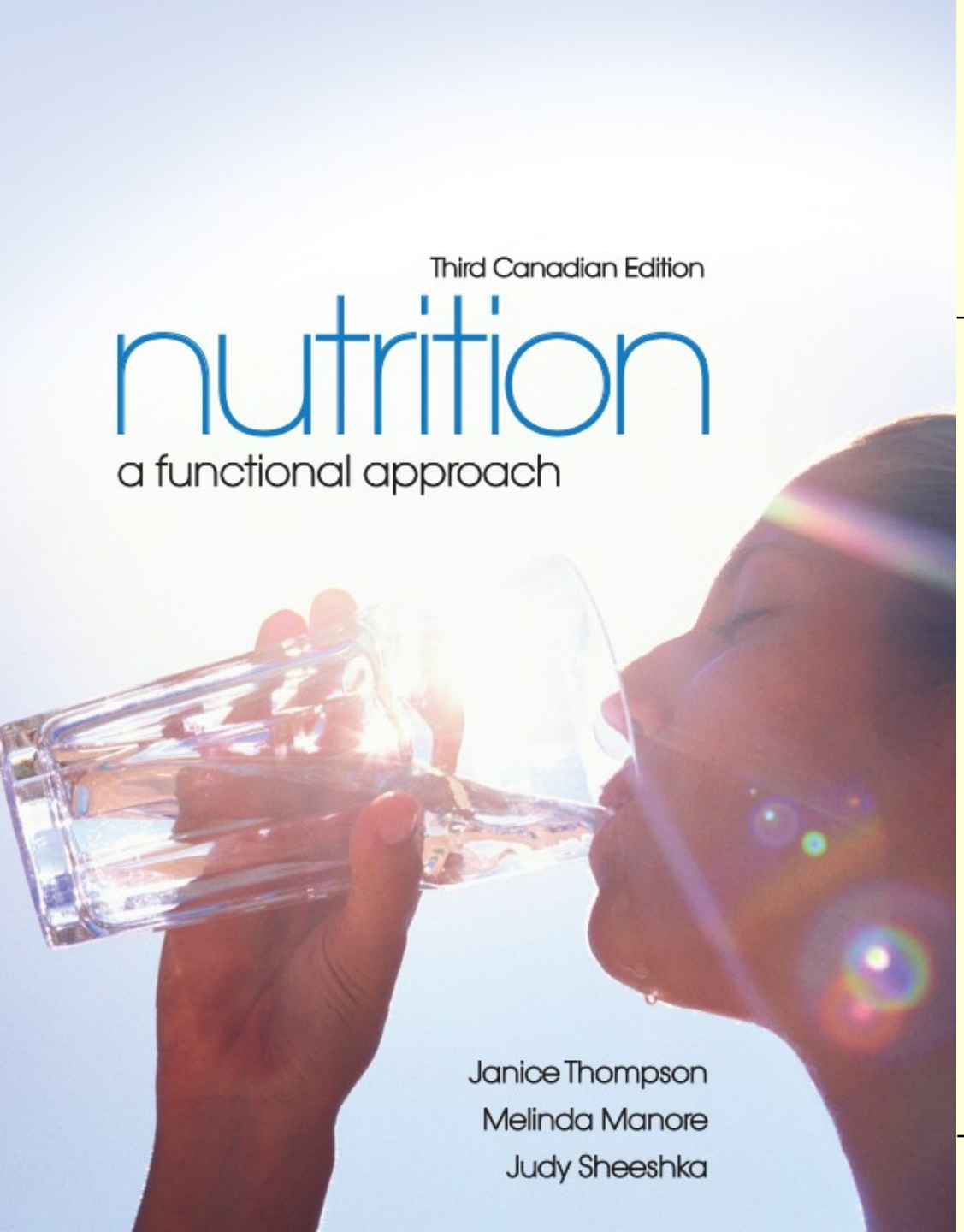

CHAPTER

14

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

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

Nutrition Before Conception

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/m^2 and appropriate level of physical activity

Nutrition Before Conception

A healthful diet before conception reduces the risk of developing nutrition-related disorders during pregnancy, such as

- Gestational diabetes
- Hypertensive disorders

The man’s nutrition is important too: malnutrition contributes to abnormalities in sperm

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

Nutrition During Pregnancy

First trimester

- Zygote (fertilized egg) travels through the fallopian tube and implants in the wall of the uterus
- Zygote divides into 12 – 16 cells, and further cell growth, multiplication and differentiation result in an embryo
- Development of organs, limb buds, facial features, and placenta occur
- Embryos are extremely vulnerable to teratogens during this time

Ovulation, Conception, and Implantation

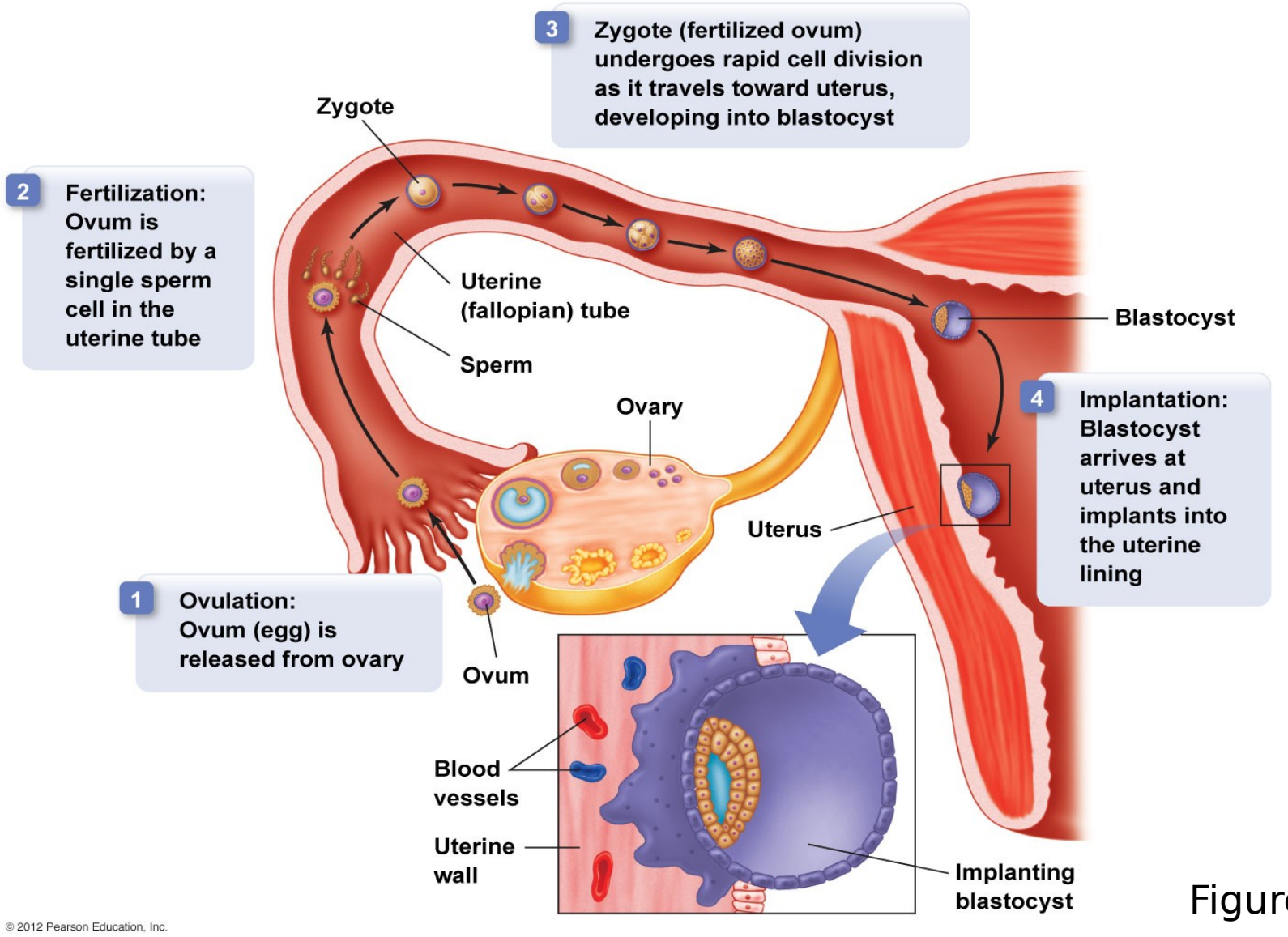

Figure 14.1

The First 10 Weeks

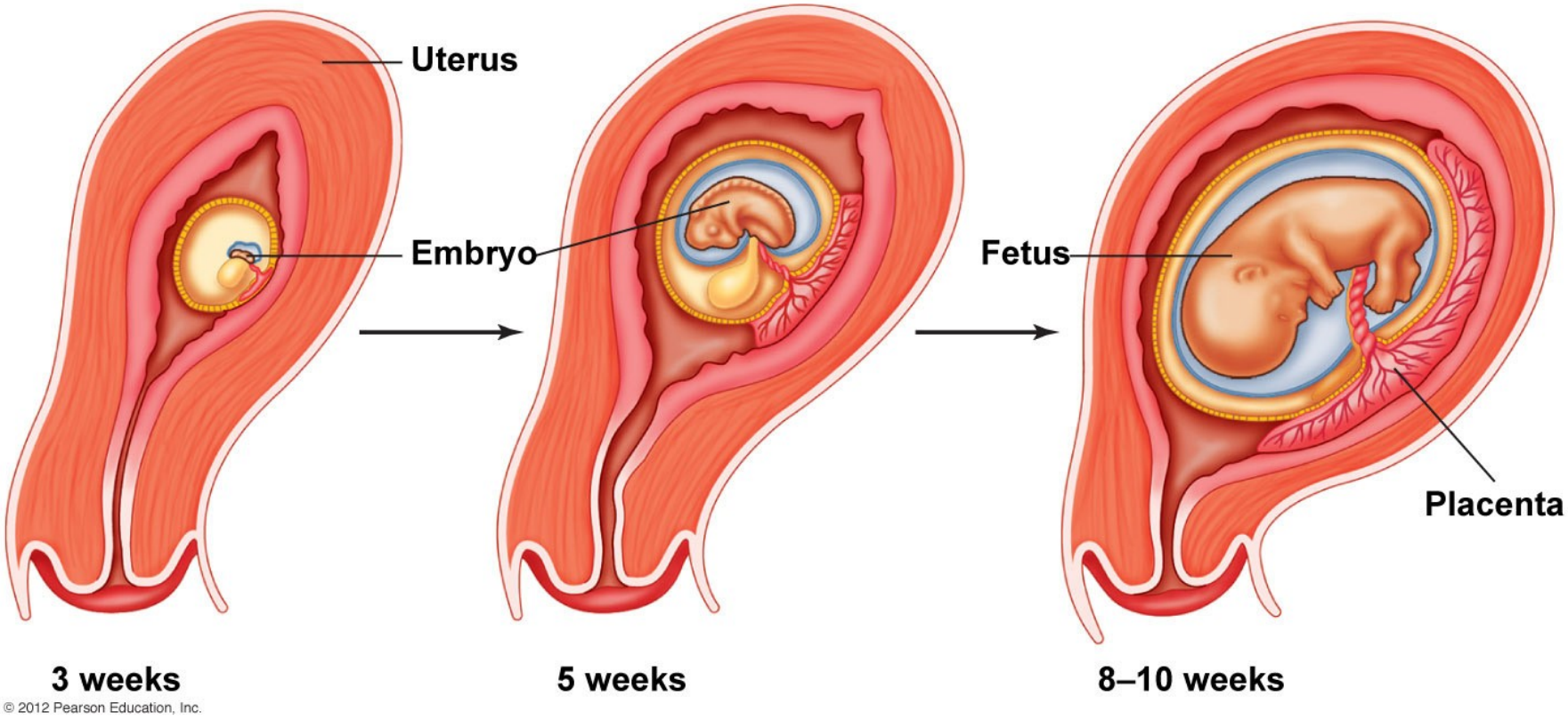

Figure 14.2

The First Trimester

- During the third month of pregnancy, the embryo becomes a fetus

- The fetus receives nutrients from the umbilical cord

Placental Development

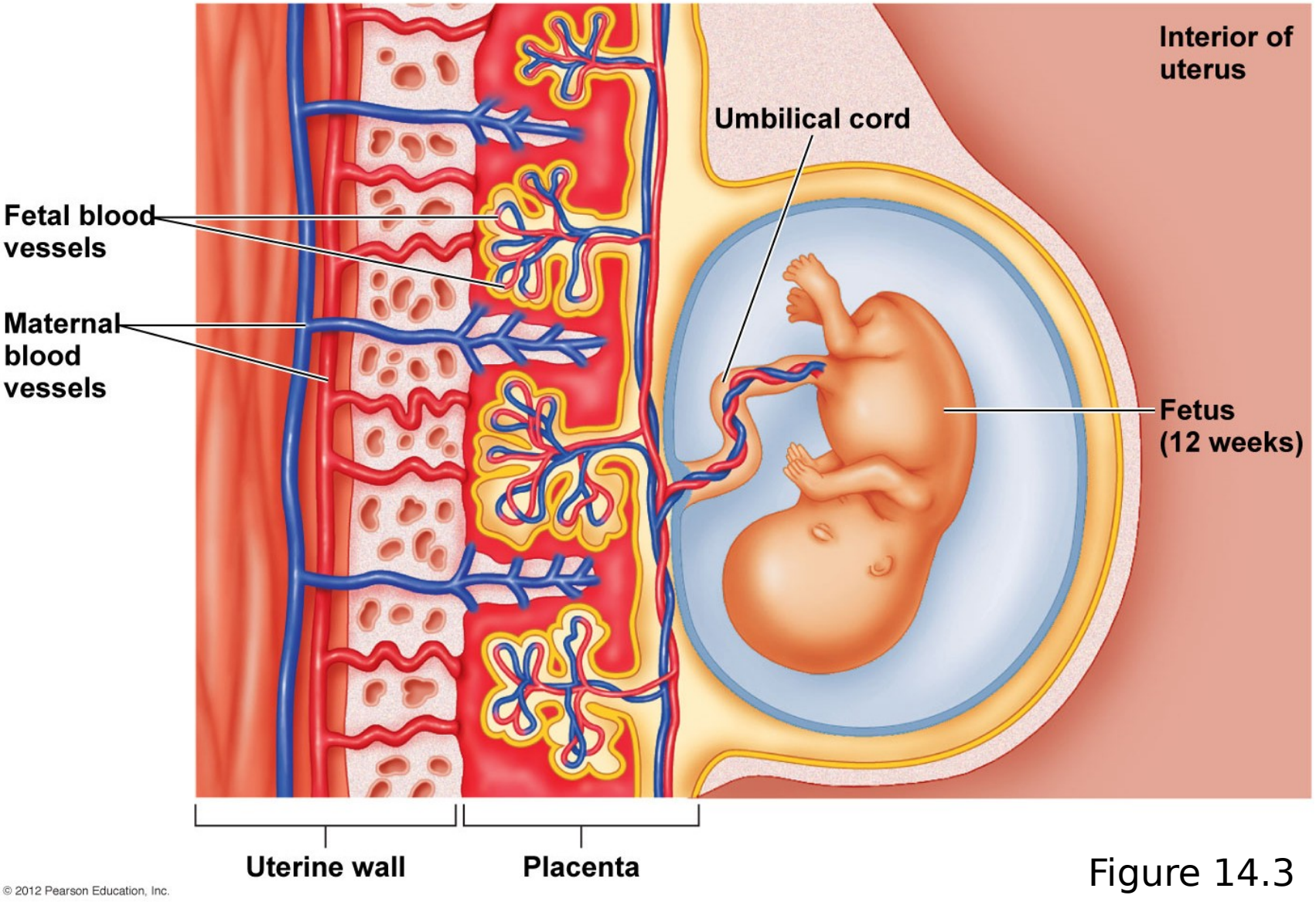

Figure 14.3

Nutrition During Pregnancy

Second trimester

- Continued development of organ systems
- Growth from approximately 7.5 cm to over 30 cm (3 inches to over 1 foot) long by the end of the second trimester
- Weight grows to approximately 1 kg (2.2 pounds)

Nutrition During Pregnancy

Third trimester

- Time of considerable growth
- Fetus gains 3/4 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

Nutrition During Pregnancy

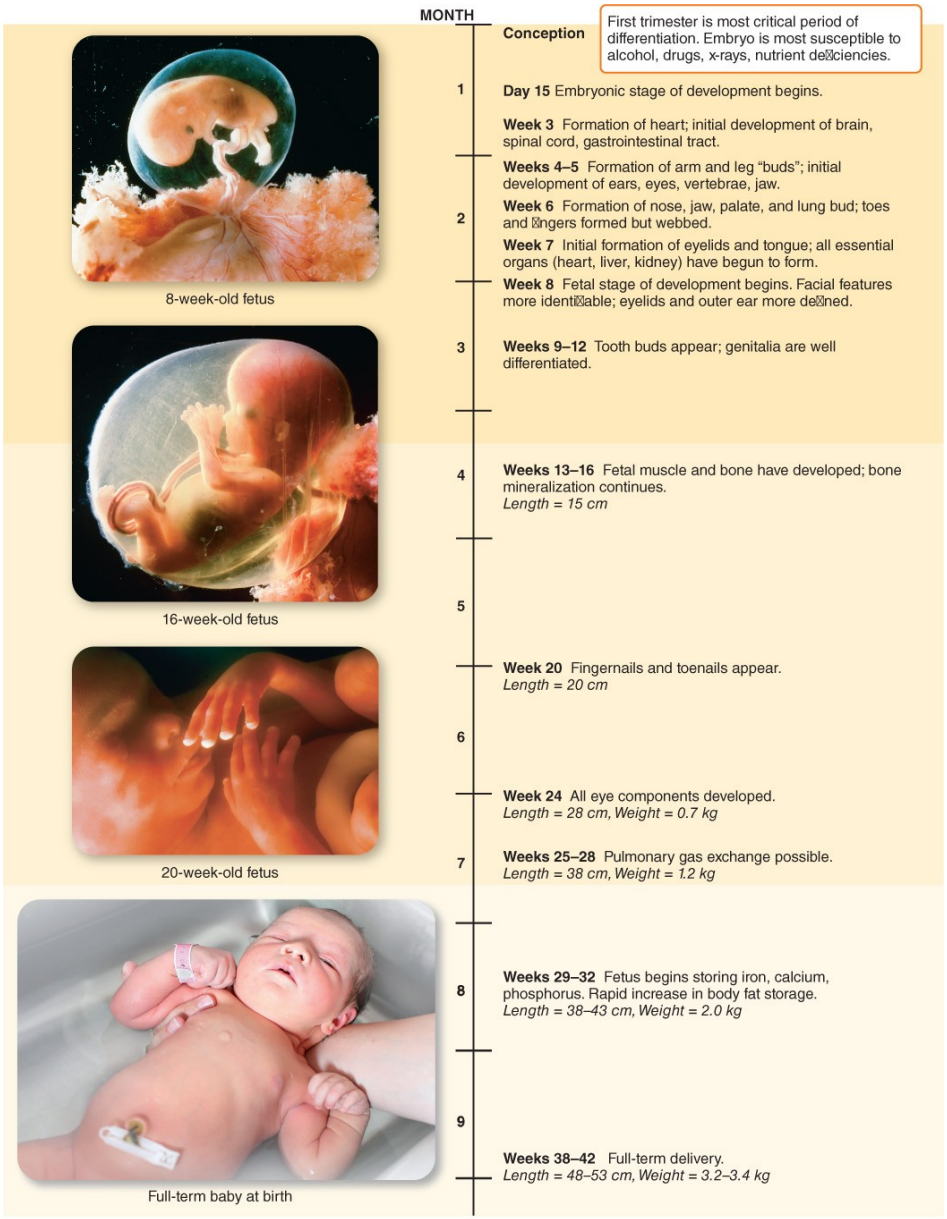

Figure 14.4 A timeline of embryonic and fetal development.

Figure 14.4

Nutrition During Pregnancy

An undernourished mother is more likely to give birth to a low-birth-weight baby

- Low birth weight: any baby born weighing less than 2500 grams (5.5 pounds)
- Increased risk of infections, learning disabilities, impaired physical development, and death in the first year

Nutrition During Pregnancy

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

Nutrition During Pregnancy

- Recommendations for weight gain vary according to a woman's weight before she becomes pregnant and whether she is expecting a single or multiple birth

- See Table 14.1 (next slide)

Weight Gain During Pregnancy

TABLE 14.1 Recommended Weight Gain for Women During Pregnancy

Pre-Pregnancy Weight Status	Body Mass Index (kg/m^2)	Recommended Weight Gain kg (lb.)
Normal	18.5–24.9	11.5–16.0 kg (25–35 lb.)
Underweight	18.5	12.5–18.0 kg (28–40 lb.)
Overweight	25.0–29.9	7.0–11.5 kg (15–25 lb.)
Obese	30+	5–9 kg (11–20 lb.)

Source: The Sensible Guide to a Healthy Pregnancy. Health Canada, 2011. Reproduced with the permission from the Minister of Health, 2012.

Table 14.1

Weight Gain During Pregnancy

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
- Women should focus on quality of food consumed rather than quantity

Weight Gain During Pregnancy

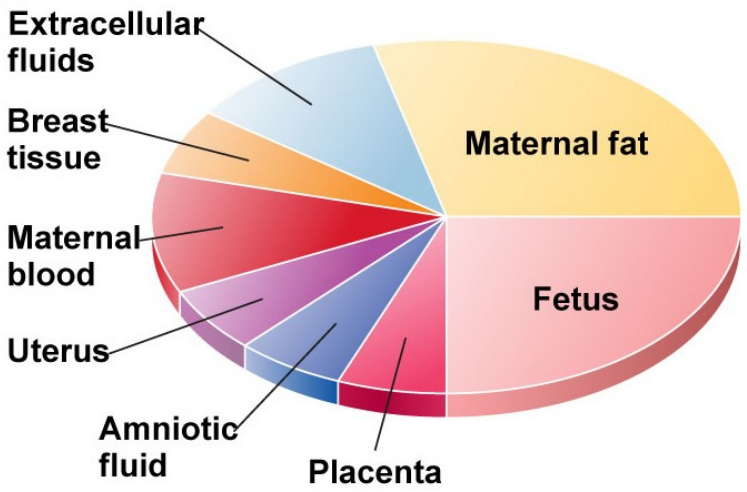

Figure 14.6

Nutrition During Pregnancy

The requirement for nearly all nutrients increases during pregnancy

Pregnant women must pay attention to their intake of

- Macronutrients
- Micronutrients
- Fluids

Macronutrients

1. Energy

- An additional 350 to 450 kcal/day may be required in the second and third trimesters
- Nutrient-dense foods are essential in order to obtain sufficient nutrients

2. Proteins and carbohydrates

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

Macronutrients

3. Fat

- The percentage of calories obtained from fat should not change during pregnancy
- Limit saturated fat; avoid *trans* fats
- Fat is required by the newborn for temperature regulation and as an energy source
- Consume rich sources of docosahexaenoic acid (DHA), an omega-3 polyunsaturated fatty acid

Micronutrients

The micronutrients that are most critical during pregnancy include

- folate
- vitamin B_{12}
- vitamin C
- vitamin A
- vitamin D
- calcium
- iron
- zinc
- sodium
- iodine

Micronutrients

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 µg/day for sexually active women
- 600 µg/day for pregnant women

Micronutrients

Vitamin B_{12}

- Regenerates the active form of folate
- 2.6 µg/day during pregnancy

Vitamin C

- Production of collagen (connective tissue)
- 85 mg/day during pregnancy
- Deficiency results in elevated risk for preterm births and other complications

Micronutrients

Vitamin A

- Needs increase by 10% in pregnancy
  - 770 µg/day
- Excess preformed vitamin A can cause fetal abnormalities, particularly heart defects and facial malformations
- Supplementation is not recommended due to toxicity risk
- Beta-carotene (provitamin A) is not associated with birth defects

Micronutrients

Vitamin D

- RDA does not increase during pregnancy
- If exposure to sunlight is limited or milk consumption is low, supplementation is advised
- Prenatal vitamin supplements contain 10-µg/dose
- Excessive vitamin D can cause developmental disabilities in newborns

Micronutrients

Calcium

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

Micronutrients

Iron

- Increased need for red blood cells increases the need for iron by 50% (27 mg/day)
- Fetal need for iron increases in the third trimester
- Iron supplements are routinely prescribed during the last 2 trimesters
- Iron stores of mother are depleted to support needs of the fetus
- Iron-deficiency anemia is common during pregnancy

Micronutrients

Zinc

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

Micronutrients

Sodium

- 1,500 mg/day, same as for non-pregnant women
- Necessary to maintain fluid balance

Iodine

- Need for iodine increases significantly
- 220 µg/day can be obtained from iodized salt

Nutrient Recommendations During Pregnancy

TABLE 14.2 Changes in Nutrient Recommendations with Pregnancy for Adult Women

Micronutrient	Pre-Pregnancy	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	5 µg/day	5 µg/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 µg/day	220 µg/day	47

Table 14.2

Do Pregnant Women Need Supplements?

- Prenatal multivitamin and mineral supplements are not strictly necessary, but most health-care providers recommend them

- Supplements are to be taken in addition to, NOT as a substitute for, a nutrient-rich diet

Fluids During Pregnancy

The need for fluids increases to 3 litres 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

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)

Morning Sickness

Morning sickness: nausea and vomiting associated with pregnancy

- Can occur at any time; often lasts all day
- Can last 12 to 16 weeks, but some women experience it throughout pregnancy
- Can be severe enough to require hospitalization
- No cure, but symptoms can be reduced
- Women should check with their health-care provider before using any morning sickness therapy

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

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 laying down
- Sleep with your head elevated

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 fibre, plenty of fluids, and remaining physically active

Gestational Diabetes

Gestational diabetes: insufficient insulin production or insulin resistance that increases blood glucose levels during pregnancy

- 3.7% of non-Aboriginal and up to 8 – 18% of Aboriginal women in Canada experience gestational diabetes
- Condition resolves after birth occurs
- Risk of delivering a large baby
- Exposing a fetus to maternal diabetes significantly increases the risk for overweight, type 2 diabetes, and metabolic syndrome during later life

Hypertensive Disorders of Pregnancy

- 1% of pregnancies are complicated by pre-existing hypertension, and 5 – 6% develop gestational hypertension
- The term, “hypertensive disorders of pregnancy” encompasses several different conditions

Pre-eclampsia: 1 – 2% of pregnant women

- characterized by a sudden increase in maternal blood pressure with swelling, excessive and rapid weight gain unrelated to food intake, and protein in the urine

Hypertensive Disorders of Pregnancy

Preeclampsia, continued

- Can be fatal if left untreated, and develops into eclampsia
- Deficiencies in vitamin C, vitamin E, dietary protein, calcium, and magnesium increase the risk
- Treatment focuses on managing blood pressure and often includes bed rest
- The only cure is childbirth
- A woman who develops high blood pressure with no other symptoms = gestational hypertension

Nutrition-Related Concerns

- Adolescent pregnancy
- Vegetarianism
- Caffeine
- Alcohol
- Smoking
- Illegal drugs
- Food safety
- Exercise

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
- Pregnant adolescents are more likely to have preterm babies, low-birth-weight babies, and other complications

Vegetarianism

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

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

vitamin D	calcium
vitamin B_6	iron
vitamin B_{12}	zinc

A prenatal supplement will meet vitamin and iron needs, but will need a calcium supplement or consumption of calcium-fortified soy milk or orange juice

Consumption of Caffeine

- Caffeine is a stimulant that crosses the placenta and reaches the fetus
- 250 ml – 500 ml (1 - 2 cups of coffee) per day very likely will cause no harm: this is the equivalent of 300 mg of caffeine
- More than 500 ml (2 cups) of coffee may slightly increase the risk of miscarriage and low birth weight

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
- Best advice is to abstain before conception and as soon as pregnancy is suspected
- Fetal Alcohol Spectrum Disorder (FASD): variety of characteristics associated with prenatal exposure to high quantities of alcohol
- Fetal Alcohol Syndrome (FAS):
  - Malformations of face, limbs, and heart
  - Many developmental disabilities

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

Food Safety

- Avoid eating large fish (high mercury content)
- Other foods to avoid include soft cheeses that are made with unpasteurized milk
- Pregnant women should follow safe food-handling practices

Food Safety

TABLE 14.3 Foods to Avoid and Safer Alternatives During Pregnancy

Type of Food	Food to Avoid	Safer Alternative
Hot Dogs	Hot dogs straight from the package without further heating	Hot dogs thoroughly cooked to a safe internal temperature. The middle of the hot dog should be steaming hot or 74°C (165°F) Wash your hands after handling hot dogs.
Deli meats	Non-dried deli meats, such as bologna, roast beef and turkey breast.	Dried and salted deli meats such as salami and pepperoni. Non-dried deli meats heated throughout to steaming hot.
Egg and egg products	Raw or lightly cooked egg or egg products, including salad dressings, cookie dough or cake batter, sauces, and drinks such as homemade eggnog.	Egg dishes thoroughly cooked to a safe internal temperature. Eggs should be cooked until the yolk is firm. Homemade eggnog must be heated to 71°C (160°F). Pasteurized egg products can be used when making uncooked food that calls for raw eggs.
Meat and poultry	Raw or undercooked meat or poultry, such as steak tartare.	Meat and poultry cooked to a safe internal temperature (check using a digital food thermometer).
Seafood	Raw seafood, such as sushi. Raw oysters, clams, and mussels. Refrigerated, smoked seafood.	Seafood cooked to a safe internal temperature of 74°C (165°F). Cook until the shell has opened. Smoked seafood in cans that do not require refrigeration until after opening. Refrigerated smoked seafood can be eaten safely when fully cooked to a safe internal temperature.
Dairy products	Raw or unpasteurized dairy products, including soft and semi-soft cheese, such as Brie, Camembert, and blue-veined cheese.	Pasteurized dairy products, hard cheeses such as Colby, Cheddar, Swiss, and Parmesan.
Sprouts	Raw sprouts such as alfalfa, clover, radish, and mung beans.	Thoroughly cooked sprouts.
Pâtés and meat spreads	Refrigerated pâtés and meat spreads.	Pâtés and meat spreads sold in cans or those that do not require refrigeration until after opening.
Fruit juice and cider	Unpasteurized fruit juice and cider.	Unpasteurized fruit juice and cider brought to a rolling boil and cooled. Pasteurized fruit juice and cider.

Source: It's Your Health: Food Safety for Pregnant Women. Health Canada, 2010. Reproduced with the permission from the Minister of Health, 2012.

Table 14.3

Exercise During Pregnancy

- Keeps a woman physically fit
- Is a great mood booster
- Helps compensate for an increased appetite
- Helps keep blood pressure down
- Makes it easier to lose weight after the pregnancy

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, micronutrients, antibodies, vitamins, and minerals

Oxytocin: hormone responsible for milk “letdown”

Breastfeeding

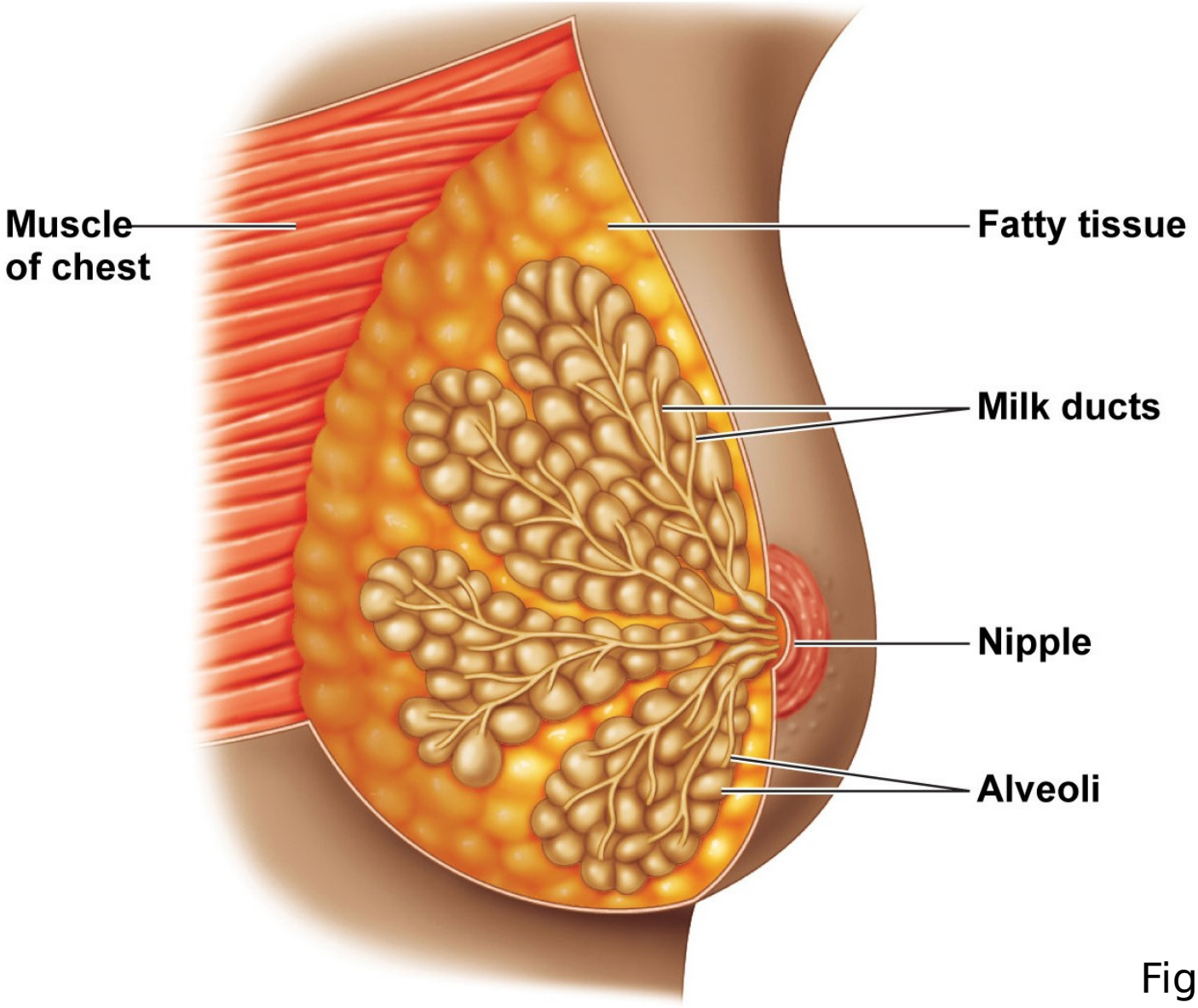

Figure 14.9

Breastfeeding

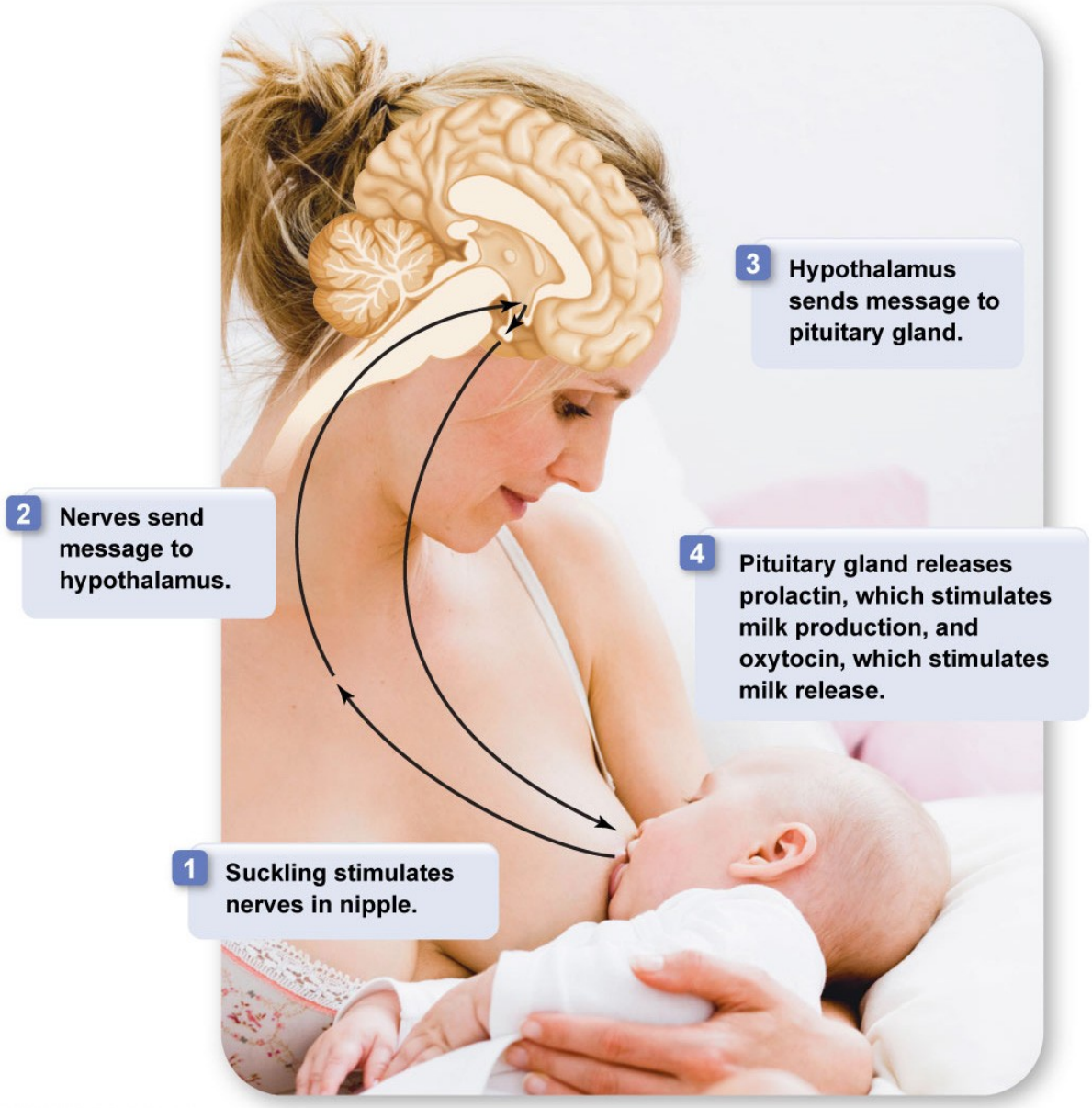

Figure 14.10

Breastfeeding

- Milk production requires 2930 – 3350 kJ (700–800 kcal)/day
- Lactating women should consume 1390 kJ (330 kcal)/day above their prepregnancy needs the first 6 months, 1680 kJ (400 kcal)/day the second 6 months
- This allows a woman to gradually lose weight 0.5 – 2.0 kg (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, but requirements for iron decrease significantly

Breastfeeding

- If a breastfeeding woman appropriately increases her energy intake with nutrient-dense foods, no supplements are required
- Lactating women should take omega-3 fatty acids by eating fish or in supplement form to increase DHA in breast milk
- Lactating women require 1 extra litre of fluid daily for milk production and to prevent dehydration

The Benefits of Breastfeeding

- High-quality nutrition
- Protection from allergies and infections
- Assists the mother in weight loss
- Suppresses ovulation
- Provides an opportunity for bonding
- Convenient and cost efficient

Breastfeeding

Nutritional quality of breast milk

- The main protein, lactalbumin, is easily digested
- Primary carbohydrate is lactose
- Rich source of omega-3 fatty acids and readily absorbed calcium and magnesium

Breastfeeding

Composition of milk changes during a feeding

- Foremilk is watery and low in fat
- Hindmilk is very high in fat

It is important to let infant suckle for at least 20 minutes

Obstacles to Breastfeeding

- Many harmful substances are passed into breast milk, including
  - Illegal drugs, caffeine, alcohol, nicotine, and prescription and over-the-counter medications
- HIV is passed through breast milk
- Conflicts with mother's employment
- Social concerns
- Bonding for fathers and siblings can be a concern

Infant Nutrition

Optimal nutrition is critical in the first year because

- High energy needs, 460kJ/kg (110kcal/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 25 cm(10 inches) in length and triple their weight in the first year

Infant Nutrition

Infants' nutritional needs are unique because

- Their energy needs are high to support rapid growth
- Their digestive tracts and kidneys are still immature
- They are small in size

Infant Nutrition

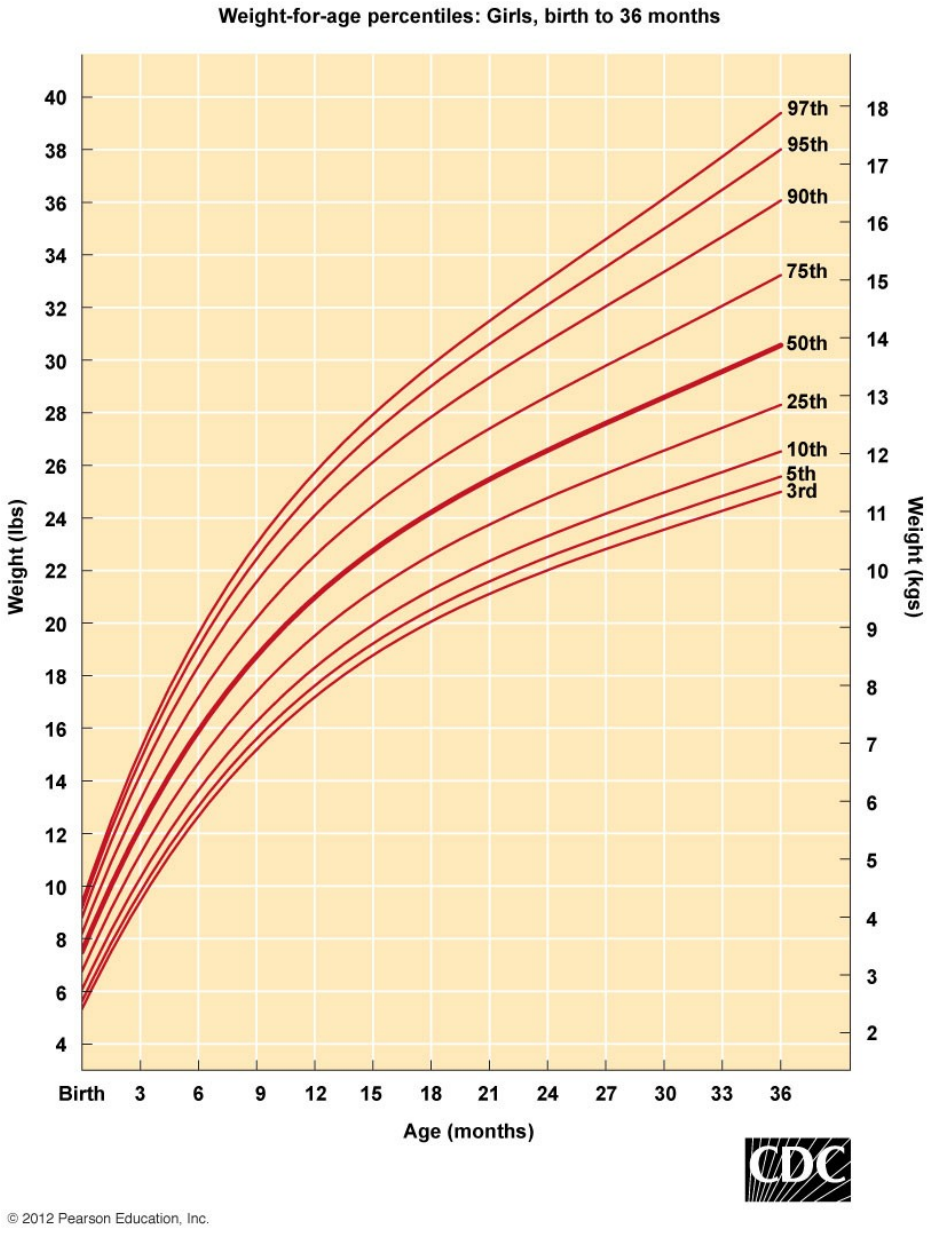

Figure 14.11

Supplements for Infants?

Several micronutrients may need supplementation

- Vitamin D because of limited exposure to sunlight
- Iron—stores are depleted by the 6th month
- Fluoride for tooth development
- Vitamin B_{12} 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

Infant Nutrition

- World Health Organization (WHO) recommends breastfeeding for at least the first 2 years

- Breast milk or formula should be supplemented with solid food beginning at 4 to 6 months

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 fatty acids
- Recently, some manufacturers have added the fatty acids AA and DHA to more closely mimic the nutrient profile of human milk

Specialized formulas are available: soy-based, predigested, others for certain medical conditions

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

Infant Nutrition

Infants should not eat

- Foods they could choke on
- Corn syrup or honey
- Goat’s milk
- Cow’s milk
- Too much salt or sugar
- Too much breast milk, formula, or water

Infant Nutrition

Nutrition-related concerns for infants include

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

Infant Nutrition

Allergies

- Solid foods should be introduced 1 at a time for a week to watch for allergies
- Cow's milk, egg whites, peanuts, and wheat commonly trigger food allergies

Dehydration

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

Infant Nutrition

Colic

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

Anemia

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

Infant Nutrition

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

Infant Nutrition

Lead poisoning

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

In Depth: The Fetal Environment

Evidence has grown suggesting 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"

Exposure to Famine

- If exposed in the first trimester, the child has increased risk for obesity, heart disease, abnormal serum lipid profile, stroke, diabetes, premature death, and even schizophrenia

- 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

In Depth: The Fetal Environment

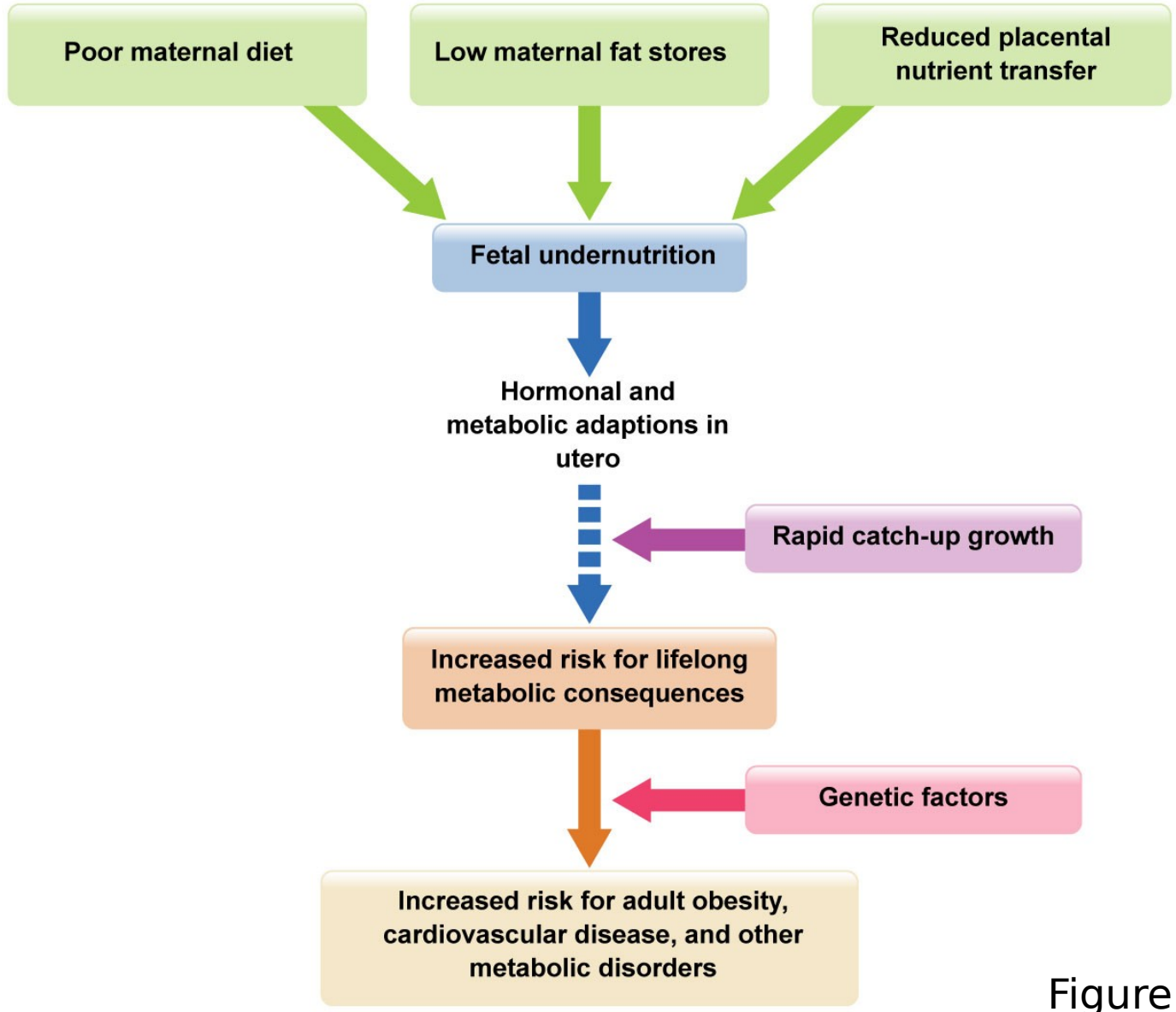

Figure 1: In Depth

Exposure to Nutrient Deficiencies

- Low maternal intake of calcium increases risk of hypertension in offspring
- Poor maternal folate intake is linked to neural tube defects and atherosclerosis in adult offspring
- Low maternal intake of fish is associated with infant developmental delays
- Zinc deficiency can account for metabolic deficits and disease risks

Exposure to Dietary Excesses

- 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 for infant type 2 diabetes, overweight, and metabolic syndrome

In Depth: The Fetal Environment

Other detrimental maternal impacts on a fetus include exposure to

- Alcohol
- Tobacco
- Toxic agents, such as environmental pollutants