CHAPTER 8

Anatomy and Physiology of Pregnancy

DEITRA LEONARD LOWDERMILK

LEARNING OBJECTIVES

- *Determine gravidity and parity by using the five- and four-digit systems.*
- *Describe the various types of pregnancy tests including the timing of tests and interpretation of results.*
- *Explain the expected maternal anatomic and physiologic adaptations to pregnancy for each body system.*
- *Differentiate among presumptive, probable, and positive signs of pregnancy.*
- *Compare normal adult laboratory values with values for pregnant women.*
- *Identify the maternal hormones produced during pregnancy, their target organs, and their major effects on pregnancy.*
- *Compare the characteristics of the abdomen, vulva, and cervix of the nullipara and multipara.*

KEY TERMS AND DEFINITIONS

ballottement Diagnostic technique using palpation: a floating fetus, when tapped or pushed, moves away and then returns to touch the examiner's hand

Braxton Hicks sign Mild, intermittent, painless uterine contractions that occur during pregnancy; occur more frequently as pregnancy advances but do not represent true labor; however, they should be distinguished from preterm labor

carpal tunnel syndrome Pressure on the median nerve at the point at which it goes through the carpal tunnel of the wrist; causes soreness, tenderness, and weakness of the muscles of the thumb

Chadwick sign Violet color of vaginal mucous membrane that is visible from approximately the fourth week of pregnancy; caused by increased vascularity

chloasma Increased pigmentation over bridge of nose and cheeks of pregnant women and some women taking oral contraceptives; also known as "mask of pregnancy"

colostrum Fluid in the acini cells of the breasts present from early pregnancy into the early postpartal period; rich in antibodies, which provide protection to the breastfed newborn from many diseases; high in protein, which binds bilirubin; and laxative acting, which speeds the elimination of meconium and helps loosen mucus

diastasis recti abdominis Separation of the two rectus muscles along the median line of the abdominal wall; often seen in women with repeated childbirths or with a multiple gestation (e.g., triplets)

epulis Tumorlike benign lesion of the gingiva seen in pregnant women

funic souffle Soft, muffled, blowing sound produced by blood rushing through the umbilical vessels and synchronous with the fetal heart sounds

Goodell sign Softening of the cervix, a probable sign of pregnancy, occurring during the second month

Hegar sign Softening of the lower uterine segment that is classified as a probable sign of pregnancy, may be present during the second and third months of pregnancy, and is palpated during bimanual examination

human chorionic gonadotropin (hCG) Hormone that is produced by chorionic villi; the biologic marker in pregnancy tests

leukorrhea White or yellowish mucus discharge from the cervical canal or the vagina that may be normal physiologically or caused by pathologic states of the vagina and endocervix

lightening Sensation of decreased abdominal distention produced by uterine descent into the pelvic cavity as the fetal presenting part settles into the pelvis; usually occurs 2 weeks before the onset of labor in nulliparas

KEY TERMS AND DEFINITIONS—cont'd

linea nigra Line of darker pigmentation seen in some women during the latter part of pregnancy that appears on the middle of the abdomen and extends from the symphysis pubis toward the umbilicus

Montgomery tubercles Small, nodular prominences (sebaceous glands) on the areolas around the nipples of the breasts that enlarge during pregnancy and lactation

operculum Plug of mucus that fills the cervical canal during pregnancy

palmar erythema Rash on the surface of the palms sometimes seen in pregnancy

ptyalism Excessive salivation

pyrosis Burning sensation in the epigastric and sternal region from stomach acid (heartburn)

quickening Maternal perception of fetal movement; usually occurs between weeks 16 and 20 of gestation

striae gravidarum "Stretch marks"; shining reddish lines caused by stretching of the skin, often found on the abdomen, thighs, and breasts during pregnancy; these streaks turn to a fine pinkish white or silver tone in time in fair-skinned women and brownish in darker-skinned women

uterine souffle Soft, blowing sound made by the blood in the arteries of the pregnant uterus and synchronous with the maternal pulse

ELECTRONIC RESOURCES

Additional information related to the content in Chapter 8 can be found on

the companion website at evolve
http://evolve.elsevier.com/Lowdermilk/Maternity/
- NCLEX Review Questions
- WebLinks

or on the interactive companion CD
- NCLEX Review Questions

The goal of maternity care is a healthy pregnancy with a physically safe and emotionally satisfying outcome for mother, infant, and family. Consistent health supervision and surveillance are of utmost importance in achieving this outcome. However, many maternal adaptations are unfamiliar to pregnant women and their families. Helping the pregnant woman recognize the relation between her physical status and the plan for her care assists her in making decisions and encourages her to participate in her own care.

GRAVIDITY AND PARITY

An understanding of the following terms used to describe pregnancy and the pregnant woman is essential to the study of maternity care.

- ***gravida:*** a woman who is pregnant
- ***gravidity:*** pregnancy
- ***multigravida:*** a woman who has had two or more pregnancies
- ***multipara:*** a woman who has completed two or more pregnancies to the stage of fetal viability
- ***nulligravida:*** a woman who has never been pregnant
- ***nullipara:*** a woman who has not completed a pregnancy with a fetus or fetuses who have reached the stage of fetal viability
- ***parity:*** the number of pregnancies in which the fetus or fetuses have reached viability when they are born, not the number of fetuses (e.g., twins) born. Whether the fetus is born alive or is stillborn (fetus who shows no signs of life at birth) after viability is reached does not affect parity
- ***postdate or postterm:*** a pregnancy that goes beyond 42 weeks of gestation
- ***preterm:*** a pregnancy that has reached 20 weeks of gestation but before completion of 37 weeks of gestation
- ***primigravida:*** a woman who is pregnant for the first time
- ***primipara:*** a woman who has completed one pregnancy with a fetus or fetuses who have reached the stage of fetal viability
- ***term:*** a pregnancy from the beginning of week 38 of gestation to the end of week 42 of gestation
- ***viability:*** capacity to live outside the uterus; about 22 to 24 weeks since last menstrual period, or fetal weight greater than 500 g

Gravidity and parity information is obtained during history-taking interviews and may be recorded in patient records in several ways. One way is to describe gravidity and parity with two numbers. For example 1/0 means that a woman is pregnant for the first time and has not yet carried a pregnancy to viability. Another system commonly used in maternity centers consists of five digits separated with hyphens.

TABLE 8-1

Gravidity and Parity Using Five-Digit (GTPAL) System

CONDITION	PREGNANCIES	TERM BIRTHS	PRETERM BIRTHS	ABORTIONS AND MISCARRIAGES	LIVING CHILDREN
Jamilla is pregnant for the first time.	1	0	0	0	0
She carries the pregnancy to 35 weeks, and the neonate survives.	1	0	1	0	1
She becomes pregnant again.	2	0	1	0	1
Her second pregnancy ends in miscarriage at 10 weeks.	2	0	1	1	1
During her third pregnancy, she gives birth at 38 weeks.	3	1	1	1	2

This system provides more specific information about parity. The first digit represents the total number of pregnancies, including the present one (gravidity); the second digit represents the total number of term births; the third indicates the number of preterm births; the fourth identifies the number of abortions (miscarriage or elective termination of pregnancy before viability); and the fifth is the number of children currently living. The acronym *GTPAL* (gravidity, term, preterm, abortions, living children) may be helpful in remembering this system of notation. For example, if a woman pregnant only once gives birth at week 34 and the infant survives, the abbreviation that represents this information is "1-0-1-0-1." During her next pregnancy, the abbreviation is "2-0-1-0-1." Additional examples are given in Table 8-1.

PREGNANCY TESTS

Early detection of pregnancy allows early initiation of care. **Human chorionic gonadotropin (hCG)** is the earliest biochemical marker for pregnancy, and pregnancy tests are based on the recognition of hCG or a beta (β) subunit of hCG. Production of β-hCG begins as early as the day of implantation and can be detected as early as 7 to 10 days after conception (Stewart, 2004). The level of hCG increases until it peaks at about 60 to 70 days of gestation and then declines until about 80 days of pregnancy. It remains stable until about 30 weeks and then gradually increases until term. Higher than normal levels of hCG may indicate ectopic pregnancy, abnormal gestation (e.g., fetus with Down syndrome), or multiple gestation; abnormally slow increase or a decrease in hCG levels may indicate impending miscarriage (Buster & Carson, 2002).

Serum and urine pregnancy tests are performed in clinics, offices, women's health centers, and laboratory settings, and urine pregnancy tests may be performed at home. Both serum and urine tests can provide accurate results. A 7- to 10-ml sample of venous blood is collected for serum testing. Most urine tests require a first-voided morning urine specimen because it contains levels of hCG approximately the same as those in serum. Random urine samples usually have lower levels. Urine tests are less expensive and provide more immediate results than do serum tests (Stewart, 2004).

Many different pregnancy tests are available. The wide variety of tests precludes discussion of each; however, several categories of tests are described here. The nurse should read the manufacturer's directions for the test to be used.

Radioimmunoassay (RIA) pregnancy tests for the beta subunit of hCG in serum or urine samples use radioactively

Critical Thinking Exercise

Home Pregnancy Testing

Sylvia and her partner want to have a baby and have not been using any contraception for 3 months. Sylvia's period is now a week late. She uses a home pregnancy test kit and the results are negative. She is disappointed and has called the health line at the local women's health clinic for advice about having another test.

1. Evidence—Is there sufficient evidence to draw conclusions about what advice the nurse should give to Sylvia?
2. Assumptions—What assumptions can be made about home pregnancy testing?
3. What implications and priorities for giving advice to Sylvia can be made at this time?
4. Does the evidence objectively support your conclusion?
5. Are there alternative perspectives to your conclusion?

labeled markers and are usually performed in a laboratory. These tests are accurate with low hCG levels (5 milli-international units/ml) and can confirm pregnancy as soon as 1 week after conception. Results are available within a few hours (Stewart, 2004).

Radioreceptor assay (RRA) is a serum test that measures the ability of a blood sample to inhibit the binding of radiolabeled hCG to receptors. The test is 90% to 95% accurate from 6 to 8 days after conception (Pagana & Pagana, 2003).

Enzyme-linked immunosorbent assay (ELISA) testing is the most popular method of testing for pregnancy. It uses a specific monoclonal antibody (anti-hCG) with enzymes to bond with hCG in urine. Depending on the specific test, levels of hCG as low as 25 milli-international units/ml can be detected as early as 7 days after conception (Stewart, 2004). As an office or home procedure, it requires minimal time and offers results in less than 5 minutes. A positive test result is indicated by a simple color change reaction.

ELISA technology is the basis for most over-the-counter home pregnancy tests. With these one-step tests, the woman usually applies urine to a strip and reads the results. The test kits come with directions for collection of the specimen, the testing procedure, and reading of the results. Most manufacturers of the kits provide a toll-free telephone number to call if users have concerns and questions about test procedures or results (see Teaching Guidelines). The most common error in performing home pregnancy tests is performing the test too early in pregnancy (Stewart, 2004).

Interpreting the results of pregnancy tests requires some judgment. The type of pregnancy test and its degree of sensitivity (ability to detect low levels of a substance) and specificity (ability to discern the absence of a substance) must be considered in conjunction with the woman's history. This includes the date of her last normal menstrual period (LNMP), her usual cycle length, and results of previous pregnancy tests. It is important to know if the woman is a substance abuser and what medications she is taking, because medications such as anticonvulsants and tranquilizers can cause false-positive results, whereas diuretics and promethazine can cause false-negative results (Pagana & Pagana, 2003). Improper collection of the specimen, hormone-producing tumors, and laboratory errors also may cause false results. Whenever there is any question, further evaluation or retesting may be appropriate.

TEACHING GUIDELINES

Home Pregnancy Testing

- Follow the manufacturer's instructions carefully. Do not omit steps.
- Review the manufacturer's list of foods, medications, and other substances that can affect the test results.
- Use a first-voided morning urine specimen.
- If the test done at the time of your missed period is negative, repeat the test in 1 week if you still have not had a period.
- If you have questions about the test, contact the manufacturer.
- Contact your health care provider for follow-up if the test result is positive or if the test result is negative and you still have not had a period.

ADAPTATIONS TO PREGNANCY

Maternal physiologic adaptations are attributed to the hormones of pregnancy and to mechanical pressures arising from the enlarging uterus and other tissues. These adaptations protect the woman's normal physiologic functioning, meet the metabolic demands pregnancy imposes on her body, and provide a nurturing environment for fetal development and growth. Although pregnancy is a normal phenomenon, problems can occur.

Signs of Pregnancy

Some of the physiologic adaptations are recognized as signs and symptoms of pregnancy. Three commonly used categories of signs and symptoms of pregnancy are presumptive (those changes felt by the woman—e.g., amenorrhea, fatigue, nausea and vomiting, breast changes); probable (those changes observed by an examiner—e.g., Hegar sign, ballottement, pregnancy tests); and positive (those signs that are attributable only to the presence of the fetus—e.g., hearing fetal heart tones, visualization of the fetus, and palpating fetal movements). Table 8-2 summarizes these signs of pregnancy in relation to when they might occur and other causes for their occurrence.

Reproductive System and Breasts

Uterus

Changes in size, shape, and position. The phenomenal uterine growth in the first trimester is stimulated by high levels of estrogen and progesterone. Early uterine enlargement results from increased vascularity and dilation of blood vessels, hyperplasia (production of new muscle fibers and fibroelastic tissue) and hypertrophy (enlargement of preexisting muscle fibers and fibroelastic tissue), and development of the decidua. By 7 weeks of gestation, the uterus is the size of a large hen's egg; by 10 weeks of gestation, it is the size of an orange (twice its nonpregnant size); and by 12 weeks of gestation, it is the size of a grapefruit. After the third month, uterine enlargement is primarily the result of mechanical pressure of the growing fetus.

As the uterus enlarges, it also changes in shape and position. At conception the uterus is shaped like an upside-down pear. During the second trimester, as the muscular walls strengthen and become more elastic, the uterus becomes spherical or globular. Later, as the fetus lengthens, the uterus becomes larger and more ovoid and rises out of the pelvis into the abdominal cavity.

The pregnancy may "show" after the fourteenth week, although this depends to some degree on the woman's height

TABLE 8-2

Signs of Pregnancy

TIME OF OCCURRENCE (GESTATIONAL AGE)	SIGN	OTHER POSSIBLE CAUSE
PRESUMPTIVE SIGNS		
3-4 wk	Breast changes	Premenstrual changes, oral contraceptives
4 wk	Amenorrhea	Stress, vigorous exercise, early menopause, endocrine problems, malnutrition
4-14 wk	Nausea, vomiting	Gastrointestinal virus, food poisoning
6-12 wk	Urinary frequency	Infection, pelvic tumors
12 wk	Fatigue	Stress, illness
16-20 wk	Quickening	Gas, peristalsis
PROBABLE SIGNS		
5 wk	Goodell sign	Pelvic congestion
6-8 wk	Chadwick sign	Pelvic congestion
6-12 wk	Hegar sign	Pelvic congestion
4-12 wk	Positive result of pregnancy test (serum)	Hydatidiform mole, choriocarcinoma
6-12 wk	Positive result of pregnancy test (urine)	False-positive results may be caused by pelvic infection, tumors
16 wk	Braxton Hicks contractions	Myomas, other tumors
16-28 wk	Ballottement	Tumors, cervical polyps
POSITIVE SIGNS		
5-6 wk	Visualization of fetus by real-time ultrasound examination	No other causes
6 wk	Fetal heart tones detected by ultrasound examination	No other causes
16 wk	Visualization of fetus by radiographic study	No other causes
8-17 wk	Fetal heart tones detected by Doppler ultrasound stethoscope	No other causes
17-19 wk	Fetal heart tones detected by fetal stethoscope	No other causes
19-22 wk	Fetal movements palpated	No other causes
Late pregnancy	Fetal movements visible	No other causes

and weight. Abdominal enlargement may be less apparent in the nullipara with good abdominal muscle tone (Fig. 8-1). Posture also influences the type and degree of abdominal enlargement that occurs. In normal pregnancies, the uterus enlarges at a predictable rate. As the uterus grows, it may be palpated above the symphysis pubis some time between the twelfth and fourteenth weeks of pregnancy (Fig. 8-2). The uterus rises gradually to the level of the umbilicus at 22 to 24 weeks of gestation and nearly reaches the xiphoid process at term. Between weeks 38 and 40, fundal height drops as the fetus begins to descend and engage in the pelvis **(lightening)** (see Fig. 8-2, *dashed line*). Generally, lightening occurs in the nullipara about 2 weeks before the onset of labor and at the start of labor in the multipara.

Uterine enlargement is determined by measuring fundal height, a measurement commonly used to estimate the duration of pregnancy. However, variation in the position of the fundus or the fetus, variations in the amount of amniotic fluid present, the presence of more than one fetus, maternal obesity, and variation in examiner techniques can reduce the accuracy of this estimation of the duration of pregnancy.

The uterus normally rotates to the right as it elevates, probably because of the presence of the rectosigmoid colon on the left side, but the extensive hypertrophy (enlargement) of the round ligaments keeps the uterus in the midline. Eventually the growing uterus touches the anterior abdominal wall and displaces the intestines to either side of the abdomen (Fig. 8-3). Whenever a pregnant woman is standing, most of her uterus rests against the anterior abdominal wall, and this contributes to altering her center of gravity.

At approximately 6 weeks of gestation, softening and compressibility of the lower uterine segment (the uterine isthmus) occur **(Hegar sign)** (Fig. 8-4). This results in exaggerated uterine anteflexion during the first 3 months of pregnancy. In this position, the uterine fundus presses on the urinary bladder, causing the woman to have urinary frequency.

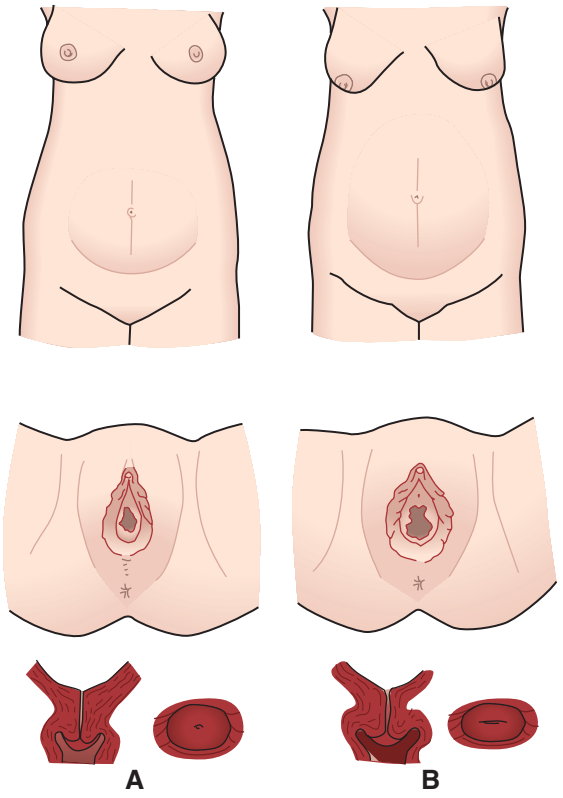

Fig. 8-1 Comparison of abdomen, vulva, and cervix in **A,** nullipara, and **B,** multipara, at the same stage of pregnancy.

Changes in contractility. Soon after the fourth month of pregnancy, uterine contractions can be felt through the abdominal wall. These contractions are referred to as the **Braxton Hicks sign.** Braxton Hicks contractions are irregular and painless and occur intermittently throughout pregnancy. These contractions facilitate uterine blood flow through the intervillous spaces of the placenta and thereby promote oxygen delivery to the fetus. Although Braxton Hicks contractions are not painful, some women complain that they are annoying. After the twenty-eighth week, these contractions become much more definite, but they usually cease with walking or exercise. Braxton Hicks contractions can be mistaken for true labor; however, they do not increase in intensity or frequency or cause cervical dilation.

Uteroplacental blood flow. Placental perfusion depends on the maternal blood flow to the uterus. Blood flow increases rapidly as the uterus increases in size. Although uterine blood flow increases twentyfold, the fetoplacental unit grows more rapidly. Consequently, more oxygen is extracted from the uterine blood during the latter part of pregnancy (Cunningham et al., 2005). In a normal term pregnancy, one sixth of the total maternal blood volume is within the uterine vascular system. The rate of blood flow through the uterus averages 500 ml/min, and oxygen consumption of the gravid uterus increases to meet fetal needs. A low maternal arterial pressure, contractions of the uterus, and maternal supine position are three factors known to decrease blood flow. Estrogen stimulation may increase uterine blood flow. Doppler ultrasound examination can be used to measure uterine blood flow velocity, especially in pregnancies at risk because of conditions associated with decreased placental perfusion such as hypertension, intrauterine growth restriction, diabetes mellitus, and multiple gestation (Harman, 2004). By using an ultrasound device or a fetal stethoscope, the health care provider may hear the **uterine souffle** (sound made by blood in the uterine arteries that is synchronous with the maternal pulse) or the **funic souffle** (sound made by blood rushing through the umbilical vessels and synchronous with the fetal heart rate).

Cervical changes. A softening of the cervical tip called **Goodell sign** may be observed about the beginning of the sixth week in a normal, unscarred cervix. This sign is brought about by increased vascularity, slight hypertrophy, and hyperplasia (increase in number of cells) of the muscle and its collagen-rich connective tissue, which becomes loose, edematous, highly elastic, and increased in volume. The glands near the external os proliferate beneath the stratified squamous epithelium, giving the cervix the velvety appearance characteristic of pregnancy. *Friability* is increased and may cause slight bleeding after coitus with deep penetration or after vaginal examination. Pregnancy also can cause the squamocolumnar junction, the site for obtaining cells for cervical cancer screening, to be located away from the cervix. Because of all these changes, evaluation of abnormal Papanicolaou (Pap) tests during pregnancy can be complicated. Careful assessment of all pregnant women is important, however, because about 3% of

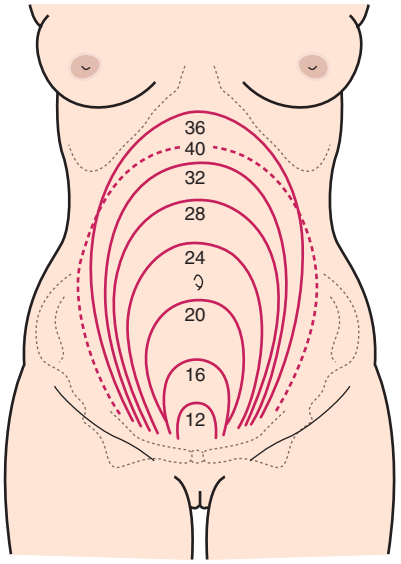

Fig. 8-2 Height of fundus by weeks of normal gestation with a single fetus. Dashed line, height after lightening. (From Seidel, H., Ball, J., Dains, J., & Benedict, G. [2003]. *Mosby's guide to physical examination* [5th ed.]. St. Louis: Mosby.)

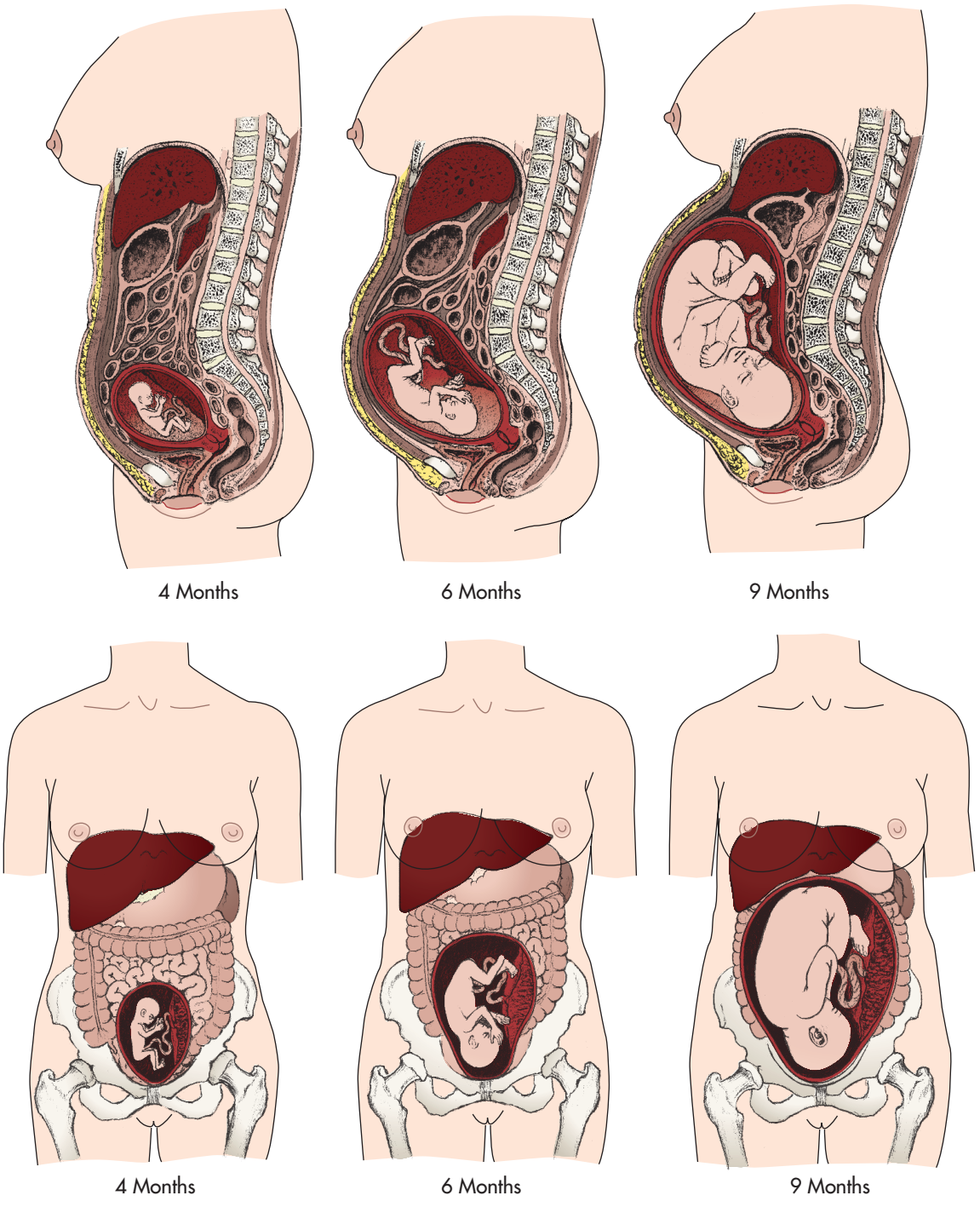

Fig. 8-3 Displacement of internal abdominal structures and diaphragm by the enlarging uterus at 4, 6, and 9 months of gestation.

all cervical cancers are diagnosed during pregnancy (Berman, DiSaia, & Tewari, 2004).

The cervix of the nullipara is rounded. Lacerations of the cervix almost always occur during the birth process. With or without lacerations, however, after childbirth, the cervix becomes more oval in the horizontal plane, and the external os appears as a transverse slit (see Fig. 8-1).

Changes related to the presence of the fetus. Passive movement of the unengaged fetus is called **ballottement** and can be identified generally between the sixteenth and eighteenth week. Ballottement is a technique of palpating a floating structure by bouncing it gently and feeling it rebound. In the technique used to palpate the fetus, the examiner places a finger in the vagina and taps gently

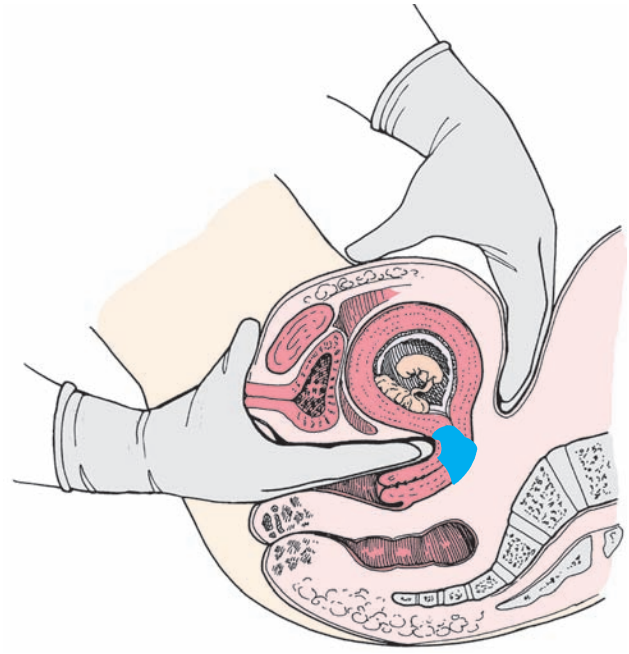

Fig. 8-4 Hegar sign. Bimanual examination for assessing compressibility and softening of the isthmus (lower uterine segment) while the cervix is still firm.

upward, causing the fetus to rise. The fetus then sinks, and a gentle tap is felt on the finger (Fig. 8-5).

The first recognition of fetal movements, or "feeling life," by the multiparous woman may occur as early as the fourteenth to sixteenth week. The nulliparous woman may not notice these sensations until the eighteenth week or later. **Quickening** is commonly described as a flutter and is difficult to distinguish from peristalsis. Fetal movements gradually increase in intensity and frequency. The week when quickening occurs provides a tentative clue in dating the duration of gestation.

Vagina and vulva

Pregnancy hormones prepare the vagina for stretching during labor and birth by causing the vaginal mucosa to thicken, the connective tissue to loosen, the smooth muscle to hypertrophy, and the vaginal vault to lengthen. Increased vascularity results in a violet-bluish color of the vaginal mucosa and cervix. The deepened color, termed the **Chadwick sign,** may be evident as early as the sixth week but is easily noted at the eighth week of pregnancy (Monga & Sanborn, 2004).

Leukorrhea is a white or slightly gray mucoid discharge with a faint musty odor. This copious mucoid fluid occurs in response to cervical stimulation by estrogen and progesterone. The fluid is whitish because of the presence of many exfoliated vaginal epithelial cells caused by the hyperplasia of normal pregnancy. This vaginal discharge is never pruritic or blood stained. Because of the progesterone effect, fern-ing usually does not occur in the dried cervical mucus smear, as it would in a smear of amniotic fluid. Instead, a beaded or cellular crystallizing pattern formed in the dried mucus is seen (Gibbs, Sweet, & Duff, 2004). The mucus fills the endocervical canal, resulting in the formation of the mucous plug **(operculum)** (Fig. 8-6). The operculum acts as a barrier against bacterial invasion during pregnancy.

During pregnancy, the pH of vaginal secretions is more acidic (ranging from about 3.5 to 6 [normal 4 to 7]) because of increased production of lactic acid caused by *Lactobacillus acidophilus* action on glycogen in the vaginal epithelium, probably resulting from increased estrogen levels (Cunningham et al., 2005). While this acidic environment provides more protection from some organisms, the pregnant woman is more vulnerable to other infections, especially yeast infections because the glycogen-rich environment is more susceptible to *Candida albicans* (Gibbs, Sweet, & Duff, 2004).

The increased vascularity of the vagina and other pelvic viscera results in a marked increase in sensitivity. The increased sensitivity may lead to a high degree of sexual interest and arousal, especially during the second trimester of pregnancy. The increased congestion plus the relaxed walls of the blood vessels and the heavy uterus may result in edema and varicosities of the vulva. The edema and varicosities usually resolve during the postpartum period.

External structures of the perineum are enlarged during pregnancy because of an increase in vasculature, hypertrophy of the perineal body, and deposition of fat (Fig. 8-7).

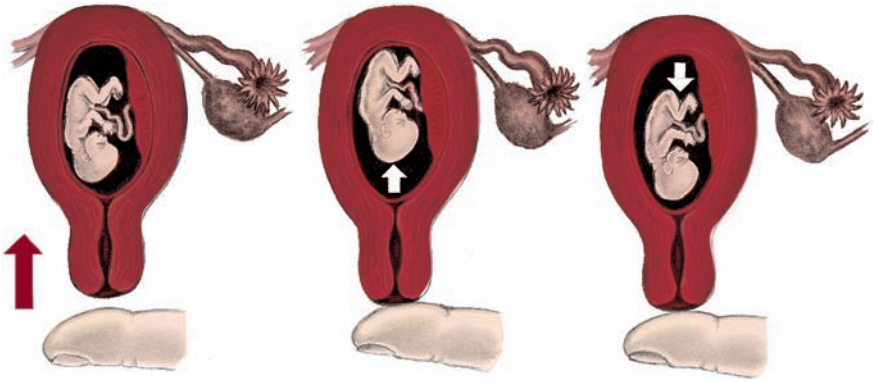

Fig. 8-5 Internal ballottement (18 weeks).

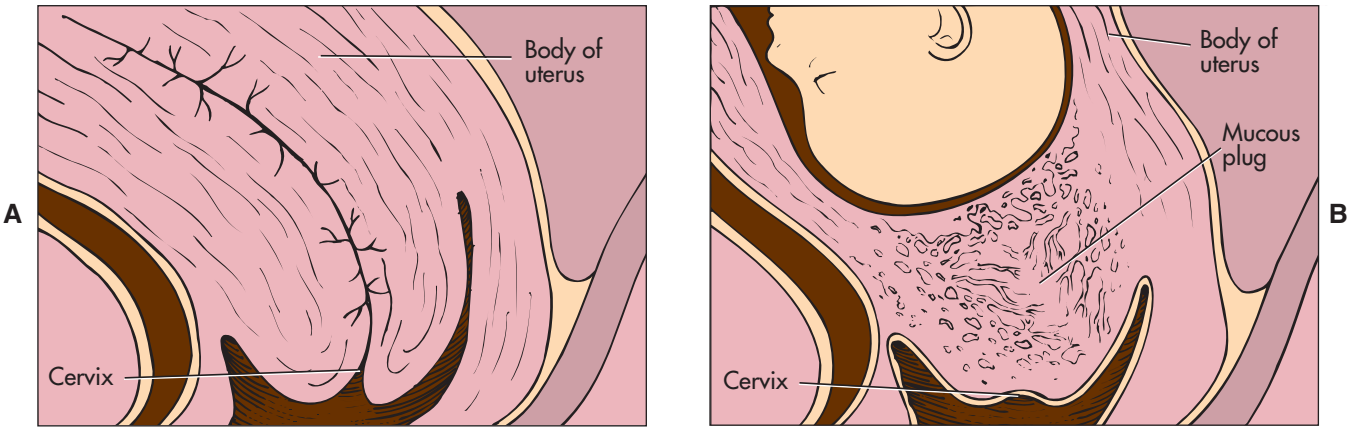

Fig. 8-6 **A,** Cervix in nonpregnant woman. **B,** Cervix during pregnancy.

The labia majora of the nullipara approximate and obscure the vaginal introitus; those of the parous woman separate and gape after childbirth and perineal or vaginal injury. Fig. 8-1 compares the perineum of the nullipara and the multipara in relation to the pregnant abdomen, vulva, and cervix.

Breasts

Fullness, heightened sensitivity, tingling, and heaviness of the breasts begin in the early weeks of gestation in response to increased levels of estrogen and progesterone. Breast sensitivity varies from mild tingling to sharp pain. Nipples and areolae become more pigmented, secondary pinkish areolae develop, extending beyond the primary areolae, and nipples become more erectile. Hypertrophy of the sebaceous (oil) glands embedded in the primary areolae, called **Montgomery tubercles** (see Fig. 4-6), may be seen around the nipples. These sebaceous glands may have a protective role in that they keep the nipples lubricated for breastfeeding.

The richer blood supply causes the vessels beneath the skin to dilate. Once barely noticeable, the blood vessels become visible, often appearing in an intertwining blue network beneath the surface of the skin. Venous congestion in the breasts is more obvious in primigravidas. Striae gravidarum may appear at the outer aspects of the breasts.

During the second and third trimesters, growth of the mammary glands accounts for the progressive breast enlargement. The high levels of luteal and placental hormones in pregnancy promote proliferation of the lactiferous ducts and lobule-alveolar tissue, so that palpation of the breasts reveals a generalized, coarse nodularity. Glandular tissue

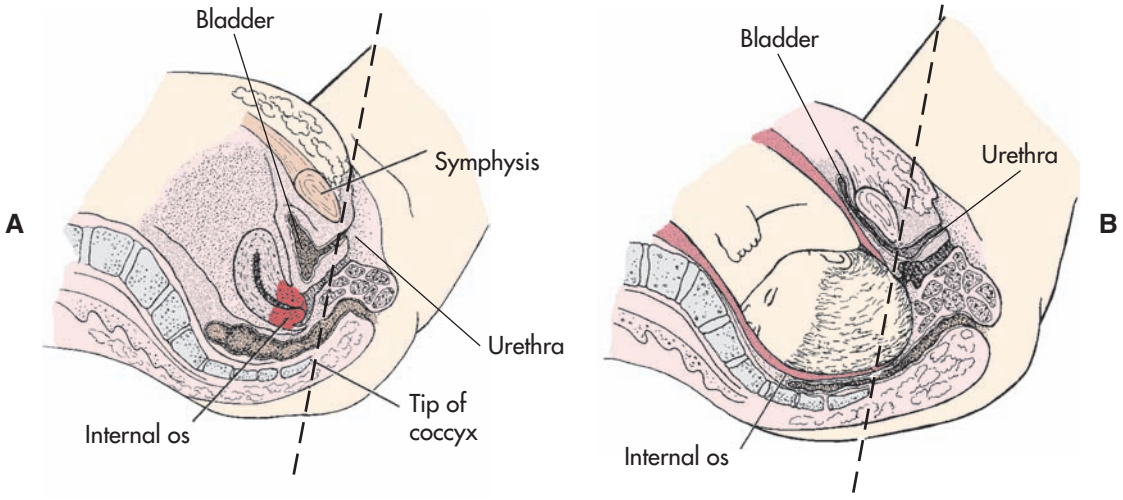

Fig. 8-7 **A,** Pelvic floor in nonpregnant woman. **B,** Pelvic floor at end of pregnancy. Note marked hypertrophy and hyperplasia below dotted line joining tip of coccyx and inferior margin of symphysis. Note elongation of bladder and urethra as a result of compression. Fat deposits are increased.

displaces connective tissue, and as a result, the tissue becomes softer and looser.

Although development of the mammary glands is functionally complete by midpregnancy, lactation is inhibited until a decrease in estrogen level occurs after the birth. A thin, clear, viscous secretory material (precolostrum) can be found in the acini cells by the third month of gestation. **Colostrum,** the creamy, white-to-yellowish to orange premilk fluid, may be expressed from the nipples as early as 16 weeks of gestation (Lawrence & Lawrence, 2004). See Chapter 20 for discussion of lactation.

General Body Systems

Cardiovascular system

Maternal adjustments to pregnancy involve extensive changes in the cardiovascular system, both anatomic and physiologic. Cardiovascular adaptations protect the woman's normal physiologic functioning, meet the metabolic demands pregnancy imposes on her body, and provide for fetal developmental and growth needs.

Slight cardiac hypertrophy (enlargement) is probably secondary to the increased blood volume and cardiac output that occurs. The heart returns to its normal size after childbirth. As the diaphragm is displaced upward by the enlarging uterus, the heart is elevated upward and rotated forward to the left (Fig. 8-8). The apical impulse, a point of maximal intensity (PMI), is shifted upward and laterally about 1 to 1.5 cm. The degree of shift depends on the duration of pregnancy and the size and position of the uterus.

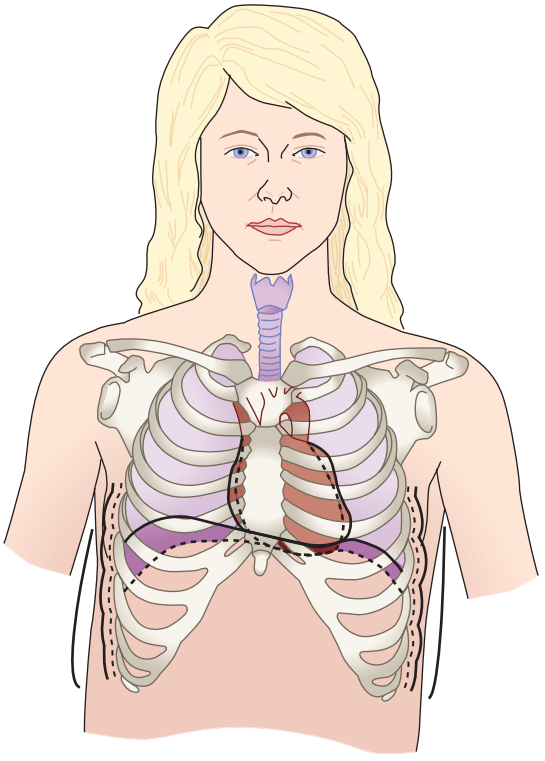

Fig. 8-8 Changes in position of heart, lungs, and thoracic cage in pregnancy. *Broken line,* nonpregnant; *solid line,* change that occurs in pregnancy.

The changes in heart size and position and increases in blood volume and cardiac output contribute to auscultatory changes common in pregnancy. There is more audible splitting of S_1 and S_2, and S_3 may be readily heard after 20 weeks of gestation. In addition, systolic and diastolic murmurs may be heard over the pulmonic area. These are transient and disappear shortly after the woman gives birth (Cunningham et al., 2005).

Between 14 and 20 weeks of gestation, the pulse increases about 10 to 15 beats/min, which then persists to term. Palpitations may occur. In twin gestations the maternal heart rate increases significantly in the third trimester (Malone & D'Alton, 2004).

The cardiac rhythm may be disturbed. The pregnant woman may experience sinus arrhythmia, premature atrial contractions, and premature ventricular systole. In the healthy woman with no underlying heart disease, no therapy is needed; however, women with preexisting heart disease will need close medical and obstetric supervision during pregnancy (see Chapter 22).

Blood pressure. Arterial blood pressure (brachial artery) is affected by age, activity level, presence of health problems, and circadian rhythm (Hermida, Ayala, Mojon, & Fernandez, 2001). Additional factors must be considered during pregnancy. These factors include maternal anxiety, maternal position, and size and type of blood pressure apparatus.

Maternal anxiety can elevate readings. If an elevated reading is found, the woman is given time to rest, and the reading is repeated.

Maternal position affects readings. Brachial blood pressure is highest when the woman is sitting, lowest when she is lying in the lateral recumbent position, and intermediate when she is supine, except for some women who experience supine hypotensive syndrome (see discussion later). Therefore at each prenatal visit, the reading should be obtained in the same arm and with the woman in the same position. The position and arm used should be recorded along with the reading (Gonik & Foley, 2004).

The proper-size cuff is absolutely necessary for accurate readings. The cuff should be 20% wider than the diameter of the arm around which it is wrapped, or about 12 to 14 cm for average-sized individuals and 18 to 20 cm for obese persons. Too small a cuff yields a false high reading; too large a cuff yields a false low reading. Caution also should be used when comparing auscultatory and oscillatory blood pressure readings, because discrepancies can occur (Pickering, 2002).

Systolic blood pressure usually remains the same as the prepregnancy level but may decrease slightly as pregnancy advances. Diastolic blood pressure begins to decrease in the first trimester, continues to drop until 24 to 32 weeks, then gradually increases and returns to prepregnancy levels by term (Blackburn, 2003; Monga, 2004).

Calculating the *mean arterial pressure (MAP)* (mean of the blood pressure in the arterial circulation) can increase the diagnostic value of the findings. Normal MAP readings in the nonpregnant woman are 86.4 mm Hg ± 7.5 mm Hg. MAP readings for a pregnant woman are slightly higher (Gonik & Foley, 2004). One way to calculate an MAP is illustrated in Box 8-1.

Some degree of compression of the vena cava occurs in all women who lie flat on their backs during the second half of pregnancy (see Fig. 14-5). Some women experience a decrease in their systolic blood pressure of more than 30 mm Hg. After 4 to 5 minutes a reflex bradycardia is noted, cardiac output is reduced by half, and the woman feels faint. This condition is referred to as *supine hypotensive syndrome* (Cunningham et al., 2005).

Compression of the iliac veins and inferior vena cava by the uterus causes increased venous pressure and reduced blood flow in the legs (except when the woman is in the lateral position). These alterations contribute to the dependent edema, varicose veins in the legs and vulva, and hemorrhoids that develop in the latter part of term pregnancy (Fig. 8-9).

Blood volume and composition. The degree of blood volume expansion varies considerably. Blood volume increases by approximately 1500 ml, or 40% to 45% above nonpregnancy levels (Cunningham et al., 2005). This increase consists of 1000 ml plasma plus 450 ml red blood cells (RBCs). The blood volume starts to increase at about the tenth to twelfth week, peaks at about the thirty-second to thirty-fourth week, and then decreases slightly at the fortieth week. The increase in volume of a multiple gestation is greater than that for a pregnancy with a single fetus (Malone & D'Alton, 2004). Increased volume is a protective mechanism. It is essential for meeting the blood volume needs of the hypertrophied vascular system of the enlarged uterus, for adequately hydrating fetal and maternal tissues when the woman assumes an erect or supine position, and for providing a fluid reserve to compensate for blood loss during birth and the puerperium. Peripheral vasodilation maintains a normal blood pressure despite the increased blood volume in pregnancy.

BOX 8-1

Calculation of Mean Arterial Pressure

Blood pressure: 106/70 mm Hg

Formula: $\frac{(\text{systolic}) + 2(\text{diastolic})}{3}$

$\frac{(106) + 2(70)}{3}$

$\frac{106 + 140}{3}$

246/3 = 82 mm Hg

Fig. 8-9 Hemorrhoids. (Courtesy Marjorie Pyle, RNC, Lifecircle, Costa Mesa, CA.)

During pregnancy there is an accelerated production of RBCs (normal, 4.2 to 5.4 million/mm^3). The percentage of increase depends on the amount of iron available. The RBC mass increases by about 20% to 30% (Monga, 2004).

Because the plasma increase exceeds the increase in RBC production, there is a decrease in normal hemoglobin values (12 to 16 g/dl blood) and hematocrit values (37% to 47%). This state of hemodilution is referred to as *physiologic anemia.* The decrease is more noticeable during the second trimester, when rapid expansion of blood volume takes place faster than RBC production. If the hemoglobin value decreases to 10 g/dl or less or if the hematocrit decreases to 35% or less, the woman is considered anemic.

The total white cell count increases during the second trimester and peaks during the third trimester. This increase is primarily in the granulocytes; the lymphocyte count stays about the same throughout pregnancy. See Table 8-3 for laboratory values during pregnancy.

Cardiac output. Cardiac output increases from 30% to 50% over the nonpregnant rate by the thirty-second week of pregnancy; it declines to about a 20% increase at 40 weeks of gestation. This elevated cardiac output is largely a result of increased stroke volume and heart rate and occurs in response to increased tissue demands for oxygen (Monga, 2004). Cardiac output in late pregnancy is appreciably higher when the woman is in the lateral recumbent position than when she is supine. In the supine position the large, heavy uterus often impedes venous return to the heart and affects blood pressure. Cardiac output increases with any exertion, such as labor and birth. Table 8-4 summarizes cardiovascular changes in pregnancy.

TABLE 8-3

Laboratory Values for Pregnant and Nonpregnant Women

VALUES	NONPREGNANT	PREGNANT
HEMATOLOGIC		
Complete Blood Count (CBC)		
Hemoglobin, g/dl	12-16*	>11*
Hematocrit, PCV, %	37-47	>33*
Red blood cell (RBC) volume, per ml	1600	1500-1900
Plasma volume, per ml	2400	3700
RBC count, million per mm^3	4.2-5.4	5.0-6.25
White blood cells, total per mm^3	5000-10,000	5000-15,000
Neutrophils, %	55-70	60-85
Lymphocytes, %	20-40	15-40
Erythrocyte sedimentation rate, mm/hr	20	Elevated in second and third trimesters
Mean corpuscular hemoglobin concentration (MCHC), g/dl packed RBCs	32-36	No change in hemoglobin concentration
Mean corpuscular hemoglobin (MCH), pg	27-31	No change per pg (less than 1 ng)
Mean corpuscular volume (MCV), μm^3	80-95	No change per μm^3
Blood Coagulation and Fibrinolytic Activity†		
Factor VII	65-140	Increase in pregnancy, return to normal in early puerperium
Factor VIII	55-145	Increases during pregnancy and immediately after birth
Factor IX	60-140	Increase in pregnancy returns to normal in early puerperium
Factor X	45-155	
Factor XI	65-135	Decrease in pregnancy
Factor XII	50-150	Increase in pregnancy, returns to normal in early puerperium
Prothrombin time (PT), sec	11-12.5	Slight decrease in pregnancy
Partial thromboplastin time (PTT), sec	60-70	Slight decrease in pregnancy and decrease during second and third stage of labor (indicates clotting at placental site)
Bleeding time, min	1-9 (Ivy)	No appreciable change
Coagulation time, min	6-10 (Lee/White)	No appreciable change
Platelets, per mm^3	150,000-400,000	No significant change until 3-5 days after birth and then a rapid increase (may predispose woman to thrombosis) and gradual return to normal
Fibrinolytic activity	Normal	Decreases in pregnancy and then abruptly returns to normal (protection against thromboembolism)
Fibrinogen, mg/dl	200-400	Increased levels late in pregnancy
Mineral and Vitamin Concentrations		
Vitamin B_{12}, folic acid, ascorbic acid	Normal	Moderate decrease
Serum Proteins		
Total, g/dl	6.4-8.3	5.5-7.5
Albumin, g/dl	3.5-5	Slight increase
Globulin, total, g/dl	2.3-3.4	3.0-4.0
Blood glucose		
Fasting, mg/dl	70-105	Decreases
2-hr postprandial, mg/dl	<140	<140 after a 100-g carbohydrate meal is considered normal

*At sea level. Permanent residents of higher altitudes (e.g., Denver) require higher levels of hemoglobin.
†Pregnancy represents a hypercoagulable state.
pg, picogram; μm^3, cubic micrometer; mm^3, cubic millimeter; *dl*, deciliter; *ng*, nanogram; *PVC*, packed cell volume.

Continued

TABLE 8-3

Laboratory Values for Pregnant and Nonpregnant Women—cont'd

VALUES	NONPREGNANT	PREGNANT
HEMATOLOGIC—cont'd		
Acid-base Values in Arterial Blood		
Po_2, mm Hg	80-100	104-108 (increased)
Pco_2, mm Hg	35-45	27-32 (decreased)
Sodium bicarbonate (HCO_3), mEq/L	21-28	18-31 (decreased)
Blood pH	7.35-7.45	7.40-7.45 (slightly increased, more alkaline)
HEPATIC		
Bilirubin, total, mg/dl	≤1	Unchanged
Serum cholesterol, mg/dl	120-200	Increases from 16 to 32 weeks of pregnancy; remains at this level until after birth
Serum alkaline phosphatase, units/L	30-120	Increases from week 12 of pregnancy to 6 weeks after birth
Serum albumin, g/dl	3.5-5.0	Slight increase
RENAL		
Bladder capacity, ml	1300	1500
Renal plasma flow (RPF), ml/min	490-700	Increase by 25%-30%
Glomerular filtration rate (GFR), ml/min	88-128	Increase by 30%-50%
Nonprotein nitrogen (NPN), mg/dl	25-40	Decreases
Blood urea nitrogen (BUN), mg/dl	10-20	Decreases
Serum creatinine, mg/dl	0.5-1.1	Decreases
Serum uric acid, mg/dl	2.7-7.3	Decreases
Urine glucose	Negative	Present in 20% of pregnant women
Intravenous pyelogram (IVP)	Normal	Slight-to-moderate hydroureter and hydronephrosis; right kidney larger than left kidney

From Gordon, M. (2002). Maternal physiology in pregnancy. In S. Gabbe, J. Niebyl, & J. Simpson (Eds.), *Obstetrics: Normal and problem pregnancies* (4th ed.). New York: Churchill Livingstone; Pagana, K., & Pagana, T. (2003). *Mosby's diagnostic and laboratory test reference* (6th ed.). St. Louis: Mosby.

TABLE 8-4

Cardiovascular Changes in Pregnancy

Heart rate	Increases 10-15 beats/min
Blood pressure	Remains at prepregnancy levels in first trimester Slight decrease in second trimester Returns to prepregnancy levels in third trimester
Blood volume	Increases by 1500 ml or 40%-50% above prepregnancy level
Red blood cell mass	Increases 17%
Hemoglobin	Decreases
Hematocrit	Decreases
White blood cell count	Increases in second and third trimesters
Cardiac output	Increases 30%-50%

Circulation and coagulation times. The circulation time decreases slightly by week 32. It returns to near normal by near term. There is a greater tendency for blood to coagulate (clot) during pregnancy because of increases in various clotting factors (factors VII, VIII, IX, X, and fibrinogen). This, combined with the fact that fibrinolytic activity (the splitting up or the dissolving of a clot) is depressed during pregnancy and the postpartum period, provides a protective function to decrease the chance of bleeding but also makes the woman more vulnerable to thrombosis, especially after cesarean birth.

Respiratory system

Structural and ventilatory adaptations occur during pregnancy to provide for maternal and fetal needs. Maternal oxygen requirements increase in response to the acceleration in the metabolic rate and the need to add to the tissue mass in the uterus and breasts. In addition, the fetus requires oxygen and a way to eliminate carbon dioxide.

Elevated levels of estrogen cause the ligaments of the rib cage to relax, permitting increased chest expansion (see Fig. 8-8). The transverse diameter of the thoracic cage increases by about 2 cm, and the circumference increases by 6 cm (Cunningham et al., 2005). The costal angle increases, and the lower rib cage appears to flare out. The chest may not return to its prepregnant state after birth (Seidel, Ball, Dains, & Benedict, 2003).

The diaphragm is displaced by as much as 4 cm during pregnancy. As pregnancy advances, thoracic (costal) breathing replaces abdominal breathing, and it becomes less possible for the diaphragm to descend with inspiration. Thoracic breathing is accomplished primarily by the diaphragm rather than by the costal muscles (Whitty & Dombrowski, 2004).

The upper respiratory tract becomes more vascular in response to elevated levels of estrogen. As the capillaries become engorged, edema and hyperemia develop within the nose, pharynx, larynx, trachea, and bronchi. This congestion within the tissues of the respiratory tract gives rise to several conditions commonly seen during pregnancy, including nasal and sinus stuffiness, epistaxis (nosebleed), changes in the voice, and a marked inflammatory response that can develop into a mild upper respiratory infection.

Increased vascularity of the upper respiratory tract also can cause the tympanic membranes and eustachian tubes to swell, giving rise to symptoms of impaired hearing, earaches, or a sense of fullness in the ears.

Pulmonary function. Respiratory changes in pregnancy are related to the elevation of the diaphragm and to chest wall changes. Changes in the respiratory center result in a lowered threshold for carbon dioxide. The actions of progesterone and estrogen are presumed responsible for the increased sensitivity of the respiratory center to carbon dioxide. In addition, pregnant women become more aware of the need to breathe; some may even complain of dyspnea at rest, especially in the third trimester (Blackburn, 2003) (see Table 8-5 for respiratory changes in pregnancy). Although pulmonary function is not impaired by pregnancy, diseases of the respiratory tract may be more serious during this time (Cunningham et al., 2005). One important factor responsible for this may be the increased oxygen requirement.

Basal metabolic rate. The basal metabolic rate (BMR) increases during pregnancy. This increase varies considerably depending on the prepregnancy nutritional status of the woman and fetal growth (Blackburn, 2003). The BMR returns to nonpregnant levels by 5 to 6 days after birth. The elevation in BMR during pregnancy reflects increased oxygen demands of the uterine-placental-fetal unit and greater oxygen consumption because of increased maternal cardiac work. Peripheral vasodilation and acceleration of sweat gland activity help dissipate the excess heat resulting from the increased BMR during pregnancy. Pregnant women may experience heat intolerance, which is annoying to some women. Lassitude and fatigability after only slight exertion are experienced by many women in early pregnancy. These feelings, along with a greater need for sleep, may persist and may be caused in part by the increased metabolic activity.

TABLE 8-5

Respiratory Changes in Pregnancy

Respiratory rate	Unchanged or slightly increased
Tidal volume	Increased 30%-40%
Vital capacity	Unchanged
Inspiratory capacity	Increased
Expiratory volume	Decreased
Total lung capacity	Unchanged to slightly decreased
Oxygen consumption	Increased 15%-20%

Acid-base balance. By about the tenth week of pregnancy, there is a decrease of about 5 mm Hg in the partial pressure of carbon dioxide (P_{CO_2}). Progesterone may be responsible for increasing the sensitivity of the respiratory center receptors, so that tidal volume is increased, P_{CO_2} decreases, the base excess (HCO_3 or bicarbonate) decreases, and pH increases slightly. These alterations in acid-base balance indicate that pregnancy is a state of compensatory respiratory alkalosis (Blackburn, 2003). These changes also facilitate the transport of CO_2 from the fetus and O_2 release from the mother to the fetus (see Table 8-3).

Renal system

The kidneys are responsible for maintaining electrolyte and acid-base balance, regulating extracellular fluid volume, excreting waste products, and conserving essential nutrients.

Anatomic changes. Changes in renal structure during pregnancy result from hormonal activity (estrogen and progesterone), pressure from an enlarging uterus, and an increase in blood volume. As early as the tenth week of pregnancy, the renal pelves and the ureters dilate. Dilation of the ureters is more pronounced above the pelvic brim, in part because they are compressed between the uterus and the pelvic brim. In most women, the ureters below the pelvic brim are of normal size. The smooth-muscle walls of the ureters undergo hyperplasia, hypertrophy, and muscle tone relaxation. The ureters elongate, become tortuous, and form single or double curves. In the latter part of pregnancy, the renal pelvis and ureter are dilated more on the right side than on the left because the heavy uterus is displaced to the right by the sigmoid colon.

Because of these changes, a larger volume of urine is held in the pelves and ureters, and urine flow rate is slowed. The resulting urinary stasis or stagnation has the following consequences:

- A lag occurs between the time urine is formed and when it reaches the bladder. Therefore clearance test results may reflect substances contained in glomerular filtrate several hours before.
- Stagnated urine is an excellent medium for the growth of microorganisms. In addition, the urine of pregnant women contains more nutrients, including glucose, thereby increasing the pH (making the urine more alkaline). This makes pregnant women more susceptible to urinary tract infection.

Bladder irritability, nocturia, and urinary frequency and urgency (without dysuria) are commonly reported in early pregnancy. Near term, bladder symptoms may return, especially after lightening occurs.

Urinary frequency results initially from increased bladder sensitivity and later from compression of the bladder (see Fig. 8-7). In the second trimester, the bladder is pulled up out of the true pelvis into the abdomen. The urethra lengthens to 7.5 cm as the bladder is displaced upward. The pelvic congestion that occurs in pregnancy is reflected in hyperemia of the bladder and urethra. This increased vascularity causes the bladder mucosa to be traumatized and bleed easily. Bladder tone may decrease, which increases the bladder capacity to 1500 ml. At the same time, the bladder is compressed by the enlarging uterus, resulting in the urge to void even if the bladder contains only a small amount of urine.

Functional changes. In normal pregnancy, renal function is altered considerably. Glomerular filtration rate (GFR) and renal plasma flow (RPF) increase early in pregnancy (Cunningham et al., 2005). These changes are caused by pregnancy hormones, an increase in blood volume, the woman's posture, physical activity, and nutritional intake. The woman's kidneys must manage the increased metabolic and circulatory demands of the maternal body and the excretion of fetal waste products. Renal function is most efficient when the woman lies in the lateral recumbent position and least efficient when the woman assumes a supine position. A side-lying position increases renal perfusion, which increases urinary output and decreases edema. When the pregnant woman is lying supine, the heavy uterus compresses the vena cava and the aorta, and cardiac output decreases. As a result, blood flow to the brain and heart is continued at the expense of other organs, including the kidneys and uterus.

Fluid and electrolyte balance. Selective renal tubular reabsorption maintains sodium and water balance regardless of changes in dietary intake and losses through sweat, vomitus, or diarrhea. From 500 to 900 mEq of sodium is normally retained during pregnancy to meet fetal needs. To prevent excessive sodium depletion, the maternal kidneys undergo a significant adaptation by increasing tubular reabsorption. Because of the need for increased maternal intravascular and extracellular fluid volume, additional sodium is needed to expand fluid volume and to maintain an isotonic state. As efficient as the renal system is, it can be overstressed by excessive dietary sodium intake or restriction or by use of diuretics. Severe hypovolemia and reduced placental perfusion are two consequences of using diuretics during pregnancy.

The capacity of the kidneys to excrete water during the early weeks of pregnancy is more efficient than it is later in pregnancy. As a result, some women feel thirsty in early pregnancy because of the greater amount of water loss. The pooling of fluid in the legs in the latter part of pregnancy decreases renal blood flow and GFR. This pooling of blood in the lower legs is sometimes referred to as *physiologic edema* or dependent edema and requires no treatment. The normal diuretic response to the water load is triggered when the woman lies down, preferably on her side, and the pooled fluid reenters general circulation.

Normally the kidney reabsorbs almost all of the glucose and other nutrients from the plasma filtrate. In pregnant women, however, tubular reabsorption of glucose is impaired, so that glucosuria occurs at varying times and to varying degrees. Normal values range from 0 to 20 mg/dl, meaning that during any day, the urine is sometimes positive and sometimes negative. In nonpregnant women, blood glucose levels must be at 160 to 180 mg/dl before glucose is "spilled" into the urine (not reabsorbed). During pregnancy, glucosuria (glycosuria) occurs when maternal glucose levels are lower than 160 mg/dl. Why glucose, as well as other nutrients such as amino acids, is wasted during pregnancy is not understood, nor has the exact mechanism been discovered. Although glucosuria may be found in normal pregnancies (2+ levels may be seen with increased anxiety states), the possibility of diabetes mellitus and gestational diabetes must be kept in mind.

Proteinuria usually does not occur in normal pregnancy except during labor or after birth (Cunningham et al., 2005). However, the increased amount of amino acids that must be filtered may exceed the capacity of the renal tubules to absorb it, so that small amounts of protein are then lost in the urine. Values of trace to 1+ protein (dipstick assessment) or less than 300 mg per 24 hours are acceptable during pregnancy (Gordon, 2002). The amount of protein excreted is not an indication of the severity of renal disease, nor does an increase in protein excretion in a pregnant woman with known renal disease necessarily indicate a progression in her disease. However, a pregnant woman with hypertension and proteinuria must be carefully evaluated because she may be at greater risk for an adverse pregnancy outcome (see Table 8-3).

Integumentary system

Alterations in hormonal balance and mechanical stretching are responsible for several changes in the integumentary system during pregnancy. Hyperpigmentation is stimulated by the anterior pituitary hormone melanotropin, which is increased during pregnancy. Darkening of the nipples, areolae, axillae, and vulva occurs about the sixteenth week of gestation. Facial melasma, also called **chloasma** or mask of pregnancy, is a blotchy, brownish hyperpigmentation of the skin over the cheeks, nose, and forehead, especially in dark-complexioned pregnant women. Chloasma appears in 50% to 70% of pregnant women, beginning after the sixteenth week and increasing gradually until term. The sun intensifies this pigmentation in susceptible women. Chloasma caused by normal pregnancy usually fades after birth.

The **linea nigra** (Fig. 8-10) is a pigmented line extending from the symphysis pubis to the top of the fundus in the midline; this line is known as the *linea alba* before

Fig. 8-10 Striae gravidarum and linea nigra in a dark-skinned person. (Courtesy Shannon Perry, Phoenix, AZ.)

hormone-induced pigmentation. In primigravidas the extension of the linea nigra, beginning in the third month, keeps pace with the rising height of the fundus; in multigravidas, the entire line often appears earlier than the third month. Not all pregnant women develop linea nigra, and some women notice hair growth along the line with or without the change in pigmentation.

Striae gravidarum, or stretch marks (seen over lower abdomen in Fig. 8-10), which appear in 50% to 90% of pregnant women during the second half of pregnancy, may be caused by action of adrenocorticosteroids. Striae reflect separation within the underlying connective (collagen) tissue of the skin. These slightly depressed streaks tend to occur over areas of maximal stretch (i.e., abdomen, thighs, and breasts). The stretching sometimes causes a sensation that resembles itching. The tendency to develop striae may be familial. After birth they usually fade, although they never disappear completely. Color of striae varies depending on the pregnant woman's skin color. The striae appear pinkish on a woman with light skin and are lighter than surrounding skin in dark-skinned women. In the multipara, in addition to the striae of the present pregnancy, glistening silvery lines (in light-skinned women) or purplish lines (in dark-skinned women) are commonly seen. These represent the scars of striae from previous pregnancies.

Angiomas are commonly referred to as *vascular spiders.* They are tiny, star-shaped or branched, slightly raised and pulsating end-arterioles usually found on the neck, thorax, face, and arms. They occur as a result of elevated levels of circulating estrogen. The spiders are bluish in color and do not blanch with pressure. Vascular spiders appear during the second to the fifth month of pregnancy in almost 65% of Caucasian women and 10% of African-American women. The spiders usually disappear after birth (Blackburn, 2003).

Pinkish-red, diffuse mottling or well-defined blotches are seen over the palmar surfaces of the hands in about 60% of Caucasian women and 35% of African-American women during pregnancy (Blackburn, 2003). These color changes, called **palmar erythema,** are related primarily to increased estrogen levels.

NURSE ALERT *Because integumentary system changes vary greatly among women of different racial backgrounds, the color of a woman's skin should be noted along with any changes that may be attributed to pregnancy when performing physical assessments.*

Some dermatologic conditions have been identified as unique to pregnancy or as having an increased incidence during pregnancy. Pruritus is a relatively common dermatologic symptom in pregnancy, with *cholestasis of pregnancy* being the most common cause of pruritic rash. Other forms are uncommon or rare (Rapini, 2004) (Box 8-2). The goal of management is to relieve the itching. Topical steroids are the usual treatment, although systemic steroids may be needed. The problem usually resolves in the postpartum period (Stambuk & Colven, 2002). Preexisting skin diseases may complicate pregnancy or be improved.

NURSE ALERT *Women with severe acne taking isotretinoin (Accutane) should avoid pregnancy while receiving the treatment because it is teratogenic and is associated with major malformations.*

Gum hypertrophy may occur. An **epulis** (gingival granuloma gravidarum) is a red, raised nodule on the gums that bleeds easily. This lesion may develop around the third month and usually continues to enlarge as pregnancy progresses. It is usually managed by avoiding trauma to the gums (e.g., using a soft toothbrush). An epulis usually regresses spontaneously after birth.

Nail growth may be accelerated. Some women may notice thinning and softening of the nails. Oily skin and acne vulgaris may occur during pregnancy. For some women, the skin clears and looks radiant. Hirsutism, the excessive growth of hair or growth of hair in unusual places, is commonly reported. An increase in fine hair growth may occur but tends to disappear after pregnancy; however, growth of coarse or

BOX 8-2

Frequency of Dermatologic Disorders of Pregnancy

Cholestasis of pregnancy: 1.5%-2%
Pruritic urticarial papules and plaques of pregnancy: 0.6%
Prurigo of pregnancy: 0.3%
Herpes gestationis: 0.002%
Impetigo herpetiformis: very rare

Source: Rapini, R. (2004). The skin and pregnancy. In R. Creasy, R. Resnik, & J. Iams (Eds.), *Maternal-fetal medicine: Principles and practice* (5th ed.). Philadelphia: Saunders.

bristly hair does not usually disappear. The rate of scalp hair loss slows during pregnancy, and increased hair loss may be noted in the postpartum period.

Increased blood supply to the skin leads to increased perspiration. Women feel hotter during pregnancy, a condition possibly related to a progesterone-induced increase in body temperature and the increased BMR.

Musculoskeletal system

The gradually changing body and increasing weight of the pregnant woman cause noticeable alterations in her posture (Fig. 8-11) and the way she walks. The great abdominal distention that gives the pelvis a forward tilt, decreased abdominal muscle tone, and increased weight bearing require a realignment of the spinal curvature late in pregnancy. The woman's center of gravity shifts forward. An increase in the normal lumbosacral curve (lordosis) develops, and a compensatory curvature in the cervicodorsal region (exaggerated anterior flexion of the head) develops to help her maintain her balance. Aching, numbness, and weakness of the upper extremities may result. Large breasts and a stoop-shouldered stance will further accentuate the lumbar and dorsal curves. Walking is more difficult, and the waddling gait of the pregnant woman, called "the proud walk of pregnancy" by Shakespeare, is well known. The ligamentous and muscular structures of the middle and lower spine may be severely stressed. These and related changes often cause musculoskeletal discomfort, especially in older women or those with a back disorder or a faulty sense of balance.

Slight relaxation and increased mobility of the pelvic joints are normal during pregnancy. They are secondary to the exaggerated elasticity and softening of connective and collagen tissue caused by increased circulating steroid sex hormones, especially estrogen. Relaxin, an ovarian hormone, assists in this relaxation and softening. These adaptations permit enlargement of pelvic dimensions to facilitate labor and birth. The degree of relaxation varies, but considerable separation of the symphysis pubis and the instability of the sacroiliac joints may cause pain and difficulty in walking. Obesity and multifetal pregnancy tend to increase the pelvic instability. Peripheral joint laxity also increases as pregnancy progresses, but the cause is not known (Cunningham et al., 2005).

The muscles of the abdominal wall stretch and ultimately lose some tone. During the third trimester, the rectus abdominis muscles may separate (Fig. 8-12), allowing abdominal contents to protrude at the midline. The umbilicus flattens or protrudes. After birth, the muscles gradually regain tone; however, separation of the muscles **(diastasis recti abdominis)** may persist.

Neurologic system

Little is known regarding specific alterations in function of the neurologic system during pregnancy, aside from hypothalamic-pituitary neurohormonal changes. Specific

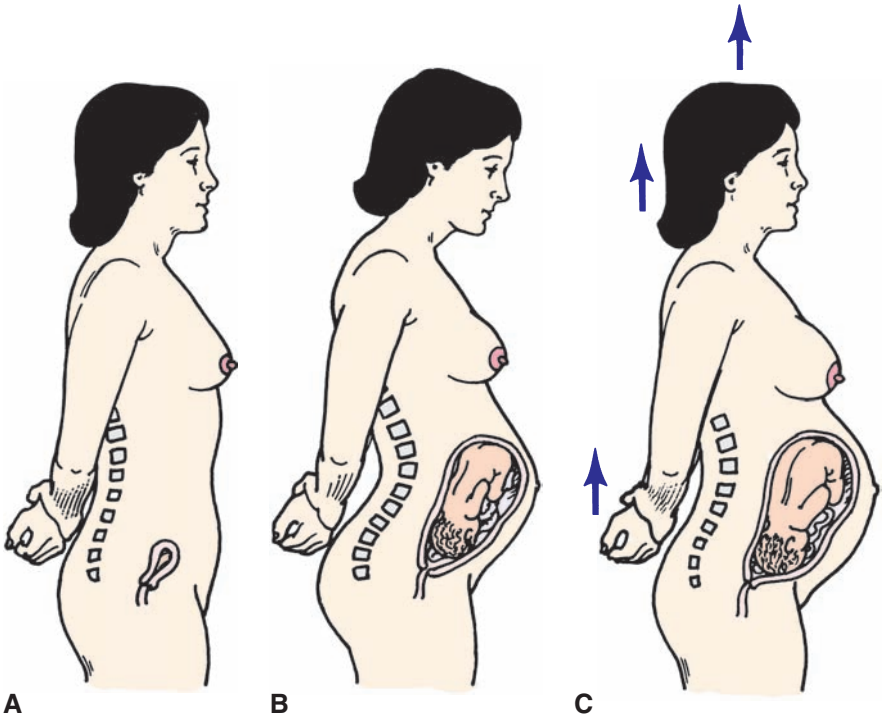

Fig. 8-11 Postural changes during pregnancy. **A,** Nonpregnant. **B,** Incorrect posture. **C,** Correct posture during pregnancy.

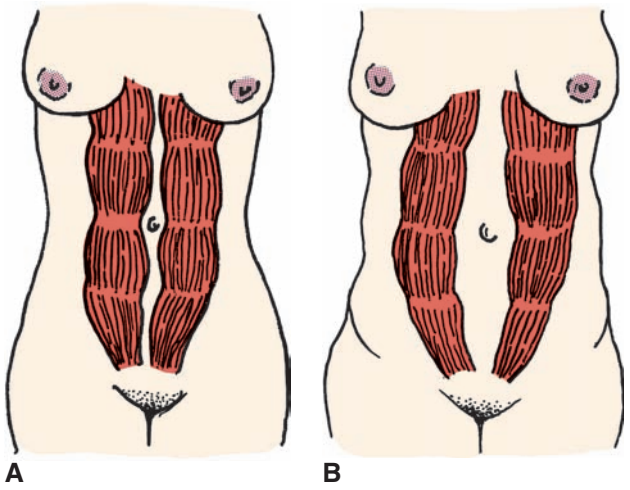

Fig. 8-12 Possible change in rectus abdominis muscles during pregnancy. **A,** Normal position in nonpregnant woman. **B,** Diastasis recti abdominis in pregnant woman.

physiologic alterations resulting from pregnancy may cause the following neurologic or neuromuscular symptoms:

- Compression of pelvic nerves or vascular stasis caused by enlargement of the uterus may result in sensory changes in the legs.
- Dorsolumbar lordosis may cause pain because of traction on nerves or compression of nerve roots.
- Edema involving the peripheral nerves may result in **carpal tunnel syndrome** during the last trimester (Padua et al., 2001). The syndrome is characterized by paresthesia (abnormal sensation such as burning or tingling) and pain in the hand, radiating to the elbow. The sensations are caused by edema that compresses the median nerve beneath the carpal ligament of the wrist. Smoking and alcohol consumption can impair the microcirculation and may worsen the symptoms (Padua et al., 2001). The dominant hand is usually affected most, although as many as 80% of women experience symptoms in both hands. Symptoms usually regress after pregnancy. In some cases, surgical treatment may be necessary (Aminoff, 2004).
- Acroesthesia (numbness and tingling of the hands) is caused by the stoop-shouldered stance (see Fig. 8-11, *B*) assumed by some women during pregnancy. The condition is associated with traction on segments of the brachial plexus.
- Tension headache is common when anxiety or uncertainty complicates pregnancy. However, vision problems, sinusitis, or migraine also may be responsible for headaches.
- "Light-headedness," faintness, and even syncope (fainting) are common during early pregnancy. Vasomotor instability, postural hypotension, or hypoglycemia may be responsible.
- Hypocalcemia may cause neuromuscular problems such as muscle cramps or tetany.

Gastrointestinal system

Appetite. During pregnancy, the woman's appetite and food intake fluctuate. Early in pregnancy, some women have nausea with or without vomiting (morning sickness), possibly in response to increasing levels of hCG and altered carbohydrate metabolism (Gordon, 2002). Morning sickness or nausea and vomiting of pregnancy (NVP) appears at about 4 to 6 weeks of gestation and usually subsides by the end of the third month (first trimester) of pregnancy. Severity varies from mild distaste for certain foods to more severe vomiting. The condition may be triggered by the sight or odor of various foods. By the end of the second trimester, the appetite increases in response to increasing metabolic needs. Rarely does NVP have harmful effects on the embryo, fetus, or the woman; some beneficial effects may be that these pregnancies may be less likely to result in miscarriage, preterm labor, or intrauterine growth restriction (Furneaux, Langley-Evans, & Langley-Evans, 2001). Whenever the vomiting is severe or persists beyond the first trimester, or when it is accompanied by fever, pain, or weight loss, further evaluation is necessary, and medical intervention is likely.

Women also may have changes in their sense of taste, leading to cravings and changes in dietary intake. Some women have nonfood cravings (called *pica*), such as for ice, clay, and laundry starch. Usually the subjects of these cravings, if consumed in moderation, are not harmful to the pregnancy if the woman has adequate nutrition with appropriate weight gain (Gordon, 2002).

Mouth. The gums become hyperemic, spongy, and swollen during pregnancy. They tend to bleed easily because the increasing levels of estrogen cause selective increased vascularity and connective tissue proliferation (a nonspecific gingivitis). Epulis (discussed in the section on the integumentary system) may develop at the gumline. Some pregnant women complain of **ptyalism** (excessive salivation), which may be caused by the decrease in unconscious swallowing by the woman when nauseated or from stimulation of salivary glands by eating starch (Cunningham et al., 2005).

Esophagus, stomach, and intestines. Herniation of the upper portion of the stomach (hiatal hernia) occurs after the seventh or eighth month of pregnancy in about 15% to 20% of pregnant women. This condition results from upward displacement of the stomach, which causes the hiatus of the diaphragm to widen. It occurs more often in multiparas and older or obese women.

Increased estrogen production causes decreased secretion of hydrochloric acid; therefore peptic ulcer formation or flare-up of existing peptic ulcers is uncommon during pregnancy and may improve (Winbery & Blaho, 2001).

Increased progesterone production causes decreased tone and motility of smooth muscles, resulting in esophageal regurgitation, slower emptying time of the stomach, and reverse peristalsis. As a result, the woman may experience "acid indigestion" or heartburn **(pyrosis)** beginning as early as the first trimester and intensifying through the third trimester.

EVIDENCE-BASED PRACTICE

Relief for First-Trimester Nausea and Vomiting

BACKGROUND

- In the first trimester of pregnancy, nausea affects 70% to 85% of all women, and vomiting affects 50%. The discomfort can last all day, and, for 13% of affected women, can persist beyond the twentieth week. About one pregnant woman in three loses some time from work or home duties. In its most severe form, hyperemesis gravidarum can cause dehydration and starvation, and even death. Before the current era of easy replacement with intravenous fluids, hyperemesis was a major reason for pregnancy termination. It has been speculated that nausea and vomiting of pregnancy is attributable to the level of human chorionic gonadotropin. The occurrence of nausea and vomiting is low in women who eventually have a miscarriage and high in women with multiple pregnancies.

OBJECTIVES

- The authors of this review wished to discover any effective interventions for relief of nausea and vomiting of early pregnancy.
- Intervention for nausea and vomiting of pregnancy could include antihistamine or antiemetic medications, pyridoxine (vitamin B_6), acupuncture, or acupressure at the p6 point, which is the inner aspect of the wrist, between the two tendons, about three fingerbreadths proximal from the wrist. For hyperemesis gravidarum, interventions could include ginger, corticosteroid or adrenocorticotropic hormone (ACTH) injections, intravenous diazepam, oral ondansetron, and acupuncture. Outcome measures included nausea, vomiting, retching, side effects of medications, and fetal outcomes.

METHODS

Search Strategy

- Search strategy included Cochrane, MEDLINE, manual searches of 30 journals, and weekly awareness service of 37 journals. Search keywords included *nausea and vomiting* and *pregnancy.*
- Twenty-eight trials met the inclusion criteria, representing 3577 women. Publication dates ranged from 1958 to 2000. Countries were not noted in the review.

Statistical Analyses

- Statistical analyses of homogeneous data enabled pooling. All data were assigned an odds ratio with a 95% confidence interval. Analysis revealed whether the differences between groups were possibly a result of chance alone (insignificant).

FINDINGS

- *Antiemetic drugs (12 trials):* Nausea is significantly reduced by use of antiemetic drugs, but the medications may cause sleepiness. Bendectin was withdrawn from the market in 1983 owing to fears that it could cause birth defects, but subsequent large, randomized, controlled trials showed no evidence of teratogenicity.
- *Pyridoxine (vitamin B_6):* Two trials found significantly reduced nausea but no effect on vomiting in the pyridoxine groups compared with controls. There may be greater effect of 75 mg/day than with 30 mg/day.
- *Ginger:* One trial reported that ginger is significantly helpful with nausea and vomiting.
- *Acupuncture or p6 acupressure:* Six trials found that p6 acupressure or acupuncture was significantly more effective at relieving nausea and vomiting than sham acupuncture or sham acupressure at incorrect sites.
- No intervention helped hyperemesis gravidarum, but oral methylprednisone and intravenous diazepam were associated with lower readmission rates. Ginger showed some promise, but not significantly.
- There was no evidence of birth defects caused by the interventions in these trials.

LIMITATIONS

- The challenges in reviewing such a large pool of studies are the diverse protocols, variable periods of observation, and diverse sample criteria. Several trials did not report how they randomized, or what happened to their dropouts, which limits generalizability. Most of the trials were small. The long time span (42 years) in which the trials occurred makes comparisons problematic, because technology has solved some problems (such as ease of intravenous hydration) and created others (such as side effects of antiemetic drugs).

CONCLUSIONS

- Several therapies are effective in reducing nausea and vomiting of early pregnancy. These therapies include pyridoxine, fresh ginger root, Sea-Bands, and antiemetic drugs.

IMPLICATIONS FOR PRACTICE

- Women may benefit from taking 10 to 25 mg of pyridoxine three times a day for nausea and vomiting of early pregnancy. Fresh ginger root may be beneficial. Women can try Sea-Bands, which are elastic wristbands with a plastic knob, to be applied to the p6 acupressure site. Remedies may not work consistently. Antiemetic drugs are available, if necessary.

IMPLICATIONS FOR FURTHER RESEARCH

- More information about hyperemesis gravidarum is necessary to identify interventions for this intractable disease. More information about the fetal outcomes of antiemetic medications is essential.

Reference: Jewell, D., & Young, G. (2003). Interventions for nausea and vomiting in early pregnancy (Cochrane Review). In *The Cochrane Library,* Issue 2, 2004. Chichester, UK: John Wiley & Sons.

Iron is absorbed more readily in the small intestine in response to increased needs during pregnancy. Even when the woman is deficient in iron, it will continue to be absorbed in sufficient amounts for the fetus to have a normal hemoglobin level.

Increased progesterone (causing loss of muscle tone and decreased peristalsis) results in an increase in water absorption from the colon and may cause constipation. Constipation also may result from hypoperistalsis (sluggishness of the bowel), food choices, lack of fluids, iron supplementation, decreased activity level, abdominal distention by the pregnant uterus, and displacement and compression of the intestines. If the pregnant woman has hemorrhoids (see Fig. 8-9) and is constipated, the hemorrhoids may become everted or may bleed during straining at stool.

Gallbladder and liver. The gallbladder is quite often distended because of its decreased muscle tone during pregnancy. Increased emptying time and thickening of bile caused by prolonged retention are typical changes. These features, together with slight hypercholesterolemia from increased progesterone levels, may account for the development of gallstones during pregnancy.

Hepatic function is difficult to appraise during pregnancy; however, only minor changes in liver function develop. Occasionally, intrahepatic cholestasis (retention and accumulation of bile in the liver, caused by factors within the liver) occurs late in pregnancy in response to placental steroids and may result in pruritus gravidarum (severe itching) with or without jaundice. These distressing symptoms subside soon after birth.

Abdominal discomfort. Intraabdominal alterations that can cause discomfort include pelvic heaviness or pressure, round ligament tension, flatulence, distention and bowel cramping, and uterine contractions. In addition to displacement of intestines, pressure from the expanding uterus causes an increase in venous pressure in the pelvic organs. Although most abdominal discomfort is a consequence of normal maternal alterations, the health care provider must be constantly alert to the possibility of disorders such as bowel obstruction or an inflammatory process.

Appendicitis may be difficult to diagnose in pregnancy because the appendix is displaced upward and laterally, high and to the right, away from McBurney's point (Fig. 8-13).

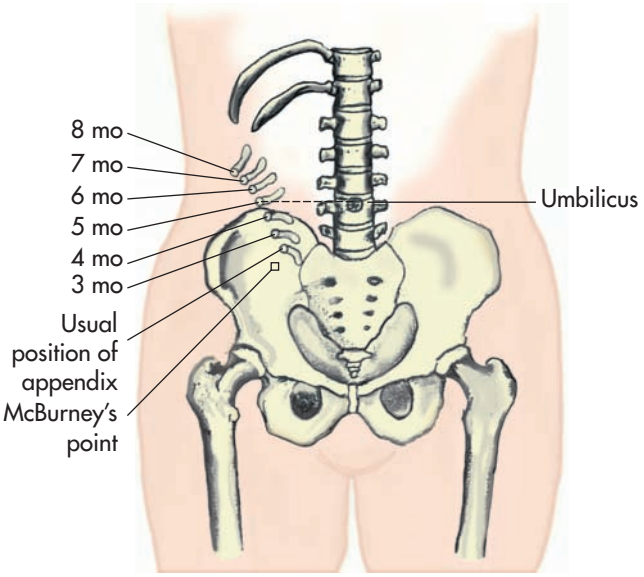

Fig. 8-13 Change in position of appendix in pregnancy. Note McBurney's point.

Endocrine system

Profound endocrine changes are essential for pregnancy maintenance, normal fetal growth, and postpartum recovery.

Pituitary and placental hormones. During pregnancy, the elevated levels of estrogen and progesterone (produced first by the corpus luteum in the ovary until about 14 weeks of gestation and then by the placenta) suppress secretion of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) by the anterior pituitary. The maturation of a follicle and ovulation do not occur. Although the majority of women have amenorrhea (absence of menses), at least 20% have some slight, painless spotting during early gestation. Implantation bleeding and bleeding after intercourse related to cervical friability can occur. Most of the women experiencing slight gestational bleeding continue to term and have normal infants; however, all instances of bleeding should be reported and evaluated.

After implantation, the fertilized ovum and the chorionic villi produce hCG, which maintains the production by the corpus luteum of estrogen and progesterone until the placenta takes over production (Buster & Carson, 2002).

Progesterone is essential for maintaining pregnancy by relaxing smooth muscles, resulting in decreased uterine contractility and prevention of miscarriage. Progesterone and estrogen cause fat to deposit in subcutaneous tissues over the maternal abdomen, back, and upper thighs. This fat serves as an energy reserve for both pregnancy and lactation. Estrogen also promotes the enlargement of the genitals, uterus, and breasts and increases vascularity, causing vasodilation. Estrogen causes relaxation of pelvic ligaments and joints. It also alters metabolism of nutrients by interfering with folic acid metabolism, increasing the level of total body proteins, and promoting retention of sodium and water by kidney tubules. Estrogen may decrease secretion of hydrochloric acid and pepsin, which may be responsible for digestive upsets such as nausea.

Serum prolactin produced by the anterior pituitary begins to increase early in the first trimester and increases progressively to term. It is responsible for initial lactation; however, the high levels of estrogen and progesterone inhibit lactation by blocking the binding of prolactin to breast tissue until after birth (Liu, 2004).

Oxytocin is produced by the posterior pituitary in increasing amounts as the fetus matures. This hormone can stimulate uterine contractions during pregnancy, but high levels of progesterone prevent contractions until near term.

Oxytocin also stimulates the let-down or milk-ejection reflex after birth in response to the infant's sucking at the mother's breast.

Human chorionic somatomammotropin (hCS), previously called human placental lactogen and produced by the placenta has been suggested to act as a growth hormone and contribute to breast development. It also may decrease the maternal metabolism of glucose and increase the amount of fatty acids for metabolic needs; however, its function is poorly understood (Liu, 2004).

Thyroid gland. During pregnancy, gland activity and hormone production increase. The increased activity is reflected in a moderate enlargement of the thyroid gland caused by hyperplasia of the glandular tissue and increased vascularity (Cunningham et al., 2005). Thyroxine-binding globulin (TBG) increases as a result of increased estrogen levels. This increase begins at about 20 weeks of gestation. The level of total (free and bound) thyroxine (T_4) increases between 6 and 9 weeks of gestation and plateaus at 18 weeks of gestation. Free thyroxine (T_4) and free triiodothyronine (T_3) return to nonpregnant levels after the first trimester. Despite these changes in hormone production, hyperthyroidism usually does not develop in the pregnant woman (Cunningham et al., 2005).

Parathyroid gland. Parathyroid hormone controls calcium and magnesium metabolism. Pregnancy induces a slight hyperparathyroidism, a reflection of increased fetal requirements for calcium and vitamin D. The peak level of parathyroid hormone occurs between 15 and 35 weeks of gestation, when the needs for growth of the fetal skeleton are greatest. Levels return to normal after birth.

Pancreas. The fetus requires significant amounts of glucose for its growth and development. To meet its need for fuel, the fetus not only depletes the store of maternal glucose but also decreases the mother's ability to synthesize glucose by siphoning off her amino acids. Maternal blood glucose levels decrease. Maternal insulin does not cross the placenta to the fetus. As a result, in early pregnancy the pancreas decreases its production of insulin.

As pregnancy continues, the placenta grows and produces progressively greater amounts of hormones (i.e., hCS, estrogen, and progesterone). Cortisol production by the adrenals also increases. Estrogen, progesterone, hCS, and cortisol collectively decrease the mother's ability to use insulin. Cortisol stimulates increased production of insulin but also increases the mother's peripheral resistance to insulin (i.e., the tissues cannot use the insulin). Decreasing the mother's ability to use her own insulin is a protective mechanism that ensures an ample supply of glucose for the needs of the fetoplacental unit. The result is an added demand for insulin by the mother that continues to increase at a steady rate until term. The normal beta cells of the islets of Langerhans in the pancreas can meet this demand for insulin.

Adrenal glands. The adrenal glands change little during pregnancy. Secretion of aldosterone is increased, resulting in reabsorption of excess sodium from the renal tubules. Cortisol levels also are increased (Blackburn, 2003).

COMMUNITY ACTIVITY

Go to a local pharmacy and get information on at least three different home pregnancy test kits. (The pharmacist may be able to provide product information.)

1. Compare the directions for use, interpretation of test results, and the costs. Do any of the kits have directions in languages other than English?
2. During a conference with others in your clinical group, discuss the pros and cons of using the different types of kits.
3. Develop a poster presentation to guide women in decisions about use of home pregnancy tests for display in a family planning clinic.

Key Points

- The biochemical, physiologic, and anatomic adaptations that occur during pregnancy are profound and revert to the nonpregnant state after birth and lactation.
- Maternal adaptations are attributed to the hormones of pregnancy and to mechanical pressures exerted by the enlarging uterus and other tissues.
- ELISA testing, with monoclonal antibody technology, is the most popular method of pregnancy testing and is the basis for most over-the-counter home pregnancy tests.
- Presumptive, probable, and positive signs of pregnancy aid in the diagnosis of pregnancy; only positive signs (identification of a fetal heartbeat, verification of fetal movements, and visualization of the fetus) can establish the diagnosis of pregnancy.
- Adaptations to pregnancy protect the woman's normal physiologic functioning, meet the metabolic demands pregnancy imposes, and provide for fetal development and growth needs.
- Although the pH of the pregnant woman's vaginal secretions is more acidic, she is more vulnerable to some vaginal infections, especially yeast infections.
- Increased vascularity and sensitivity of the vagina and other pelvic viscera may lead to a high degree of sexual interest and arousal.
- Some adaptations to pregnancy result in discomforts such as fatigue, urinary frequency, nausea, and breast sensitivity.
- As pregnancy progresses, balance and coordination are affected by changes in the woman's joints and her center of gravity.

Answer Guidelines to Critical Thinking Exercise

Home Pregnancy Testing

1 No. More information is needed about Sylvia's menstrual cycle history to determine regularity and possible ovulation time and what if any medications she may be taking that could affect the results of the test. More information is also needed about the test used, what time of day the test was taken, and how the test was performed in relation to the directions.

2 a. Home pregnancy tests are based on presence of hCG in urine sample as early as 7 days after conception.
b. False-negative results are more common than false positive results.
c. All tests do not have the same degree of sensitivity or specificity.

3 The priority is to help Sylvia become aware of timing and events that could have affected the result of her test and to assist her in making a decision to retest or come in for a serum test.

4 Yes. The test may have been performed too soon–the most common mistake in home testing. Suggesting that retesting with a home urine test be done in 1 week or having a serum test done is the appropriate intervention.

5 Other conditions can cause a woman to miss a menstrual period. If a second test is negative, further assessment would be appropriate.

Resources

Alexian Brothers Medical Center
Elk Grove, IL
www.alexian.org/progserv/babies/ babytoo.html

Ovulation calculation and other information
www.ovulation.com

Babies Online
(information on pregnancy and baby care)
www.babiesonline.com

Childbirth.org (source of links to other sites related to pregnancy and birth)
www.childbirth.org

New York Online Access to Health (consumer-level information site, includes information on tests, fetal development, postnatal topics, etc., in English and Spanish)
www.noah-health.org/en/pregnancy

Perinatal Education Associates, Inc. (source of information on physiologic and emotional aspects of pregnancy)
www.birthsource.com

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