ESSENTIALS of Maternity, Newborn, & Women's Health Nursing - **THIRD EDITION**

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11: Maternal Adaptation During Pregnancy

Learning Objectives

Upon completion of the chapter, you will be able to:

- **1.** Define the key terms used in this chapter.
- **2.** Differentiate between subjective (presumptive), objective (probable), and diagnostic (positive) signs of pregnancy.
- **3.** Appraise maternal physiologic changes that occur during pregnancy.
- **4.** Summarize the nutritional needs of the pregnant woman and her fetus.
- **5.** Characterize the emotional and psychological changes that occur during pregnancy.

KEY TERMS

ballottement

Braxton Hicks contractions

Chadwick's sign

dietary reference intakes (DRIs)

Goodell's sign

Hegar's sign

linea nigra

physiologic anemia of pregnancy

pica

quickening

trimester

Marva, age 17, appeared at the health department clinic complaining that she had a stomach virus and needed to be seen today. When the nurse asked her additional questions about her illness, Marva reported that she had been sick to her stomach and "beat tired" for days. She had stopped eating to avoid any more nausea and vomiting.

WOW: *Words of Wisdom*

When a woman discovers that she is pregnant, she must remember to protect and nourish the fetus by making wise choices.

Pregnancy is a normal life event that involves considerable physical and psychological adjustments for the mother. A pregnancy is divided into three **trimesters** of 13 weeks each (Edelman & Mandle, 2010). Within each trimester, numerous adaptations take place that facilitate the growth of the fetus. The most obvious are physical changes to accommodate the growing fetus, but pregnant women also undergo psychological changes as they prepare for parenthood.

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Consider This

Jim and I decided to start our family, so I stopped taking the pill 3 months ago. One morning when I got out of bed to take the dog out, I felt queasy and light-headed. I sure hoped I wasn't coming down with the flu. By the end of the week, I was feeling really tired and started taking naps in the afternoon. In addition, I seemed to be going to the bathroom frequently, despite not drinking much fluid. When my breasts started to tingle and ache, I decided to make an appointment with my doctor to see what "illness" I had contracted.

After listening to my list of physical complaints, the office nurse asked me if I might be pregnant. My eyes opened wide: I had somehow missed the link between my symptoms and pregnancy. I started to think about when my last period was, and it had been 2 months ago. The office ran a pregnancy test and much to my surprise it was positive!

Thoughts: Many women stop contraceptives in an attempt to achieve pregnancy but miss the early signs of pregnancy. This woman was experiencing several signs of early pregnancy—urinary frequency, fatigue, morning nausea, and breast tenderness. What advice can the nurse give this woman to ease these symptoms? What additional education related to her pregnancy would be appropriate at this time?

SIGNS AND SYMPTOMS OF PREGNANCY

Traditionally, signs and symptoms of pregnancy have been grouped into the following categories: presumptive, probable, and positive (**Box 11.1**). The only signs that can determine a pregnancy with 100% accuracy are positive signs.

BOX 11.1: SIGNS AND SYMPTOMS OF PREGNANCY

Presumptive (Time of Occurrence)	Probable (Time of Occurrence)	Positive (Time of Occurrence)
Fatigue (12 wks)	Braxton Hicks contractions (16–28 wks)	Ultrasound verification of embryo or fetus (4–6 wks)
Breast tenderness (3–4 wks)	Positive pregnancy test (4–12 wks)	Fetal movement felt by experienced clinician (20 wks)
Nausea and vomiting (4–14 wks)	Abdominal enlargement (14 wks)	Auscultation of fetal heart tones via Doppler (10–12 wks)
Amenorrhea (4 wks)	Ballottement (16–28 wks)	
Urinary frequency (6–12 wks)	Goodell's sign (5 wks)	
Hyperpigmentation of the skin (16 wks)	Chadwick's sign (6–8 wks)	
Fetal movements (quickening; 16–20 wks)	Hegar's sign (6–12 wks)	
Uterine enlargement (7–12 wks)		
Breast enlargement (6 wks)		

Adapted from Bope, E. T., & Kellerman, R. D. (2012). *Conn's current therapy 2012*. Philadelphia, PA: Saunders Elsevier; Shields, A. D. (2012). Pregnancy diagnosis. *eMedicine*. Retrieved from http://emedicine.medscape.com/article/262591-overview; and Simpson, K. R., & Creehan, P. A. (2011). *AWHONN's perinatal nursing* (3rd ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

What additional information is necessary to complete the assessment of Marva, the 17-year-old with nausea and vomiting? What diagnostic tests might be done to confirm the nurse's suspicion that she is pregnant?

Subjective (Presumptive) Signs

Presumptive signs are those signs that the mother can perceive. The most obvious presumptive sign of pregnancy is the absence of menstruation. Skipping a period is not a reliable sign of pregnancy by itself, but if it is accompanied by consistent nausea, fatigue, breast tenderness, and urinary frequency, pregnancy would seem very likely.

Presumptive changes are the least reliable indicators of pregnancy because any one of them can be caused by conditions other than pregnancy (Shields, 2012). For example, amenorrhea can be caused by early menopause, endocrine dysfunction, malnutrition, anemia, diabetes mellitus, long-distance running, cancer, or stress. Nausea and vomiting can be caused by gastrointestinal disorders, food poisoning, acute infections, or eating disorders. Fatigue could be caused by anemia, stress, or viral

infections. Breast tenderness may result from chronic cystic mastitis, premenstrual changes, or the use of oral contraceptives. Urinary frequency could have a variety of causes other than pregnancy, such as infection, cystocele, structural disorders, pelvic tumors, or emotional tension (Tharpe, Farley, & Jordan, 2012).

Objective (Probable) Signs

Probable signs of pregnancy are those that can be detected on physical examination by a health care professional. Common probable signs of pregnancy include softening of the lower uterine segment or isthmus (Hegar's sign), softening of the cervix (Goodell's sign), and a bluish-purple coloration of the vaginal mucosa and cervix (Chadwick's sign). Other probable signs include changes in the shape and size of the uterus, abdominal enlargement, Braxton Hicks contractions, and **ballottement** (the examiner pushes against the woman's cervix during a pelvic examination and feels a rebound from the floating fetus).

Along with these physical signs, pregnancy tests are also considered a probable sign of pregnancy. In-home pregnancy testing became available in the United States in late 1977. In-home testing appeals to the general public because of convenience, cost, and confidentiality. Several pregnancy tests are available (Table 11.1). The tests vary in sensitivity, specificity, and accuracy and are influenced by the length of gestation, specimen concentration, presence of blood, and the presence of some drugs. Human chorionic gonadotropin (hCG) is detectable in the serum of approximately 5% of clients 8 days after conception and in more than 98% of clients by day 11 (Shields, 2012). At least 25 different home pregnancy tests are currently marketed in the United States. Most of these tests claim "99% accuracy" according to a U.S. Food and Drug Administration (FDA) guideline or make other similar statements on the packaging or product insert. The 99% accuracy statement in reference to the FDA guideline is misleading in that it has no bearing on the ability of the home pregnancy test to detect early pregnancy (Shields, 2012). The limitations of these tests must be understood so that pregnancy detection is not delayed significantly. Early pregnancy detection allows for the commencement of prenatal care, potential medication changes, and lifestyle changes to promote a healthy pregnancy.

TABLE 11.1: SELECTED PREGNANCY TESTS

Type	Specimen	Example	Remarks
Agglutination inhibition tests	Urine	Pregnosticon, Gravindex	If hCG is present in urine, agglutination does not occur, which is positive for pregnancy; reliable 14–21 days after conception; 95% accurate in diagnosing pregnancy

Type	Specimen	Example	Remarks
Immunoradiometric assay	Blood serum	Neocept, Pregnosis	Measures ability of blood sample to inhibit the binding of radiolabeled hCG to receptors; reliable 6–8 days after conception; 99% accurate in diagnosing pregnancy
Enzyme-linked immunosorbent assay (ELISA)	Blood serum or urine	Over-the-counter home/office pregnancy tests; precise	Uses an enzyme to bond with hCG in the urine if present; reliable 4 days after implantation; 99% accurate if hCG specific

Adapted from Hackley, B., Kriebs, J. M., & Rousseau, M. E. (2010). *Primary care of women: A guide for midwives and women's health providers* (2nd ed.). Sudbury, MA: Jones & Bartlett; and Shields, A. D. (2012). Pregnancy diagnosis. *eMedicine*. Retrieved from http://emedicine.medscape.com/article/262591-overview.

hCG is a glycoprotein and the earliest biochemical marker for pregnancy. Many pregnancy tests are based on the recognition of hCG or a beta subunit of hCG. hCG levels in normal pregnancy usually double every 48 to 72 hours until they peak approximately 60 to 70 days after fertilization. At this point, they decrease to a plateau at 100 to 130 days of pregnancy. The hCG doubling time has been used as a marker by clinicians to differentiate normal from abnormal gestations. Low levels are associated with an ectopic pregnancy and higher-than-normal levels may indicate a molar pregnancy or multiple-gestational pregnancies (Levin, Hopkins, & Tiffany, 2011).

Take Note!

This elevation of hCG corresponds to the morning sickness period of approximately 6 to 12 weeks during early pregnancy.

Although probable signs suggest pregnancy and are more reliable than presumptive signs, they still are not 100% reliable in confirming a pregnancy. For example, uterine tumors, polyps, infection, and pelvic congestion can cause changes to uterine shape, size, and consistency.

And although pregnancy tests are used to establish the diagnosis of pregnancy when the physical signs are still inconclusive, they are not completely reliable, because conditions other than

pregnancy (e.g., ovarian cancer, choriocarcinoma, hydatidiform mole) can also elevate hCG levels.

Positive Signs

Usually within 2 weeks after a missed period, enough subjective symptoms are present so that a woman can be reasonably sure she is pregnant. However, an experienced health care professional can confirm her suspicions by identifying positive signs of pregnancy that can be directly attributed to the fetus. The positive signs of pregnancy confirm that a fetus is growing in the uterus. Visualizing the fetus by ultrasound, palpating for fetal movements, and hearing a fetal heartbeat are all signs that make the pregnancy a certainty.

Once pregnancy has been confirmed, the health care professional will set up a schedule of prenatal visits to assess the woman and her fetus throughout the entire pregnancy. Assessment and education begins at the first visits and continues throughout the pregnancy (see **Chapter 12**).

Remember Marva, who thought she had a stomach virus? Her pregnancy test was positive. On questioning by the nurse, she acknowledged missing two menstrual periods and being sexually active with her boyfriend without using protection. What is the nurse's role at this point with Marva? What instructions might be given to her while she waits for her first prenatal visit?

PHYSIOLOGIC ADAPTATIONS DURING PREGNANCY

Every system of a woman's body changes during pregnancy to accommodate the needs of the growing fetus, and these changes occur with startling rapidity. The physical changes of pregnancy can be uncomfortable, although every woman reacts uniquely.

Reproductive System Adaptations

Significant changes occur throughout the woman's body during pregnancy to accommodate the growing human being within her. Many have a protective role for maternal homeostasis and are essential to meet the demands of both the mother and the fetus. Many adaptations are reversible after the woman gives birth, but some persist for life.

Uterus

During the first few months of pregnancy, estrogen stimulates uterine growth, and the uterus undergoes a tremendous increase in size, weight, length, width, depth, volume, and overall capacity throughout pregnancy. The weight of the uterus increases from 70 g to about 1,100 to 1,200 g at term; its capacity increases from 10 to 5,000 mL or more at term (Cunningham et al., 2010). The uterine walls thin to 1.5 cm or less; from a solid globe, the uterus becomes a hollow vessel.

Uterine growth occurs as a result of both hyperplasia and hypertrophy of the myometrial cells, which do not increase much in number but do increase in size. In early pregnancy, uterine growth is due to hyperplasia of uterine smooth muscle cells within the myometrium; however, the major component of myometrial growth occurs after mid-gestation due to smooth muscle cell hypertrophy caused by mechanical stretch of uterine tissue by the growing fetus (Shynlova, Kwong, & Lye, 2010). Blood vessels elongate, enlarge, dilate, and sprout new branches to support and nourish the growing muscle tissue, and the increase in uterine weight is accompanied by a large increase in uterine blood flow, which is necessary to perfuse the uterine muscle and accommodate the growing fetus. As pregnancy progresses, 80% to 90% of uterine blood flow goes to the placenta, with the remainder distributed between the endometrium and myometrium. During pregnancy, the diameter of the main uterine artery approximately doubles in size. This enlargement from a narrow to a larger-caliber vessel enhances the capacity of the uteroplacental vessels to accommodate the increased blood volume needed to supply the placenta (Blackburn, 2012).

Uterine contractility is enhanced as well. Spontaneous, irregular, and painless contractions, called **Braxton Hicks contractions**, begin during the first trimester. These contractions continue throughout pregnancy, becoming especially noticeable during the last month, when they function to thin out or efface the cervix before birth (see **Chapter 12** for more information).

The lower portion of the uterus (the isthmus) does not undergo hypertrophy and becomes increasingly thinner as pregnancy progresses, thereby forming the lower uterine segment

Changes in the lower uterus occurring during the first 6 to 8 weeks of gestation produce some of the typical findings, including a positive **Hegar's sign**. This softening and compressibility of the lower uterine segment results in exaggerated uterine anteflexion during the early months of pregnancy, which adds to urinary frequency (Brosens et al., 2010).

The uterus remains in the pelvic cavity for the first 3 months of pregnancy, after which it progressively ascends into the abdomen (**Fig. 11.1**). As the uterus grows, it presses on the urinary bladder and causes the increased frequency of urination experienced during early pregnancy. In addition, the heavy gravid uterus in the last trimester can fall back against the inferior vena cava in the supine position, resulting in vena cava compression, which reduces venous return and decreases cardiac output and blood pressure, with increasing orthostatic stress. This occurs when the woman changes her position from recumbent to sitting to standing. This acute hemodynamic change, termed supine hypotensive syndrome, causes the woman to experience symptoms of weakness, light-headedness, nausea, dizziness, or syncope (**Fig. 11.2**). These changes are reversed when the woman is in the side-lying position, which displaces the uterus to the left and off the vena cava.

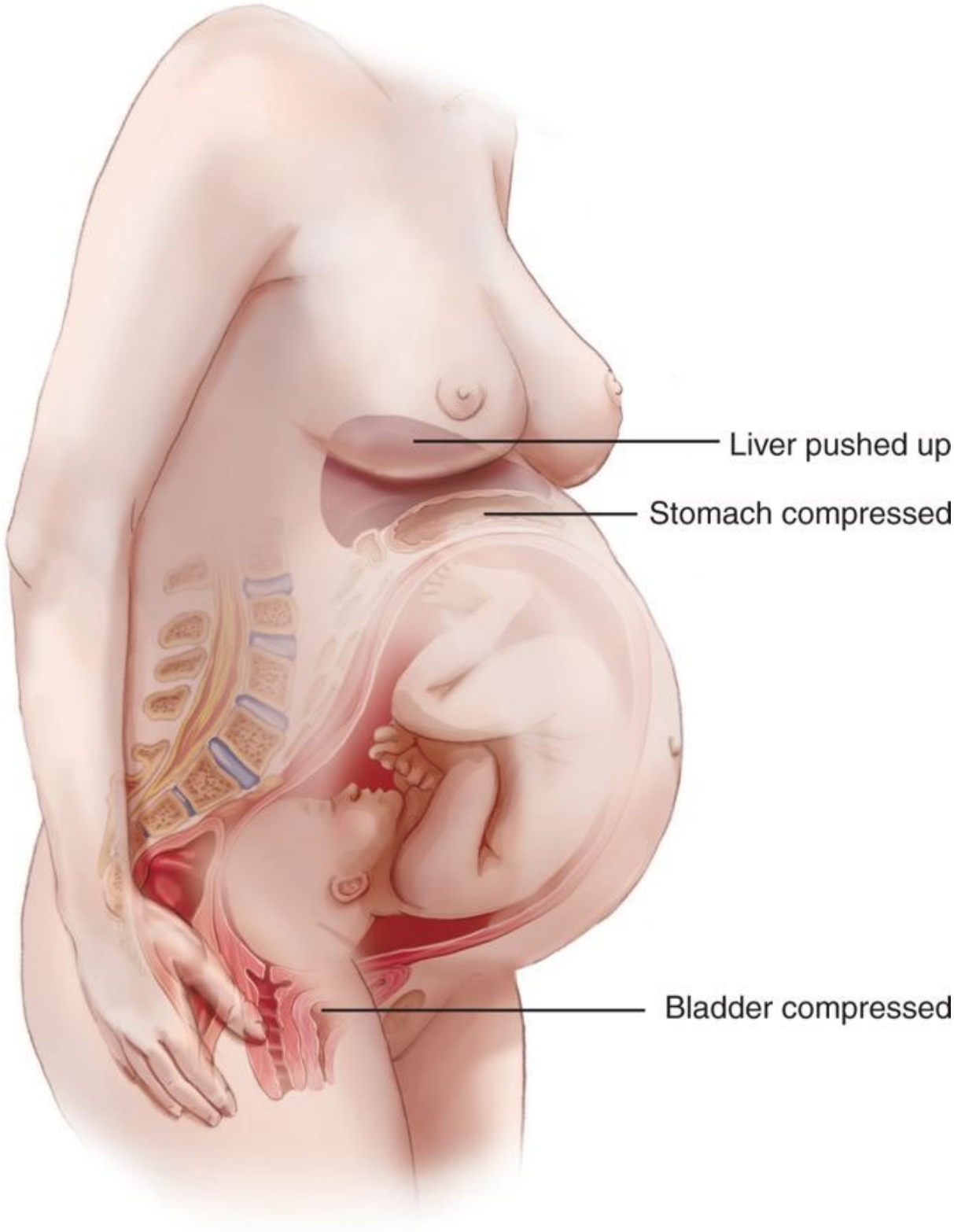


FIGURE 11.2

Supine hypotensive syndrome.

The uterus, which starts as a pear-shaped organ, becomes ovoid as length increases over width. By 20 weeks' gestation, the fundus, or top of the uterus, is at the level of the umbilicus and measures 20 cm. A monthly measurement of the height of the top of the uterus in centimeters, which corresponds to the number of gestational weeks, is commonly used to date the pregnancy.

Take Note!

Fundal height usually can be correlated with gestational weeks most accurately between 18 and 32 weeks. Obesity, hydramnios and uterine fibroids interfere with the accuracy of this correlation.

The fundus reaches its highest level, at the xiphoid process, at approximately 36 weeks. Between 38 and 40 weeks, fundal height drops as the fetus begins to descend and engage into the pelvis. Because it pushes against the diaphragm, many women experience shortness of breath. By 40 weeks, the fetal head begins to descend and engage in the pelvis, which is termed *lightening*. For the woman who is pregnant for the first time, lightening usually occurs approximately 2 weeks before the onset of labor; for the woman who is experiencing her second or subsequent pregnancy, it usually occurs at the onset of labor. Although breathing becomes easier because of this descent, the pressure on the urinary bladder now increases and women experience urinary frequency again.

Cervix

Between weeks 6 and 8 of pregnancy, the cervix begins to soften (**Goodell's sign**) due to vasocongestion. Along with the softening, the endocervical glands increase in size and number and produce more cervical mucus. Under the influence of progesterone, a thick mucus plug is formed that blocks the cervical os and protects the opening from bacterial invasion. At about the same time, increased vascularization of the cervix causes **Chadwick's sign**. Cervical ripening (softening, effacement, and increased distensibility) begins about 4 weeks before birth. The connective tissues of the cervix undergo biochemical modifications in preparation for labor that result in changes to its elasticity and strength. These changes are mediated through several factors, including inflammation, cervical stretch, pressure of the fetal presenting part, and release of hormones, including oxytocin, relaxin, nitric oxide, and prostaglandins (Dubicke et al., 2010).

Vagina

During pregnancy, vascularity increases because of the influences of estrogen, resulting in pelvic congestion and hypertrophy of the vagina in preparation for the distention needed for birth. The

vaginal mucosa thickens, the connective tissue begins to loosen, the smooth muscle begins to hypertrophy, and the vaginal vault begins to lengthen (Bope & Kellerman, 2012).

Vaginal secretions become more acidic, white, and thick. Most women experience an increase in a whitish vaginal discharge, called leukorrhea, during pregnancy. This is normal except when it is accompanied by itching and irritation, possibly suggesting *Candida albicans*, a monilial vaginitis, which is a very common occurrence in this glycogen-rich environment (Gor, 2011). Symptomatic vulvovaginal candidiasis affects 15% of pregnant women (Babic & Hukic, 2010). It is a benign fungal condition that is uncomfortable for the woman and can be transmitted from an infected mother to her newborn at birth. Neonates develop an oral infection known as thrush, which presents as white patches on the mucous membranes of their mouths. It is self-limiting and is treated with local antifungal agents.

Ovaries

The increased blood supply to the ovaries causes them to enlarge until approximately the 12th to 14th week of gestation. The ovaries are not palpable after that time because the uterus fills the pelvic cavity. Ovulation ceases during pregnancy because of the elevated levels of estrogen and progesterone, which block secretion of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) from the anterior pituitary. The ovaries are very active in hormone production to support the pregnancy until about weeks 6 to 7, when the corpus luteum regresses and the placenta takes over the major production of progesterone.

Breasts

The breasts increase in fullness, become tender, and grow larger throughout pregnancy under the influence of estrogen and progesterone. The breasts become highly vascular, and veins become visible under the skin. The nipples become larger and more erect. Both the nipples and the areola become deeply pigmented, and tubercles of Montgomery (sebaceous glands) become prominent. These sebaceous glands keep the nipples lubricated for breast-feeding.

Changes that occur in the connective tissue of the breasts, along with the tremendous growth, lead to striae (stretch marks) in approximately half of all pregnant women (Tharpe et al., 2013). Initially they appear as pink to purple lines on the skin, but they eventually fade to a silver color. Although they become less conspicuous in time, they never completely disappear.

Creamy, yellowish breast fluid called colostrum can be expressed by the third trimester. This fluid provides nourishment for the breast-feeding newborn during the first few days of life (see **Chapters 15** and **16** for more information). **Table 11.2** summarizes reproductive system adaptations.

TABLE 11.2: SUMMARY OF REPRODUCTIVE SYSTEM ADAPTATIONS

Reproductive Organ	Adaptations
Uterus	Size increases to 20 times that of nonpregnant size. Capacity increases by 2,000 times to accommodate the developing fetus. Weight increases from 2 oz to approximately 2 lb at term. Uterine growth occurs as a result of both hyperplasia and hypertrophy of the myometrial cells. Increased strength and elasticity allow uterus to contract and expel fetus during birth.
Cervix	Increases in mass, water content, and vascularization Changes from a relatively rigid to a soft, distensible structure that allows the fetus to be expelled Under the influence of progesterone, a thick mucus plug is formed, which blocks the cervical os and protects the developing fetus from bacterial invasion.
Vagina	Increased vascularity because of estrogen influences, resulting in pelvic congestion and hypertrophy Increased thickness of mucosa, along with an increase in vaginal secretions to prevent bacterial infections
Ovaries	Increased blood supply to the ovaries causes them to enlarge until approximately the 12th to 14th week of gestation. They actively produce hormones to support the pregnancy until weeks 6 to 7 when the placenta takes over the production of progesterone.
Breasts	Breast changes begin soon after conception; they increase in size and areolar pigmentation. The tubercles of Montgomery enlarge and become more prominent, and the nipples become more erect. The blood vessels become more prominent, and blood flow to the breast doubles.

General Body System Adaptations

In addition to changes in the reproductive system, the pregnant woman also experiences changes in virtually every other body system in response to the growing fetus.

Gastrointestinal System

The gastrointestinal (GI) system begins in the oral cavity and ends at the rectum. During pregnancy, the gums become hyperemic, swollen, and friable and tend to bleed easily. This change is influenced by estrogen and increased proliferation of blood vessels and circulation to the mouth. In addition, the saliva produced in the mouth becomes more acidic. Some women complain about excessive salivation, termed ***ptyalism***, which may be caused by the decrease in unconscious swallowing by the woman when nauseated (Cunningham et al., 2010). Dental plaque, calculus, and debris deposits increase during pregnancy and are all associated with gingivitis. An increased production of female hormones during pregnancy contributes to the development of gingivitis and periodontitis because vascular permeability and possible tissue edema are both increased. It is reported that as many as 50% to 70% of pregnant women will have some level of gingivitis during pregnancy as a result of hormonal changes that promote inflammation (Straka, 2011). Previous studies linked periodontal disease with preterm birth and low-birth-weight risk, but more recent research findings indicated no reduction in preterm births with the treatment of periodontal disease during pregnancy (Macones et al., 2010).

Smooth muscle relaxation and decreased peristalsis occur related to the influence of progesterone. Elevated progesterone levels cause smooth muscle relaxation, which results in delayed gastric emptying and decreased peristalsis. Transition time of food throughout the GI tract may be so much slower that more water than normal is reabsorbed, leading to bloating and constipation. Constipation can also result from low-fiber food choices, reduced fluid intake, use of iron supplements, decreased activity level, and intestinal displacement secondary to a growing uterus. Constipation, increased venous pressure, and the pressure of the gravid uterus contribute to the formation of hemorrhoids.

The slowed gastric emptying combined with relaxation of the cardiac sphincter allows reflux, which causes heartburn. Acid indigestion or heartburn (pyrosis) seems to be a universal problem for pregnant women. It is caused by regurgitation of the stomach contents into the upper esophagus and may be associated with the generalized relaxation of the entire digestive system. Over-the-counter antacids will usually relieve the symptoms, but they should be taken with the health care provider's knowledge and only as directed.

The emptying time of the gallbladder is prolonged secondary to the smooth muscle relaxation from progesterone. Hypercholesterolemia can follow, increasing the risk of gallstone formation. Other risk factors for gallbladder disease include obesity, Hispanic ethnicity, and increasing maternal age (Dhupar, Smaldone, & Hamad, 2010).

Nausea and vomiting, better known as morning sickness, plague about 80% of pregnant women (Shrim, Weisz, Gindes, Dulitzki, & Almog, 2010). Although it occurs most often in the morning, the nauseated feeling can last all day in some women. The highest incidence of morning sickness occurs between 6 and 12 weeks. The physiologic basis for morning sickness is still debatable. It has been linked to the high levels of hCG, high levels of circulating estrogens, prostaglandins,

reduced stomach acidity, advancing maternal age, and the lowered tone and motility of the digestive tract (Chan et al., 2011).

Cardiovascular System

Cardiovascular changes occur early during pregnancy to meet the demands of the enlarging uterus and the placenta for more blood and more oxygen. Perhaps the most striking cardiac alteration occurring during pregnancy is the increase in blood volume.

BLOOD VOLUME

Blood volume increases by approximately 1,500 mL, or 50% above nonpregnant levels, by the 30th week of gestation, and remains more or less constant thereafter (Cunningham et al., 2010). The increase is made up of 1,000 mL plasma plus 450 mL red blood cells (RBCs). It begins at weeks 10 to 12, peaks at weeks 32 to 34, and decreases slightly by week 40.

Take Note!

The rise in blood volume correlates directly with fetal weight.

This increase in blood volume is needed to provide adequate hydration of fetal and maternal tissues, to supply blood flow to perfuse the enlarging uterus, and to provide a reserve to compensate for blood loss at birth and during postpartum (Hornstein & Schwein, 2012). This increase is also necessary to meet the increased metabolic needs of the mother and to meet the need for increased perfusion of other organs, especially the woman's kidneys, because she is excreting waste products for herself and the fetus.

CARDIAC OUTPUT AND HEART RATE

Cardiac output, the product of stroke volume and heart rate, is a measure of the functional capacity of the heart. It increases from 30% to 50% over the nonpregnant rate by the 32nd week of pregnancy and declines to about a 20% increase at 40 weeks' gestation. The increase in cardiac output is associated with an increase in venous return and greater right ventricular output, especially in the left lateral position (Bope & Kellerman, 2012). Heart rate increases by 10 to 15 bpm between 14 and 20 weeks of gestation, and this persists to term. There is slight hypertrophy or enlargement of the heart during pregnancy. This is probably to accommodate the increase in blood volume and cardiac output. The heart works harder and pumps more blood to supply the oxygen needs of the fetus as well as those of the mother. Both heart rate and venous return are increased in pregnancy, contributing to the increase in cardiac output seen throughout gestation.

A woman with preexisting heart disease may become symptomatic and begin to decompensate during the time the blood volume peaks. Close monitoring is warranted during 28 to 35 weeks' gestation.

BLOOD PRESSURE

Blood pressure, especially the diastolic pressure, declines slightly during pregnancy as a result of peripheral vasodilation caused by progesterone. It usually reaches a low point at mid-pregnancy and thereafter increases to prepregnant levels until term. During the first trimester, blood pressure typically remains at the prepregnancy level. During the second trimester, the blood pressure decreases 5 to 10 mm Hg and thereafter returns to first-trimester levels (Nama, Antonios, Onwude, & Manyonda, 2011). Any significant rise in blood pressure during pregnancy should be investigated to rule out gestational hypertension.

BLOOD COMPONENTS

The number of RBCs also increases throughout pregnancy to a level 25% to 33% higher than nonpregnant values, depending on the amount of iron available. This increase is necessary to transport the additional oxygen required during pregnancy. Although there is an increase in RBCs, there is a greater increase in the plasma volume as a result of hormonal factors and sodium and water retention. Because the plasma increase exceeds the increase of RBC production, normal hemoglobin and hematocrit values decrease. This state of hemodilution is referred to as **physiologic anemia of pregnancy**. Changes in RBC volume are due to increased circulating erythropoietin and accelerated RBC production. The rise in erythropoietin in the last two trimesters is stimulated by progesterone, prolactin, and human placental lactogen (Sheppard & Khalil, 2010).

Iron requirements during pregnancy increase because of the demands of the growing fetus and the increase in maternal blood volume. The fetal tissues prevail over the mother's tissues with respect to use of iron stores. With the accelerated production of RBCs, iron is necessary for hemoglobin formation, the oxygen-carrying component of RBCs.

Take Note!

Many women enter pregnancy with insufficient iron stores and thus need supplementation to meet the extra demands of pregnancy.

Both fibrin and plasma fibrinogen levels increase, along with various blood-clotting factors. These factors make pregnancy a hypercoagulable state. These changes, coupled with venous stasis secondary to venous pooling, which occurs during late pregnancy after long periods of

standing in the upright position with the pressure exerted by the uterus on the large pelvic veins, contribute to slowed venous return, pooling, and dependent edema. These factors also increase the woman's risk for venous thrombosis (O'Connor et al., 2011).

Respiratory System

The growing uterus and the increased production of the hormone progesterone cause the lungs to function differently during pregnancy. During pregnancy, the amount of space available to house the lungs decreases as the uterus puts pressure on the diaphragm and causes it to shift upward by 4 cm above its usual position. The growing uterus does change the size and shape of the thoracic cavity, but diaphragmatic excursion increases, chest circumference increases by 2 to 3 inches, and the transverse diameter increases by an inch, allowing a larger tidal volume, as evidenced by deeper breathing (Blackburn, 2012). Tidal volume, or the volume of air inhaled, increases by 40% (from 500 to 700 mL) as the pregnancy progresses. This increase results in maternal hyperventilation and hypocapnia. As a result of these changes, the woman's breathing becomes more diaphragmatic than abdominal. Concomitant with the increase in tidal volume is a 20% to 40% increase in maternal oxygen consumption due to the increased oxygen requirements of the developing fetus, placenta, and maternal organs. Anatomic and physiologic changes of pregnancy predispose the mother to increased morbidity and mortality and increase the risks of a less than optimal outcome for the fetus. The frequency and significance of acute and chronic respiratory conditions in pregnant women have increased in recent years. Because of these various changes, pregnant women with asthma, pneumonia, or other respiratory pathology are more susceptible to early decompensation (Frye, Clark, Piacenza, & Shay-Zapien, 2011).

A pregnant woman breathes faster and more deeply because she and the fetus need more oxygen. Oxygen consumption increases during pregnancy even as airway resistance and lung compliance remain unchanged. Changes in the structures of the respiratory system take place to prepare the body for the enlarging uterus and increased lung volume (Alexander, LaRosa, Bader, & Garfield, 2010). As muscles and cartilage in the thoracic region relax, the chest broadens, with a conversion from abdominal breathing to thoracic breathing. This leads to a 50% increase in air volume per minute. All of these structural alterations are temporary and revert back to their prepregnant state at the end of the pregnancy.

Increased vascularity of the respiratory tract is influenced by increased estrogen levels, leading to congestion. Rising levels of sex hormones and heightened sensitivity to allergens may influence the nasal mucosa, precipitating epistaxis (nosebleed) and rhinitis. This congestion gives rise to nasal and sinus stuffiness and changes in the tone and quality of the woman's voice (Kumar, Hayhurst, & Robson, 2011).

Renal/Urinary System

The renal system must handle the effects of increased maternal intravascular and extracellular volume and metabolic waste products as well as excretion of fetal wastes. The predominant structural change in the renal system during pregnancy is dilation of the renal pelvis and uterus. Changes in renal structure occur as a result of the hormonal influences of estrogen and

progesterone, pressure from an enlarging uterus, and an increase in maternal blood volume. Like the heart, the kidneys work harder throughout the pregnancy. Changes in kidney function occur to accommodate a heavier workload while maintaining a stable electrolyte balance and blood pressure. As more blood flows to the kidneys, the glomerular filtration rate (GFR) increases, leading to an increase in urine flow and volume, substances delivered to the kidneys, and filtration and excretion of water and solutes (Cunningham et al., 2010).

Anatomically, the kidneys enlarge during pregnancy. Each kidney increases in length and weight as a result of hormonal effects that cause increased tone and decreased motility of the smooth muscle. The renal pelvis becomes dilated. The ureters (especially the right ureter) elongate, widen, and become more curved above the pelvic rim as early as the 10th gestational week (Baum, 2010). Progesterone is thought to cause both of these changes because of its relaxing influence on smooth muscle.

Blood flow to the kidneys increases by 50% to 80% as a result of the increase in cardiac output. This in turn leads to an increase in the GFR by as much as 40% to 60% starting during the second trimester. This elevation continues until birth (Krane, 2011).

The activity of the kidneys normally increases when a person lies down and decreases on standing. This difference is amplified during pregnancy, which is one reason a pregnant woman feels the need to urinate frequently while trying to sleep. Late in the pregnancy, the increase in kidney activity is even greater when the woman lies on her side rather than her back. Lying on the side relieves the pressure that the enlarged uterus puts on the vena cava carrying blood from the legs. Subsequently, venous return to the heart increases, leading to increased cardiac output. Increased cardiac output results in increased renal perfusion and glomerular filtration. As a rule, all the physiologic changes maximize by the end of the second trimester and then start to return to the prepregnant level. However, changes in the anatomy take up to 3 months postpartum to subside (Krane, 2011).

Musculoskeletal System

Changes in the musculoskeletal system are progressive, resulting from the influence of hormones, fetal growth, and maternal weight gain. Pregnancy is characterized by changes in posture and gait. By the 10th to 12th week of pregnancy, the ligaments that hold the sacroiliac joints and the pubis symphysis in place begin to soften and stretch, and the articulations between the joints widen and become more movable (Bope & Kellerman, 2012). The relaxation of the joints peaks by the beginning of the third trimester. The purpose of these changes is to increase the size of the pelvic cavity and to make delivery easier.

The postural changes of pregnancy—an increased swayback and an upper spine extension to compensate for the enlarging abdomen—coupled with the loosening of the sacroiliac joints may result in lower back pain. The woman's center of gravity shifts forward, requiring a realignment of the spinal curvatures. Factors thought to contribute to these postural changes include the alteration to the center of gravity that come with pregnancy, the influence of the pregnancy-related hormone relaxin on the pelvic joints, and the increasing weight and position of the growing fetus.

An increase in the normal lumbosacral curve (lordosis) occurs and a compensatory curvature in the cervicodorsal area develops to assist her in maintaining her balance (Fig. 11.3). In addition, relaxation and increased mobility of joints occur because of the hormones progesterone and relaxin, which lead to the characteristic "waddle gait" that pregnant women demonstrate toward term. Increased weight gain can add to this discomfort by accentuating the lumbar and dorsal curves (Cumisky, 2011).

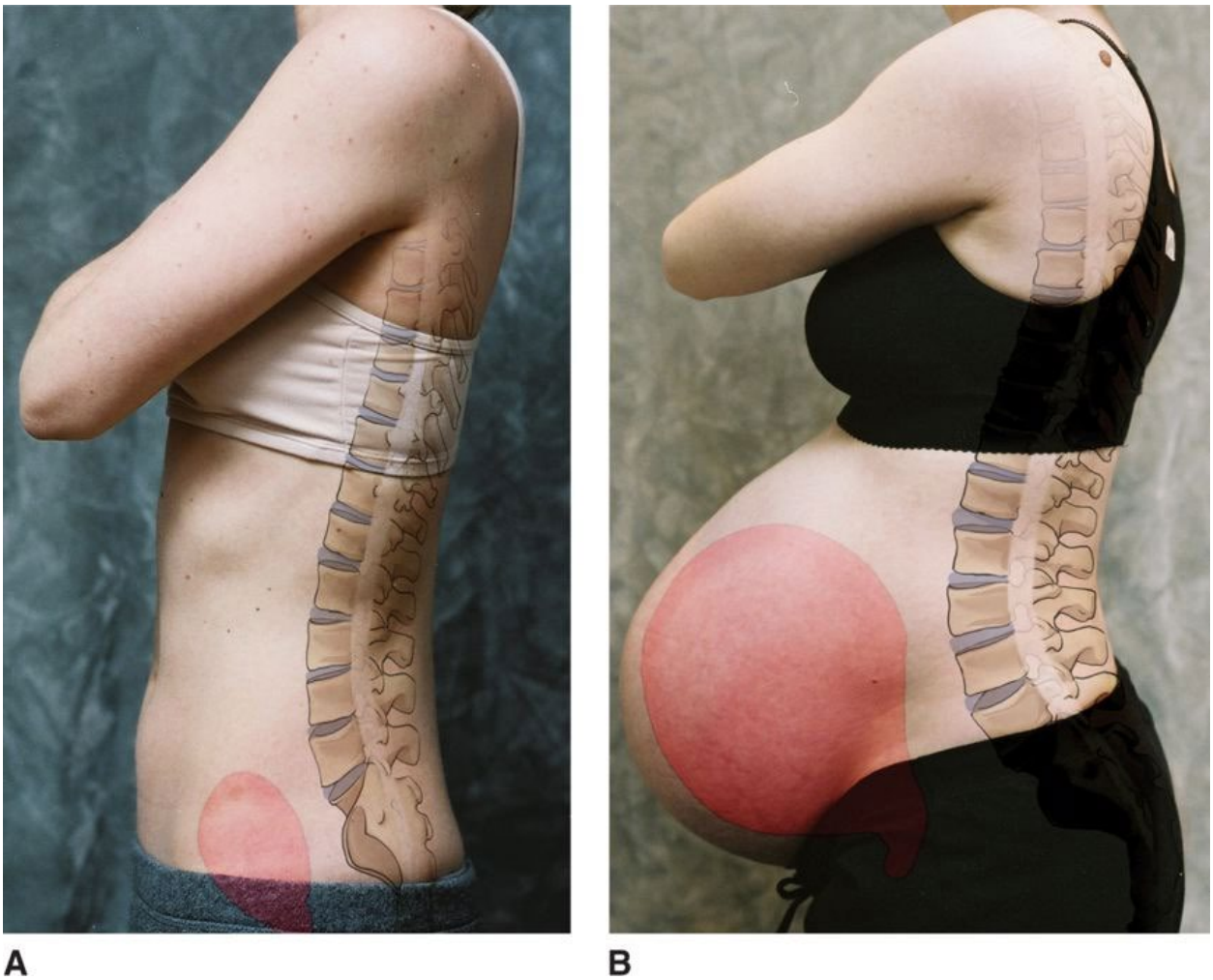


FIGURE 11.3

Postural changes during (**A**) the first trimester and (**B**) the third trimester.

Integumentary System

The skin of pregnant women undergoes hyperpigmentation primarily as a result of estrogen, progesterone, and melanocyte-stimulating hormone levels. These changes are mainly seen on the nipples, areola, umbilicus, perineum, and axilla. Although many integumentary

changes disappear after giving birth, some only fade. Many pregnant women express concern about stretch marks, skin color changes, and hair loss. Unfortunately, little is known about how to avoid these changes.

Complexion changes are not unusual. The increased pigmentation that occurs on the breasts and genitalia also develops on the face to form the "mask of pregnancy," which is also called facial melasma or chloasma. It occurs in up to 70% of pregnant women. There is a genetic predisposition toward melasma, which is exacerbated by the sun, and it tends to recur in subsequent pregnancies. This blotchy, brownish pigment covers the forehead and cheeks in dark-haired women. Most facial pigmentation fade as the hormones subside at the end of the pregnancy, but some may linger. The skin in the middle of the abdomen may develop a pigmented line called **linea nigra**, which extends from the umbilicus to the pubic area (**Fig. 11.4**).

FIGURE 11.4

Linea nigra.

Striae gravidarum, or stretch marks, are irregular reddish streaks that appear on the abdomen, breasts, and buttocks in about half of pregnant women. Striae are most prominent by 6 to 7 months. They result from reduced connective tissue strength resulting from the elevated adrenal steroid levels and

stretching of the structures secondary to growth (Bremmer, Driscoll, & Colgan, 2010). They are more common in younger women, women with larger infants, and women with higher body mass indices. Nonwhites and women with a history of breast or thigh striae or a family history of striae gravidarum also are at higher risk. Several creams and lotions such as cocoa butter have been touted as being able to prevent striae gravidarum, but a recent study by Buchanan, Fletcher, & Reid (2010) found that cocoa butter does not prevent them. A recent study by Buchanan, Fletcher, & Reid (2010) found that cocoa butter cream does not prevent striae gravidarum.

Vascular changes during pregnancy manifested in the integumentary system include varicosities of the legs, vulva, and perineum. Varicose veins commonly are the result of distention, instability, and poor circulation secondary to prolonged standing or sitting and the heavy gravid uterus placing pressure on the pelvic veins, preventing complete venous return. Interventions to reduce the risk of developing varicosities include:

- Elevating both legs when sitting or lying down
- Avoiding prolonged standing or sitting; changing position frequently
- Resting in the left lateral position
- Walking daily for exercise
- Avoiding tight clothing or knee-high hosiery
- Wearing support hose if varicosities are a preexisting condition to pregnancy

Another skin manifestation, believed to be secondary to vascular changes and high estrogen levels, is the appearance of small blood vessels called vascular spiders. They may appear on the neck, thorax, face, and arms. They are especially obvious in white women and typically disappear after childbirth. Palmar erythema is a well-delineated pinkish area on the palmar surface of the hands. This integumentary change is also related to elevated estrogen levels (Trupin, 2011).

Some women also notice a decline in hair growth during pregnancy. The hair follicles normally undergo a growing and resting phase. The resting phase is followed by a loss of hair; the hairs are then replaced by new ones. During pregnancy, fewer hair follicles go into the resting phase. After delivery, the body catches up with subsequent hair loss for several months. Nails typically grow faster during pregnancy. Pregnant women may experience increased brittleness, distal separation of the nail bed, whitish discoloration, and transverse grooves on the nails, but most of these conditions resolve in the postpartum period (Blackburn, 2012).

Endocrine System

The endocrine system undergoes many changes during pregnancy because hormonal changes are essential in meeting the needs of the growing fetus. Hormonal changes play a major role in controlling the supplies of maternal glucose, amino acids, and lipids to the fetus. Although estrogen and progesterone are the main hormones involved in pregnancy changes, other endocrine glands and hormones also change during pregnancy.

THYROID GLAND

The thyroid gland enlarges slightly and becomes more active during pregnancy as a result of increased vascularity and hyperplasia. Increased gland activity results in an increase in thyroid hormone secretion starting during the first trimester; levels taper off within a few weeks after birth and return to normal limits. Maternal thyroid hormone is transferred to the fetus beginning soon after conception and is critical for fetal brain development, neurogenesis, and organizational processes prior to 20 weeks when fetal thyroid production is low. However, even after the fetal thyroid is producing increasing amounts of hormone, much of the thyroxin (T_4) needed for development continues to be provided by the mother. Low maternal thyroid levels with thyroid insufficiency, hypothyroidism, or low or inadequate iodine intake may compromise fetal neurologic development (Blackburn, 2012). With an increase in the secretion of thyroid hormones, the basal metabolic rate (BMR; the amount of oxygen consumed by the body over a unit of time in milliliters per minute) progressively increases by 25%, along with heart rate and cardiac output (Blackburn, 2012).

PITUITARY GLAND

The pituitary gland, also known as the hypophysis, is a small, oval gland about the size of a pea that is connected to the hypothalamus by a stalk called the infundibulum. During pregnancy, the pituitary gland enlarges; it returns to normal size after birth.

The anterior lobe of the pituitary is glandular tissue and produces multiple hormones. The release of these hormones is regulated by releasing and inhibiting hormones produced by the hypothalamus. Some of these anterior pituitary hormones induce other glands to secrete their hormones. The increase in blood levels of the hormones produced by the final target glands (e.g., the ovary or thyroid) inhibits the release of anterior pituitary hormones. Changes in levels of pituitary hormones are discussed in the following paragraphs.

FSH and LH secretion are inhibited during pregnancy, probably as a result of hCG produced by the placenta and corpus luteum, and the increased secretion of prolactin by the anterior pituitary gland. Levels remain decreased until after delivery.

Thyroid-stimulating hormone (TSH) is reduced during the first trimester but usually returns to normal for the remainder of the pregnancy. Decreased TSH is thought to be one of the factors, along with elevated hCG levels, associated with morning sickness, nausea, and vomiting during the first trimester.

Growth hormone (GH) is an anabolic hormone that promotes protein synthesis. It stimulates most body cells to grow in size and divide, facilitating the use of fats for fuel and conserving glucose. During pregnancy, there is a decrease in the number of GH-producing cells and a corresponding decrease in GH blood levels. The action of human placental lactogen (hPL) is thought to decrease the need for and use of GH.

During pregnancy, prolactin is secreted in pulses and increases 10-fold to promote breast development and the lactation process. High levels of progesterone secreted by the placenta inhibit the direct influence of prolactin on the breast during pregnancy, thus suppressing lactation. At birth, as soon as the placenta is expelled and there is a drop in progesterone, lactogenesis can begin (Cunningham et al., 2010).

Melanocyte-stimulating hormone (MSH), another anterior pituitary hormone, increases during pregnancy. For many years, its increase was thought to be responsible for many of the skin changes of pregnancy, particularly changes in skin pigmentation (e.g., darkening of the areola, melasma, and linea nigra). However, currently it is thought that the skin changes are due to estrogen (and possibly progesterone) as well as the increase in MSH.

The two hormones oxytocin and antidiuretic hormone (ADH) released by the posterior pituitary are actually synthesized in the hypothalamus. They migrate along nerve fibers to the posterior pituitary and are stored until stimulated to be released into the general circulation.

Oxytocin is released by the posterior pituitary gland, and its production gradually increases as the fetus matures (Simpson & Creehan, 2011). Oxytocin is responsible for uterine contractions, both before and after delivery. The muscle layers of the uterus (myometrium) become more sensitive to oxytocin near term. Toward the end of a term pregnancy, levels of progesterone decline and contractions that were previously suppressed by progesterone begin to occur more frequently and with stronger intensity. This change in the hormonal levels is believed to be one of the initiators of labor.

Oxytocin is responsible for stimulating the uterine contractions that bring about delivery. Contractions lead to cervical thinning and dilation. They also exert pressure, helping the fetus to descend in the pelvis for eventual delivery. After delivery, oxytocin secretion continues, causing the myometrium to contract and helping to constrict the uterine blood vessels, decreasing the amount of vaginal bleeding after delivery.

Oxytocin is also responsible for milk ejection during breast-feeding. Stimulation of the breasts through sucking or touching stimulates the secretion of oxytocin from the posterior pituitary gland. Oxytocin causes contraction of the myoepithelial cells in the lactating mammary gland. With breast-feeding, "after pains" often occur, which signals that oxytocin is being released.

Vasopressin, also known as antidiuretic hormone (ADH) functions to inhibit or prevent the formation of urine via vasoconstriction, which results in increased blood pressure. Vasopressin also exhibits an antidiuretic effect and plays an important role in the regulation of water balance (Mattson & Smith, 2011).

PANCREAS

The pancreas is an exocrine organ, supplying digestive enzymes and buffers, and an endocrine organ. The endocrine pancreas consists of the islets of Langerhans, which are groups of cells scattered throughout, each containing four cell types. One of the cell types is the beta cell, which produces insulin. Insulin lowers blood glucose by increasing the rate of glucose uptake and utilization by most body cells. The growing fetus needs significant amounts of glucose, amino acids, and lipids. Even during early pregnancy the fetus makes demands on the maternal glucose stores. Ideally, hormonal changes of pregnancy help meet fetal needs without putting the mother's metabolism out of balance.

A woman's insulin secretion works on a "supply vs. demand" mode. As the demand to meet the needs of pregnancy increases, more insulin is secreted. Maternal insulin does not cross the placenta, so the

fetus must produce his or her own supply to maintain glucose control. (Box 11.2 gives information about pregnancy, glucose, and insulin.)

BOX 11.2: PREGNANCY, INSULIN, AND GLUCOSE

- During early pregnancy, maternal glucose levels decrease because of the heavy fetal demand for glucose. The fetus is also drawing amino acids and lipids from the mother, decreasing the mother's ability to synthesize glucose. Maternal glucose is diverted across the placenta to assist the growing embryo/fetus during early pregnancy, and thus levels decline in the mother. As a result, maternal glucose concentrations decline to a level that would be considered "hypoglycemic" in a nonpregnant woman. During early pregnancy there is also a decrease in maternal insulin production and insulin levels.
- The pancreas is responsible for the production of insulin, which facilitates entry of glucose into cells. Although glucose and other nutrients easily cross the placenta to the fetus, insulin does not. Therefore, the fetus must produce its own insulin to facilitate the entry of glucose into its own cells.
- After the first trimester, hPL from the placenta and steroids (cortisol) from the adrenal cortex act against insulin. hPL acts as an antagonist against maternal insulin, and thus more insulin must be secreted to counteract the increasing levels of hPL and cortisol during the last half of pregnancy.
- Prolactin, estrogen, and progesterone are also thought to oppose insulin. As a result, glucose is less likely to enter the mother's cells and is more likely to cross over the placenta to the fetus

Adapted from Cunningham, F. G., Levano, K. J., Bloom, S. L., Hauth, J. C., Rouse, D. J., & Spong, C. Y. (2010). *William's obstetrics* (23rd ed.). New York, NY: McGraw-Hill.

During the first half of pregnancy, much of the maternal glucose is diverted to the growing fetus, and thus the mother's glucose levels are low. hPL and other hormonal antagonists increase during the second half of pregnancy. Therefore, the mother must produce more insulin to overcome the resistance by these hormones. Insulin resistance in pregnancy is consequent to the physiologic adaptation necessary to provide glucose to the growing fetus. Disturbance in the maternal metabolism can induce structural and functional adaptations during fetal development (Das, Behera, Misra, & Baliarsihna, 2010).

If the mother has normal beta cells of the islets of Langerhans, there is usually no problem meeting the demands for extra insulin. However, if the woman has inadequate numbers of beta cells, she may be unable to produce enough insulin and will develop glucose intolerance during pregnancy. If the woman has glucose intolerance, she is not able to meet the increasing demands and her blood glucose level increases.

ADRENAL GLANDS

Pregnancy does not cause much change in the size of the adrenal glands themselves, but there are changes in some secretions and activity. One of the key changes is the marked increase in cortisol

secretion, which regulates carbohydrate and protein metabolism and is helpful in times of stress. Although pregnancy is considered a normal condition, it is a time of stress for a woman's body. The rate of secretion of cortisol by maternal adrenals is not increased in pregnancy, but the rate of clearance is decreased. Cortisol increases in response to increased estrogen levels throughout pregnancy and returns to normal levels within 6 weeks postpartum (Abraham, 2011).

During the stress of pregnancy, cortisol:

- Helps keep up the level of glucose in the plasma by breaking down noncarbohydrate sources, such as amino and fatty acids, to make glycogen. Glycogen, stored in the liver, is easily broken down to glucose when needed so that glucose is available in times of stress.
- Breaks down proteins to repair tissues and manufacture enzymes.
- Has anti-insulin, anti-inflammatory, and antiallergic actions.
- Is needed to make the precursors of adrenaline, which the adrenal medulla produces and secretes (Cunningham et al., 2010).

The amount of aldosterone, also secreted by the adrenal glands, is increased during pregnancy. It normally regulates absorption of sodium from the distal tubules of the kidney. During pregnancy, progesterone allows salt to be "wasted" (or lost) in the urine. Aldosterone is a key regulator of electrolyte and water homeostasis and plays a central role in blood pressure regulation. Hormonal changes during pregnancy, among them increased progesterone and aldosterone production, lead to the required plasma volume expansion of the maternal body as an accommodation mechanism for fetus growth. Aldosterone is produced in increased amounts by the adrenal glands as early as 15 weeks of pregnancy (Abdelmannan & Aron, 2011).

PROSTAGLANDIN SECRETION DURING PREGNANCY

Prostaglandins are not protein or steroid hormones; they are chemical mediators, or "local" hormones. Although hormones circulate in the blood to influence distant tissues, prostaglandins act locally on adjacent cells. The fetal membranes of the amniotic sac—the amnion and chorion—are both believed to be involved in the production of prostaglandins. Various maternal and fetal tissues, as well as the amniotic fluid itself, are considered to be sources of prostaglandins, but details about their composition and sources are limited. It is widely believed that prostaglandins play a part in softening the cervix and initiating and/or maintaining labor, but the exact mechanism is unclear.

PLACENTAL SECRETION

The placenta has a feature possessed by no other endocrine organ—the ability to form protein and steroid hormones. Very early during pregnancy, the placenta begins to produce the following hormones:

- hCG
- hPL
- Relaxin
- Progesterone
- Estrogen

Table 11.3 summarizes the role of these hormones.

TABLE 11.3: PLACENTAL HORMONES

Hormone	Description
Human chorionic gonadotropin (hCG)	• Responsible for maintaining the maternal corpus luteum, which secretes progesterone and estrogens, with synthesis occurring before implantation • Production by fetal trophoblast cells until the placenta is developed sufficiently to take over that function • Basis for early pregnancy tests because it appears in the maternal bloodstream soon after implantation • Production peaks at 8 weeks and then gradually declines.
hPL (also known as human chorionic somatomammotropin [hCS])	• Preparation of mammary glands for lactation and involved in the process of making glucose available for fetal growth by altering maternal carbohydrate, fat, and protein metabolism • Antagonist of insulin because it decreases tissue sensitivity or alters the ability to use insulin • Increase in the amount of circulating free fatty acids for maternal metabolic needs and decrease in maternal metabolism of glucose to facilitate fetal growth
Relaxin	• Secretion by the placenta as well as the corpus luteum during pregnancy • Thought to act synergistically with progesterone to maintain pregnancy • Increase in flexibility of the pubic symphysis, permitting the pelvis to expand during delivery • Dilation of the cervix, making it easier for the fetus to enter the vaginal canal; thought to suppress the release of oxytocin by the hypothalamus, thus delaying the onset of labor contractions
Progesterone	• Often called the "hormone of pregnancy" because of the critical role it plays in supporting the endometrium of the uterus • Supports the endometrium to provide an environment conducive to fetal survival • Produced by the corpus luteum during the first few weeks of pregnancy and then by the placenta until term • Initially, causes thickening of the uterine lining in anticipation of implantation of the fertilized ovum. From then on, it maintains the endometrium, inhibits uterine

Hormone	Description
	contractility, and assists in the development of the breasts for lactation.
Estrogen	• Promotes enlargement of the genitals, uterus, and breasts, and increases vascularity, causing vasodilatation. • Relaxation of pelvic ligaments and joints • Associated with hyperpigmentation, vascular changes in the skin, increased activity of the salivary glands, and hyperemia of the gums and nasal mucous membranes • Aids in developing the ductal system of the breasts in preparation for lactation
Adapted from Cunningham, F. G., Levano, K. J., Bloom, S. L., Hauth, J. C., Rouse, D. J., & Spong, C. Y. (2010). *William's obstetrics (23rd ed.)*. New York, NY: McGraw-Hill; Edelman, C. L., & Mandle, C. L. (2010). *Health promotion throughout the lifespan* (7th ed.). St. Louis, MO: Mosby Elsevier; and Shields, A. D. (2012). Pregnancy diagnosis. *eMedicine*. Retrieved from http://emedicine.medscape.com/article/262591-overview.	

Immune System

The immune system is made up of organs and specialized cells whose primary purpose is to defend the body from foreign substances (antigens) that may cause tissue injury or disease. The mechanisms of innate and adaptive immunity work cooperatively to prevent, control, and eradicate foreign antigens in the body.

A general enhancement of innate immunity (inflammatory response and phagocytosis) and suppression of adaptive immunity (protective response to a specific foreign antigen) take place during pregnancy. These immunologic alterations help prevent the mother's immune system from rejecting the fetus (foreign body), increase her risk of developing certain infections such as urinary tract infections, and influence the course of chronic disorders such as autoimmune diseases. Some chronic conditions worsen (diabetes) while others seem to stabilize (asthma) during pregnancy, but this is individualized and not predictable. In general, immune function in pregnant women is similar to immune function in nonpregnant women.

Marva returns for her first prenatal appointment and tells the nurse that her whole body is "out of sorts." She is overwhelmed and feels poorly. Outline the bodily changes Marva can expect each trimester to help her understand the adaptations taking place. What guidance can the nurse give Marva to help her understand the changes of pregnancy?

Table 11.4 summarizes the general body systems' adaptations to pregnancy.

TABLE 11.4: SUMMARY OF GENERAL BODY SYSTEM ADAPTATIONS

System	Adaptation
Gastrointestinal system	*Mouth and pharynx:* Gums become hyperemic, swollen, and friable and tend to bleed easily. Saliva production increases. *Esophagus:* Decreased lower esophageal sphincter pressure and tone, which increases the risk of developing heartburn *Stomach:* Decreased tone and mobility with delayed gastric emptying time, which increases the risk of gastroesophageal reflux and vomiting. Decreased gastric acidity and histamine output, which improves symptoms of peptic ulcer disease. *Intestines:* Decreased intestinal tone motility with increased transit time, which increases risk of constipation and flatulence *Gallbladder:* Decreased tone and motility, which may increase risk of gallstone formation
Cardiovascular system	*Blood volume:* Marked increase in plasma (50%) and RBCs (25–33%) compared to nonpregnant values. Causes hemodilution, which is reflected in a lower hematocrit and hemoglobin. *Cardiac output and heart rate:* CO increases from 30% to 50% over the nonpregnant rate by the 32nd week of pregnancy. The increase in CO is associated with an increase in venous return and greater right ventricular output, especially in the left lateral position. Heart rate increases by 10–15 bpm between 14 and 20 wks of gestation, and this increase persists to term. *Blood pressure:* Diastolic pressure decreases typically 10–15 mm Hg to reach its lowest point by mid-pregnancy; it then gradually returns to nonpregnant baseline values by term. *Blood components:* The number of RBCs increases throughout pregnancy to a level 25–33% higher than nonpregnant values. Both fibrin and plasma fibrinogen levels increase, along with various blood-clotting factors. These factors make pregnancy a hypercoagulable state.
Respiratory system	Enlargement of the uterus shifts the diaphragm up to 4 cm above its usual position. As muscles and cartilage in the thoracic region relax, the chest broadens, with conversion from abdominal breathing to thoracic breathing. This leads to a 50%

System	Adaptation
	increase in air volume per minute. Tidal volume, or the volume of air inhaled, increases gradually by 30–40% (from 500 to 700 mL) as the pregnancy progresses.
Renal/urinary system	The renal pelvis becomes dilated. The ureters (especially the right ureter) elongate, widen, and become more curved above the pelvic rim. Bladder tone decreases and bladder capacity doubles by term. GFR increases 40–60% during pregnancy. Blood flow to the kidneys increases by 50–80% as a result of the increase in cardiac output.
Musculoskeletal system	Distention of the abdomen with growth of the fetus tilts the pelvis forward, shifting the center of gravity. The woman compensates by developing an increased curvature (lordosis) of the spine. Relaxation and increased mobility of joints occur because of the hormones progesterone and relaxin, which lead to the characteristic "waddle gait" that pregnant women demonstrate toward term.
Integumentary system	Hyperpigmentation of the skin is the most common alteration during pregnancy. The most common areas include the areola, genital skin, axilla, inner aspects of the thighs, and linea nigra. Striae gravidarum, or stretch marks, are irregular reddish streaks that may appear on the abdomen, breasts, and buttocks in about half of pregnant women. The skin in the middle of the abdomen may develop a pigmented line called linea nigra, which extends from the umbilicus to the pubic area. Melasma ("mask of pregnancy") occurs in 45–70% of pregnant women. It is characterized by irregular, blotchy areas of pigmentation on the face, most commonly on the cheeks, chin, and nose.
Endocrine system	Controls the integrity and duration of gestation by maintaining the corpus luteum via hCG secretion; production of estrogen, progesterone, hPL, and other hormones and growth factors via the placenta; release of oxytocin (by the posterior pituitary gland), prolactin (by the anterior pituitary), and relaxin (by the ovary, uterus, and placenta).
Immune system	A general enhancement of innate immunity (inflammatory response and phagocytosis) and suppression of adaptive immunity (protective response to a

System	Adaptation
	specific foreign antigen) take place during pregnancy. These immunologic alterations help prevent the mother's immune system from rejecting the fetus (foreign body), increase her risk of developing certain infections, and influence the course of chronic disorders such as autoimmune diseases.

CHANGING NUTRITIONAL NEEDS OF PREGNANCY

Healthy eating during pregnancy enables optimal gestational weight gain and reduces complications, both of which are associated with positive birth outcomes. During pregnancy, maternal nutritional needs change to meet the demands of the pregnancy. Healthy eating can help ensure that adequate nutrients are available for both mother and fetus.

Nutritional intake during pregnancy has a direct effect on fetal well-being and birth outcome. Inadequate nutritional intake, for example, is associated with preterm birth, low birth weight, and congenital anomalies. Excessive nutritional intake is connected with fetal macrosomia (>4,000 g), leading to a difficult birth, neonatal hypoglycemia, and continued obesity in the mother (Guelinckx, Devlieger, Mullie, & Vansant, 2010).

Since the requirements for so many nutrients increase during pregnancy, pregnant women should take a vitamin and mineral supplement daily. Prenatal vitamins are prescribed routinely as a safeguard against a less-than-optimal diet. In particular, iron and folic acid need to be supplemented because their increased requirements during pregnancy are usually too great to be met through diet alone. With the exception of folic acid, there is little scientific evidence to support giving vitamin supplements to healthy pregnant women, but it seems to be a standard of care today (Nelson, 2011). Iron and folic acid are needed to form new blood cells for the expanded maternal blood volume and to prevent anemia. Iron is essential for fetal growth and brain development and in the prevention of maternal anemia. An increase in folic acid is essential before pregnancy and in the early weeks of pregnancy to prevent neural tube defects in the fetus. For most pregnant women, supplements of 30 mg of ferrous iron and 400 to 800 mcg of folic acid per day are recommended by the **dietary reference intakes (DRIs)** (Institute of Medicine [IOM], 2010f; Ross et al., 2011; U.S. Preventive Services Task Force, 2010). Women with a previous history of a fetus with a neural tube defect are often prescribed a higher dose of folic acid.

There is an abundance of conflicting advice about nutrition during pregnancy and what is good or bad to eat. Overall, the following guidelines are helpful:

- Increase your consumption of fruits and vegetables.
- Replace saturated fats with unsaturated ones.
- Avoid hydrogenated or partially hydrogenated fats.
- Do not consume any alcoholic beverages.

- Use reduced-fat spreads and dairy products instead of full-fat ones.
- Eat at least two servings of fish weekly, with one of them being an oily fish.
- Consume at least 2 quarts of water daily (Ural & Booker, 2011).

In the months before conception, food choices are key. The foods and vitamins consumed can ensure that the woman and her fetus will have the nutrients that are essential for the very start of pregnancy.

While most women recognize the importance of healthy eating during pregnancy, some find it challenging to achieve. Many women say they have little time and energy to devote to meal planning and preparation. Another barrier to healthy eating is conflicting messages from various sources, resulting in a lack of clear, reliable, and relevant information. Moreover, many women are eating less in an effort to control their weight, putting them at greater risk of inadequate nutrient intake.

Nutritional Requirements During Pregnancy

Pregnancy is one of the most nutritionally demanding periods of a woman's life. Gestation involves rapid cell division and organ development, and an adequate supply of nutrients is essential to support this tremendous fetal growth.

Most women are usually motivated to eat properly during pregnancy for the sake of the fetus. The Food and Nutrition Board of the National Research Council has made recommendations for nutrient intakes for people living in the United States. The DRIs are more comprehensive than previous nutrient guidelines issued by the board. They have replaced previous recommendations because they are not limited to preventing deficiency diseases. Rather, the DRIs incorporate current concepts about the role of nutrients and food components in reducing the risk of chronic disease, developmental disorders, and other related problems. The DRIs can be used to plan and assess diets for healthy people (Dudek, 2010).

These dietary recommendations also include information for women who are pregnant or lactating, because growing fetal and maternal tissues require increased quantities of essential dietary components. For example, the current DRIs suggest an increase in the pregnant woman's intake of protein from 60 to 80 g/day, iron from 18 to 27 g/day, and folic acid from 400 to 800 mcg/day, along with an increase of 300 calories/day over the recommended intake of 1,800 to 2,200 calories/day for nonpregnant women (IOM, 2010a, 2010b, 2010c, 2010d, 2010e, 2010f) (**Table 11.5**).

TABLE 11.5: DIETARY RECOMMENDATIONS FOR THE PREGNANT AND LACTATING WOMAN

Nutrient	Nonpregnant Women	Pregnant Woman	Lactating Woman
Calories	2,200	2,500	2,700
Protein	60 g	80 g	80 g
Water/fluids	6–8 glasses daily	8 glasses daily	8 glasses daily
Vitamin A	700 mcg	770 mcg	1,300 mcg
Vitamin C	75 mg	85 mg	120 mg
Vitamin D	5 mcg	5 mcg	5 mcg
Vitamin E	15 mcg	15 mcg	19 mcg
B_1 (thiamine)	1.1 mg	1.5 mg	1.5 mg
B_2 (riboflavin)	1.1 mg	1.4 mg	1.6 mg
B_3 (niacin)	14 mg	18 mg	17 mg
B_6 (pyridoxine)	1.3 mg	1.9 mg	2 mg
B_{12} (cobalamin)	2.4 mcg	2.6 mcg	2.8 mcg
Folate	400 mcg	600 mcg	500 mcg
Calcium	1,000 mg	1,000 mg	1,000 mg
Phosphorus	700 mg	700 mg	700 mg
Iodine	150 mcg	220 mcg	290 mcg
Iron	18 mg	27 mg	9 mg
Magnesium	310 mg	350 mg	310 mg
Zinc	8 mg	11 mg	12 mg

Adapted from Institute of Medicine [IOM]. (2010a). *Dietary reference intakes for calcium, phosphorus, magnesium, vitamin D and fluoride*. Washington, DC: National

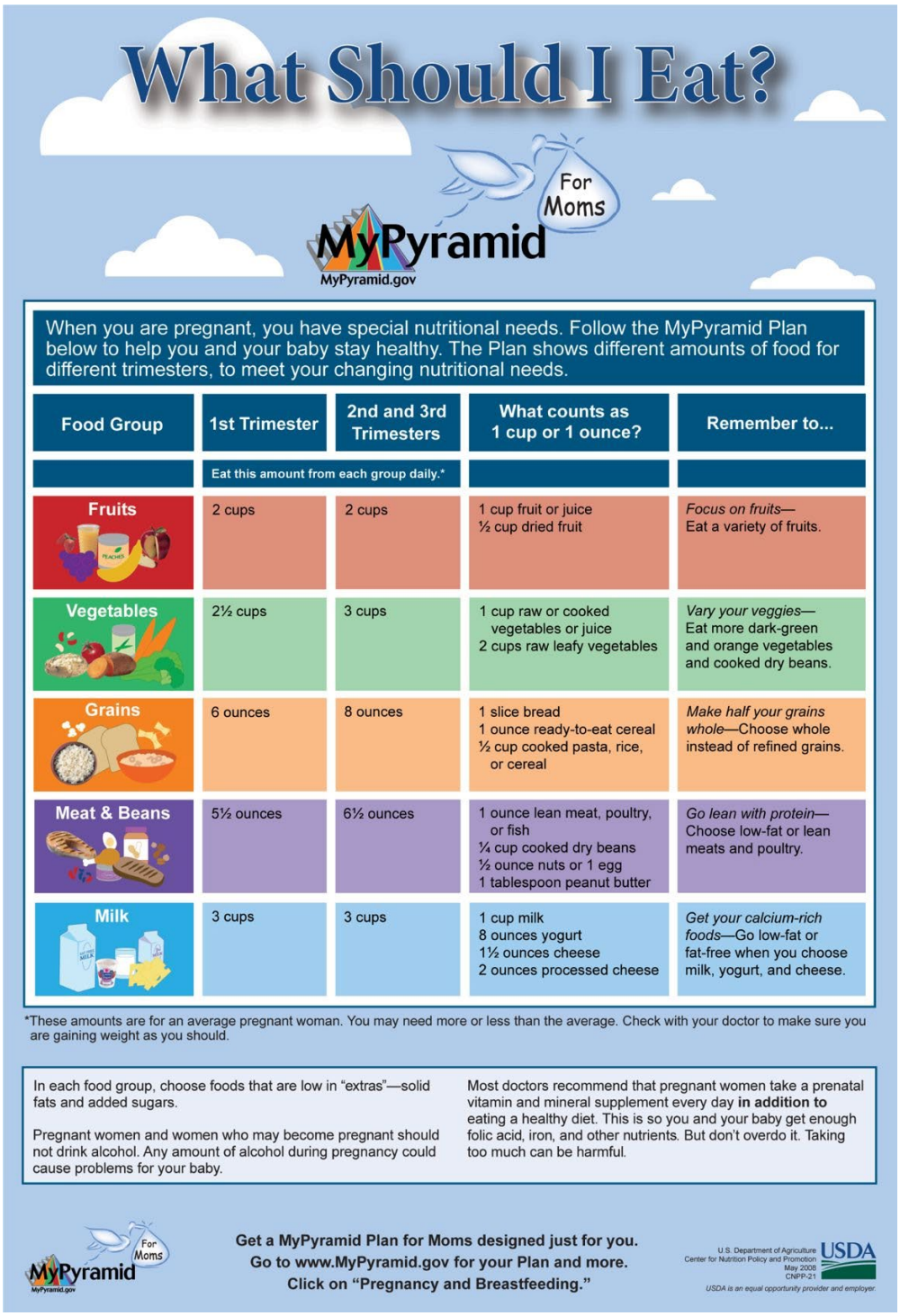
Nutrient	Nonpregnant Women	Pregnant Woman	Lactating Woman

Academy Press; IOM. (2010b). *Dietary reference intakes for energy, carbohydrates, fiber, protein and amino acids*. Washington, DC: National Academy Press; IOM. (2010c). *Dietary reference intakes for thiamine, riboflavin, niacin, vitamin B_6, vitamin B_{12}, pantothenic acid, biotin, and choline. Washington*, DC: National Academy Press; IOM. (2010d). *Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, manganese, molybdenum, nickel, silicon, vanadium, and zinc.* Washington, DC: National Academy Press; IOM. (2010e). *Dietary reference intakes for vitamin C, vitamin E, selenium, and carotenoids*. Washington, DC: National Academy Press; IOM. (2010f). *Nutrition during pregnancy. Part I: Weight gain. Part II: Nutrient supplements*. Washington, DC: National Academy Press; and Ural, S. H., & Booker, C. J. (2011). Prenatal nutrition. *eMedicine*. Retrieved from **http://emedicine.medscape.com/article/259059-overview**.

For a pregnant woman to meet recommended DRIs, she should eat according to the U.S. Department of Agriculture (USDA) Food Guide *MyPlate* (**Fig. 11.5**). The *Dietary Guidelines for Americans, 2010*, are the basis for federal nutrition policy (USDA and U.S. Department of Health and Human Services [USDHHS], 2010). The Food Guide *MyPlate* provides guidance to help implement these guidelines. The USDA has designed an interactive online diet-planning program called the Daily Food Plan for Moms that helps pregnant women personalize their dietary intake throughout their pregnancy.

(Refer to for additional information about this food plan.) A summary of the new guidelines is as follows:

- Eat a variety of food from all food groups using portion control.
- Increase intake of vitamins, minerals, and dietary fiber.
- Lower intake of saturated fats, trans fats, and cholesterol.
- Consume adequate synthetic folic acid from supplements or from fortified foods.
- Increase intake of fruits, vegetables, and whole grains.
- Balance calorie intake with exercise to maintain ideal healthy weight (USDA, 2011).



What Should I Eat?

For Moms

MyPyramid

MyPyramid.gov

When you are pregnant, you have special nutritional needs. Follow the MyPyramid Plan below to help you and your baby stay healthy. The Plan shows different amounts of food for different trimesters, to meet your changing nutritional needs.

Food Group	1st Trimester	2nd and 3rd Trimesters	What counts as 1 cup or 1 ounce?	Remember to...
	Eat this amount from each group daily.*			
Fruits	2 cups	2 cups	1 cup fruit or juice ½ cup dried fruit	*Focus on fruits*—Eat a variety of fruits.
Vegetables	2½ cups	3 cups	1 cup raw or cooked vegetables or juice 2 cups raw leafy vegetables	*Vary your veggies*—Eat more dark-green and orange vegetables and cooked dry beans.
Grains	6 ounces	8 ounces	1 slice bread 1 ounce ready-to-eat cereal ½ cup cooked pasta, rice, or cereal	*Make half your grains whole*—Choose whole instead of refined grains.
Meat & Beans	5½ ounces	6½ ounces	1 ounce lean meat, poultry, or fish ¼ cup cooked dry beans ½ ounce nuts or 1 egg 1 tablespoon peanut butter	*Go lean with protein*—Choose low-fat or lean meats and poultry.
Milk	3 cups	3 cups	1 cup milk 8 ounces yogurt 1½ ounces cheese 2 ounces processed cheese	*Get your calcium-rich foods*—Go low-fat or fat-free when you choose milk, yogurt, and cheese.

*These amounts are for an average pregnant woman. You may need more or less than the average. Check with your doctor to make sure you are gaining weight as you should.

In each food group, choose foods that are low in "extras"—solid fats and added sugars.

Pregnant women and women who may become pregnant should not drink alcohol. Any amount of alcohol during pregnancy could cause problems for your baby.

Most doctors recommend that pregnant women take a prenatal vitamin and mineral supplement every day **in addition to** eating a healthy diet. This is so you and your baby get enough folic acid, iron, and other nutrients. But don't overdo it. Taking too much can be harmful.

For Moms MyPyramid MyPyramid.gov

Get a MyPyramid Plan for Moms designed just for you.
Go to www.MyPyramid.gov for your Plan and more.
Click on "Pregnancy and Breastfeeding."

U.S. Department of Agriculture
Center for Nutrition Policy and Promotion
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USDA

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FIGURE 11.5

Food Guide for pregnancy.

The safety of artificial sweeteners consumed during pregnancy remains controversial. Some health care providers advise their pregnant clients to avoid all nonnutritive sweeteners during pregnancy, while others suggest they can be used in moderation (Dudek, 2010). The debate continues on this matter until additional research can be completed.

An eating plan that follows the pyramid should provide sufficient nutrients for a healthy pregnancy. Except for iron, folic acid, and calcium, most of the nutrients a woman needs during pregnancy can be obtained by making healthy food choices. However, a vitamin and mineral supplement is generally prescribed.

Take Note!

Good food sources of folic acid include dark green vegetables, such as broccoli, romaine lettuce, and spinach; baked beans; black-eyed peas; citrus fruits; peanuts; and liver.

Fish and shellfish are an important part of a healthy diet because they contain high-quality protein, are low in saturated fat, and contain omega-3 fatty acids. However, nearly all fish and shellfish contain traces of mercury and some contain higher levels of mercury that may harm a developing fetus if ingested by pregnant women in large amounts. Human exposure to mercury occurs primarily through the consumption of fish contaminated through atmospheric mercury releases. The U.S. Environmental Protection Agency (EPA) and the United Nations Environment Program have identified coal-fired power plants as the source of 50% to 75% of the atmospheric mercury pollution in the United States and worldwide. Once airborne, rainfall transfers mercury particles into waterways where it is converted to the neurotoxic methylmercury form through a microbial process. Plankton absorbs the methylmercury and as the smaller fish eat the plankton and the larger predatory fish consume the smaller fish, the methylmercury bioaccumulates up the food chain to humans.

All fish contain methylmercury regardless of the size or the geographic location of the waters from which the fish is caught, although size and type of fish as well as the geographic location of waters can influence lower or higher amounts of methylmercury. In addition, because methylmercury resides in the tissue of the fish, no method of cleaning or cooking will reduce the amount of mercury in a meal of contaminated fish (Pouzaud et al., 2010).

With this in mind, the FDA and the EPA are advising women who may become pregnant, pregnant women, and nursing mothers to do the following:

- Avoid consumption of fish with moderate-to-high mercury levels (e.g., for 6 to 12 months prior to conception and throughout pregnancy).
- Avoid eating shark, swordfish, king mackerel, orange roughy, ahi tuna, and tilefish because they are high in mercury levels.

- Eat up to 12 ounces (two average meals) weekly of low-mercury-level fish such as shrimp, canned light tuna, salmon, pollock, and catfish.
- Check local advisories about the safety of fish caught by family and friends in local lakes, rivers, and coastal areas (Kuntz, Ricco, Hill, & Anderko, 2010).

Another food issue concern for pregnant women is consumption of food contaminated with the gram-positive bacillus *Listeria*. *Listeria* is a type of bacteria found in soil, water, and sometimes on plants. Listeria is commonly found in processed and prepared foods and listeriosis is associated with high morbidity and mortality. Though *Listeria* is all around our environment, most *Listeria* infections in people result from eating contaminated foods. Listeriosis can be passed to an unborn baby through the placenta even if the mother is not showing signs of illness. This can lead to preterm births, miscarriages, stillbirths, and high neonatal mortality rates (Mattson & Smith, 2011).

The Food Safety and Inspection Service and the FDA (2011) provide the following advice for pregnant women:

- Do not eat hot dogs, luncheon meats, or deli meats unless they are reheated until steaming hot.
- Avoid getting fluid from hot dog packages on other foods, utensils, and food preparation surfaces, and wash hands after handling hot dogs, luncheon meats, and deli meats.
- Do not eat soft cheeses such as feta, Brie, Camembert, and blue-veined cheeses.
- It is safe to eat hard cheeses, semi-soft cheeses such as mozzarella, pasteurized processed cheese slices and spreads, cream cheese, and cottage cheese.
- Do not eat refrigerated pâté or meat spreads.
- It is safe to eat canned or shelf-stable pâté and meat spreads.
- Do not eat refrigerated smoked seafood unless it is an ingredient in a cooked dish such as a casserole. Examples of refrigerated smoked seafood include salmon, trout, whitefish, cod, tuna, and mackerel and are most often labeled as "nova-style," "lox," "kippered," "smoked," or "jerky." This fish is found in the refrigerated section or sold at deli counters of grocery stores and delicatessens.
- It is safe to eat canned fish such as salmon and tuna or shelf-stable smoked seafood.
- Do not drink raw (unpasteurized) milk or eat foods that contain unpasteurized milk.
- Use all refrigerated perishable items that are precooked or ready-to-eat as soon as possible.
- Use a refrigerator thermometer to make sure that the refrigerator always stays at 40° F (about 5° C) or below.
- Do not eat salads made in the store such as ham salad, chicken salad, egg salad, tuna salad, or seafood salad.
- Clean your refrigerator regularly.

Maternal Weight Gain

The amount of weight that a woman gains during pregnancy is not as important as what she eats. A woman can lose extra weight after a pregnancy, but she can never make up for a poor nutritional status during the pregnancy. Earlier guidelines recommended weight gain that

would be optimal for the infant, but new guidelines take into account the well-being of the mother too (**Table 11.6**).

TABLE 11.6: NORMAL DISTRIBUTION OF WEIGHT GAIN DURING PREGNANCY

Component	Weight (pounds)
Infant birth weight	7.5
Blood volume increase	4
Uterus	2
Increase in breast tissue	2
Placenta	1.5
Maternal fluid volume	4
Maternal fat tissue	7
Amniotic fluid	2
Approximate total weight gain	30

Adapted from American College of Obstetricians and Gynecologists [ACOG]. (2011). *Weight gain during pregnancy*. Retrieved from **http://pause.acog.org/president/weight-during-pregnancy**; and Dudek, S. G. (2010). *Nutrition essentials for nursing practice* (6th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

The IOM (2009) and the National Research Council have issued recommendations for weight gain during pregnancy based on prepregnancy body mass index (BMI) as follows (**Box 11.3**):

- Underweight (BMI < 18.5) total weight gain range = 28 to 40 pounds
- Normal weight (BMI = 18.5–24.9) total weight gain range = 25 to 35 pounds
- Overweight (BMI = 25–29.9) total weight gain range = 15 to 25 pounds
- Obese (BMI = 30 or higher) total weight gain range = 11 to 20 pounds.

BOX 11.3: BODY MASS INDEX

Body mass index (BMI) provides an accurate estimate of total body fat and is considered a good method to assess overweight and obesity in people. BMI is a weight-to-height ratio calculation that can be determined by dividing a woman's weight in kilograms by her height in meters squared. BMI can also be calculated by weight in pounds divided by the height in inches squared, multiplied by 704.5.

The Centers for Disease Control and Prevention (2011) categorizes BMI as follows:

- Underweight: <18.5
- Healthy weight: 18.5–24.9
- Overweight: 25–29.9
- Obese: 30 or higher

Use this example to calculate BMI:

Mary is 5 feet 5 inches tall and weighs 150 pounds.

- 1. Convert weight into kilograms 150 divided by 2.2 lb/kg = 68.18 kg.
- 2. Convert height into meters:
  - a. 5 feet 5 inches = 65 inches × 2.54 cm/in. = 165.1 cm
  - b. 165.1 cm/100 cm = 1.65 m
- 3. Then square the height in meters: 1.65 × 1.65 = 2.72
- 4. Calculate BMI: 68.18 kg divided by 2.72 = 25.

Unfortunately, an estimated 40% to 73% of women gain weight outside of those ranges (Ural & Booker, 2011).

A woman who is underweight before pregnancy or who has a low maternal weight gain pattern should be monitored carefully because she is at risk of giving birth to a low-birth-weight infant (<2,500 g or 5.5 pounds). Frequently these women simply need advice on what to eat to add weight. Encourage the woman to eat snacks that are high in calories such as nuts, peanut butter, milkshakes, cheese, fruit, yogurt, and ice cream. Any woman who has a prepregnancy BMI of less than 18.5 is considered to be high risk and should be referred to a nutritionist (IOM, 2010f).

Conversely, women who start a pregnancy while overweight (BMI > 25–29) run the risk of having a high-birth-weight infant, with resulting cephalopelvic disproportion and, potentially, a surgical birth. Dieting during pregnancy is never recommended, even for women who are obese. Severe restriction of caloric intake is associated with a decrease in birth weight. Because of the expansion of maternal blood volume and the development of fetal and placental tissues, some weight gain is essential for a healthy pregnancy. Women who gain more than the recommended weight during pregnancy and who fail to lose this weight 6 months after giving birth are at much higher risk of being obese nearly a decade later (American College of Obstetricians and Gynecologists [ACOG], 2011). Women who are overweight when beginning a pregnancy should gain no more than 15 to 25 pounds during the pregnancy, depending on their nutritional status and degree of obesity (ACOG, 2011).

The best way to assess whether a pregnant woman is consuming enough calories is to follow her pattern of weight gain. All pregnant women should aim for a steady rate of weight gain throughout pregnancy. If she is gaining in a steady, gradual manner, then she is taking in enough calories. However, consuming an adequate amount of calories does not guarantee that her nutrients are sufficient. It is critical to evaluate both the quantity and the quality of the foods eaten.

During the first trimester, for women whose prepregnant weight is within the normal weight range, weight gain should be about 3.5 to 5 pounds. For underweight women, weight gain should be at least 5 pounds. For overweight women, weight gain should be about 2 pounds. Much of the weight gained during the first trimester is caused by growth of the uterus and expansion of the blood volume.

During the second and third trimesters, the following pattern is recommended: For women whose prepregnant weight is within the normal weight range, weight gain should be about 1 pound per week. For underweight women, weight gain should be slightly more than 1 pound per week. For overweight women, weight gain should be about two thirds of a pound per week (Phelan, 2010).

Nutrition Promotion

Through education, nurses can play an important role in ensuring adequate nutrition for pregnant women. During the initial prenatal visit, health care providers conduct a thorough assessment of a woman's typical dietary practices and address any conditions that may cause inadequate nutrition, such as nausea and vomiting or lack of access to adequate food. Assess and reinforce dietary information at every prenatal visit to promote good nutrition. A normal pregnancy and a well-balanced diet generally provide most of the recommended nutrients except iron and folate, both of which must be supplemented in the form of prenatal vitamins.

The USDA Food Guide *MyPlate* replaced *MyPyramid* in 2011 as the government's primary food group symbol. *MyPlate* is an easy-to-understand visual cue to help consumers adopt healthy eating habits by encouraging them to build a healthy plate, consistent with the *Dietary Guidelines for Americans, 2010* (USDA & USD-HHS, 2010). This new tool will serve as a basis for dietary instruction and it can be tailored to meet each woman's individual needs (**Teaching Guidelines 11.1**).

Teaching Guidelines 11.1: TEACHING TO PROMOTE OPTIMAL NUTRITION DURING PREGNANCY

- Follow the USDA Food Guide ***MyPlate*** and select a variety of foods from each group.

- Gain between 15 and 40 pounds in a gradual and steady manner depending on prepregnant weight as follows:
  - Underweight (BMI < 18.5) total weight gain range = 28–40 pounds
  - Normal weight (BMI = 18.5–24.0) total weight gain range = 25–35 pounds
  - Overweight (BMI = 25–29) total weight gain range = 15–25 pounds
  - Obese (BMI = 30 or higher) total weight gain range = 11–20 pounds (IOM, 2009).
- Take your prenatal vitamin/mineral supplementation daily.
- Avoid weight-reduction diets during pregnancy.
- Do not skip meals; eat three meals with one or two snacks daily.
- Limit the intake of sodas and caffeine-rich drinks.
- Avoid the use of diuretics during pregnancy.
- Do not restrict the use of salt unless instructed to do so by your health care provider.
- Engage in reasonable physical activity daily.

Special Nutritional Considerations

Many factors play an important role in shaping a person's food habits, and these factors must be taken into account if nutritional counseling is to be realistic and appropriate. Nurses need to be aware of these factors to ensure individualized teaching and care.

Cultural Variations and Restrictions

Food is important to every cultural group. It is often part of celebrations and rituals. When working with women from various cultures, the nurse needs to adapt American nutritional guidelines to meet their nutritional needs within their cultural framework. Food choices and variations for different cultures might include the following:

- Bread, cereal, rice, and pasta group:
  - Bolillo
  - Couscous
  - Flaxseed
  - Hau juan
- Vegetable group:
  - Agave
  - Bok choy
  - Water chestnuts
  - Jicama
  - Okra
- Protein group:
  - Bean paste
  - Blood sausage
  - Legumes
  - Shellfish
- Fruit group:
  - Catalpa

  - Kumquats
  - Plantain
  - Yucca fruit
  - Zapote
- Milk and dairy:
  - Buffalo milk
  - Buttermilk
  - Soybean milk

Lactose Intolerance

EVIDENCE-BASED PRACTICE 11.1: EFFECTS OF ZINC SUPPLEMENTATION IN PREGNANCY ON MATERNAL, FETAL, NEONATAL, AND INFANT OUTCOMES

It has been suggested that low serum zinc levels may be associated with suboptimal outcomes of pregnancy such as prolonged labor, atonic postpartum hemorrhage, pregnancy-induced hypertension, preterm labor, and post-term pregnancies, although many of these associations have not yet been established. Many women of childbearing age may have mild to moderate zinc deficiency. Low zinc levels may cause preterm birth or may prolong labor. It is also possible that zinc deficiency may affect infant growth.

STUDY

A review of 17 trials, involving over 9,000 women and their babies, found that although zinc supplementation has a small effect on reducing preterm births, it does not help to prevent low-birth-weight babies. Finding ways to improve women's overall nutritional status, particularly in low-income areas, will do more to improve the health of mothers and babies than giving pregnant women zinc supplements.

Findings

The 14% relative reduction in preterm birth for zinc compared with placebo was primarily in the group of studies involving women of low income, and this has some relevance in areas of high perinatal mortality. There was no convincing evidence that zinc supplementation during pregnancy results in other important benefits. Because the preterm association could well reflect poor nutrition, studies to address ways of improving the overall nutritional status of populations in impoverished areas, rather than focusing on micronutrient and/or zinc supplementation in isolation, should be a priority.

Nursing Implications

Nurses can dispel any myths associated with the use of zinc as a preventive measure for preterm births, since research does not seem to validate this. Encouraging better nutrition, increasing water consumption, and taking rest periods throughout the day are all associated with longevity of pregnancy. At this point, the exact triggering mechanism for preterm labor is not known.

Adapted from Mahomed, K., Bhutta, Z., & Middleton, P. (2011). Zinc supplementation for improving pregnancy and infant outcome. *Cochrane Database of Systematic Reviews, 2011*(8). doi:10.1002/14651858.CD000230.pub3.

The best source of calcium is milk and dairy products, but for women with lactose intolerance, adaptations are necessary. Women with lactose intolerance lack an enzyme (lactase) needed for the breakdown of lactose into its component simple sugars, glucose and galactose. Without adequate lactase, lactose passes through the small intestine undigested and causes abdominal discomfort, gas, and diarrhea. Lactose intolerance is especially common among women of African, Asian, and Middle Eastern descent (Lutz & Przytulski, 2011).

Additional or substitute sources of calcium may be necessary. These may include peanuts, almonds, sunflower seeds, broccoli, salmon, kale, and molasses (Wilkinson & Tolcher, 2010). In addition, encourage the woman to drink lactose-free dairy products or calciumenriched orange juice or soy milk.

Vegetarians

Vegetarian diets are becoming increasing prevalent in the United States. People choose a vegetarian diet for various reasons, including environmental, animal rights, philosophical, religious, and health beliefs (Lutz & Przytulski, 2011). Vegetarians choose not to eat meat, poultry, and fish. Their diets consist mostly of plant-based foods, such as legumes, vegetables, whole grains, nuts, and seeds. Vegetarians fall into groups defined by the types of foods they eat. Lacto-ovo-vegetarians omit red meat, fish, and poultry, but eat eggs, milk, and dairy products in addition to plant-based foods. Lacto-vegetarians consume milk and dairy products along with plant-based foods; they omit eggs, meat, fish, and poultry. Vegans eliminate all foods from animals, including milk, eggs, and cheese, and eat only plant-based foods (Dudek, 2010).

The concern with any form of vegetarianism, especially during pregnancy, is that the diet may be inadequate in nutrients. Other risks of vegetarian eating patterns during pregnancy may include low gestational weight gain, iron-deficiency anemia, compromised protein utilization, and decreased mineral absorption (Dudek, 2010). A diet can become so restrictive that a woman is not gaining weight or is consistently not eating enough from one or more of the food groups. Generally, the more restrictive the diet is, the greater the chance of nutrient deficiencies.

Well-balanced vegetarian diets that include dairy products provide adequate caloric and nutrient intake and do not require special supplementation; however, vegan diets do not include any meat, eggs, or dairy products. Pregnant vegetarians must pay special attention to their intake of protein, iron, calcium, and vitamin B_{12}. Suggestions include:

- ***For protein:*** substitute soy foods, beans, lentils, nuts, grains, and seeds.

- ***For iron:*** eat a variety of meat alternatives, along with vitamin C–rich foods.
- ***For calcium:*** substitute soy, calcium-fortified orange juice, and tofu.
- ***For vitamin B_{12}:*** eat fortified soy foods and a B_{12} supplement.

The Academy of Nutrition and Dietetics (2011) used an evidence-based review to show that well-planned vegetarian diets are appropriate for individuals during all stages of the life cycle, including pregnancy, lactation, infancy, childhood, and adolescence, and for athletes.

Pica

Many women experience unusual food cravings during their pregnancy. Having cravings during pregnancy is perfectly normal. Sometimes, however, women crave substances that have no nutritional value and can even be dangerous to themselves and their fetus. **Pica** is the compulsive ingestion of nonfood substances. Pica is derived from the Latin term for magpie, a bird that is known to consume a variety of nonfood substances. Unlike the bird, however, pregnant women who develop a pica habit typically have one or two specific cravings.

The exact cause of pica is not known. Many theories have been advanced to explain it, but none has been proven scientifically. The incidence of pica is difficult to determine, since it is underreported. It is more common in the United States among African American women compared to other ethnicities, but the practice of pica is not limited to any one geographic area, race, creed, or culture. In the United States, pica is also common in women from rural areas and women with a family history of it (Curran, 2011).

The three main substances consumed by women with pica are soil or clay (geophagia), ice (pagophagia), and laundry starch (amylophagia). Nutritional implications include:

- ***Soil:*** replaces nutritive sources and causes iron-deficiency anemia.
- ***Clay:*** produces constipation; can contain toxic substances and cause parasitic infection.
- ***Ice:*** can cause iron-deficiency anemia, tooth fractures, freezer burn injuries.
- ***Laundry starch:*** replaces iron-rich foods, leads to iron deficiencies, and replaces protein metabolism, thus depriving the fetus of amino acids needed for proper development (American Pregnancy Association, 2011).

Clinical manifestations of anemia often precede the identification of pica because the health care provider rarely addresses the behavior and the woman does not usually volunteer such information (Curran, 2011). Secrecy surrounding this habit makes research and diagnosis difficult because some women fail to view their behavior as anything unusual, harmful, or worth reporting. Because of the clinical implications, pica should be discussed with all pregnant women as a preventive measure. The topic can be part of a general discussion of cravings, and the nurse should stress the harmful effects outlined above.

Suspect pica when the woman exhibits anemia although her dietary intake is appropriate. Ask about her usual dietary intake, and include questions about the ingestion of nonfood substances. Consider the potential negative outcomes for the pregnant woman and her fetus, and take appropriate action.

PSYCHOSOCIAL ADAPTATIONS DURING PREGNANCY

Pregnancy is a unique time in a woman's life. It is a time of dramatic alterations in her body and her appearance, as well as a time of change in her social status. All of these changes occur simultaneously. Concurrent with the physiologic changes within her body systems are psychosocial changes within the mother and family members as they face significant role and lifestyle changes.

Maternal Emotional Responses

Motherhood, perhaps more than any role in society, has acquired a special significance for women. Women are taught they should find fulfillment and satisfaction in the role of the "ever-bountiful, ever-giving, self-sacrificing mother" (Van den Bergh, 2010). With such high expectations, many pregnant women experience various emotions throughout their pregnancy. The woman's approach to these emotions is influenced by her emotional makeup, her sociologic and cultural background, her acceptance or rejection of the pregnancy, whether the pregnancy was planned, if the father is known, and her support network (Alexander et al., 2010).

Despite the wide-ranging emotions associated with the pregnancy, many women experience similar responses. These responses commonly include ambivalence, introversion, acceptance, mood swings, and changes in body image.

Ambivalence

The realization of a pregnancy can lead to fluctuating responses, possibly at the opposite ends of the spectrum. For example, regardless of whether the pregnancy was planned, the woman may feel proud and excited at her achievement while at the same time fearful and anxious of the implications. The reactions are influenced by several factors, including the way the woman was raised, her current family situation, the quality of the relationship with the expectant father, and her hopes for the future. Some women express concern over the timing of the pregnancy, wishing that goals and life objectives had been met before becoming pregnant. Other women may question how a newborn or infant will affect their career or their relationships with friends and family. These feelings can cause conflict and confusion about the pregnancy.

Ambivalence, or having conflicting feelings at the same time, is a universal feeling and is considered normal when preparing for a lifestyle change and new role. Pregnant women commonly experience ambivalence during the first trimester. Usually ambivalence evolves into acceptance by the second trimester, when fetal movement is felt. The woman's personality, her ability to adapt to changing circumstances, and the reactions of her partner will affect her adjustment to being pregnant and her acceptance of impending motherhood.

Introversion

Introversion, or focusing on oneself, is common during the early part of pregnancy. The woman may withdraw and become increasingly preoccupied with herself and her fetus. As a result, she may participate less with the outside world, and she may appear passive to her family and friends.

This introspective behavior is a normal psychological adaptation to motherhood for most women. Introversion seems to heighten during the first and third trimesters, when the woman's focus is on behaviors that will ensure a safe and health pregnancy outcome. Couples need to be aware of this behavior and should be informed about measures to maintain and support the focus on the family.

Acceptance

During the second trimester, the physical changes of the growing fetus, including an enlarging abdomen and fetal movement, bring reality and validity to the pregnancy. There are many tangible signs that someone separate from herself is present. The pregnant woman feels fetal movement and may hear the heartbeat. She may see the fetal image on an ultrasound screen and feel distinct parts, recognizing independent sleep and wake patterns. She becomes able to identify the fetus as a separate individual and accepts this.

Many women will verbalize positive feelings about the pregnancy and will conceptualize the fetus. The woman may accept her new body image and talk about the new life within. Generating a discussion about the woman's feelings and offering support and validation at prenatal visits are important.

Mood Swings

Emotional lability is characteristic throughout most pregnancies. One moment a woman can feel great joy, and within a short time she can feel shock and disbelief. Frequently, pregnant women will start to cry without any apparent cause. Some women feel as though they are riding an "emotional roller-coaster." These extremes in emotion can make it difficult for partners and family members to communicate with the pregnant woman without placing blame on themselves for their mood changes. Clear explanations about how common mood swings are during pregnancy are essential.

Change in Body Image

The way in which pregnancy affects a woman's body image varies greatly from person to person. Some women feel as if they have never been more beautiful, whereas others spend their pregnancy feeling overweight and uncomfortable. For some women pregnancy is a relief from worrying about weight, whereas for others it only exacerbates their fears of weight gain. Changes in body image are normal but can be very stressful for the pregnant woman. Offering a thorough explanation and initiating discussion of the expected bodily changes may help the family to cope with them.

Maternal Role Tasks

Reva Rubin (1984) identified maternal tasks that a woman must accomplish to incorporate the maternal role into her personality. Accomplishing these tasks helps the expectant mother to develop her self-concept as a mother and to form a mutually gratifying relationship with her infant. These tasks are listed in **Box 11.4**.

BOX 11.4: MATERNAL ROLE TASKS

- **Ensuring safe passage throughout pregnancy and birth**
  - Primary focus of the woman's attention
  - First trimester: woman focuses on herself, not on the fetus
  - Second trimester: woman develops attachment of great value to her fetus
  - Third trimester: woman has concern for herself and her fetus as a unit
  - Participation in positive self-care activities related to diet, exercise, and overall well-being
- **Seeking acceptance of infant by others**
  - First trimester: acceptance of pregnancy by herself and others
  - Second trimester: family needs to relate to the fetus as member
  - Third trimester: unconditional acceptance without rejection
- **Seeking acceptance of self in maternal role to infant ("binding in")**
  - First trimester: mother accepts idea of pregnancy, but not of infant
  - Second trimester: with sensation of fetal movement (**quickening**), mother acknowledges fetus as a separate entity within her
  - Third trimester: mother longs to hold infant and becomes tired of being pregnant
- **Learning to give of oneself**
  - First trimester: identifies what must be given up to assume new role
  - Second trimester: identifies with infant, learns how to delay own desires
  - Third trimester: questions her ability to become a good mother to infant

Adapted from Rubin, R. (1984). *Maternal identity and the maternal experience*. New York, NY: Springer.

Pregnancy and Sexuality

Sexuality is an important part of health and well-being. Sexual behavior modifies as pregnancy progresses, influenced by biologic, psychological, and social factors. The way a pregnant woman feels and experiences her body during pregnancy can affect her sexuality. The woman's changing shape, emotional status, fetal activity, changes in breast size, pressure on the bladder, and other discomforts of pregnancy result in increased physical and emotional demands. These can produce stress on the sexual relationship between the pregnant woman and her partner. As the changes of pregnancy ensue, many partners become confused, anxious, and fearful of how the relationship may be affected.

The sexual desire of pregnant women may change throughout the pregnancy. During the first trimester, the woman may be less interested in sex because of fatigue, nausea, and fear of disturbing the early embryonic development. During the second trimester, her interest may increase because of the stability

of the pregnancy. During the third trimester, her enlarging size may produce discomfort during sexual activity (Bope & Kellerman, 2012).

Potential complications of sex during pregnancy include preterm labor, pelvic inflammatory disease, antepartum hemorrhage in placenta previa, and venous air embolism. Generally, sexual relations are generally considered safe in pregnancy. Abstinence is usually only recommended for women who are at risk for preterm labor or for antepartum hemorrhage because of placenta previa (Jones, Chan, & Farine, 2011).

A woman's sexual health is intimately linked to her own self-image. Sexual positions to increase comfort as the pregnancy progresses as well as alternative noncoital modes of sexual expression, such as cuddling, caressing, and holding, should be discussed. Giving permission to talk about and then normalizing sexuality can help enhance the sexual experience during pregnancy and, ultimately, the couple's relationship. If avenues of communication are open regarding sexuality during pregnancy, any fears and myths the couple may have can be dispelled.

Pregnancy and the Partner

Nursing care related to childbirth has expanded from a narrow emphasis on the physical health needs of the mother and infant to a broader focus on family-related social and emotional needs. One prominent feature of this family-centered approach is the recent movement toward promoting the mother–infant bond. To achieve a truly family-centered practice, nursing must make a comparable commitment to understanding and meeting the needs of the partner in the emerging family. Recent studies suggest that the partner's potential contribution to the infant's overall development has been misperceived or devalued and that the partner's ability and willingness to assume a more active role in the infant's care may have been underestimated.

Reactions to pregnancy and to the psychological and physical changes by the woman's partner vary greatly. Some enjoy the role of being the nurturer, whereas others experience alienation and may seek comfort or companionship elsewhere. Some expectant fathers may view pregnancy as proof of their masculinity and assume the dominant role, whereas others see their role as minimal, leaving the pregnancy up to the woman entirely. Each expectant partner reacts uniquely.

Emotionally and psychologically, expectant partners may undergo fewer visible changes than women, but most of these changes remain unexpressed and unappreciated (Pauleta, Pereira & Graça, 2010). Expectant partners also experience a multitude of adjustments and concerns. Physically, they may gain weight around the middle and experience nausea and other GI disturbances—a reaction termed *couvade syndrome* that is a sympathetic response to their partner's pregnancy. They also experience ambivalence during early pregnancy, with extremes of emotions (e.g., pride and joy versus an overwhelming sense of impending responsibility).

During the second trimester of pregnancy, partners go through acceptance of their role of breadwinner, caretaker, and support person. They come to accept the reality of the fetus when movement is felt, and they experience confusion when dealing with the woman's mood swings and introspection. During the third trimester, the expectant partner prepares for the reality of this

new role and negotiates what the role will be during the labor and birthing process. Many express concern about being the primary support person during labor and birth and worry how they will react when faced with their loved one in pain. Expectant partners share many of the same anxieties as their pregnant partners. However, it is uncommon for them to reveal these anxieties to the pregnant partner or health care professionals. Often, how the expectant partner responds during the third trimester depends on the state of the marriage or partnership. When the marriage or partnership is struggling, the impending increase in responsibility toward the end of pregnancy acts to drive the expectant partner further away. Often it manifests as working late, staying out late with friends, or beginning new or superficial relationships. In the stable marriage or partnership, the expectant partner who may have been struggling to find his or her place in the pregnancy now finds concrete tasks to do—for example, painting the nursery, or assembling the car seat, attending Lamaze classes.

Pregnancy and Siblings

A sibling's reaction to pregnancy is age dependent. Some children might express excitement and anticipation, whereas others might have negative reactions. A young toddler might regress in toilet training or ask to drink from a bottle again. An older school-aged child may ignore the new addition to the family and engage in outside activities to avoid the new member. The introduction of an infant into the family is often the beginning of sibling rivalry, which results from the child's fear of change in the security of the relationship with his or her parents (Parker, 2012). Preparation of the siblings for the anticipated birth is imperative and must be designed according to the age and life experiences of the sibling at home. Constant reinforcement of love and caring will help to reduce the older child's fear of change and worry about being replaced by the new family member.

If possible, parents should include siblings in preparation for the birth of the new baby to help them feel as if they have an important role to play (**Fig. 11.6**). Parents must also continue to focus on the older sibling after the birth to reduce regressive or aggressive behavior toward the newborn.

FIGURE 11.6

Parents preparing sibling for the birth of a new baby.

Pregnancy is an extremely busy time, not only in terms of the bodily changes taking place, but tasks that must be done such as choosing a provider to care for them, preparing for the new family member in a matter of months, and making lifestyle modifications to promote the best possible pregnancy outcome. See **Chapter 12** for more specifics on this content.

KEY CONCEPTS

- Pregnancy is a normal life event that involves considerable physical, psychosocial, emotional, and relationship adjustments.
- The signs and symptoms of pregnancy have been grouped into those that are subjective (presumptive) and experienced by the woman herself, those that are objective (probable) and observed by the health care professional, and those that are the positive, beyond-the-shadow-of-a-doubt signs.

- Physiologically, almost every system of a woman's body changes during pregnancy with startling rapidity to accommodate the needs of the growing fetus. A majority of the changes are influenced by hormonal changes.
- The placenta is a unique kind of endocrine gland; it has a feature possessed by no other endocrine organ—the ability to form protein and steroid hormones.
- Occurring in conjunction with the physiologic changes in the woman's body systems are psychosocial changes occurring within the mother and family members as they face significant role and lifestyle changes.
- Commonly experienced emotional responses to pregnancy in the woman include ambivalence, introversion, acceptance, mood swings, and changes in body image.
- Reactions of expectant partners to pregnancy and to the physical and psychological changes in the woman vary greatly.
- A sibling's reaction to pregnancy is age dependent. The introduction of a new infant to the family is often the beginning of sibling rivalry, which results from the established child's fear of change in security of their relationships with their parents. Therefore, preparation of the siblings for the anticipated birth is imperative.