

Chapter 14

Nutrition Through the Life Cycle: Pregnancy and the First Year of Life

14.1 Nutrition Before Conception

- Some deficiency-related problems develop very early in pregnancy
- Neural tube defects
 - Related to inadequate level of folate
 - Affects the embryo in the first few weeks
 - Adequate folate (400 µg daily) before conception can reduce the risk
- A healthful diet before conception includes
 - Avoiding **teratogens**: substances that cause birth defects
 - * Includes avoiding alcohol and illegal drugs
 - Avoiding other possible hazards
 - * Smoking, caffeine, medications, some herbs, and supplements
 - Body mass index (BMI) between 19.8 and 26.0 kg/m² and appropriate level of physical activity
- A healthful diet before conception reduces the risk of developing nutrition-related disorders during pregnancy, such as
 - Gestational diabetes
 - Hypertensive disorders

14.2 Nutrition During Pregnancy

- A full-term pregnancy lasts 38 to 42 weeks
 - First trimester:** conception to week 13
 - Second trimester:** week 14 to week 27
 - Third trimester:** week 28 to week 40
- **Embryonic stage:** approximately day 15 to week 8
- After week 8, the developing baby is called a fetus

14.2.1 First trimester

- **Zygote** (fertilized egg) travels through the fallopian tube and implants in the wall of the uterus
- Development of organs, limb buds, facial features, and placenta
- Embryos are extremely vulnerable to **teratogens** during this time

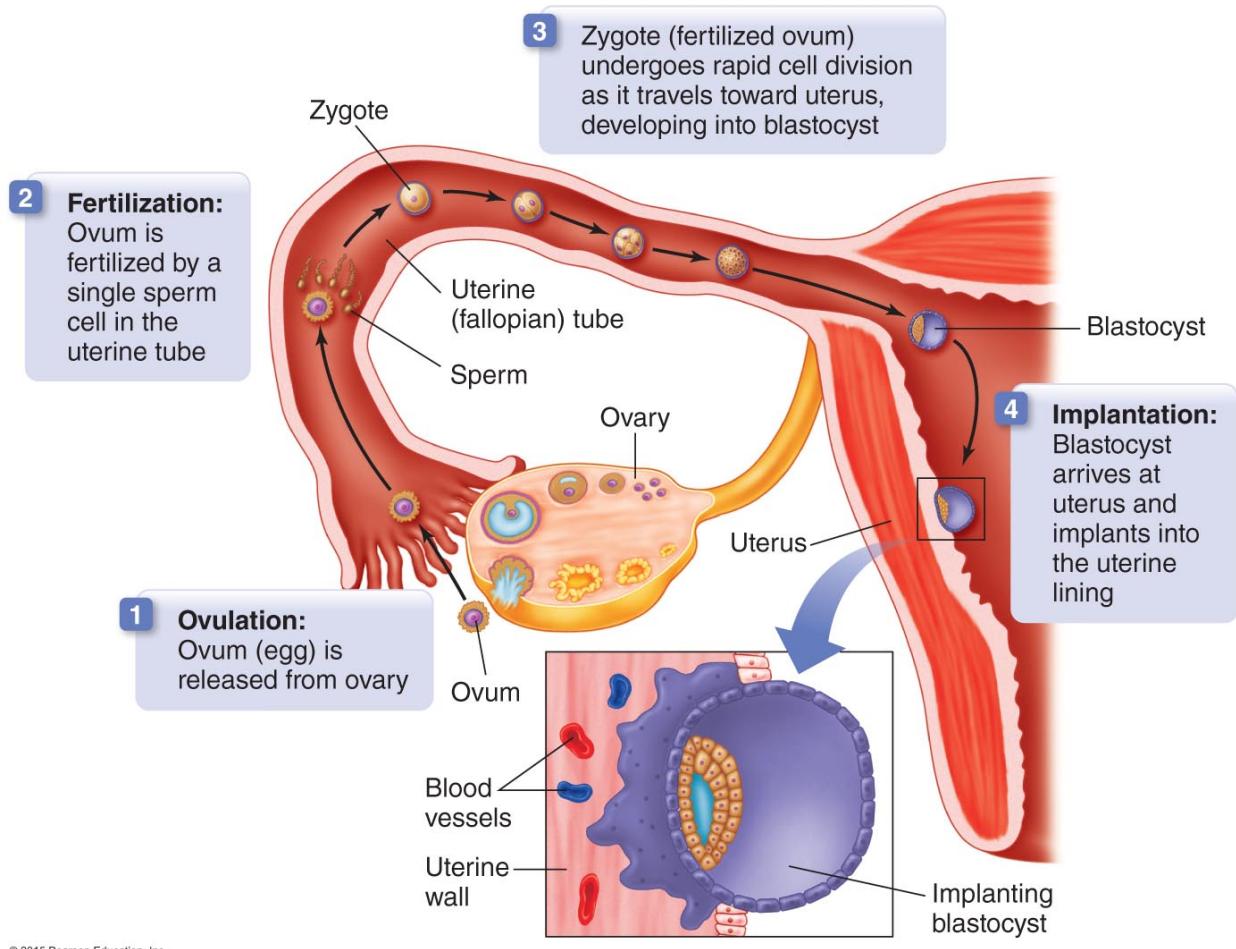


Figure 14.1: Ovulation, Conception, and Implantation

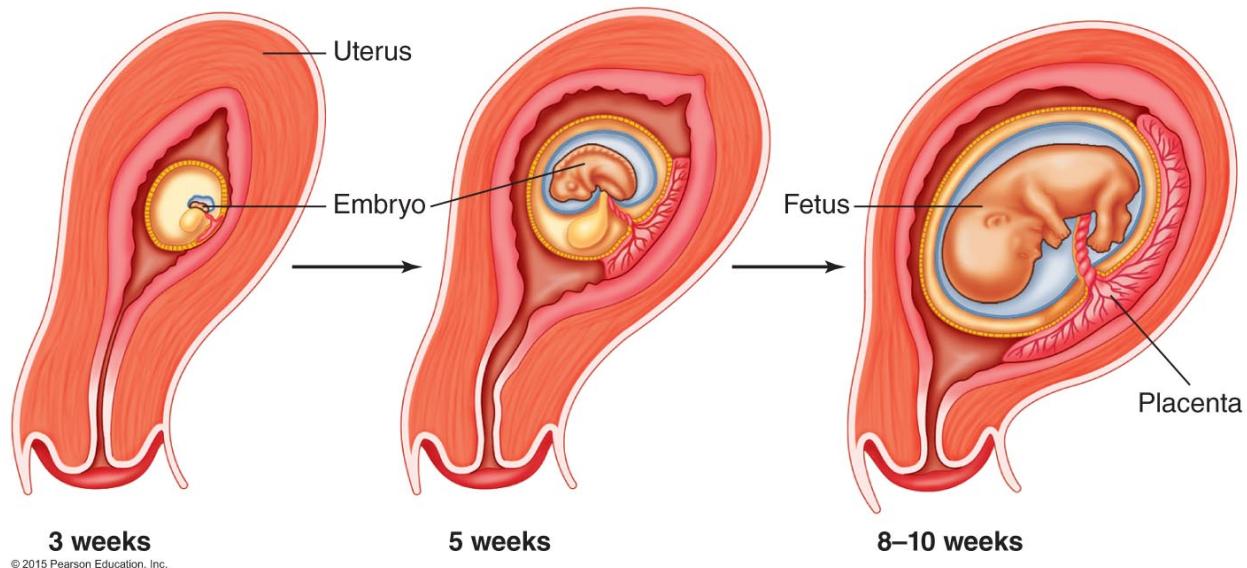


Figure 14.2: The First 10 Weeks

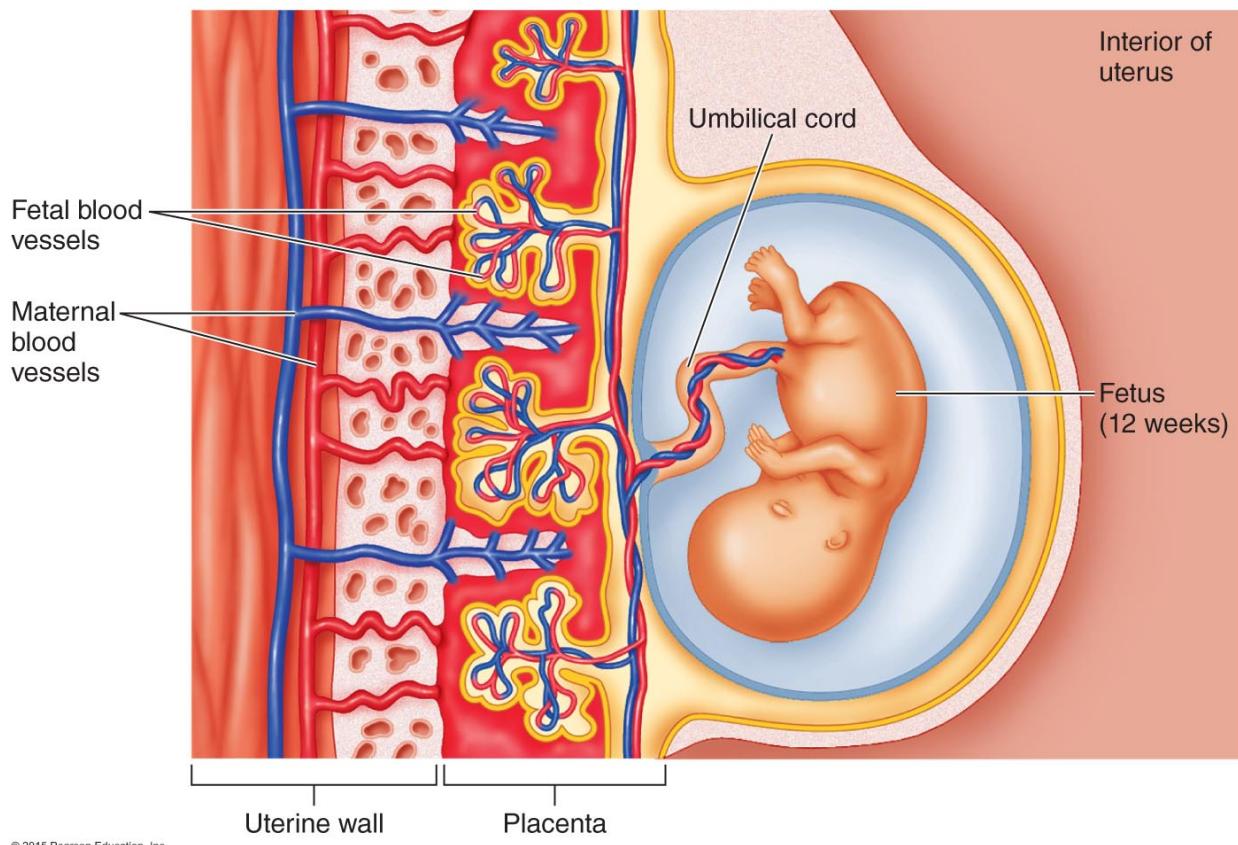


Figure 14.3: Placental Development

14.2.2 Second trimester

- Weeks 14–27
- Continued development of organ systems
- Growth from approximately 3 inches to over 1 foot long by the end of the second trimester

14.2.3 Third trimester

- Weeks 28 to birth
- Time of considerable growth
- Fetus gains three-quarters of its weight in this time
- Brain growth is also extensive
- Lungs become fully mature
- A balanced, adequate diet for the mother is essential during this time

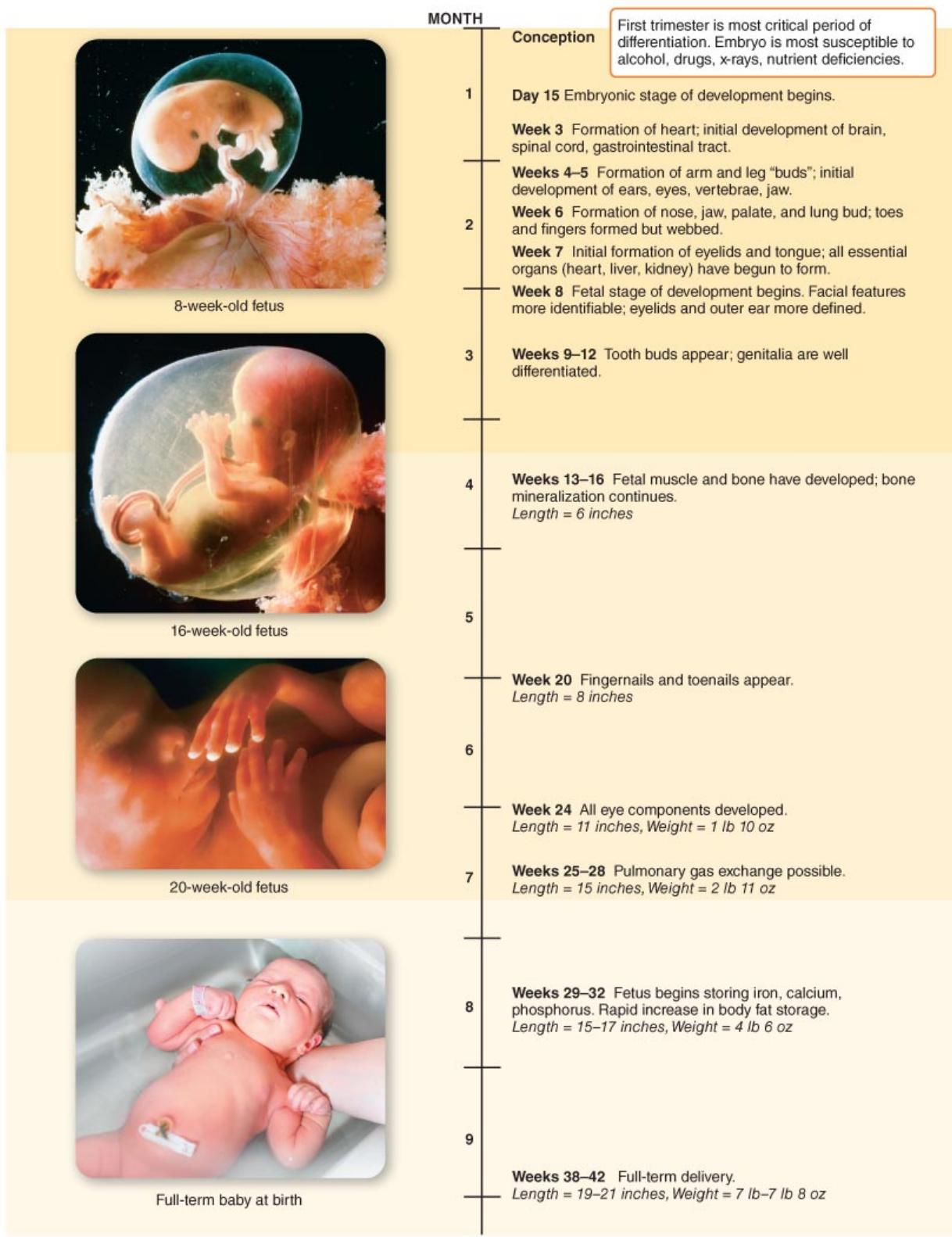


Figure 14.4: Embryonic and Fetal Development

- An undernourished mother is more likely to give birth to a low-birth-weight baby
 - **Low birth weight:** describes any baby born weighing less than 5.5 pounds
 - Increased risk of infections, learning disabilities, impaired physical development, and death in the first year



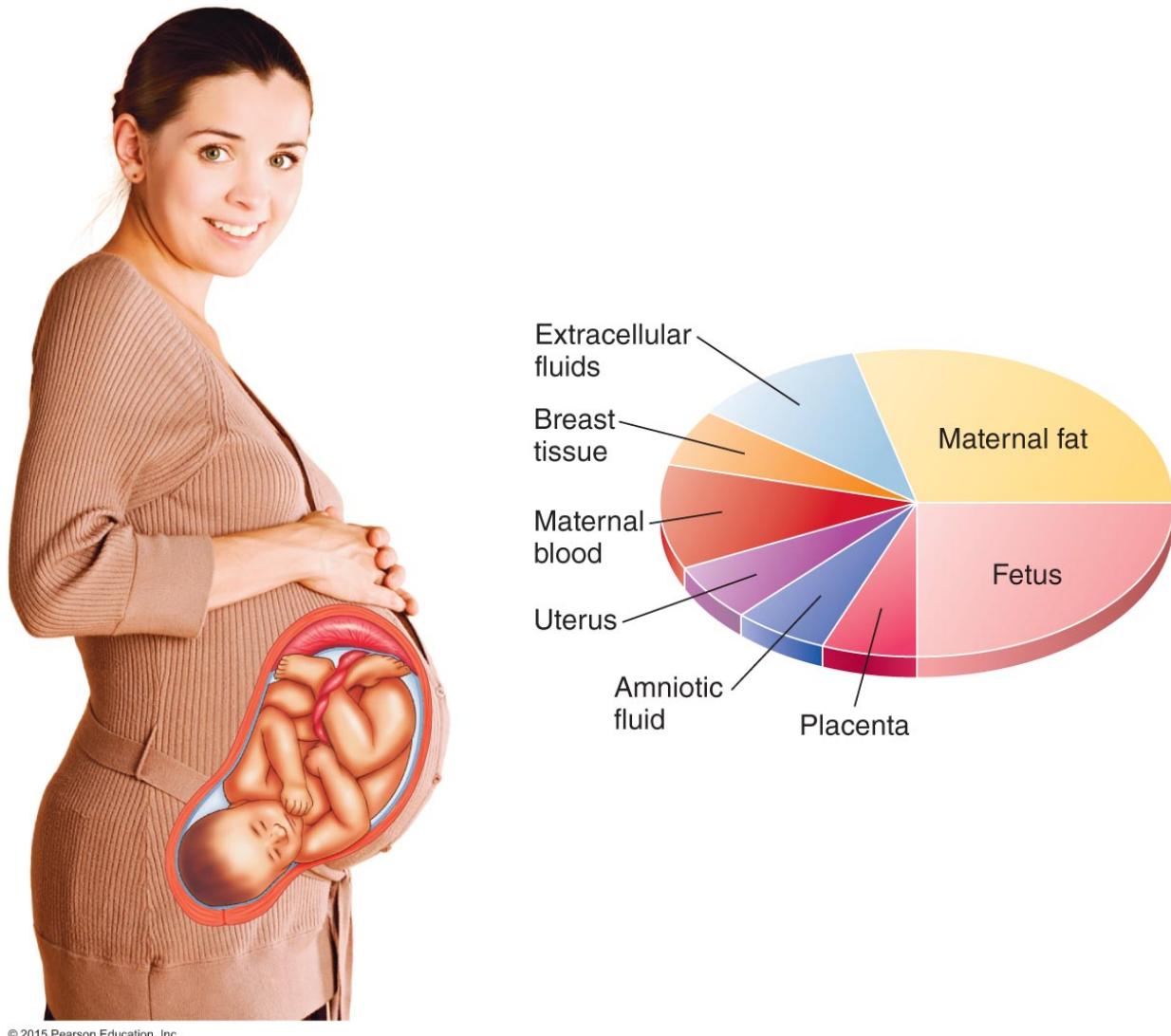
Figure 14.5: Low-Birth-Weight Twins and Healthy Infant

- **Preterm** babies are born before 38 weeks and may be low-birth-weight babies
- **Small-for-gestational-age** babies are born at term but weigh less than would be expected for their gestational age
- Nutrition plays a major role in these conditions
- Weight gain during pregnancy
 - Women who do not gain enough weight are at risk of having a low-birth-weight baby
 - Too much weight gain is also risky
 - Women should not diet during pregnancy since this may deprive the fetus of critical nutrients

Table 14.1: Recommended Weight Gain for Women During Pregnancy

Pregnancy Weight Status	Body Mass Index (kg/m ²)	Recommended Weight Gain
Normal	18.5–24.9	25–35
Underweight	<18.5	28–40
Overweight	25.0–29.9	15–25

Source: Data adapted from Rasmussen, K. M., and A. L. Yaktine, eds. 2009. *Weight Gain During Pregnancy: Reexamining the Guidelines*. Institute of Medicine; National Research Council. Washington, DC: National Academies Press.



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Figure 14.6: Weight Gain During Pregnancy

- The requirement for nearly all nutrients increases during pregnancy
- Pregnant women must pay attention to their intake of:
 - Macronutrients
 - Micronutrients
 - Fluids

14.3 Macronutrients

14.3.1 Energy

- An additional 300 to 450 kcal/day may be required in the second and third trimesters

- Nutrient-dense foods are essential in order to obtain sufficient nutrients

14.3.2 Protein and carbohydrate

- 1.1 g/day/kg body weight (~additional 25 g/day) of protein
- At least 175 g/day of carbohydrates

14.3.3 Fat

- The percentage of Calories obtained from fat should not change during pregnancy
- Limit saturated fat; avoid trans fats
- Consume rich sources of docosahexaenoic acid (DHA), an omega-3 polyunsaturated fatty acid

14.4 Micronutrients

Table 14.2: The micronutrients that are most critical during pregnancy include

folate	calcium
vitamin B ₁₂	iron
vitamin C	zinc
vitamin A	sodium
vitamin D	iodine

Table 14.3: Nutrient Recommendations

Micronutrient	Prepregnancy	Pregnancy	% Increase
Folate	400 µg/day	600 µg/day	50
Vitamin B ₁₂	2.4 µg/day	2.6 µg/day	8
Vitamin C	75 mg/day	85 mg/day	13
Vitamin A	700 µg/day	770 µg/day	10
Vitamin D	600 IU/day	600 IU/day	0
Calcium	1,000 mg/day	1,000 mg/day	0
Iron	18 mg/day	27 mg/day	50
Zinc	8 mg/day	11 mg/day	38
Sodium	1,500 mg/day	1,500 mg/day	0
Iodine	150 mg/day	220 mg/day	47

14.4.1 Folate

- Required for cell division

- Critical in the first 28 days for development of the **neural tube**, which becomes the brain and spinal cord
- $400 \mu\text{g}/\text{day}$ for sexually active women
- $600 \mu\text{g}/\text{day}$ for pregnant women
- Deficiency is associated with **anencephaly** and **spina bifida**

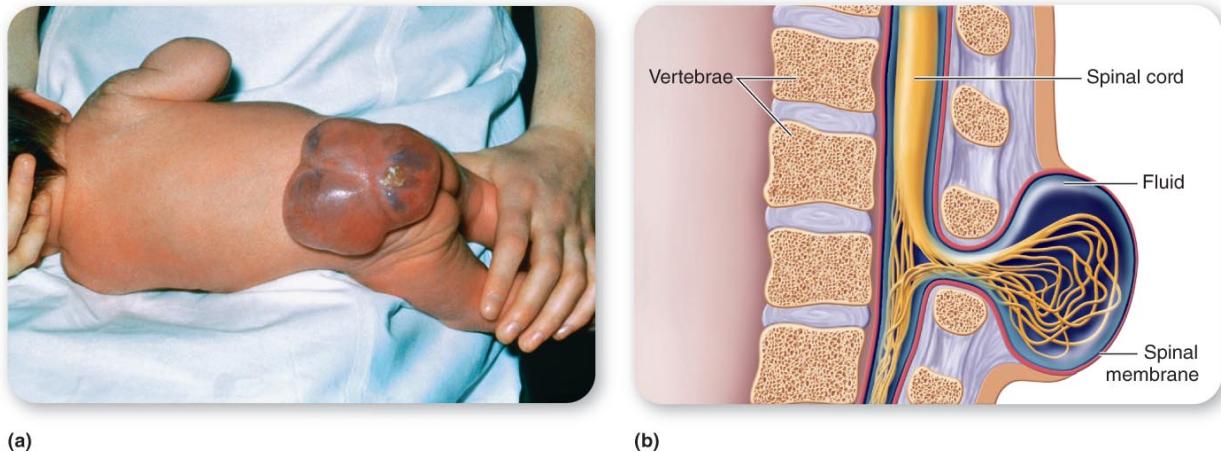


Figure 14.7: Spina Bifida

14.4.2 Vitamin B₁₂

- Regenerates the active form of folate
- $2.6 \mu\text{g}/\text{day}$ during pregnancy

14.4.3 Vitamin C

- Production of collagen (connective tissue)
- $85 \text{ mg}/\text{day}$ during pregnancy
- Deficiency results in elevated risk of preterm births and preeclampsia

14.4.4 Vitamin A

- Needs increase by 10% in pregnancy
 - $770 \mu\text{g}/\text{day}$
- Excess vitamin A can cause fetal abnormalities
- Supplementation is not recommended due to toxicity risk
- Beta-carotene (provitamin A) is not associated with birth defects

14.4.5 Vitamin D

- Adequate intake (AI) does not increase during pregnancy
- Excessive vitamin D can cause developmental disabilities in newborns
- If exposure to sunlight is limited or milk consumption is low, supplementation is advised
- Prenatal vitamin supplements contain $10 \mu\text{g}/\text{dose}$

14.4.6 Calcium

- 1,000 mg/day, same as for non-pregnant women
- Calcium absorption is more efficient during pregnancy

14.4.7 Iron

- Increased need for red blood cells increases the need for iron by 50–80% (27 mg/day)
- Fetal need for iron increases in the third trimester
- Iron stores of mother are depleted to support needs of the fetus
- Iron-deficiency anemia is common during pregnancy

14.4.8 Zinc

- Critical for making proteins, DNA, and RNA
- Need increases 38% during pregnancy (11 mg/day)

14.4.9 Sodium

- 1,500 mg/day, same as for non-pregnant women

14.4.10 Iodine

- Need for iodine increases significantly
- $220 \mu\text{g}/\text{day}$ can be obtained from iodized salt

14.5 Fluids During Pregnancy

- The amount of fluids needed increases to 3 liters per day
 - Increase in maternal blood volume
 - Body temperature regulation
 - Production of **amniotic fluid** to protect and cushion the fetus
 - Combat fluid retention and constipation
 - Reduce risk of **urinary tract infections**

14.5.1 Nutrition-Related Concerns

- Nutrition-related problems during pregnancy can include
 - Morning sickness
 - Food and nonfood cravings and aversions
 - Gastroesophageal reflux (GER)/heartburn
 - Constipation
 - Gestational diabetes
 - Preeclampsia (maternal blood pressure increase)

14.6 Morning Sickness

- **Morning sickness** – nausea and vomiting associated with pregnancy
 - Can occur at any time; often lasts all day
 - May begin after the first missed period and can last 12 to 16 weeks
 - Can be severe enough to require hospitalization
 - No cure, but symptoms can be reduced

14.7 Cravings and Aversions

- Most women crave a certain type of food (sweet, salty) rather than a specific food
 - Little evidence supports the idea that cravings indicate a deficiency
 - Due to hormonal fluctuations, physiologic changes, or familial or cultural roots
 - **Pica** – craving a nonfood item (ice, clay, laundry starch)
 - Food aversions are common but not universal among pregnant women

14.7.1 Gastroesophageal Reflux (GER)

- Gastroesophageal reflux (GER) is common during pregnancy
- Tips to help minimize it include
 - Avoid excessive weight gain
 - Chew food slowly
 - Wait for 1 hour after eating before lying down
 - Sleep with your head elevated

14.8 Constipation

- Pregnancy hormones that cause smooth muscles to relax also slow the movement of material through the large intestine
- Reduce constipation by consuming 25–35 g/day of fiber and plenty of fluids, and remaining physically active

14.9 Gestational Diabetes

- **Gestational diabetes** – insufficient insulin production or insulin resistance that increases blood glucose levels during pregnancy
 - Affects as many as 10% of U.S. pregnancies
 - Condition resolves after birth occurs
 - Risk of delivering a large baby
 - Gestational diabetes increases a woman's risk of developing type 2 diabetes

14.10 Gestational Hypertension

- **Preeclampsia** – pregnancy-induced hypertension
 - Affects up to 10% of U.S. pregnancies
 - Can be fatal if left untreated
 - Deficiencies in vitamin C, vitamin E, and magnesium increase the risk
 - Treatment focuses on managing blood pressure and often includes bed rest
 - The only cure is childbirth

14.11 Foodborne Illness

- Pregnancy alters a woman's immune system leaving them more vulnerable to infectious diseases including foodborne illnesses
 - Listeriosis: a serious and sometimes fatal illness caused by listeria monocytogenes
 - Third leading cause of death by foodborne illness
 - Severe infections of listeria can lead to premature birth or miscarriage

14.12 Food Safety

- Pregnant women should avoid consuming
 - Unpasteurized milk, raw or partially cooked eggs, raw or undercooked meat/fish/poultry, unpasteurized juices, and raw sprouts
 - Large fish such as shark, swordfish, and king mackerel, along with canned albacore tuna
 - Soft cheeses unless the label specifically states the product is made with pasteurized milk

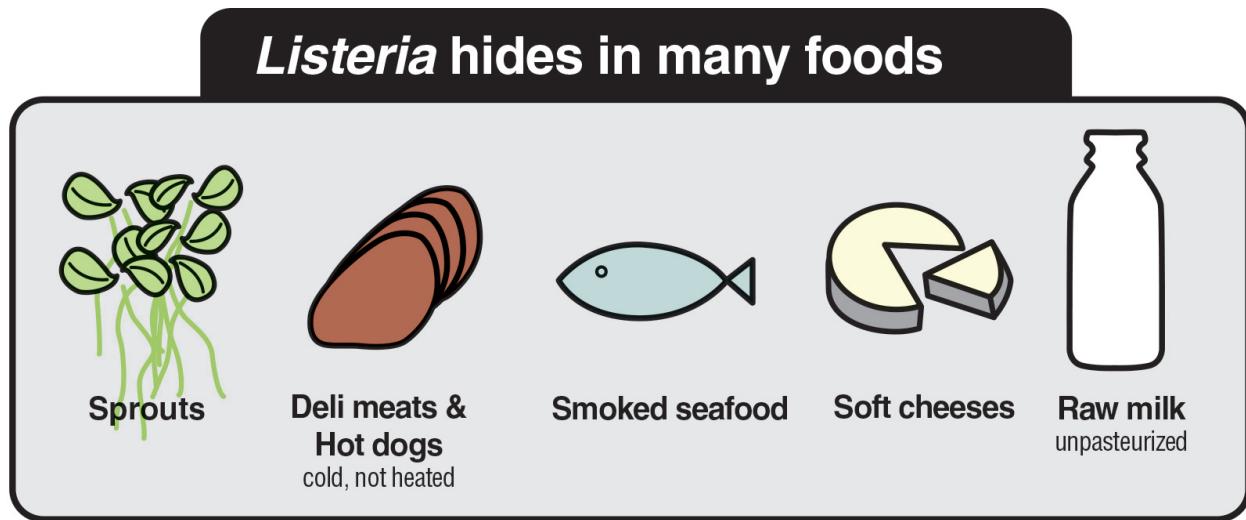


Figure 14.8: Foodborne Illness

14.13 Nutrition-Related Concerns

- Adolescent pregnancy
- Vegetarianism
- Exercise

- Caffeine consumption
- Alcohol consumption
- Smoking
- Illegal drug use
- Food safety

14.14 Adolescent Pregnancy

- Nutritional needs of pregnant adolescents are higher than those of adult women
- Adolescent bodies are still growing and changing, adding to the nutritional needs of pregnancy
- 24 births for every 1,000 adolescents; currently the lowest adolescent pregnancy rate in 60 years

14.15 Vegetarianism

- A vegetarian consuming eggs and dairy products has the same nutritional concerns as a nonvegetarian

Table 14.4: A complete vegetarian (vegan) must carefully monitor the intake of

vitamin D	calcium
vitamin B ₆	iron
vitamin B ₁₂	zinc

14.16 Exercise During Pregnancy

- Reduces risk of gestational diabetes and preeclampsia
- Helps prevent excessive prenatal weight and body fat gain
- Improves mood, energy level, sleep patterns
- Enhances posture and balance
- Improves muscle tone, strength, and endurance
- Reduces lower back pain and shortens the duration of active labor
- Reduces risk of preterm birth and large-for-gestational age infants

14.17 Consumption of Caffeine

- Caffeine is a stimulant that crosses the placenta and reaches the fetus
- 200–300 mg of caffeine per day very likely will cause no harm
- Some studies have linked 100 mg per day intakes to an increased risk of miscarriage, stillbirth, preterm birth, and decreased birth weight

14.18 Consumption of Alcohol

- Alcohol is a known **teratogen** that crosses the placenta and is associated with various birth defects, delivery complications, sudden infant death syndrome, and increased risk of miscarriage
- Fetal alcohol syndrome (FAS): variety of characteristics associated with prenatal exposure to high quantities of alcohol
 - Malformations of face, limbs, heart, and nervous system
 - Many developmental disabilities

14.19 Smoking and Drug Use

- Maternal smoking exposes the fetus to toxins
 - Smoke contains lead, cadmium, cyanide, nicotine, and carbon monoxide
 - Fetal blood flow is reduced
 - Increased risk of miscarriage, stillbirth, placental abnormalities, preterm delivery, and low birth weight
- Most drugs pass through the placenta into fetal blood
 - Newborns suffer withdrawal symptoms

14.20 Breastfeeding

- **Lactation** – production of breast milk
 - **Prolactin** – hormone responsible for the synthesis of milk
 - * Produced toward the end of pregnancy
 - * Suppressed by estrogen and progesterone until childbirth
- **Colostrum** – first milk produced (from birth up to 3 days after); rich in proteins, antibodies, vitamins, and minerals

- **Oxytocin** – hormone responsible for milk let-down

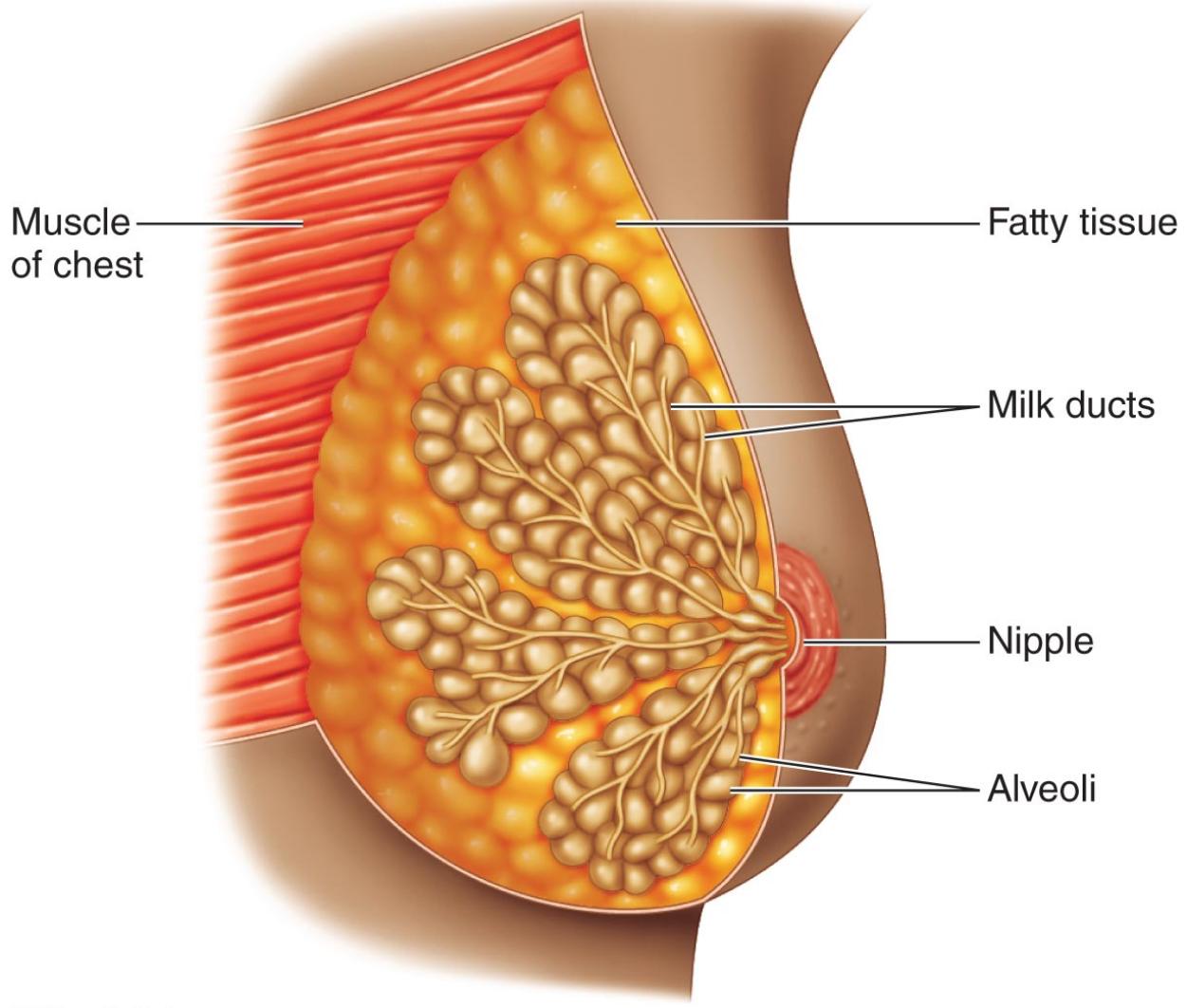


Figure 14.9: Anatomy of the Breast

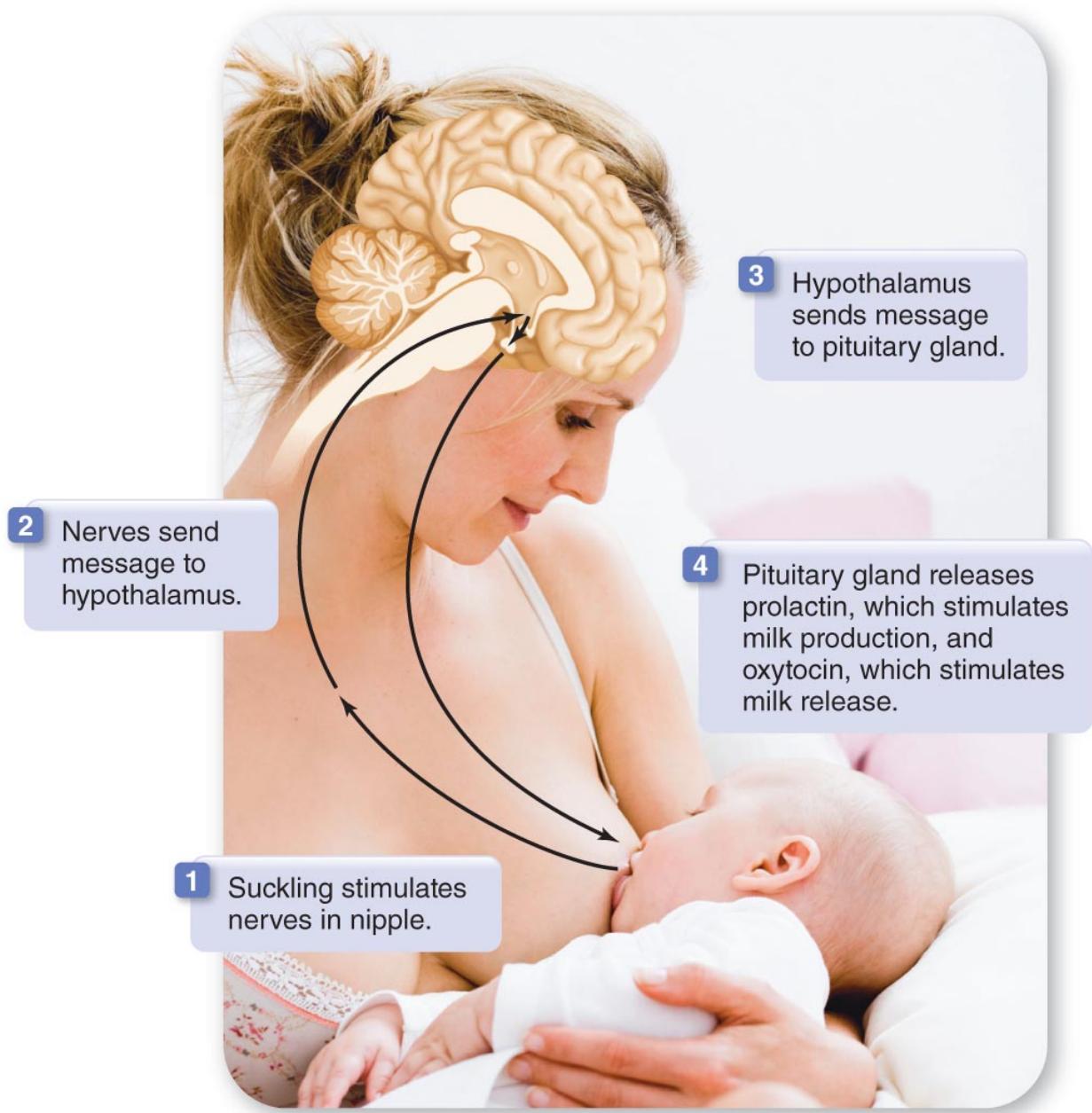


Figure 14.10: Milk and Mother–Child Interaction

- Milk production requires 700–800 kcal/day
- Lactating women should consume 330 kcal/day above their prepregnancy needs the first 6 months, 400 kcal/day the second 6 months
- This allows a woman to gradually lose weight (1–4 pounds per month)
- 15–20 g of protein and 80 g of carbohydrate required per day above prepregnancy needs

- Fluid and many micronutrient needs are increased

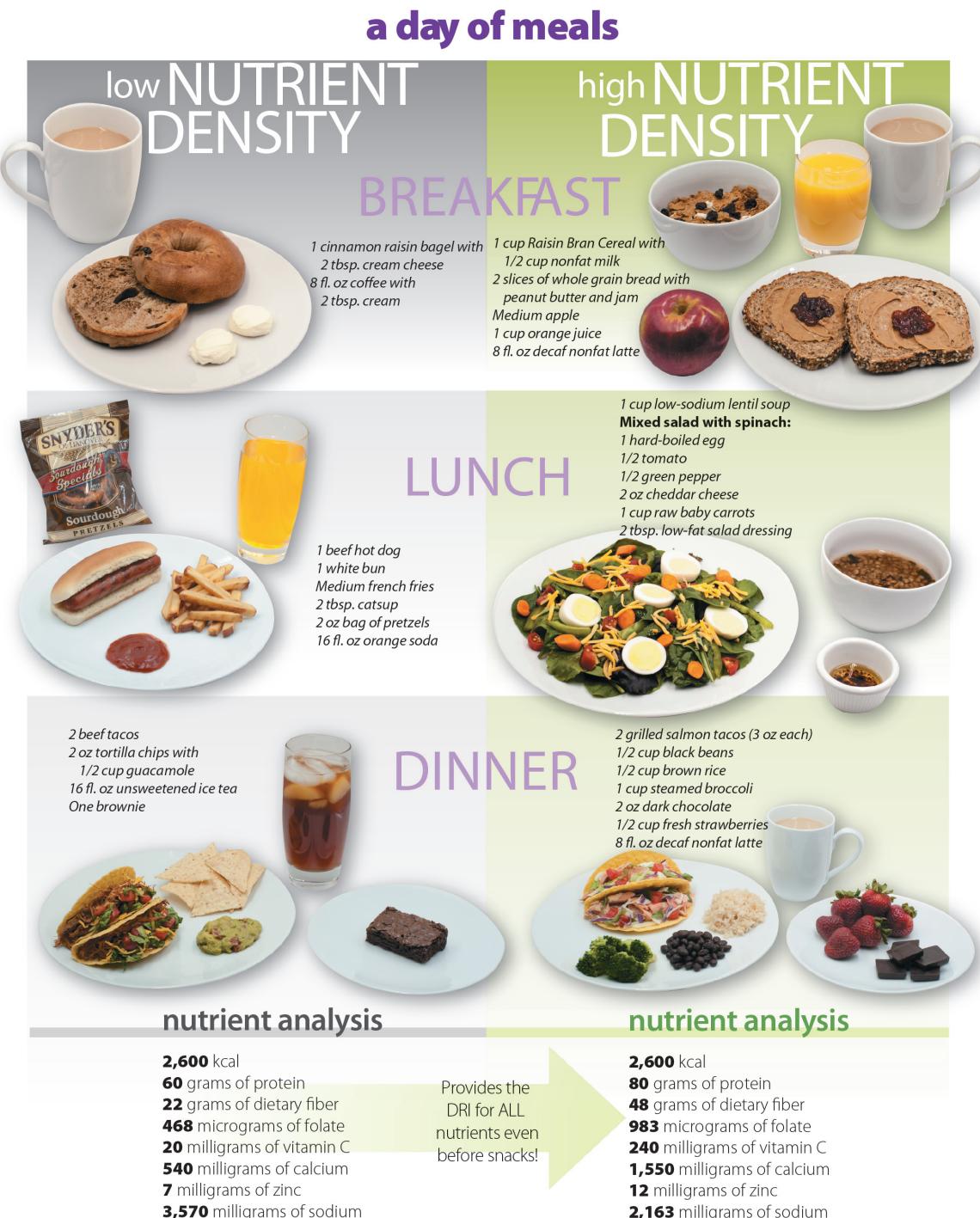


Figure 14.11: Breastfeeding

14.20.1 The Benefits of Breastfeeding

- High-quality nutrition
- Protection from infections, allergies, and residues
- Assists the mother in weight loss
- Suppresses ovulation
- Provides an opportunity for bonding
- Convenience and cost efficient
- Nutritional quality of breast milk
 - The main protein, **lactalbumin**, is easily digested
 - Primary carbohydrate is lactose
 - Rich source of readily absorbed calcium and magnesium
- Composition of milk changes during a feeding
 - Foremilk:** watery and low in fat
 - Hindmilk:** very high in fat
- It is important to let infant suckle for at least 20 minutes

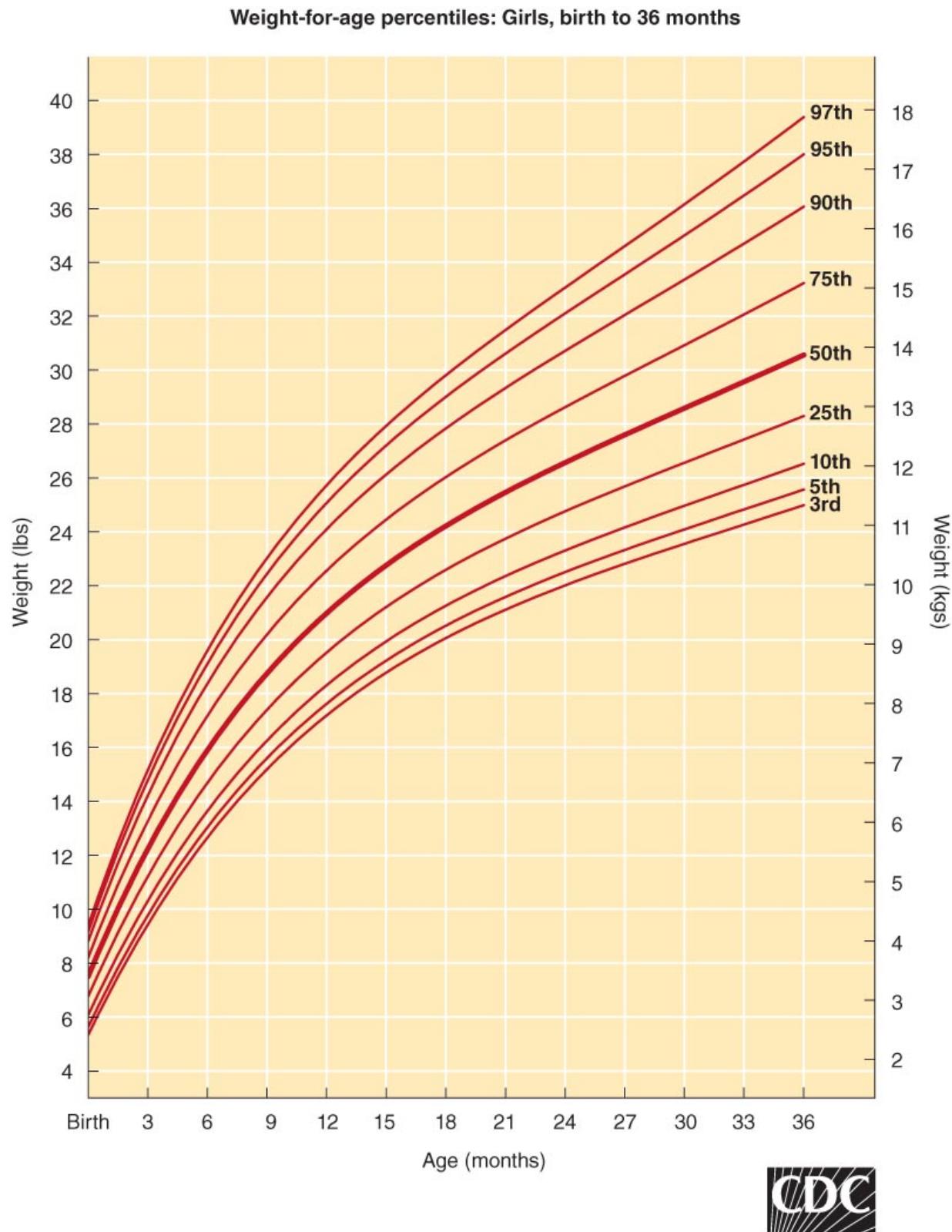
14.21 Challenges Associated with Breastfeeding

- Many harmful substances are passed into breast milk, including
 - Illegal drugs, caffeine, nicotine, and prescription and over-the-counter medications
- HIV is passed through breast milk
- Conflicts with mother's employment
- Social concerns

14.22 Infant Nutrition

- Optimal nutrition is critical in the first year
 - High energy needs, 40–50 kcal/lb/day
 - 40–50% of energy should come from fat
 - Iron, vitamin D, zinc, fluoride, and iodide needs are a concern
 - The nervous system continues to develop

- Infants typically grow 10 inches in length and triple their weight in the first year
- Infants' nutritional needs are unique
 - Their energy needs are high to support rapid growth
 - Their digestive tracts and kidneys are still immature
 - They are small in size



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Figure 14.12: Weight-to-Age Growth Chart

14.22.1 Infant Nutrient Needs

- 40–50 kcals per pound of body weight per day
 - Approximately 600–650 kcals per day at around 6 months of age
 - Breastmilk and commercial formulas are energy and nutrient dense to meet these demands
- Breast milk or formula should be supplemented with solid food beginning at 4 to 6 months
- 40–50% of energy needs should be consumed from fat during the first year of life
- No more than 20% of an infant's daily energy needs should be consumed from protein

14.23 Supplements for Infants?

- Several micronutrients may need supplementation
 - Vitamin D because of limited exposure to sunlight
 - Iron—stores are depleted by the sixth month
 - Fluoride for tooth development
 - Vitamin B₁₂ if the mother is a vegan
 - Water is generally not required unless loss is excessive (diarrhea, vomiting, fever, hot weather)
- Care must be taken to prevent oversupplementation

14.24 Formulas

- Very tightly regulated by federal government
 - Minimum and maximum standards for 29 nutrients
 - Protein source: casein or whey from cow's milk
 - Carbohydrate source: lactose and sucrose
 - Fat source: vegetable oils or microbiologically produced lipids
- Specialized formulas are available: soy-based, predigested, others for certain medical conditions

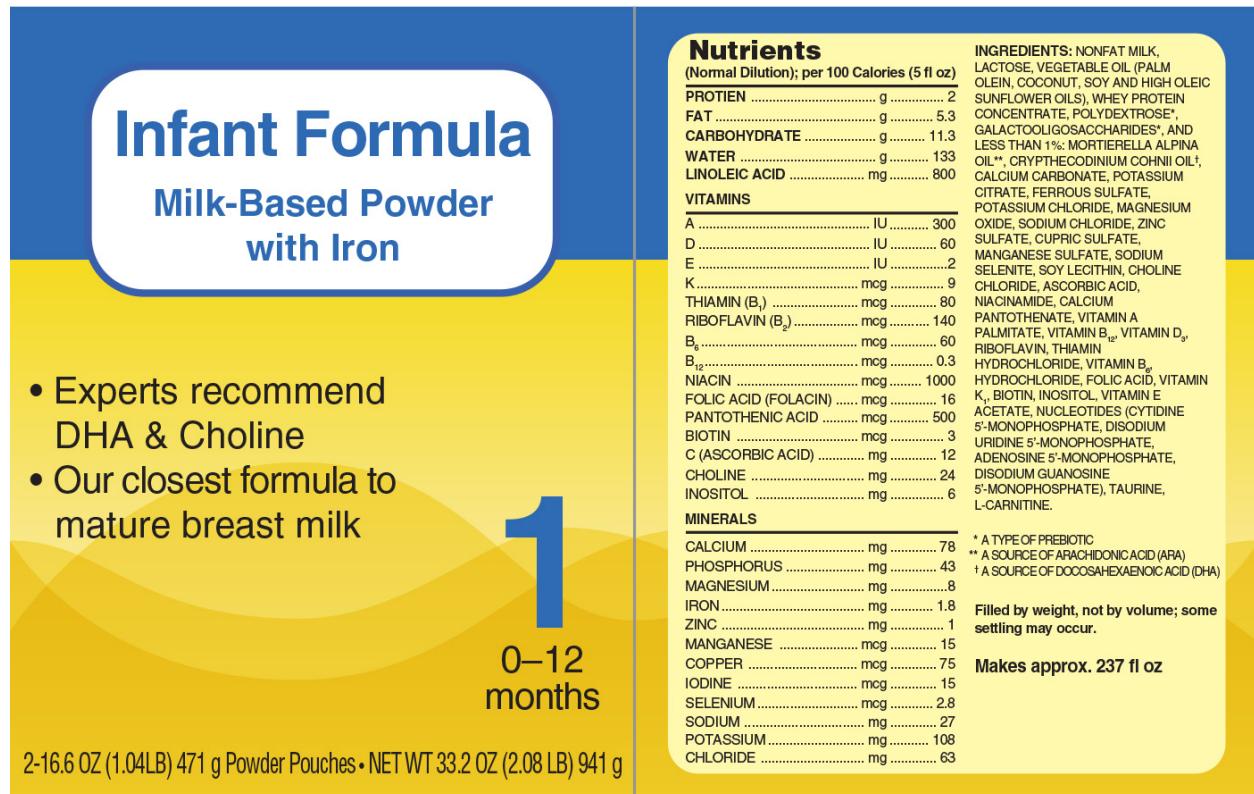


Figure 14.13: Infant Formula Label

14.24.1 When to Introduce Solid Food

- Introduce solid food at 6 months
 - Tongue movement allows swallowing
 - Muscle development allows infant to sit up
 - Digestive system and kidneys have matured
 - Less likely to develop food allergies
 - Iron-fortified cereals are well tolerated
- Infants should not eat
 - Foods they could choke on
 - Corn syrup or honey
 - Goat's milk
 - Cow's milk
 - Too much salt or sugar
- Nutrition-related concerns for infants include

- Allergies
- Dehydration
- Colic
- Anemia
- Nursing bottle syndrome
- Lead poisoning

14.24.2 Allergies

- Solid foods should be introduced one at a time for a week to watch for allergies
- Cow's milk, egg whites, peanuts, and wheat commonly trigger food allergies

14.24.3 Dehydration

- Extremely dangerous for infants
- Caused by diarrhea, vomiting, and inadequate fluid intake
- Pediatric electrolyte solution may be used

14.24.4 Colic

- Uncontrollable crying that can last for hours
- Precise cause is unknown

14.24.5 Anemia

- Infants are born with enough iron for only 6 months
- Anemia can develop
- Iron-fortified cereal/supplement may be needed

14.24.6 Nursing bottle syndrome

- Leaving an infant alone with a bottle can lead to cavities (dental caries) and tooth decay
- The high-carbohydrate fluid provides an optimal food source for bacteria that cause dental caries
- Rather than a bottle, begin using a cup by 8 months and no bottle after 18 months



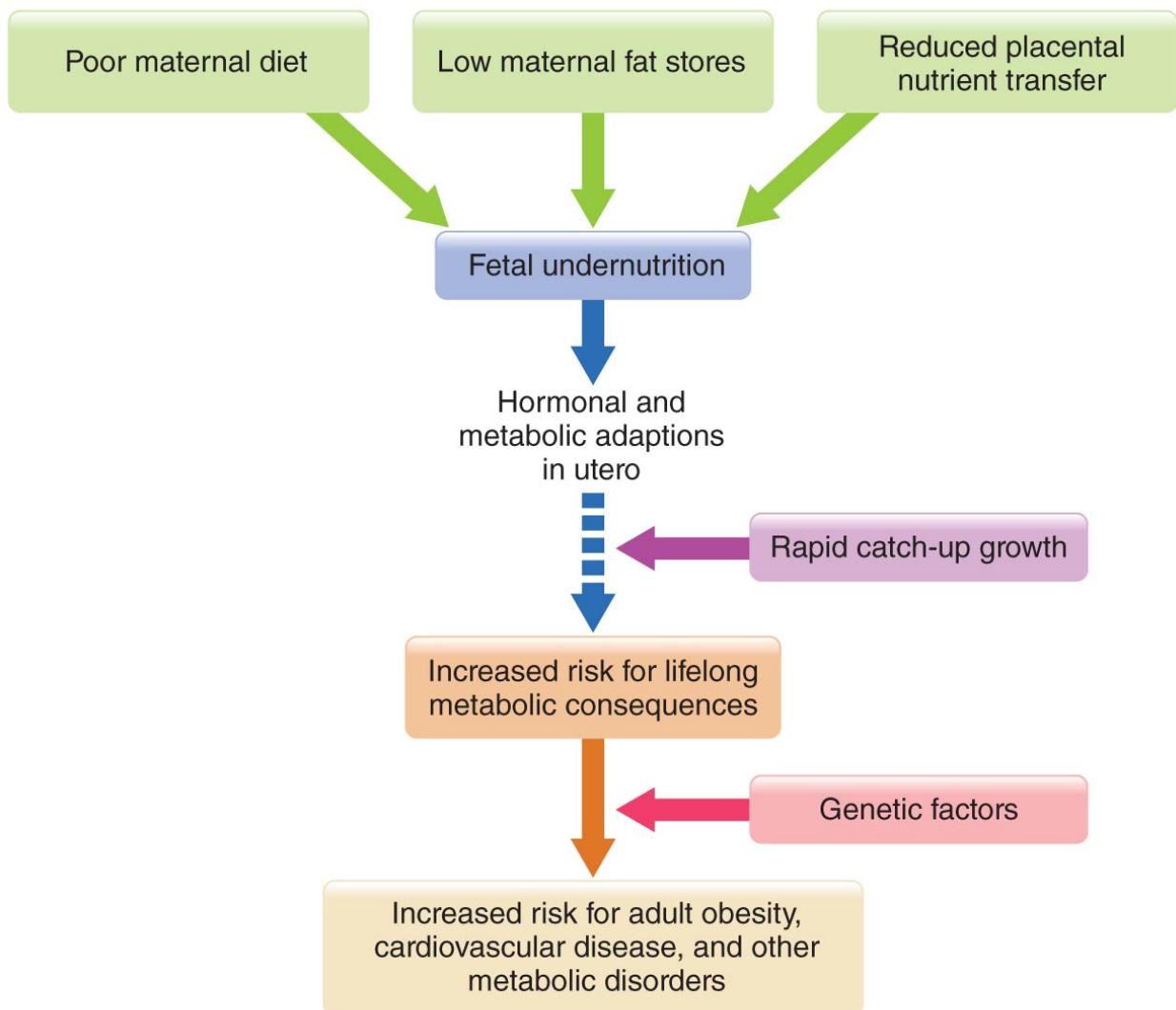
Figure 14.14: Nursing Bottle Syndrome

14.24.7 Lead poisoning

- Especially toxic to infants because the brain and nervous system are still developing
- Results in reduced mental capacity, behavioral problems, and impaired growth
- Remove old, lead-based paint
- Allow tap water to run a minute before use to discard lead leached from pipes
- Use only cold tap water because hot tap water is more likely to leach lead

14.25 In Depth: The Fetal Environment

- Increased evidence suggests that the fetal environment—including a mother's nutritional status—can influence risks for obesity and chronic diseases later in life
- This relationship has been called “fetal origins theory”
- If exposed to famine in the first trimester, the child has increased risk of obesity, coronary heart disease, abnormal serum lipid profile, and metabolic syndrome
- **Fetal adaptation** – when a fetus is exposed to harmful elements, it goes into “survival mode”: hormones shift to promote energy storage, and enzymes can increase or decrease the size and function of various body organs



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Figure 14.15: The Fetal Environment

- Fetal stressors that influence adult health include nutrient deficiencies
 - Low maternal intake of calcium increases risk of hypertension in offspring
 - Poor maternal folate intake is linked to neural tube defects and early signs of atherosclerosis
 - Zinc deficiency has been linked to later-life disorders such as diabetes and atherosclerosis
- Strong evidence links maternal dietary excesses to health problems in adult offspring
 - Maternal obesity may account for changes in the “programming” of the fetal brain, resulting in lifelong health consequences
 - Maternal obesity increases rates of spina bifida, neural tube defects, infant heart defects, cleft lip and palate, and abnormal arms or legs

- Maternal diabetes can increase risks of infant type 2 diabetes, overweight, and metabolic syndrome
- Other detrimental maternal impacts on a fetus include exposure to
 - Alcohol
 - Tobacco
 - Toxic agents, such as environmental pollutants