it is especially common among African American women. Pica is often associated with iron deficiency, but whether iron deficiency leads to pica or pica leads to iron deficiency is unclear. Eating clay or soil may interfere with iron absorption and displace iron-rich foods from the diet. Furthermore, if the soil or clay contains environmental contaminants such as lead or parasites, health and nutrition suffer.

The nausea of “morning” (actually, anytime) sickness seems unavoidable and may even be a welcome sign of a healthy pregnancy because it arises from the hormonal changes of early pregnancy. Many women complain that odors, especially cooking smells, make them sick. Thus, minimizing odors can alleviate morning sickness. Sipping carbonated drinks and nibbling plain crackers or other salty snack foods before getting out of bed can sometimes prevent nausea. Some women do best by simply eating what they desire whenever they feel hungry. Table 13-5 offers some other suggestions, but morning sickness can be persistent. If morning sickness interferes with normal eating for more than a week or two, the woman should seek medical advice to prevent nutrient deficiencies.

As the hormones of pregnancy alter her muscle tone and the thriving fetus crowds her intestinal organs, an expectant mother may complain of heartburn or constipation. Raising the head of the bed with two or three pillows can help to relieve nighttime heartburn. A high-fiber diet, physical activity, and a plentiful water intake will help relieve constipation. The pregnant woman should use laxatives or heartburn medications only if her physician prescribes them.

**KEY POINT** Food cravings usually do not reflect physiological needs, and some may interfere with nutrition. Nausea arises from normal hormonal changes of pregnancy.

### Some Cautions for the Pregnant Woman

Some choices that pregnant women make or substances they encounter can harm the fetus, sometimes severely. Among these threats, smoking, medications, herbal supplements, illegal drugs, environmental contaminants, foodborne illness, vitamin-mineral megadoses, dieting, sugar substitutes, and caffeine deserve consideration. Alcohol constitutes a major threat to fetal health and is given a section of its own.

#### Cigarette Smoking

A surgeon general’s warning states that parental smoking can kill an otherwise healthy fetus or newborn. Unfortunately, an estimated 10 percent of pregnant women in the United States smoke, and rates are even higher for unmarried women and those who have not graduated from high school. Constituents of cigarette smoke, such as nicotine, carbon monoxide, arsenic, and cyanide, are toxic to a fetus. Smoking during pregnancy can damage fetal DNA, which could lead to developmental defects or diseases such as cancer. Smoking restricts the blood supply to the growing fetus and so limits the delivery of oxygen and nutrients and the removal of wastes. It slows fetal growth, can reduce brain size, and may impair the intellectual and behavioral development of the child later in life.

A mother who smokes is more likely to have a complicated birth and a low-birthweight infant. The more a mother smokes, the smaller her baby will be. Of all preventable causes of low birthweight in the United States, smoking has the greatest impact. Smokers tend to have lower intakes of dietary fiber, vitamin A, beta-carotene, folate, and vitamin C—nutrients necessary for a healthy pregnancy. The margin on page 504 lists complications of smoking during pregnancy.

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**CONCEPT LINK 13-5**

Pica was described in Chapter 8 (page 303).

**TABLE 13-5**

Tips for Relieving Common Discomforts of Pregnancy

<table>
<thead>
<tr>
<th>To alleviate the nausea of pregnancy:</th>
<th>To prevent or alleviate constipation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• On waking, get up slowly.</td>
<td>• Eat foods high in fiber.</td>
</tr>
<tr>
<td>• Eat dry toast or crackers.</td>
<td>• Exercise daily.</td>
</tr>
<tr>
<td>• Chew gum or suck hard candies.</td>
<td>• Drink at least 8 glasses of liquids a day.</td>
</tr>
<tr>
<td>• Eat small, frequent meals whenever hunger strikes.</td>
<td>• Respond promptly to the urge to defecate.</td>
</tr>
<tr>
<td>• Avoid foods with offensive odors.</td>
<td>• Use laxatives only as prescribed by a physician; avoid mineral oil—it carries needed fat-soluble vitamins out of the body.</td>
</tr>
<tr>
<td>• When nauseated, do not drink citrus juice, water, milk, coffee, or tea.</td>
<td>• To prevent or relieve heartburn:</td>
</tr>
<tr>
<td></td>
<td>• Relax and eat slowly.</td>
</tr>
<tr>
<td></td>
<td>• Chew food thoroughly.</td>
</tr>
<tr>
<td></td>
<td>• Eat small, frequent meals.</td>
</tr>
<tr>
<td></td>
<td>• Drink liquids between meals.</td>
</tr>
<tr>
<td></td>
<td>• Avoid spicy or greasy foods.</td>
</tr>
<tr>
<td></td>
<td>• Sit up while eating.</td>
</tr>
<tr>
<td></td>
<td>• Wait an hour after eating before lying down.</td>
</tr>
<tr>
<td></td>
<td>• Wait 2 hours after eating before exercising.</td>
</tr>
</tbody>
</table>
• Complications associated with smoking during pregnancy:
  • Slowed fetal growth.
  • Low birthweight.
  • Complications in labor.
  • Spontaneous abortion.
  • Fetal death.
  • Sudden infant death syndrome (SIDS).
  • Childhood middle ear infections; cardiac and respiratory diseases.

CONCEPT LINK 13-6
The Consumer Corner in Chapter 11 offered more information about herbal supplements and other alternative therapies (page 427).

CONCEPT LINK 13-7
Chapter 12 offers details on mercury, other contaminants in foods, and many foodborne illnesses.

• To protect their fetuses and newborns from listeriosis, pregnant women should:
  • Avoid the following Mexican soft cheeses: queso blanco, queso fresco, queso de hoja, queso de crema, and asadero. Also avoid feta cheese, brie, Camembert, and blue-veined cheeses like Roquefort.
  • Use only pasteurized juices and dairy products.
  • Eat only thoroughly cooked meat, poultry, eggs, and seafood.
  • Before eating hot dogs and luncheon or deli meats, including cured meats like salami, thoroughly reheat them until steaming hot.
  • Wash all fruits and vegetables.
  • Do not eat refrigerated smoked seafood, such as salmon or trout, or any fish labeled “nova-style,” “lox,” or “kippered,” unless it is an ingredient in a cooked dish.
  • Do not eat refrigerated pâté or meat spreads. Canned or shelf-stable pâté and meat spreads are safer.

environmental tobacco smoke the combination of exhaled smoke (mainstream smoke) and smoke from lighted cigarettes, pipes, or cigars (sidestream smoke) that enters the air and may be inhaled by other people.
listeriosis a serious foodborne infection that can cause severe brain infection or death in a fetus or a newborn; caused by the bacterium Listeria monocytogenes, which is found in soil and water.

Smoking during pregnancy interferes with fetal lung development and increases the risks of respiratory infections and childhood asthma. Sudden infant death syndrome (SIDS), the unexplained deaths that sometimes occur in otherwise healthy infants, has been linked to the mother’s cigarette smoking during pregnancy. Research suggests that even in nonsmokers, regular exposure to environmental tobacco smoke (or secondhand smoke) during pregnancy increases the risk of low birthweight and the likelihood of SIDS.

Medicinal Drugs and Herbal Supplements Medicinal drugs taken during pregnancy may cause serious birth defects. Pregnant women should not take over-the-counter drugs or any medications not prescribed by a physician; then, they should read the labels and take warnings seriously.

Some pregnant women mistakenly consider herbal supplements to be safe alternatives to medicinal drugs and take them to relieve nausea, promote water loss, alleviate depression, aid sleep, or for other reasons. Some herbal products may be safe, but almost none have been tested for safety or effectiveness during pregnancy. Pregnant women should stay away from herbal supplements, teas, or other products unless their safety during pregnancy has been ascertained.

Drugs of Abuse Drugs of abuse such as cocaine easily cross the placenta and impair fetal growth and development. Furthermore, such drugs are responsible for preterm births, low-birthweight infants, and sudden infant deaths. If these newborns survive, central nervous system damage is evident: their cries, sleep, and behaviors early in life are abnormal, and their cognitive development later in life is impaired. They may be hypersensitive or underaroused; infants who test positive for drugs suffer the greatest effects of toxicity and withdrawal. Their childhood growth continues, but at a slow rate.

Environmental Contaminants Pregnant women who are exposed to contaminants such as lead often bear low-birthweight infants with delayed mental and psychomotor development who struggle to survive. During pregnancy, lead readily moves across the placenta, inflicting severe damage on the developing fetal nervous system. For pregnant women, a diet free of contamination takes on extra urgency. Dietary calcium can help to defend against lead toxicity by reducing its absorption.

Mercury is a contaminant of concern as well. As discussed in Chapter 5, fatty fish are a good source of omega-3 fatty acids, but some fish contain large amounts of the pollutant mercury, which can harm the developing fetal brain and nervous system. Because the benefits of moderate fish consumption outweigh the risks, women who may become pregnant, pregnant women, lactating women, and children up to the age of 12 are advised to do the following:
  • Avoid eating shark, swordfish, king mackerel, and tilefish (also called golden snapper or golden bass).
  • Limit average weekly consumption to 12 ounces (cooked or canned) of seafood or to 6 ounces (cooked or canned) of white (albacore) tuna.

Foodborne Illness The vomiting and diarrhea caused by many foodborne illnesses can leave a pregnant woman exhausted and dangerously dehydrated. Particularly threatening, however, is listeriosis, which can cause miscarriage, stillbirth, or severe brain or other infections in fetuses and newborns. Pregnant women are about 20 times more likely than other healthy adults to get listeriosis. A woman with listeriosis may develop symptoms such as fever, vomiting, and diarrhea in about 12 hours after eating a contaminated food; serious symptoms may develop a week to six weeks later. A blood test can reliably detect listeriosis, and antibiotics given promptly to the pregnant sufferer can often prevent infection of the fetus or newborn. The margin lists preventive measures pregnant women can take to avoid contracting listeriosis.

Vitamin-Mineral Megadoses Many vitamins and minerals are toxic when taken in excess. Excessive vitamin A is widely known for its role in fetal malformations of
the cranial nervous system. Intakes before the seventh week of pregnancy appear to be the most damaging. For this reason, vitamin A supplements are not given during pregnancy, unless there is specific evidence of deficiency, which is rare.

**Dieting**  As mentioned, weight loss is not recommended during pregnancy and dieting, even for short periods, can be hazardous. In particular, low-carbohydrate diets or fasts that cause ketosis deprive the growing fetal brain of needed glucose and may impair its development. Many popular diets are deficient in many nutrients vital to fetal growth. Energy restriction during pregnancy is not recommended, regardless of the woman’s prepregnancy weight or the amount of weight gained in the previous month.

**Sugar Substitutes**  Artificial sweeteners have been studied extensively and found to be acceptable during pregnancy if used within the FDA’s guidelines. Women with the inborn error of metabolism known as phenylketonuria should not use the artificial sweetener aspartame.

**Caffeine**  Caffeine crosses the placenta, and the fetus has only a limited ability to metabolize it. Research studies do not indicate that caffeine (even in high doses) causes birth defects in human infants (as it does in animals), but limited evidence suggests that heavy use—intake equaling three or more cups of coffee a day—may increase the risk of miscarriage and fetal death. Depending on the quantities consumed and the mother’s metabolism, caffeine may also interfere with fetal growth. The most sensible course, therefore, is to limit caffeine consumption to the equivalent of about one cup of coffee or two 12-ounce cola beverages a day. Caffeine amounts in food and beverages are listed in Controversy 14 on page 571.

**KEY POINT**  Abstaining from smoking and other drugs, limiting intake of foods known to contain unsafe levels of contaminants such as mercury, taking precautions against foodborne illness, avoiding large doses of nutrients, refraining from dieting, using artificial sweeteners in moderation, and limiting caffeine use are recommended during pregnancy.

**LO 13.3 Drinking During Pregnancy**

Alcohol is arguably the most hazardous drug to future generations because it is legally available, heavily promoted, and widely abused. Society sends mixed messages concerning alcohol. Beverage companies promote an image of drinkers as healthy and active. Opposing this image, health authorities warn that alcohol can injure health, especially during pregnancy (see Figure 13-9). Every container of beer, wine, liquor, or mixed drinks for sale in the United States is required to warn pregnant women of the dangers of drinking during pregnancy.

**Alcohol’s Effects**  Women of childbearing age need to know about alcohol’s harmful effects on a fetus. Alcohol crosses the placenta freely and is directly toxic:

- A sudden dose of alcohol can halt the delivery of oxygen through the umbilical cord. The fetal brain and nervous system are extremely vulnerable to a glucose or oxygen deficit, and alcohol causes both by disrupting placental functioning. Alcohol slows cell division, reducing the number of cells produced and inflicting abnormalities on those that are produced and all of their progeny.

- During the first month of pregnancy, the fetal brain is growing at the rate of 100,000 new brain cells a minute. Even a few minutes of alcohol exposure during this critical period can exert a major detrimental effect.

**CONCEPT LINK 13-8**  The safety of artificial sweeteners was discussed in Chapter 12 (pages 475–478).
Alcohol interferes with placental transport of nutrients to the fetus and can cause malnutrition in the mother; then, all of malnutrition’s harmful effects compound the effects of the alcohol.

Before fertilization, alcohol can damage the ovum or sperm in the mother- or father-to-be, leading to abnormalities in the child.

**KEY POINT** Alcohol limits oxygen delivery to the fetus, slows cell division, and reduces the number of cells organs produce. Alcoholic beverages must bear warnings to pregnant women.

**Fetal Alcohol Syndrome**

Drinking alcohol during pregnancy threatens the fetus with irreversible brain damage, growth retardation, mental retardation, facial abnormalities, vision abnormalities, and many more health problems—a spectrum of symptoms known as **fetal alcohol spectrum disorders**, or FASD. Children at the most severe end of the spectrum (those with all of the symptoms) are defined as having **fetal alcohol syndrome**, or FAS. The life-long mental retardation and other tragedies of FAS can be prevented by abstaining from drinking alcohol during pregnancy. Once the damage is done, however, the child remains impaired. Figure 13-10 shows the facial abnormalities of FAS, which are easy to depict. A visual picture of the internal

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**fetal alcohol spectrum disorders** (FASD) a spectrum of physical, behavioral, and cognitive disabilities caused by prenatal alcohol exposure.

**fetal alcohol syndrome** (FAS) the cluster of symptoms including brain damage, growth retardation, mental retardation, and facial abnormalities seen in an infant or child whose mother consumed alcohol during her pregnancy.
harm is impossible, but that damage seals the fate of the child. An estimated 5 to 20 of every 10,000 children are victims of FAS, making it one of the leading known preventable causes of mental retardation in the world.\textsuperscript{70}

Even when a child does not develop full FAS, prenatal exposure to alcohol can lead to less severe, but nonetheless serious, mental and physical problems. The cluster of mental problems is known as \textit{alcohol-related neurodevelopmental disorder (ARND)}, and the physical malformations are referred to as \textit{alcohol-related birth defects (ARBD)}.\textsuperscript{†} Some of these children show no outward sign of impairment, but others are short in stature or display subtle facial abnormalities. Many perform poorly in school and in social interactions and suffer a subtle form of brain damage. Mood disorders and problem behaviors, such as aggression, are common.\textsuperscript{71}

Many children with ARND or ARBD go undiagnosed until problems develop in the preschool years. Upon reaching adulthood, such children are ill equipped for employment, relationships, and the other facets of life most adults take for granted. Anyone exposed to alcohol before birth may always respond differently to it, and also to certain drugs, than if no exposure had occurred, making addictions likely.

\textbf{KEY POINT} The birth defects of fetal alcohol syndrome arise from severe damage to the fetus caused by alcohol. Lesser conditions, ARND and ARBD, may be harder to diagnose but also rob the child of a normal life.

\textbf{Experts’ Advice}

Despite alcohol’s potential for harm, 1 out of 8 pregnant women drinks alcohol sometime during pregnancy; 1 out of 50 report “binge” drinking (five or more drinks on one occasion).\textsuperscript{72} For women who know they are pregnant and choose to drink alcohol, the question is how much alcohol is too much. Even one drink a day threatens neurological development and behaviors. Low birthweight is reported among infants born to women who drink 1 ounce (two drinks) per day during pregnancy, and FAS is also known to occur with as few as two drinks a day. Birth defects have been reliably observed among the children of women who drink 2 ounces (four drinks) of alcohol daily during pregnancy. Compared to women who do not drink, a sizable and significant increase in stillbirths occurs in women who drink five or more drinks per week.\textsuperscript{73} The most severe impact is likely to occur in the first two months, when the woman may not even be aware that she is pregnant.

Given such evidence, the American Academy of Pediatrics takes the position that women should stop drinking as soon as they plan to become pregnant. This step is important for fathers-to-be as well. Researchers have looked for a “safe” alcohol intake limit during pregnancy and have found none. Their conclusion: abstinence from alcohol is the best policy for pregnant women. The authors of this book recommend this choice, too. After the birth of a healthy baby, celebrate, with one glass of champagne. For a pregnant woman who has already been drinking alcohol, the best advice is “stop now.” A woman who has drunk heavily during the first two-thirds of her pregnancy can still prevent some organ damage by stopping during the third trimester.

\textbf{KEY POINT} Abstinence from alcohol is critical to preventing irreversible damage to the fetus.

\textbf{LO 13.4}

\textbf{Troubleshooting}

Disease during pregnancy can endanger the health of the mother and the health and growth of the fetus. If discovered early, many diseases can be controlled—another reason early prenatal care is recommended.

\textsuperscript{†}Formerly, ARND and ARBD were grouped together and called fetal alcohol effects (FAE).
Diabetes

Pregnancy presents special challenges for the management of diabetes. Without proper management, pregnant women with type 1 or type 2 diabetes may experience episodes of severe hypoglycemia or hyperglycemia, preterm labor, and pregnancy-related hypertension. Infants may be large, suffer physical and mental abnormalities, or experience other complications such as respiratory distress. Signs of fetal health problems are apparent even when maternal glucose is above normal but still below the diagnosis for diabetes. Excellence glycem control in the first trimester and throughout the pregnancy is associated with the lowest frequency of maternal, fetal, and newborn complications. Ideally, a woman will receive the prenatal care needed to achieve glucose control before conception and continued glucose control throughout pregnancy. For optimal long-term outcomes, continuation of intensified diabetes management after pregnancy is in the best interest of the mother’s health.

Some women are prone to develop a pregnancy-related form of diabetes, gestational diabetes. Gestational diabetes usually resolves after the infant is born, but some women go on to develop diabetes (usually type 2) later in life, especially if they are overweight. About half of women who have had gestational diabetes go on to develop other forms of diabetes within a few years. When gestational diabetes is identified early and managed properly, the most serious risks, fetal or infant illness or mortality, fall dramatically. More commonly, gestational diabetes leads to surgical birth and high infant birthweight. Physicians screen for the risk factors listed in the margin and test glucose tolerance in all pregnant women.

Hypertension

Hypertension during pregnancy may be chronic hypertension or gestational hypertension. In chronic hypertension, the condition is generally present before and remains after pregnancy. In women with gestational hypertension, blood pressure usually returns to normal during the first few weeks after childbirth.

Both types of hypertension pose risks to the mother and fetus; the higher the blood pressure, the worse the risk. In addition to heart attack and stroke, high blood pressure may increase the likelihood of a low-birthweight infant or spontaneous abortion.

Preeclampsia

Preeclampsia involves not only high blood pressure but also protein in the urine. Preeclampsia usually appears in first pregnancies and starts to disappear within a few days after delivery. Preeclampsia affects almost all of the mother’s organs—the circulatory system, liver, kidneys, and brain. If the condition progresses, she may experience seizures; when this occurs, the condition is called eclampsia. Maternal mortality during

Did You Know?

Hypertension is defined as blood pressure \( \geq 140/90 \) millimeters of mercury.

- Warning signs of preeclampsia:
  - Hypertension.
  - Protein in the urine.
  - Upper abdominal pain.
  - Severe and constant headaches.
  - Swelling, especially of the face.
  - Dizziness.
  - Blurred vision.
  - Sudden weight gain (1 lb/day).

gestational diabetes abnormal glucose tolerance appearing during pregnancy.
chronic hypertension hypertension that is present and documented before pregnancy; in women whose prepregnancy blood pressure is unknown, the presence of sustained hypertension before 20 weeks of gestation.
gestational hypertension high blood pressure that develops in the second half of pregnancy and usually resolves after childbirth.
preeclampsia (PRE-ee-CLAMP-see-ah) a potentially dangerous condition during pregnancy characterized by edema, hypertension, and protein in the urine.
eclampsia (eh-CLAMP-see-ah) a severe complication during pregnancy in which seizures occur.

MY TURN

Bringing Up Baby

Two students talk about some of the choices they make about the care and feeding of their babies.

To hear their stories, log on to www.cengage.com/sso.
pregnancy is rare in developed countries, but eclampsia is one of the most common causes. Preeclampsia and eclampsia demands prompt medical attention.

**KEY POINT** Gestational diabetes, hypertension, and preeclampsia are problems of some pregnancies that must be managed to minimize associated risks.

**Lactation**

As the time of childbirth nears, a woman must decide whether she will feed her baby breast milk, infant formula, or both. These options are the only foods recommended for an infant during the first four to six months of life. A woman who plans to breastfeed her baby should begin to prepare toward the end of her pregnancy. No elaborate or expensive preparations are needed, but the expectant mother can read one of the many handbooks available on breastfeeding or consult a **certified lactation consultant**, employed at many hospitals. Part of the preparation involves learning what dietary changes are needed, because adequate nutrition is essential to successful lactation.

In rare cases, women produce too little milk to nourish their infants adequately. Severe consequences, including infant dehydration, malnutrition, and brain damage, can occur should the condition go undetected for long. Early warning signs of insufficient milk are dry diapers (a well-fed infant wets about six diapers a day) and infrequent bowel movements.

**Nutrition During Lactation**

A nursing mother produces about 25 ounces of milk a day, with considerable variation from woman to woman and in the same woman from time to time. The volume produced depends primarily on the infant’s demand for milk.

**Energy Cost of Lactation** Producing milk costs a woman almost 500 calories per day above her regular need during the first six months of lactation. To meet this energy need, the woman is advised to eat an extra 330 calories of food each day. The other 170 calories can be drawn from the fat stores she accumulated during pregnancy. The food energy consumed by the nursing mother should carry with it abundant nutrients. A lactating woman’s nutrient recommendations are listed on the inside front cover; see Table 13-2 on page 495 for a sample menu to meet them.

**Fluid Need** Breast milk contains a lot of water, so the nursing mother is advised to drink plenty of fluid each day (about 13 cups) to protect herself from dehydration. To help themselves remember, many women make a habit of drinking a glass of milk, juice, or water each time the baby nurses as well as at mealtimes.

**Variations in Breast Milk** A common question is whether a mother’s milk may lack a nutrient if she fails to get enough in her diet. The answer differs from one nutrient to the next, but in general, the effect of nutritional deprivation of the mother is to reduce the *quantity*, not the *quality*, of her milk. Women can produce milk with adequate protein, carbohydrate, fat, folate, and most minerals, even when their own supplies are limited. For these nutrients, milk quality is maintained at the expense of maternal stores. This is most evident in the case of calcium: dietary calcium has no effect on the calcium concentration of breast milk, but maternal bones lose some of their density during lactation if calcium intakes are inadequate. Such losses are generally made up quickly when lactation ends, and breastfeeding has no long-term harmful effects on women’s bones. Nutrients in breast milk most likely to decline in response to prolonged inadequate intakes are the vitamins—especially vitamins B₁₂, A, and D. Vitamin supplementation of undernourished women appears to help normalize the vitamin concentrations in their milk and may be beneficial.

*La Leche League is an international organization that helps women with breastfeeding concerns: www.lalecheleague.org.

• The DRI recommendation for total water intake during lactation is 3.8 L/day. This includes 3.1 L, or about 13 cups, as total beverages, including water.

**certified lactation consultant** a health-care provider, often a registered nurse or a registered dietitian, with specialized training and certification in breast and infant anatomy and physiology who teaches the mechanics of breastfeeding to new mothers.
Some infants may be sensitive to foods such as onions or garlic in the mother’s diet and become uncomfortable when she eats them. A mother who is breastfeeding her infant is advised to eat whatever nutritious foods she chooses. If a particular food seems to cause an infant discomfort, the mother can eliminate that food from her diet for a few days and see if the problem goes away.

Current evidence does not support a major role for maternal dietary restrictions during lactation to prevent or delay the onset of food allergy in infants. Infants who develop symptoms of food allergy, however, may be more comfortable if the mother’s diet excludes the most common offenders—cow’s milk, eggs, fish, peanuts, and tree nuts. Generally, infants with a strong family history of food allergies benefit from breastfeeding.

**Lactation and Weight Loss**  
Another common question is whether breastfeeding promotes a more rapid loss of the extra body fat accumulated during pregnancy. Studies on this question have not provided a definitive answer. How much weight a woman retains after pregnancy depends on her gestational weight gain and the duration and intensity of breastfeeding. Many women who follow recommendations for gestational weight gain and breastfeeding can readily return to prepregnancy weight by six months. Neither the quality nor the quantity of breast milk is adversely affected by moderate weight loss, and infants grow normally. Women often choose to be physically active to lose weight and improve fitness, and this is compatible with breastfeeding and infant growth. A gradual weight loss (1 pound per week) is safe and does not reduce milk output. Too large an energy deficit, especially soon after birth, will inhibit lactation.

**KEY POINT**  
The lactating woman needs extra fluid and enough energy and nutrients to make sufficient milk each day. Malnutrition most often diminishes the quantity of the milk produced without altering quality. Physical activity to lose excess weight is compatible with breastfeeding and infant growth.

**When Should a Woman Not Breastfeed?**

Some substances impair maternal milk production or enter breast milk and interfere with infant development, making breastfeeding an unwise choice. Some medical conditions also prohibit breastfeeding.

**Alcohol and Illicit Drugs**  
Alcohol enters breast milk and can adversely affect production, volume, composition, and ejection of breast milk as well as overwhelm an infant’s immature alcohol-degrading system. Alcohol concentration peaks within one hour after ingestion of even moderate amounts (equivalent to a can of beer). This amount may alter the taste of the milk to the disapproval of the nursing infant, who may, in protest, drink less milk than normal. Mothers who use illicit drugs should not breastfeed. Breast milk can deliver such high doses of drugs as to cause irritability, tremors, hallucinations, and even death in infants.

**Tobacco and Caffeine**  
Lactating women who smoke tobacco produce less milk, and milk with a lower fat content, than mothers who do not smoke. Consequently, their infants gain less weight than infants of nonsmokers. A lactating woman who smokes not only transfers nicotine and other chemicals to her infant via her breast milk but also exposes the infant to sidestream smoke. Babies who are “smoked over” experience a wide array of health problems—poor growth, hearing impairment, vomiting, breathing difficulties, and even unexplained death. Excess caffeine can make breastfed infants jittery and wakeful. As during pregnancy, caffeine consumption should be moderate when breastfeeding.

**Medicines**  
Many medicines pose no danger during breastfeeding, but others cannot be used because they suppress lactation or are secreted into breast milk and can harm the infant. If a nursing mother must take medication that is secreted in
breast milk and is known to affect the infant, then breastfeeding must be put off for the duration of treatment. Meanwhile, the flow of milk can be sustained by pumping the breasts and discarding the milk. A nursing mother should consult with her physician before taking medicines or herbal supplements.

Many women wonder about using oral contraceptives during lactation. One type that combines the hormones estrogen and progestin seems to suppress milk output, lower the nitrogen content of the milk, and shorten the duration of breastfeeding. In contrast, progestin-only pills have no effect on breast milk or breastfeeding and are considered appropriate for lactating women.95

**Environmental Contaminants**  A woman sometimes hesitates to breastfeed because she has heard warnings that contaminants in fish, water, and other foods may enter breast milk and harm her infant. Although some contaminants do enter breast milk, others may be filtered out. Because formula is made with water, formula-fed infants consume any contaminants that may be in the water supply. Any woman who is concerned about breastfeeding on this basis can consult with a physician or dietitian familiar with the local circumstances. With the exception of rare, massive exposure to a contaminant, the many benefits of breastfeeding far outweigh the risk associated with environmental hazards in the United States.

**Maternal Illness**  If a woman has an ordinary cold, she can continue nursing without worry. The infant will probably catch it from her anyway, and thanks to immunological protection, a breastfed baby may be less susceptible than a formula-fed baby. With appropriate treatment, a woman who has an infectious disease such as hepatitis or tuberculosis can breastfeed; transmission is rare.96 If a woman has active, untreated tuberculosis, however, breastfeeding is contraindicated.97

The human immunodeficiency virus (HIV), responsible for causing AIDS, can be passed from an infected mother to her infant during pregnancy, at birth, or through breast milk, especially during the early months of breastfeeding. In developed countries such as the United States, where safe alternatives are available, HIV-positive women should not breastfeed their infants.98 In developing countries, where feeding inappropriate or contaminated formulas causes 1.5 million infant deaths each year, breastfeeding can be critical to infant survival. The World Health Organization (WHO) recommends exclusive breastfeeding for infants of HIV-infected women for the first six months of life unless replacement feeding is acceptable, feasible, affordable, sustainable, and safe for mothers and their infants.99

**KEY POINT**  Breastfeeding is not advised if the mother’s milk is contaminated with alcohol, drugs, or environmental pollutants. Most ordinary infections such as colds have no effect on breastfeeding. Where safe alternatives are available, HIV-infected women should not breastfeed their infants.

**LO 13.5**

**Feeding the Infant**

Early nutrition affects later development, and early feedings establish eating habits that influence nutrition throughout life. Trends change and experts may argue the fine points, but nourishing a baby is relatively simple. Common sense and a nurturing, relaxed environment go far to promote the infant’s well-being.

**Nutrient Needs**

A baby grows faster during the first year of life than ever again, as Figure 13-11 shows. Pediatricians carefully monitor the growth of infants and children because growth directly reflects their nutrition status. An infant’s birthweight doubles by about 5 months of age and triples by the age of 1 year. (If a 150-pound adult were to
grow like this, the person would weigh 450 pounds after a single year.) The infant’s length changes more slowly than weight, increasing about 10 inches from birth to 1 year. By the end of the first year, the growth rate slows considerably; an infant typically gains less than 10 pounds during the second year and grows about 5 inches in height.

Not only do infants grow rapidly but their basal metabolic rate is remarkably high—about twice that of an adult’s, based on body weight. The rapid growth and metabolism of the infant demand an ample supply of all the nutrients. Of special importance during infancy are the energy nutrients and the vitamins and minerals critical to the growth process, such as vitamin A, vitamin D, and calcium.

Because they are small, babies need smaller total amounts of these nutrients than adults do, but as a percentage of body weight, babies need more than twice as much of most nutrients. Infants require about 100 calories per kilogram of body weight per day; most adults require fewer than 40 (see Table 13-6). Figure 13-12 compares a 5-month-old baby’s needs (per unit of body weight) with those of an adult man. You can see that differences in vitamin D and iodine, for instance, are extraordinary. Around 6 months of age, energy needs begin to increase less rapidly as the growth rate begins to slow down, but some of the energy saved by slower growth is spent in increased activity. When their growth slows, infants spontaneously reduce their energy intakes. Parents should expect their babies to adjust their food intakes downward when appropriate and should not force or coax them to eat more.

One of the most important nutrients for infants, as for everyone, is water. The younger a child is, the more of its body weight is water. Breast milk or infant formula normally provides enough water to replace fluid losses in a healthy infant. If the environmental temperature is extremely high, however, infants need supplemental water. Because proportionately more of an infant’s body water compared to an adult’s is between the cells and in the vascular space, this water is easy to lose. Conditions that cause rapid fluid loss, such as vomiting or diarrhea, require an electrolyte solution designed for infants.

**KEY POINT** Infants’ rapid growth and development depend on adequate nutrient supplies, including water from breast milk or formula.

**Why Is Breast Milk So Good for Babies?**

Both the AAP (American Academy of Pediatrics) and the Canadian Pediatric Society stand behind this statement: “Breastfeeding is strongly recommended for full term infants, except in the few instances where specific contraindications exist.” The American Dietetic Association (ADA) advocates breastfeeding for the nutritional health it confers on the infant as well as for the many other benefits it provides both infant and mother (see Table 13-7). The AAP and the ADA recognize exclusive breastfeeding for 6 months, and breastfeeding with complementary foods for at least 12 months, as an optimal feeding pattern for infants. All legitimate nutrition authorities share this view, but some makers of baby formula try to convince women otherwise—see the Consumer Corner on page 517.

**Table 13-6** Infant and Adult Heart Rate, Respiration Rate, and Energy Needs Compared

<table>
<thead>
<tr>
<th></th>
<th>Infants</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate (beats/minutes)</td>
<td>120 to 140</td>
<td>70 to 80</td>
</tr>
<tr>
<td>Respiration rate (breaths/minute)</td>
<td>20 to 40</td>
<td>15 to 20</td>
</tr>
<tr>
<td>Energy needs (cal/body weight)</td>
<td>45/lb (100/kg)</td>
<td>&lt;18/lb (&lt;40/kg)</td>
</tr>
</tbody>
</table>
Breast milk excels as a source of nutrients for the young infant. With the exception of vitamin D (discussed later), breast milk provides all the nutrients a healthy infant needs for the first six months of life. Breast milk also conveys immune factors, which both protect an infant against infection and inform its body about the outside environment.

**Breastfeeding Tips** Breast milk is more easily and completely digested than infant formula, so breastfed infants usually need to eat more frequently than formula-fed infants do. During the first few weeks, approximately 8 to 12 feedings a day, on demand, as soon as the infant shows early signs of hunger such as increased alertness, activity, or sucking motions, promote optimal milk production and infant growth. Crying is a late indicator of hunger. An infant who nurses every two to three hours and sleeps contentedly between feedings is adequately nourished. As the infant gets older, stomach capacity enlarges and the mother’s milk production increases, allowing for longer intervals between feedings.

**Figure 13-12** Nutrient Recommendations for a 5-Month-Old Infant and an Adult Male Compared on the Basis of Body Weight

Infants may be relatively small and inactive, but they use a large amount of energy and nutrients in proportion to their body size to keep all their metabolic processes going.

**Table 13-7** Benefits of Breastfeeding

For Infants:
- Provides the appropriate composition and balance of nutrients with high bioavailability.
- Provides hormones that promote physiological development.
- Improves cognitive development.
- Protects against a variety of infections.
- May protect against some chronic diseases, such as diabetes and hypertension, later in life.
- Protects against food allergies.

For Mothers:
- Contracts the uterus.
- Delays the return of regular ovulation, thus lengthening birth intervals. (It is not, however, a dependable method of contraception.)
- Conserves iron stores (by prolonging amenorrhea).
- May protect against breast and ovarian cancer.

Other:
- Provides cost savings from not needing medical treatment for childhood illnesses or time off work to care for sick children.
- Provides cost savings from not needing to purchase formula (even after adjusting for added foods in the diet of a lactating mother).
- Provides environmental savings to society from not needing to manufacture, package, and ship formula or dispose of packaging.
The chief protein in cow’s milk is the chief protein in human breast milk. The lactoferrin, alpha-lactalbumin, and casein (CAY-seen) are the chief protein in cow’s milk. The chief protein in cow’s milk is casein (CAY-seen). Lactoferrin (lack-toe-FERR-in) is a factor in breast milk that helps absorb iron into the infant’s bloodstream, keeps intestinal bacteria from getting enough iron, and kills certain bacteria.

Even though the baby obtains about half the milk from the breast during the first 2 or 3 minutes of suckling, the infant should be encouraged to breastfeed on the first breast for as long as he or she wishes, before being offered the second breast. Begin each feeding on the breast offered last. The infant’s suckling, as well as the complete removal of milk from the breast, stimulates lactation.

Energy Nutrients in Breast Milk  The energy-nutrient balance of breast milk differs dramatically from that recommended for adults (see Figure 13-13). Yet, for infants, breast milk is the most nearly perfect food, affirming that people at different stages of life have different nutrient needs.

The carbohydrate in breast milk (and standard infant formula) is lactose. In addition to being easily digested, lactose enhances calcium absorption. One of the carbohydrate components of breast milk helps protect the infant from infection by preventing the binding of pathogens to the infant’s intestinal cells.

The lipids in breast milk—infant formula—provide the main source of energy in the infant’s diet. Breast milk contains a generous proportion of the essential fatty acids linoleic acid and linolenic acid, as well as their longer-chain derivatives, arachidonic acid and DHA. Most formulas today also contain added arachidonic acid and DHA (read the label). Infants can produce some arachidonic acid and DHA from linoleic and linolenic acid, but some infants may need more than they can make.

DHA is the most abundant fatty acid in the brain and is also present in the retina of the eye. DHA accumulation in the brain is greatest during fetal development and early infancy. Research has focused on the visual and mental development of breastfed infants and infants fed standard formula with and without DHA added. One group of researchers found that infants fed formula fortified with DHA had sharper vision at 4 years of age than those who were fed standard formula. Most studies, however, show no beneficial effect of DHA supplementation for healthy infants.

The protein in breast milk is largely alpha-lactalbumin, a protein the human infant can easily digest. Another breast milk protein, lactoferrin, is an iron-gathering compound that helps absorb iron into the infant’s bloodstream, keeps intestinal bacteria from getting enough iron to grow out of control, and kills certain bacteria.

Vitamins and Minerals in Breast Milk  With the exception of vitamin D, the vitamin content of the breast milk of a well-nourished mother is ample. Even vitamin C, for which cow’s milk is a poor source, is supplied generously. The concentration of vitamin D in breast milk is low, however, and vitamin D deficiency impairs bone mineralization. Vitamin D deficiency is most likely in infants who are not exposed to sunlight daily, have darkly pigmented skin, and receive breast milk without vitamin D supplementation. Reports of infants in the United States developing vitamin D–deficiency disease rickets and recommendations by the AAP to keep infants under 6 months of age out of direct sunlight have prompted revisions in vitamin D guidelines. The AAP currently recommends a vitamin D supplement for all infants who are breastfed exclusively, and for any infants who do not receive at least 1 liter (1,000 milliliters) or 1 quart (32 ounces) of vitamin D–fortified formula daily.

As for minerals, the calcium content of breast milk is ideal for infant bone growth, and the calcium is well absorbed. Breast milk is also low in sodium. The limited amount of iron in breast milk is highly absorbable, and its zinc, too, is absorbed better than from cow’s milk, thanks to the presence of a zinc-binding protein.

Supplements for Infants  Pediatricians may prescribe supplements containing vitamin D, iron, and fluoride (after 6 months of age). Table 13-8 offers a schedule of supplements during infancy. Vitamin K nutrition for newborns presents a unique case. A newborn’s digestive tract is sterile, and vitamin K–producing bacteria take weeks to establish themselves in the baby’s intestines. To prevent bleeding in the newborn, the AAP recommends that a single dose of vitamin K be given at birth.

Immune Factors in Breast Milk  Breast milk offers the infant unsurpassed protection against infection. Protective factors include antiviral agents, antibacterial agents, and infection inhibitors.
During the first two or three days of lactation, the breasts produce **colostrum**, a premilk substance containing antibodies and white cells from the mother’s blood. Colostrum (like breast milk) helps protect the newborn infant from infections against which the mother has developed immunity—precisely those in the environment likely to infect the infant. The maternal antibodies in colostrum and breast milk inactivate harmful bacteria within the infant’s digestive tract before they can start infections.114

Immune factors in breast milk interfere with the growth of bacteria that could otherwise attack the infant’s vulnerable digestive tract linings. Breastfed babies are less prone to develop stomach and intestinal disorders during the first few months of life and so experience less vomiting and diarrhea than formula-fed babies. Breast milk contains antibodies and other factors against the most common cause of diarrhea in infants and young children (rotavirus).115 Breastfeeding reduces the severity and duration of symptoms associated with this infection.

Breastfeeding also protects against other common illnesses of infancy, such as middle ear infection and respiratory illness.116 Breast milk may offer protection against the development of allergies as well.117 Compared with formula-fed infants, breastfed infants have a lower incidence of allergic reactions such as asthma, wheezing, and skin rash.118 This protection is especially noticeable among infants with a family history of allergies.119 Breast milk may also offer protection against the development of cardiovascular disease. Compared with formula-fed infants, breastfed infants have lower blood pressure and lower blood cholesterol as adults.120

In addition to their protective features, colostrum and breast milk contain hormones and other factors that stimulate the development of the infant’s digestive tract. Clearly, breast milk is a very special substance.

**Other Potential Benefits**  Breastfeeding may offer some protection against excessive weight gain later, although findings are inconsistent.121 One extensive review suggests that initial breastfeeding protects against obesity in later life.122 Another study confirms this finding and adds that the longer the duration of breastfeeding, the lower the risk of overweight in childhood.123 Still another review reports that various studies have shown a protective effect, a protective effect only in certain groups, or no effect.124 Researchers note that many other factors—socioeconomic status, other infant and child feeding practices, and especially the mother’s weight—strongly predict a child’s body weight.

Many studies suggest a beneficial effect of breastfeeding on later intelligence, but when subjected to strict standards of methodology (for example, large sample
size and appropriate intelligence testing), the evidence is less convincing.\textsuperscript{125} Nevertheless, the possibility that breastfeeding may positively affect later intelligence is intriguing. It may be that some specific component of breast milk, such as DHA, contributes to brain development or that certain factors associated with the feeding process itself promote the intellect.\textsuperscript{126} Most likely, a combination of factors is involved. More large, well-controlled studies are needed to confirm the effects, if any, of breastfeeding on later intelligence.

**KEY POINT** Breast milk is the ideal food for infants because it provides the needed nutrients in the right proportions and protective factors as well.

### Formula Feeding

Formula feeding offers an acceptable alternative to breastfeeding. Nourishment for an infant from formula is adequate, and parents can choose this course with confidence. One advantage is that parents can see how much milk the infant drinks during feedings. Another is that other family members can participate in feeding sessions, giving them a chance to develop the special closeness that feeding fosters.

Mothers who return to work early after giving birth may choose formula for their infants, but they have another option. Breast milk can be pumped into bottles and given to the baby in day care. At home, mothers may breastfeed as usual. Many mothers use both methods—they breastfeed at first but \textit{wean} their children within 1 to 12 months. If infants are less than a year of age, mothers must wean them onto \textit{infant formula}, not onto plain cow’s milk of any kind—whole, reduced fat, low fat, or fat-free.

#### Infant formula Composition

The substitution of formula feeding for breastfeeding involves striving to copy nature as closely as possible. Human milk and cow’s milk differ; cow’s milk is significantly higher in protein, calcium, and phosphorus, for example, to support the calf’s faster growth rate. Thus, to prepare a formula from cow’s milk, the formula makers must first dilute the milk and then add carbohydrate and nutrients to make the proportions comparable to those of human milk. Figure 13-14 compares the energy-nutrient balance of breast milk, standard infant formula, and cow’s milk. Notice the higher protein concentration of cow’s milk, which can stress the infant’s kidneys. The AAP recommends that all formula-fed infants receive iron-fortified infant formulas.\textsuperscript{127} Low-iron formulas have no role in infant feeding. Use of iron-fortified formulas has risen in recent decades and is credited with the decline of iron-deficiency anemia in U.S. infants.

#### Special Formulas

Standard cow’s milk–based formulas are inappropriate for some infants. Special formulas have been designed to meet the dietary needs of infants with specific conditions such as prematurity or inherited diseases. Most infants allergic to milk protein can drink formulas based on soy protein.\textsuperscript{128} Soy formulas also use cornstarch and sucrose instead of lactose and so are recommended for infants with lactose intolerance as well. They are also useful as an alternative to milk-based formulas for vegan families. Some infants who are allergic to cow’s milk protein may also be allergic to soy protein.\textsuperscript{129} For these infants, special formulas based on hydrolyzed protein are available.

#### The Transition to Cow’s Milk

For good reasons, the AAP advises that whole cow’s milk is not appropriate for infants younger than 1 year old.\textsuperscript{130} In some infants, particularly those younger than 6 months of age, whole cow’s milk causes intestinal bleeding, which can lead to iron deficiency. Cow’s milk is also a poor source of iron. Consequently, plain cow’s milk both causes iron loss and fails to replace iron. Furthermore, the bioavailability of iron from infant cereal and other foods is reduced when cow’s milk replaces breast milk or iron-fortified formula during the first year.
Formula’s Advertising Advantage

Most women are free to choose whatever feeding method best suits their needs. For a few, however, breastfeeding may be prohibited because of physical conditions or for medical reasons or if medically indicated for special needs of the infant. With the strong scientific consensus that breastfeeding is preferable for most infants, why do women who could breastfeed their infants choose formula? Some women find the time and logistics of breastfeeding burdensome. For many women, though, the decision to forgo breastfeeding is influenced by aggressive advertising of formulas.

Advertisers of infant formulas often strive to create the illusion that formula is identical to human milk. No formula can match the nutrients, agents of immunity, and environmental information conveyed to infants through human milk, but the ads are convincing: “Like mother’s milk, our formula provides complete nutrition” or “Our brand is scientifically formulated to meet your baby’s needs.” Such advertising efforts seem to be working. According to a recent survey, one out of four people of various ages, races, and socioeconomic backgrounds agree with the statement “infant formula is as good as breast milk.”

Infant formula is an appropriate substitute for breast milk when breastfeeding is specifically contraindicated, but for most infants, the benefits of breast milk outweigh those of formula.

To increase market share, formula manufacturers give coupons and samples of free formula to pregnant women. After childbirth, women in the hospital may receive “goody bags” with more coupons to tempt them to receive their “formula gifts.” More coupons arrive by mail a couple of months later, at a time when many women give up breastfeeding, even though nutrition authorities urge continued breastfeeding for several more months. Aggressive marketing tactics can undermine a woman’s confidence concerning her breastfeeding choice, and lack of confidence has a significant influence on early discontinuation of breastfeeding.

National efforts to promote breastfeeding seem to be working, at least to some extent: the percentage of infants who were ever breastfed rose from 60 percent among those born in 1994 to 77 percent among infants born in 2006. Despite this encouraging trend, the rate of breastfeeding at 6 months of age did not change for infants born between 1993 and 2004. Only about one in three infants is still being breastfed at 6 months of age. The AAP and many other health organizations recommend exclusive breastfeeding for the first six months of life. Once complementary foods are offered, the AAP recommends that breastfeeding continue for at least a year and thereafter for as long as mutually desired. In the United States, only about one in five infants is still breastfeeding at 1 year of age. Increasing the rates of breastfeeding initiation and duration is one of the goals of Healthy People 2010. The percentage of mothers choosing to breastfeed their infants and continuing to do so still falls short of goals.

Many hospitals employ certified lactation consultants who specialize in helping new mothers establish a healthy breastfeeding relationship with their newborns. Table 13-9 lists 10 steps hospitals and birth centers can take to promote successful long-term breastfeeding.

Formula-fed infants in developed nations are healthy and grow normally, but they miss out on the breastfeeding advantages described in the text. In developing nations, however, the consequence of choosing not to breastfeed can be tragic. Feeding formula is often fatal to the infant in nations where poverty limits access to formula mixes, clean water is unavailable for safe formula preparation, and medical help is limited. The WHO strongly supports breastfeeding for the world’s infants in its “babyfriendly” initiative and opposes the marketing of infant formulas to new mothers.

Women are free to choose between breast and bottle, but the decision should be made by weighing valid factual information and not be influenced by sophisticated advertising ploys.

### Table 13-9 Ten Steps to Successful Breastfeeding

To promote breastfeeding, every maternity facility should:

- Develop a written breastfeeding policy that is routinely communicated to all health-care staff.
- Train all health-care staff in the skills necessary to implement the breastfeeding policy.
- Inform all pregnant women about the benefits and management of breastfeeding.
- Help mothers initiate breastfeeding within ½ hour of birth.
- Show mothers how to breastfeed and how to maintain lactation, even if they need to be separated from their infants.
- Give newborn infants no food or drink other than breast milk, unless medically indicated.
- Practice rooming-in, allowing mothers and infants to remain together 24 hours a day.
- Encourage breastfeeding on demand.
- Give no artificial nipples or pacifiers to breastfeeding infants.
- Foster the establishment of breastfeeding support groups and refer mothers to them at discharge from the facility.

*Compared with nonusers, infants who use pacifiers breastfeed less frequently and stop breastfeeding at a younger age.

Source: United Nations Children’s Fund, the World Health Organization, the Breastfeeding Hospital Initiative Feasibility Study Expert Work Group, and Baby Friendly U.S.A.
Compared with breast milk or iron-fortified formula, cow’s milk is higher in calcium and lower in vitamin C, characteristics that reduce iron absorption. In short, cow’s milk is a poor choice during the first year of life; infants need breast milk or iron-fortified formula.

Once the baby is obtaining at least two-thirds of total daily food energy from a balanced mixture of cereals, vegetables, fruits, and other foods (after 12 months of age), whole cow’s milk, fortified with vitamins A and D, is an acceptable accompanying beverage. Children 1 to 2 years of age should not be given reduced-fat, low-fat, or fat-free milk routinely. Between the ages of 2 and 5 years, a gradual transition from whole milk to the lower-fat milks can take place, but care should be taken to avoid excessive restriction of dietary fat.

**KEY POINT** Infant formulas are designed to resemble breast milk and must meet an AAP standard for nutrient composition. Special formulas are available for premature infants, allergic infants, and others. Formula should be replaced with milk only after the baby’s first birthday.

### An Infant’s First Foods

Foods can be introduced into the diet as the infant becomes physically ready to handle them. This readiness develops in stages. A newborn can swallow only liquids that are well back in the throat. Later (at 4 months or so), the tongue can move against the palate to swallow semisolid food such as cooked cereal. The stomach and intestines are immature at first; they can digest milk sugar (lactose) but not starch. At about 4 months, most infants can begin to digest starchy foods. Still later, the first teeth erupt, but not until sometime during the second year can a baby begin to handle chewy food.

### When to Introduce Solid Food

The AAP recognizes that infants between 4 and 6 months of age are often developmentally ready to accept some foods other than breast milk. Solid foods can provide needed nutrients that are no longer supplied adequately by breast milk or formula alone. The foods chosen must be those that the infant is developmentally capable of handling both physically and metabolically. The exact timing depends on the individual infant’s needs, developmental readiness (see Table 13-10), and tolerance of the food.

In short, the addition of foods to an infant’s diet should be governed by three considerations: the infant’s nutrient needs, the infant’s physical readiness to handle different forms of foods, and the need to detect and control allergic reactions, as described next. With respect to increased nutrient needs, the nutrient needed first is iron, then vitamin C.

### Foods to Provide Iron and Vitamin C

Rapid growth demands iron. At about 4 to 6 months, the infant begins to need more iron than body stores plus breast milk or iron-fortified formula can provide. In addition to breast milk or iron-fortified formula, infants can receive iron from iron-fortified cereals and, once they readily accept solid foods, from meat or meat alternates such as legumes. Iron-fortified cereals contribute a significant amount of iron to an infant’s diet, but the iron’s bioavailability is poor. Caregivers can enhance iron absorption from iron-fortified cereals by serving vitamin C–rich foods with meals.

The best sources of vitamin C are fruits and vegetables. It has been suggested that infants who are introduced to fruits before vegetables may develop a preference for sweets and find the vegetables less palatable, but there is no evidence to support offering these foods in a particular order. Fruit juice is a source of vitamin C, but excessive juice intake can lead to diarrhea in infants and young children. AAP recommendations limit juice consumption for infants and young children (1 to 6 years of age) to between 4 and 6 ounces per day. Fruit juices should be diluted and served in a cup, not a bottle, once the infant is 6 months of age or older.
Physical Readiness for Solid Foods  Foods introduced at the right times contribute to an infant’s physical development. The ability to swallow food develops at around 4 to 6 months, and food offered by spoon helps to develop swallowing ability. At 8 months to a year, a baby can sit up, can handle finger foods, and begins to teethe. At that time, hard crackers and other finger foods may be introduced to promote the development of manual dexterity and control of the jaw muscles. These feedings must occur under the watchful eye of an adult because the baby can also choke on such foods. Babies and young children cannot safely chew and swallow any of the foods listed in the margin; they can easily choke on these foods, a risk not worth taking. Nonfood items of small size should always be kept out of the infant’s reach to prevent choking.

Some parents want to feed solids as early as possible on the theory that “stuffing the baby” at bedtime will promote sleeping through the night. There is no proof for this theory. Babies start to sleep through the night when they are ready, no matter when solid foods are introduced.

Preventing Food Allergies  To prevent allergy or identify one promptly, experts recommend introducing single-ingredient foods, one at a time, in small portions, and waiting three to five days before introducing the next new food. For example, on introducing cereals, try fortified rice cereal first for several days; it causes allergy least often. Try wheat-containing cereal last; it is a common offender. If a food causes an allergic reaction (irritability due to skin rash, digestive upset, or respiratory

### Infant Development and Recommended Foods

<table>
<thead>
<tr>
<th>Age (mo)</th>
<th>Feeding Skill</th>
<th>Foods Introduced into the Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>Turns head toward any object that brushes cheek. Initially swallows using back of tongue; gradually begins to swallow using front of tongue as well. Strong reflex (extrusion) to push food out during first 2 to 3 months.</td>
<td>Feed breast milk or infant formula.</td>
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<tr>
<td>4–6</td>
<td>Extrusion reflex diminishes, and the ability to swallow nonliquid foods develops. Indicates desire for food by opening mouth and leaning forward. Indicates satiety or disinterest by turning away and leaning back. Sits erect with support at 6 months. Begins chewing action. Brings hand to mouth. Grasps objects with palm of hand.</td>
<td>Begin iron-fortified cereal mixed with breast milk, formula, or water. Begin pureed meats, legumes, vegetables, and fruits.</td>
</tr>
<tr>
<td>10–12</td>
<td>Begins to master spoon, but still spills some.</td>
<td>Add variety. Gradually increase portion sizes.²</td>
</tr>
</tbody>
</table>

²Portions of foods for infants and young children are smaller than those for an adult. For example, a grain serving might be ½ slice of bread instead of 1 slice, or ½ cup rice instead of ½ cup.

discomfort), discontinue its use before going on to the next food. If allergies run in your family, use extra caution in introducing new foods. Parents or caregivers who detect allergies early in an infant’s life can spare the whole family much grief.

Choice of Infant Foods  Infant foods should be selected to provide variety, balance, and moderation. Commercial baby foods in the United States and Canada offer a wide variety of palatable, nutritious foods in a safe and convenient form. Brands vary in their use of starch fillers and sugar—check the ingredients lists. Parents or caregivers should not feed directly from the jar—remove portions to a dish for feeding in order not to contaminate the leftovers that will be stored in the jar.

An alternative to commercial baby food is to process a small portion of the family’s table food in a blender, food processor, or baby food grinder. This necessitates cooking without salt or sugar, though, as the best baby food manufacturers do. Adults can season their own food after taking out the baby’s portion. Pureed food can be frozen in an ice cube tray to yield a dozen or so servings that can be quickly thawed, heated, and served on a busy day.

Because recommendations to restrict fat do not apply to children under age 2, labels on foods for children under 2 (such as infant meats and cereals) cannot carry information about fat. Fat information is omitted from infant food labels to prevent parents from restricting fat in infants’ diets. Fearing that their infant will become overweight, parents may unintentionally malnourish the infant by limiting fat. In fact, infants and young children, because of their rapid growth, need more fat than older children and adults.

Foods to Omit  Sweets of any kind (including baby food “desserts”) have no place in a baby’s diet. The added food energy can promote obesity, and they convey few or no nutrients to support growth. Products containing sugar alcohols such as sorbitol should also be limited, as these may cause diarrhea. Canned vegetables are inappropriate for babies because they often contain too much salt. Awareness of foodborne illness and precautions against it are imperative. Honey and corn syrup should never be fed to infants because of the risk of botulism. Infants and young children are vulnerable to foodborne illnesses, and the Dietary Guidelines address this risk.

Foods at 1 Year  For the infant weaned to whole milk after 1 year of age, whole milk can supply most of the needed nutrients: 2 to 3 cups a day meet those needs. More milk than this displaces iron-rich foods and can lead to the iron-deficiency anemia known as milk anemia. A variety of other foods—meat and meat alternates, iron-fortified cereal, enriched or whole-grain bread, fruits, and vegetables—should be supplied in amounts sufficient to round out total energy needs. Ideally, the 1-year-old sits at the table, eats many of the same foods everyone else eats, and drinks liquids from a cup, not a bottle. Table 13-11 shows a sample menu that meets the requirements for a 1-year-old.

KEY POINT  Solid food additions to an infant’s diet should begin at about 6 months and should be governed by the infant’s nutrient needs and readiness to eat. By 1 year, the baby should be receiving foods from all food groups.

Looking Ahead

The first year of life is the time to lay the foundation for future health. From the nutrition standpoint, the problems most common in later years are obesity and dental disease. Prevention of obesity may also help prevent the obesity-related diseases: atherosclerosis, diabetes, and cancer.

The most important single measure to undertake during the first year is to encourage eating habits that will support continued normal weight as the child grows. This means introducing a variety of nutritious foods in an inviting way (not forcing the baby to finish the bottle or baby food jar) and avoiding concentrated sweets and empty-calorie foods while encouraging physical activity. Parents should not teach
babies to seek food as a reward, to expect food as comfort for unhappiness, or to associate food deprivation with punishment. If they cry for companionship, pick them up—don’t feed them. If they are hungry, by all means, feed them appropriately. More pointers are offered in this chapter’s Food Feature.

An irrational fear of obesity leads some parents to underfeed their infants, depriving them of the energy and nutrients they need to grow. Others wonder if they should feed their infants a low-fat diet to reduce heart disease risk, but the AAP recommends fat intakes of 40 to 50 percent of total calories for infants. A diet too low in fat hinders growth and development even when energy from carbohydrate and protein is ample. With rare exceptions, to be identified by physicians, babies from age 1 to 2 years need the food energy and fat of whole milk. They also need frequent servings of food containing the essential fatty acids.

Dentists strongly discourage the practice of giving a baby a bottle as a pacifier and recommend limiting treats. Sucking for long periods of time pushes the normal jaw line out of shape and causes a bucktoothed profile: protruding upper and receding lower teeth. Prolonged sucking on a bottle of milk or juice also bathes the upper teeth in a carbohydrate-rich fluid that favors the growth of acid-producing bacteria, which dissolves tooth material. Babies regularly put to bed with a bottle sometimes have teeth decayed all the way to the gum line, a condition known as nursing bottle syndrome, shown in the photos below.

**KEY POINT** The early feeding of the infant lays the foundation for lifelong eating habits. It is desirable to foster preferences that will support normal development and health throughout life.

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**FOOD FEATURE**

Mealtimes with Infants

The nurturing of a young child involves more than nutrition. Those who care for young children are responsible not only for providing nutritious foods, milk, and water but also a safe, loving, secure environment in which the children may grow and develop.

**FOSTER A SENSE OF AUTONOMY**

The person feeding a 1-year-old has to be aware that the child’s exploring and experimenting are normal and desirable behaviors. The child is developing a sense of autonomy that, if allowed to develop, will provide the foundation for later assertiveness in choosing when and how much to eat and when to stop eating.

**SOME FEEDING GUIDELINES**

In light of the developmental and nutrient needs of 1-year-olds and in the face of their often contrary and willful behavior, a few feeding guidelines may be helpful:

- Discourage unacceptable behavior (such as standing at the table or throwing food) by removing the child from the table to wait until later to eat. Be consistent and firm, not punitive. For example, instead of saying “You make me mad when you don’t sit down,” say “The fruit salad tastes good—please sit down and eat some with me.” The child will soon learn to sit and eat.

- Let young children explore and enjoy food. This may mean eating with fingers for a while. Learning to use a spoon will come in time. Children who...
are allowed to touch, mash, and smell their food while exploring it are more likely to accept it.

- **Don’t force food on children.** Rejecting new foods is normal and acceptance is more likely as children become familiar with new foods through repeated opportunities to taste them. Instead of saying “You cannot go outside to play until you taste your carrots,” say “You can try the carrots again another time.”
- **Provide nutritious foods, and let children choose which ones, and how much, they will eat.** Gradually, they will acquire a taste for different foods.
- **Limit sweets.** Infants and young children have little room for empty-calorie foods in their daily energy allowance.

**Diet Analysis**

**Analyze the Adequacy of a Diet for Pregnancy**

The purpose of this exercise is to reinforce the importance of good nutrition during pregnancy and infancy.

1. **To reduce the risk for neural tube defects in infants, women who are capable of pregnancy are urged to obtain 400 micrograms (mcg) of folic acid, the most absorbable form of folate, daily in addition to a varied diet.** To help meet a woman’s need, find folic acid among enriched grains and other fortified foods. Select the Track Diet tab from the red navigation bar. Select a new date and enter the foods to create a meal that provides folic acid from enriched sources (see Table 13-3, page 497). *(Hint: A good meal to choose is breakfast.)* Select the Reports tab, then Source Analysis. Select Folate from the drop-down box, and generate a report. How close did you come to providing one-third of the needed 400 mcg?

2. **A pregnant teenager’s need for calcium soars to 1,300 mg a day to meet her need and that of the developing fetus.** Many teenagers fail to meet their calcium needs, even before pregnancy. Select the Track Diet tab and select a new day. Add foods to create a high-calcium meal for a pregnant teen. *(For tips, see Snapshot 8-3, page 293.)* Select the Reports tab, then Source Analysis. Select Calcium from the drop-down box and generate a report. How much calcium was provided by the foods you selected for this meal? What did you take into consideration when choosing the foods high in calcium? How can you increase the likelihood that the teenager will consume this meal?

3. **During lactation, a woman needs an additional 330 calories per day above her regular need.** Create a new profile from the Profile drop down box; make it for a woman, and select “pregnant and lactating.” To meet this woman’s need, choose among nutrient-dense foods *(refer to Table 13-2, page 495)* and create a one-day diet to meet her increased energy need. Select the Reports tab, then Energy Balance, and generate a report for the day’s meals. Did your food choices help this woman to meet her increased energy need? Was “330” listed in the “net kcal” column?

4. **Zinc is required for protein synthesis and cell development.** Snapshot 8-6 on page 306 demonstrated that animal products contain abundant zinc, posing a challenge to vegetarians. Create a vegetarian meal that includes zinc-rich foods. Select the Track Diet tab and select the profile for the pregnant woman. Select a new date. Choose some zinc-rich foods to create a meal. Select Reports, and then Source Analysis. Select Zinc from the drop-down box and generate a report. What foods would you advise for a pregnant vegetarian to increase her intake of zinc?

5. The fetal brain needs carbohydrate fuel each day and the pregnant woman needs carbohydrate, too. Select the Track Diet tab and select the profile for the pregnant woman. Select a new date. Choose nutrient and carbohydrate-rich foods for a dinner. Select the Reports tab, then Source Analysis. Select Carbohydrate from the drop-down menu and generate a report. What other reports would be helpful as you analyze this meal? Does it meet one-third of most of the woman’s nutrient requirements? What is lacking and how might you correct deficiencies?

6. **When an infant begins eating solid foods, the nutrients needed first in increased amounts are iron and vitamin C.** From the Profile drop-down box, create a profile for a 30-inch, 24-pound, 1-year-old child. Select the Track Diet tab and create a breakfast and snack that includes foods high in iron and vitamin C. Select the Reports tab, then Source Analysis and select Iron from the drop-down box. Generate a report. What were the top sources of iron? Do the same for vitamin C and name the top sources. Did your food choices supply more than a third of the child’s iron and vitamin C requirement? If not, what other foods might you select?
To find additional quiz questions, view videos and animations, and explore interactive exercises, go to www.cengage.com/sso.


Learn more about breastfeeding from LaLeche League International at http://www.llli.org.

Get prenatal nutrition guidelines from Health Canada at www.hc-sc.gc.ca.

Learn more about birth defects from the March of Dimes at www.marchofdimes.org.

Visit the American College of Obstetricians and Gynecologists at www.acog.org.

**Self Check**

Answers to these Self Check questions are in Appendix G.

1. A pregnant woman needs an extra 450 calories above the allowance for nonpregnant women during which trimester(s)?
   a. first
   b. second
   c. third
   d. first, second, and third

2. A deficiency of which nutrient appears to be related to an increased risk of neural tube defects in newborns?
   a. vitamin B<sub>6</sub>
   b. folate
   c. calcium
   d. niacin

3. Which of the following preventive measures should a pregnant woman take to avoid contracting listeriosis?
   a. avoid feta cheese
   b. avoid pasteurized milk
   c. thoroughly heat hot dogs
   d. (a) and (c)

4. Breastfed infants may need supplements of:
   a. fluoride, iron, and vitamin D
   b. zinc, iron, and vitamin C
   c. vitamin E, calcium, and fluoride
   d. vitamin K, magnesium, and potassium

5. Which of the following foods poses a choking hazard to infants and small children?
   a. pudding
   b. marshmallows
   c. hot dog slices
   d. (b) and (c)

6. Sweets of any kind (including baby food “desserts”) have no place in a baby’s diet.
   T F

7. A major reason why a woman’s nutrition before pregnancy is crucial is that it determines whether her uterus will support the growth of a normal placenta.
   T F

8. Fetal alcohol syndrome (FAS) is the leading known preventable cause of mental retardation in the world.
   T F

9. In general, the effect of nutritional deprivation on a breastfeeding mother is to reduce the quality of her milk.
   T F

10. A sure way to get a baby to sleep through the night is to feed solid foods as soon as the baby can swallow them.
    T F
When most people think of health problems in children and adolescents, they most often think of measles and acne, not type 2 diabetes and hypertension. Today, however, 32 percent of U.S. children and adolescents 2 to 19 years of age are overweight and many of these are obese (shown in Figure C13-1).1 Serious risk factors and “adult diseases,” such as type 2 diabetes, often accompany obesity, even in a child.2 U.S. children are not alone in these problems—childhood obesity rates are soaring around the globe.3

Although no group has fully escaped the national gain in body weight, obese children tend to have these characteristics:

- Are male.4
- Are older.
- Are of African American, Hispanic, or Native American descent.5
- Are sedentary.6
- Have parents who are obese.

Additionally, low family income predicts obesity among non-Hispanic white children.7

Medical wonders of today prevent or cure many of even the most serious childhood diseases. Obesity, however, remains an unanswered challenge.8

THE CHALLENGE OF CHILDHOOD OBESITY

Obesity takes a heavy toll on the well-being of a child. Education is urgently needed—most overweight children and their parents all but discount the health threats, focusing instead on appearance and the social costs of obesity.

Physical and Emotional Perils

Obese adolescent children often display a risky blood lipid profile that foreshadows development of atherosclerosis—43 percent of obese children test high for total cholesterol, triglycerides, or LDL cholesterol.9 Overweight children also tend to have high blood pressure; obesity is a leading cause of pediatric hypertension.10 Without intervention, millions of U.S. children may be destined to develop type 2 diabetes and hypertension in childhood and heart disease in early adulthood.11

Actions to prevent or treat childhood obesity are of critical importance.

One-third of U.S. children have poor cardiorespiratory fitness, reflective of sedentary lifestyles and body fatness.12 Asthma is also much more prevalent among obese children than among their thinner peers.13 A disease of the liver, non-alcoholic liver disease, also occurs more often, and obese children have a greater risk of complications from anesthesia.14

Obesity, high blood cholesterol, and hypertension stand with diabetes at the top of the list of factors associated with development of cardiovascular disease (CVD). When these conditions appear in childhood, CVD may set in soon afterward, and much sooner than most people expect.

Obese children may also suffer psychologically.15 Adults may dis-
criminate against them, and peers may make thoughtless comments or reject them. An obese child may develop a poor self-image, a sense of failure, and a passive approach to life. Television shows and movies, two major influences on children’s thought processes, often denigrate and stigmatize the fat person as a social misfit. Children have few defenses against these unfair portrayals and quickly internalize negative attitudes toward bulky body sizes.

Overweight or Chubby and Healthy: How Can You Tell?
An accurate assessment of a child’s body mass index (BMI) for age is essential—guesswork can lead to unneeded lifestyle changes for a healthy-weight child, or to a missed opportunity to help a truly overweight child. Physicians, registered dietitians, and other health-care providers can accurately assess a child’s BMI and interpret it using a growth chart (see the inside back cover). Although cutoffs for children generate controversy, children and adolescents are generally considered overweight from the 85th to the 94th percentile on the charts and obese at the 95th percentile and above.

Unrealistic expectations can undermine good intentions. Most overweight children tend to remain “stocky” long after losing some of their fatness, even into adulthood, and no amount of diet or exercise will make them willowy. Early maturation and the greater bone and muscle mass needed to carry their extra weight contribute to the bulk retained by obese children. In young children, genetic inheritance also plays an important determining role in body size and shape, perhaps even more so than in adults. Still, the child’s environment remains a major player in obesity development.

Darla and Gabby
Eight-year-old Gabby and her worried mother Darla tell a typical story of childhood obesity, and they model some appropriate responses. Recently, a note from the school nurse explained that, during a routine screening, Gabby’s BMI was found to be too high. “The kids next door look skinny to me,” says Darla, “Like if they got sick they couldn’t fight it off.” Because Gabby’s BMI exceeds the 95th percentile, however, her health may be in peril and the nurse has suggested further testing for risk factors of chronic diseases. With Gabby’s health in danger, Darla’s concern grows, “Both my father and his father died of diabetes-related disease, and I’m worried.”

DEVELOPMENT OF TYPE 2 DIABETES
An estimated 85 percent of the children with type 2 diabetes are obese. Diabetes is most often diagnosed around the age of puberty, but diabetes is quickly encroaching on younger and younger age groups as children become more overweight. Ethnicity (being Native American, or of African, Asian, or Hispanic descent) increases the risk, as does having a family history of type 2 diabetes. Chapter 4 described the risks associated with type 2 diabetes and Chapter 11 revealed its connection with CVD.

Determining exactly how many children suffer from type 2 diabetes is tricky. The symptoms of type 2 and type 1 diabetes differ only subtly in children. The child with type 2 diabetes may lack classic telltale symptoms, such as glucose in the urine, ketones in the blood, weight loss, or excessive thirst and urination, so the condition often advances undetected. Undiagnosed diabetes means that children suffering with the condition are left undefended against its ravages.

DEVELOPMENT OF HEART DISEASE
Atherosclerosis, first apparent as heart disease in adulthood, begins in youth. By adolescence, most children have formed fatty streaks in their coronary arteries. By early adulthood, the arterial lesions that make heart attacks and strokes likely have formed.

Research is ongoing, but results often indicate that children with the highest risks of developing heart disease in adulthood are sedentary and have central obesity; they may have diabetes, high blood pressure, and high blood LDL cholesterol. Adolescents who take up smoking greatly compound their risk.

High childhood BMI alone may not always predict increased adulthood heart disease risk, however. Many overweight youngsters appear to grow into adults with average weight and disease risks. Still, authorities recommend that all children aged 6 years and older be screened for obesity, and obese children be treated with intensive counseling that includes diet, physical activity, and behavior changes.

The note from Gabby’s school nurse prompted medical testing, including a family history, a fasting blood glucose test, a blood lipid profile, and a blood pressure test. Luckily, the results for both glucose and blood pressure were normal.

High Blood Cholesterol
Gabby’s blood lipid results, however, confirmed her mother’s fears: her LDL cholesterol is 135—too high for health. Cholesterol standards for children and adolescents (ages 2 to 18 years) are in Table C13-1.

Obesity, especially central obesity, and high blood cholesterol often occur together. As children mature into adolescents, they often choose more foods rich in saturated fats, and their blood cholesterol levels tend to rise. Further, sedentary children and adolescents have lower HDL, higher LDL, and higher blood pressure than those who are physically active.

Family history sometimes predicts high blood cholesterol. If the parents or grandparents suffered from early heart

<table>
<thead>
<tr>
<th>Cholesterol Values for Children and Adolescents</th>
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<tr>
<td>Disease Risk</td>
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<tr>
<td>--------------</td>
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<tr>
<td>Acceptable</td>
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<td>Borderline</td>
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<td>High</td>
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Note: Adult values appeared in Chapter 11.
Calories—and Cautions
Gabby, who loves sweets, budgets her pocket money (she’s saving for a bicycle) to join her friends for a chocolate granola bar (160 calories) every day after school. In addition, she knows how to bake a few peanut butter cookies from a roll of dough kept in the refrigerator to enjoy at bedtime (another 180 calories). Gabby knows that oats and peanut butter are better than candy for health, but she doesn’t know that calories from granola bars and cookies cause her to greatly exceed her calorie need each day.

Intuitively, Darla would like to eliminate these treats. However, pediatricians warn parents and caregivers to avoid overly restricting a child’s eating; while intentions may be good, excessive restriction of sweets or calories can intensify cravings, create nutrient deficiencies, impair growth, and spark unnecessary battles about food. Worse, children who feel deprived or hungry may begin to sneak banned foods or hide them and binge on them in secret—behaviors that often predict eating disorders.

Figure C13-2 lists frequent high-calorie snacking as a potential contributing factor in a child’s weight gain, but good-tasting snacks and meals are important to all children. A balanced approach may be to include favorite high-calorie treats occasionally in the context of structured, nutritious, and appealing meals and snacks.

The next chapter presents more details about designing eating plans for children.

Physical Activity
Children have grown more sedentary, and sedentary children are more often overweight. A child who spends more than an hour or two in “screen time,” that is, sitting in front of a television, computer monitor, or other media, often eats fewer family meals and may become obese (Figure C13-3). Children who watch more TV not only move less but they may also snack more, both during television viewing and afterward because of the influence of food advertising.

Darla recalls, “My sisters and I hit the door on Saturday mornings with sandwiches in a bag. We explored, climbed trees, played softball with our friends, jumped in puddles, and played ‘tag.’ But Gabby and her friends have 252 television channels to choose from, not to mention computer games and the Internet—we had only 4 channels when I was little!” The American Academy of Pediatrics (AAP) supports Darla’s view and recommends no television time before 2 years of age and a limit of two hours per day of television, computer, and other “screen time” for older children to help prevent obesity.

Food Advertising to Children
Children and youth influence a huge portion of the nation’s food spending—up

**EARLY CHILDHOOD INFLUENCES ON OBESITY**
Young children learn food behaviors largely from their families. Whole families may be eating too much, dieting inappropriately, and exercising too little.

**Factors Affecting Childhood Weight Gain**

The more of these factors in a child’s life, the greater the likelihood of unhealthy weight gain.

**Food Factors**
- Frequent snacks consisting of high-energy foods, such as candies, cookies, crackers, fried foods, and ice cream.
- Irregular or sporadic mealtimes; missed meals.
- Eating when not hungry; eating while watching TV or doing homework.
- Fast-food meals more than once per week.
- Frequent meals of fried or sugary foods and beverages.
- Exposure to advertising that promotes high-calorie foods.

**Activity Factors**
- More than an hour of sedentary activity, such as television, each day.
- Less than 20 minutes of physical activity, such as outdoor play, each day.
- No access to recreational facilities.

**Family and Other Factors**
- Overweight family members, particularly parents.
- Low-income family.
- Tall for age.
to $200 billion of their own pocket money each year—and influence hundreds of billions more in annual family purchases of foods, beverages, and restaurant meals. As a result, the average child sees an estimated 40,000 TV commercials a year and uncounted Internet commercials—many peddling foods high in sugar, saturated fat, and salt, such as sugar-coated breakfast cereals, candy and “energy” bars, chips, fast foods, and carbonated beverages. The advertisers use developmental psychology to tap children’s needs for peer acceptance, fun, love, safety, security, independence, maturity, and identity. Not surprisingly, the more time children spend watching television, the more they request the foods and beverages in advertisements—and they get their requests about half of the time.

On the Internet, food marketing agencies develop free, child-attracting “advergames,” that is, games built around a manufacturer’s foods and beverages, intended to spark brand loyalty in young children. Appealing animated “spokes-characters” speak directly to children, bypassing parents and teachers, to increase children’s desire for mostly highly processed, high-fat, high-sugar, low-nutrient treats and fast foods. Do the ads work? Yes, they do. Otherwise, the billions of dollars spent annually on advertising to children would be spent elsewhere.

A few major food companies have stopped advertising directly to children, while others have agreed to voluntarily promote physical activity and health-promoting products, while reducing the use of beloved animated characters to sell sweets and fats to children. A consumer advocacy group has questioned whether these steps are sufficient to counterbalance the effective abundant marketing of less-than-nutritious foods still aimed at children.

### Preventing and Reversing Overweight in Children: A Family Affair

Prevention and treatment of childhood obesity are national priorities. Parents are a starting point: they are encouraged to make major efforts to prevent childhood obesity or to begin treatment early—before adolescence.

For a child who is overweight or obese, an initial goal might be to slow the child’s rate of gain while the child grows taller. Weight loss ordinarily is not recommended because diet restriction can easily interfere with normal growth, but may depend on the severity of the condition. By including the whole family in an effort to consume balanced meals of appropriate portion sizes and nutritious satisfying snacks and boost physical activity, the goal is often accomplished, and the child does not feel singled out.

Gabby’s pediatrician has recommended lifestyle changes to improve both her BMI and blood lipids. Darla is motivated, “I need to take some action!” A warning to Darla: the lifestyle changes may sound easy, but implementing them may prove more difficult than she expects—people’s behaviors are notoriously resistant to change. Further, the person, in this case Gabby, must be involved at the planning stage for the changes to be successful.

### Parents Set an Example

Parents are among the most influential forces shaping the self-concept, weight concerns, and eating habits of children. Successful plans for stabilizing a child’s weight center on whole-family lifestyle changes (see Table C13-2) because when parents set patterns for family behaviors, the children will most often follow their lead.

### Lifestyle Changes First, Medications Later

A general rule for treating overweight children is “lifestyle changes first; medications later, if at all.” Children with elevated disease risk factors, such as high blood cholesterol or a family history of early heart disease, should still first be treated with diet and physical activity, but should blood cholesterol remain high after 6 to 12 months, then certain drugs may safely be used to lower blood cholesterol without interfering with normal growth or development. Two obesity drugs, orlistat and sibutramine, have been approved for limited use in children and adolescents.

### Obesity Surgery

Limited research shows that, after surgery, extremely obese adolescents lose significant weight and reduce their risk factors for type 2 diabetes and cardiovascular disease. Surgery may be an option for physically mature adolescents with a BMI of 50 or above or a BMI of 40 or above with significant weight-related health problems who have failed at previous lifestyle modifications and will adhere to the long-term lifestyle changes required after surgery.

### Positive, Loving Support

To preserve the child’s healthy sense of self, setting realistic, achievable goals is a first priority. Keeping a positive, upbeat attitude is another. The reverse—impossible goals and a critical, blaming adult—may damage the child’s developing self-image and may set the stage for eating disorders later on.

Most of all, Darla must let Gabby know that she is loved, regardless of weight. Blame is a useless concept and can trigger emotional withdrawal of the child.
Family Lifestyle Changes to Help the Overweight Child

Everyone can benefit when the whole family adopts health-promoting habits such as these:

- Learn and use appropriate food portions.
- Involve children in shopping for and preparing family meals.
- Set regular mealtimes and dine together frequently.
- For other days, plan and provide a wide variety of nutritious snacks that are low in fat and sugar.
- Provide an appropriate nutritious breakfast every day.
- Provide recommended amounts of fruit juices but no more than this amount.
- Limit high-sugar, high-fat foods, including sugar-sweetened soft drinks and fruit-flavored punches.
- Set a good example and demonstrate positive behaviors for children to imitate.
- Slow down eating and pause to enjoy table companions; stop eating when full.
- Do not use foods to reward or punish behaviors.
- Involve children in daily active outdoor play or structured physical activities, as a family or with friends.
- Limit television time; set a rule to eliminate television-watching during meals.
- Celebrate family special events and holidays with outdoor activities, such as a softball game, a hike, or a summer swim.
- Keep a calendar of scheduled family meals and activity events where everyone can read it.
- Obtain parent and child nutrition and physical activity education and training or family counseling to guide family-based behavioral and other interventions as needed.
- Work with schools to institute school-wide food and activity policies to support a healthy body weight and prevent obesity (see Chapter 14).


just when the opposite—active engagement—is needed most. By being supportive, Darla can help Gabriella grow into a healthy young woman with positive attitudes about food and herself. Meanwhile, she must make some changes to diet and physical activity—but exactly which ones? And how?

DIET MODERATION, NOT DEPRIVATION

All children should eat an appropriate amount and variety of foods, regardless of body weight (Chapter 14 provides many details). For the health of the heart, children older than 2 years of age benefit from the same diet recommended for older individuals, that is, a diet limited in fats, especially saturated fat, trans fat, and cholesterol; rich in nutrients; and age-appropriate in calories. Such a diet benefits blood lipids without compromising nutrient adequacy, physical growth, or neurological development.

Fruits and vegetables, whole grains, low-fat and nonfat dairy products, beans, fish, and lean meats appropriately make up the bulk of the child’s diet. Ice cream, doughnuts, and other high-calorie foods can supply 100–200 calories a day of unneeded calories, depending upon the child’s age and activity level. For perspective, a large (5-inch diameter) glazed doughnut provides 480 calories. Gabby’s daily treats add up to over 350 calories a day.

Gabby loves her daily granola bar. Recognizing that pleasure is important, too, Darla decides to set some goals for providing nutritious, good-tasting lower-calorie foods at regular mealtimes and other snacks to make room for Gabby’s favorite treat. Together, they decide to replace the evening cookies with whole-grain crackers or apple slices spread with a little peanut butter, which cuts the evening snack calories in half without leaving Gabby hungry or deprived. Table C13-3 outlines diet and physical activity recommendations for preventing obesity in children.

Fatty Foods

A steady diet of offerings on most “children’s menus” in restaurants, such as fried chicken nuggets, hot dogs, and French fries, easily exceeds a prudent intake of saturated fat, trans fat, sodium, and calories and invites both nutrient shortages and gains of body fat. Often, better choices can be found among appetizers, soups, salads, and side sections, and the best establishments offer steamed vegetables, fresh fruit, and broiled or grilled poultry on menus for both children and adults.49

Other fatty foods, such as nuts, avocado, vegetable oils, and safer varieties of fish, are important to include for their essential fatty acids. Fatty foods can be calorie-rich, however, making portion sizes of critical importance. Low-fat and nonfat milk products or equivalent substitutes deserve a special place in a child’s diet for the calcium and other nutrients they supply.

Soft Drinks

Most, but not all, research links sugar-sweetened soft drinks and punches, but not milk or fruit juice, with excess body fatness in children.50 Soft drinks amounting to just over two cans—the daily consumption of many adolescents—provide an extra 300 calories each day. Children everywhere seem to adore sugary soft drinks and punches, but these treats are best enjoyed in moderation and not as everyday replacements for milk, juice, or water.

PHYSICAL ACTIVITY

Active children have a better lipid profile and lower blood pressure than
The Expert Committee of the American Medical Association recommends these dietary habits for children 2 to 18 years of age:

- Limit consumption of sugar-sweetened beverages, such as soft drinks and fruit-flavored punches.
- Eat recommended amounts of fruits and vegetables every day (2 to 4.5 cups per day based on age).
- Learn to eat age-appropriate portions of food.
- Eat foods low in energy density such as those high in fiber and/or water and modest in fat.
- Eat a nutritious breakfast every day.
- Eat a diet rich in calcium.
- Eat a diet balanced in recommended proportions for carbohydrate, fat, and protein.
- Eat a diet high in fiber.
- Eat together as a family as often as possible.
- Limit the frequency of restaurant meals.
- Limit television and other screen time to no more than 2 hours a day.

**2008 Physical Activity Guidelines for Americans for Children:**

- Children and adolescents should do 60 minutes (1 hour) or more physical activity daily.
- Aerobic: Most of the 60 or more minutes a day should be either moderate- or vigorous-intensity aerobic physical activity and should include vigorous-intensity physical activity at least 3 days a week.
- Muscle-strengthening: As part of their 60 minutes of daily physical activity, children and adolescents should include muscle-strengthening physical activity on at least 3 days of the week.
- Bone-strengthening: As part of their 60 or more minutes of daily physical activity, children and adolescents should include bone-strengthening physical activity on at least 3 days of the week.

*Chapter 10 specified activities that characterize various intensity levels.


For example, Wii by Nintendo.
Darla’s Efforts and Gabby’s Future

“I’m achieving three of our goals now,” says Darla, “and others are planned. First, I’m packing Gabby a healthy, tasty, lower-calorie lunch for school. It’s easy to make ahead whole-grain sandwiches for the week and freeze them and then toss one into a lunch bag with a low-fat yogurt, or low-fat cheese sticks, and water (not soda!). I’m also including some snacks of good-for-her foods that she loves, like baby carrots and raisins, to tempt her away from the granola bar machine on some days.

“Second, because we both have a sweet tooth, I keep ready-to-eat snacks of fresh fruit, like grapes and strawberries, in clear plastic containers on a refrigerator shelf at eye level. Third, although I work days and go to school four nights a week, we have started a new tradition: family meal night each Friday at 6:00 sharp. Gabby and I choose the menu during the week and look forward to making dinner together. We find it easier to talk about healthy eating as we cook, and she doesn’t feel threatened. We also switched from full-sized dinnerware to pretty new luncheon-sized plates and small dessert-sized bowls. Gabby was charmed with the bright colors, and we both find the smaller portions just as satisfying.

“Although my daughter’s idea of a good vegetable has always been a fried potato, she’s gradually opening up to trying new foods, which is goal number four. During Friday meal preparation, she’s tried bites of broccoli, green beans—even squash! French fries are now just an occasional treat when we eat out.

“Goal number five has proved harder: we must start walking together, but when? I need to let her see that I am serious about my personal fitness, but I’m tired after work and my studies gobble my time. To get Gabby moving after school, I’ve offered her credits toward her bike in exchange for physical chores, such as raking, planting flowers, and washing the car—and when she gets her bike, she’ll be active while riding it, too. Today though, rain or shine, tired or not, I’m going to pull on my running shoes and walk around our neighborhood. And I hope Gabby will join me.

“I love my smart, stubborn, sturdy girl—chubby or lean! But I know her future will be shaped by what we are doing right now. She will grow into her weight if we can hold the line with our new healthy habits. I see her potential to do great things, and what she is learning today about taking care of herself she can pass on to others—to her own children maybe.” Darla smiles, “I am so happy we are in this together, and taking charge of our health.”