LEARNING OBJECTIVES

- Explain the five factors that affect the labor process.
- Describe the anatomic structure of the bony pelvis.
- Recognize the normal measurements of the diameters of the pelvic inlet, cavity, and outlet.
- Explain the significance of the size and position of the fetal head during labor and birth.
- Summarize the cardinal movements of the mechanism of labor for a vertex presentation.
- Assess the maternal anatomic and physiologic adaptations to labor.
- Describe fetal adaptations to labor.

KEY TERMS AND DEFINITIONS

asynclitism Oblique presentation of the fetal head at the superior strait of the pelvis; the pelvic planes and those of the fetal head are not parallel
attitude Relation of fetal parts to each other in the uterus (e.g., all parts flexed, or all parts flexed except neck is extended)
biparietal diameter Largest transverse diameter of the fetal head; extends from one parietal bone to the other
bloody show Vaginal discharge that originates in the cervix and consists of blood and mucus; increases as cervix dilates during labor
dilation Stretching of the external os from an opening a few millimeters in size to an opening large enough to allow the passage of the fetus
effacement Thinning and shortening or obliteration of the cervix that occurs during late pregnancy or labor or both
engagement In obstetrics, the entrance of the fetal presenting part into the superior pelvic strait and the beginning of the descent through the pelvic canal Ferguson reflex Reflex contractions (urge to push) of the uterus after stimulation of the cervix
fontanelles Broad areas, or soft spots, consisting of a strong band of connective tissue contiguous with cranial bones and located at the junctions of the bones
lie Relationship existing between the long axis of the fetus and the long axis of the mother; in a longitudinal lie, the fetus is lying lengthwise or vertically, whereas in a transverse lie, the fetus is lying crosswise or horizontally in the uterus
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
molding Overlapping of cranial bones or shaping of the fetal head to accommodate and conform to the bony and soft parts of the mother’s birth canal during labor
position Relationship of a reference point on the presenting part of the fetus, such as the occiput, sacrum, chin, or scapula, to its location in the front, back, or sides of the maternal pelvis
presentation That part of the fetus that first enters the pelvis and lies over the inlet; may be head, face, breech, or shoulder
pointing part That part of the fetus that lies closest to the internal os of the cervix
station Relationship of the presenting fetal part to an imaginary line drawn between the ischial spines of the pelvis
suboccipitobregmatic diameter Smallest diameter of the fetal head; follows a line drawn from the middle of the anterior fontanel to the undersurface of the occipital bone
Valsalva maneuver Any forced expiratory effort against a closed airway, such as holding one’s breath and tightening the abdominal muscles (e.g., pushing during the second stage of labor)
vertex Crown, or top, of the head
During late pregnancy the woman and fetus prepare for the labor process. The fetus has grown and developed in preparation for extrauterine life. The woman has undergone various physiologic adaptations during pregnancy that prepare her for birth and motherhood. Labor and birth represent the end of pregnancy, the beginning of extrauterine life for the newborn, and a change in the lives of the family. This chapter discusses the factors affecting labor, the process involved, the normal progression of events, and the adaptations made by both the woman and fetus.

At least five factors affect the process of labor and birth. These are easily remembered as the five Ps: passenger (fetus and placenta), passageway (birth canal), powers (contractions), position of the mother, and psychologic response. The first four factors are presented here as the basis of understanding the physiologic process of labor. The fifth factor is discussed in Chapter 12. Other factors that may be a part of the woman’s labor experience may be important as well. VandeVusse (1999) identified external forces including place of birth, preparation, type of provider (especially nurses), and procedures. Physiology (sensations) was identified as an internal force. These factors are discussed generally in Chapter 14 as they relate to nursing care during labor. Further research investigating essential forces of labor is recommended.

**Passenger**

The way the passenger, or fetus, moves through the birth canal is determined by several interacting factors: the size of the fetal head, fetal presentation, fetal lie, fetal attitude, and fetal position. Because the placenta also must pass through the birth canal, it can be considered a passenger along with the fetus; however, the placenta rarely impedes the process of labor in normal vaginal birth, except in cases of placenta previa.

**Size of the fetal head**

Because of its size and relative rigidity, the fetal head has a major effect on the birth process. The fetal skull is composed of two parietal bones, two temporal bones, the frontal bone, and the occipital bone (Fig. 11-1, A). These bones are united by membranous sutures: the sagittal, lambdoidal, coronal, and frontal (Fig. 11-1, B). Membrane-filled spaces called fontanels are located where the sutures intersect. During labor, after rupture of membranes, palpation of fontanels and sutures during vaginal examination reveals fetal presentation, position, and attitude.

The two most important fontanels are the anterior and posterior ones (see Fig. 11-1, B). The larger of these, the anterior fontanel, is diamond shaped, is about 3 cm by 2 cm, and lies at the junction of the sagittal, coronal, and frontal sutures. It closes by 18 months after birth. The posterior fontanel lies at the junction of the sutures of the two parietal bones and the occipital bone, is triangular, and is about 1 cm by 2 cm. It closes 6 to 8 weeks after birth.

Sutures and fontanels make the skull flexible to accommodate the infant brain, which continues to grow for some time after birth. Because the bones are not firmly united, however, slight overlapping of the bones, or molding of the shape of the head, occurs during labor. This capacity of the bones to slide over one another also permits adaptation to the various diameters of the maternal pelvis. Molding can be extensive, but the heads of most newborns assume their normal shape within 3 days after birth.
Although the size of the fetal shoulders may affect passage, their position can be altered relatively easily during labor, so one shoulder may occupy a lower level than the other. This creates a shoulder diameter that is smaller than the skull, facilitating passage through the birth canal. The circumference of the fetal hips is usually small enough not to create problems.

**Fetal presentation**

Presentation refers to the part of the fetus that enters the pelvic inlet first and leads through the birth canal during labor at term. The three main presentations are cephalic presentation (head first), occurring in 96% of births (Fig. 11-2); breech presentation (buttocks or feet first), occurring in 3% of births (Fig. 11-3, A-C); and shoulder presentation, seen in 1% of births (Fig. 11-3, D). The presenting part is that part of the fetal body first felt by the examining finger during a vaginal examination. In a cephalic presentation the presenting part is usually the occiput; in a breech presentation it is the sacrum; in the shoulder presentation it is the scapula.

When the presenting part is the occiput, the presentation is noted as vertex (see Fig. 11-2). Factors that determine the presenting part include fetal lie, fetal attitude, and extension or flexion of the fetal head.

**Fetal lie**

Lie is the relation of the long axis (spine) of the fetus to the long axis (spine) of the mother. The two primary lies are longitudinal, or vertical, in which the long axis of the fetus is parallel with the long axis of the mother (see Fig. 11-2); and transverse, horizontal, or oblique, in which the long axis of the fetus is at a right angle diagonal to the long axis of the mother (see Fig. 11-3, D). Longitudinal lies are either cephalic or breech presentations, depending on the fetal structure that first enters the mother’s pelvis. Vaginal birth cannot occur when the fetus stays in a transverse lie. An oblique lie, one in which the long axis of the fetus is lying at an angle to the long axis of the mother, is less common and usually converts to a longitudinal or transverse lie during labor (Cunningham et al., 2005).

**Fig. 11-2** Examples of fetal vertex (occiput) presentations in relation to front, back, or side of maternal pelvis.
Fetal attitude

Attitude is the relation of the fetal body parts to each other. The fetus assumes a characteristic posture (attitude) in utero partly because of the mode of fetal growth and partly because of the way the fetus conforms to the shape of the uterine cavity. Normally the back of the fetus is rounded so that the chin is flexed on the chest, the thighs are flexed on the abdomen, and the legs are flexed at the knees. The arms are crossed over the thorax, and the umbilical cord lies between the arms and the legs. This attitude is termed **general flexion** (see Fig. 11-2).

Deviations from the normal attitude may cause difficulties in childbirth. For example, in a cephalic presentation, the fetal head may be extended or flexed in a manner that presents a head diameter that exceeds the limits of the maternal pelvis, leading to prolonged labor, forceps- or vacuum-assisted birth, or cesarean birth.

Certain critical diameters of the fetal head are usually measured. The **biparietal diameter**, which is about 9.25 cm at term, is the largest transverse diameter and an important indicator of fetal head size (Fig. 11-4, B). In a well-flexed cephalic presentation, the biparietal diameter will be the widest part of the head entering the pelvic inlet. Of the several anteroposterior diameters, the smallest and the most critical one is the **suboccipitobregmatic diameter** (about 9.5 cm at term). When the head is in complete flexion, this diameter allows the fetal head to pass through the true pelvis easily (Fig. 11-4, A; Fig. 11-5, A). As the head is more extended, the anteroposterior diameter widens, and the head may not be able to enter the true pelvis (see Fig. 11-5, B, C).

**Fetal position**

The presentation or presenting part indicates that portion of the fetus that overlies the pelvic inlet. **Position** is the relation of the presenting part (occiput, sacrum, mentum [chin], or sinciput [deflexed vertex]) to the four quadrants of the mother’s pelvis (see Fig. 11-2). Position is denoted by a three-letter abbreviation. The first letter of the abbreviation denotes the location of the presenting part in the right (R) or left (L) side of the mother’s pelvis. The middle letter stands for the portion of the presenting part that overlies the pelvic inlet.
for the specific presenting part of the fetus (O for occiput, S for sacrum, M for mentum [chin], and Sc for scapula [shoulder]). The third letter stands for the location of the presenting part in relation to the anterior (A), posterior (P), or transverse (T) portion of the maternal pelvis. For example, ROA means that the occiput is the presenting part and is located in the right anterior quadrant of the maternal pelvis (see Fig. 11-2). LSP means that the sacrum is the presenting part and is located in the left posterior quadrant of the maternal pelvis (see Fig. 11-3).

Station is the relation of the presenting part of the fetus to an imaginary line drawn between the maternal ischial spines and is a measure of the degree of descent of the presenting part of the fetus through the birth canal. The placement of the presenting part is measured in centimeters above or below the ischial spines (Fig. 11-6). For example, when the lowermost portion of the presenting part is 1 cm above the spines, it is noted as being minus (−) 1. At the level of the spines, the station is said to be 0 (zero). When the presenting part is 1 cm below the spines, the station is said to be plus (+) 1. Birth is imminent when the presenting part is at +4 to +5 cm. The station of the presenting part should be determined when labor begins so that the rate of descent of the fetus during labor can be accurately determined.

Engagement is the term used to indicate that the largest transverse diameter of the presenting part (usually the biparietal diameter) has passed through the maternal pelvic
brim or inlet into the true pelvis and usually corresponds to station 0. Engagement often occurs in the weeks just before labor begins in nulliparas and may occur before labor or during labor in multiparas. Engagement can be determined by abdominal or vaginal examination.

**Passageway**

The passageway, or birth canal, is composed of the mother’s rigid bony pelvis and the soft tissues of the cervix, pelvic floor, vagina, and introitus (the external opening to the vagina). Although the soft tissues, particularly the muscular layers of the pelvic floor, contribute to vaginal birth of the fetus, the maternal pelvis plays a far greater role in the labor process because the fetus must successfully accommodate itself to this relatively rigid passageway. Therefore the size and shape of the pelvis must be determined before labor begins.

**Bony pelvis**

The anatomy of the bony pelvis is described in Chapter 4. The following discussion focuses on the importance of pelvic configurations as they relate to the labor process. (It may be helpful to refer to Fig. 4-4.)

The bony pelvis is formed by the fusion of the ilium, ischium, pubis, and sacral bones. The four pelvic joints are the symphysis pubis, the right and left sacroiliac joints, and the sacrococcygeal joint (Fig. 11-7, A). The bony pelvis is separated by the brim, or inlet, into two parts: the false pelvis and the true pelvis. The false pelvis is the part above the brim and plays no part in childbirth. The true pelvis, the part involved in birth, is divided into three planes: the inlet, or brim; the midpelvis, or cavity; and the outlet.

The pelvic inlet, which is the upper border of the true pelvis, is formed anteriorly by the upper margins of the
The pelvis, or midpelvis, is a curved passage with a short anterior wall and a much longer concave posterior wall. It is bounded by the posterior aspect of the symphysis pubis, the ischium, a portion of the ilium, the sacrum, and the coccyx. The pelvic inlet is the lower border of the true pelvis. Viewed from below, it is ovoid, somewhat diamond-shaped, bounded by the pubic arch anteriorly, the ischial tuberosities laterally, and the coccyx posteriorly (Fig. 11-7, B). In the latter part of pregnancy, the coccyx is movable (unless it has been broken in a fall during skiing or skating, for example, and has fused to the sacrum during healing). The pelvic canal varies in size and shape at various levels. The diameters at the plane of the pelvic inlet, midpelvis, and outlet, plus the axis of the birth canal (Fig. 11-8), determine whether vaginal birth is possible and the manner by which the fetus may pass down the birth canal.

The subpubic angle, which determines the type of pubic arch, together with the length of the pubic rami and the intertuberous diameter, is of great importance. Because the fetus must first pass beneath the pubic arch, a narrow subpubic angle will be less accommodating than a rounded wide arch. The method of measurement of the subpubic arch is shown in Fig. 11-9. A summary of obstetric measurements is given in Table 11-1.

The four basic types of pelves are classified as follows:
1. Gynecoid (the classic female type)
2. Android (resembling the male pelvis)
3. Anthropoid (resembling the pelvis of anthropoid apes)
4. Platypelloid (the flat pelvis)

The gynecoid pelvis is the most common, with major gynecoid pelvic features present in 50% of all women. Anthropoid and android features are less common, and platypelloid pelvic features are the least common. Mixed types of pelves are more common than are pure types (Cunningham et al., 2005). Examples of pelvic variations and their effects on mode of birth are given in Table 11-2.

Assessment of the bony pelvis can be performed during the first prenatal evaluation and need not be repeated if the pelvis is of adequate size and suitable shape. In the third trimester of pregnancy, the examination of the bony pelvis may be more thorough and the results more accurate because there is relaxation and increased mobility of the pelvic joints and ligaments owing to hormonal influences. Widening of the joint of the symphysis pubis and the resulting instability may cause pain in any or all of the pelvic joints. Because the examiner does not have direct access to the bony structures and because the bones are covered with varying amounts of soft tissue, estimates of size and shape are approximate. Precise bony pelvis measurements can be determined by use of computed tomography, ultrasound, or
TABLE 11-1
Obstetric Measurements

<table>
<thead>
<tr>
<th>PLANE</th>
<th>MEASUREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet (superior strait)</td>
<td>Conjugates</td>
</tr>
<tr>
<td></td>
<td>Diagonal</td>
</tr>
<tr>
<td></td>
<td>Obstetric measurement that determines whether presenting part can engage or enter superior strait</td>
</tr>
<tr>
<td></td>
<td>True (vera) (anteroposterior)</td>
</tr>
<tr>
<td></td>
<td>≥ 11 cm (12.5) (radiographic)</td>
</tr>
<tr>
<td></td>
<td>12.5-13 cm</td>
</tr>
<tr>
<td></td>
<td>1.5-2 cm less than diagonal (radiographic)</td>
</tr>
<tr>
<td>Midplane</td>
<td>10.5 cm</td>
</tr>
<tr>
<td></td>
<td>Transverse diameter (interspinous diameter)</td>
</tr>
<tr>
<td></td>
<td>The midplane of the pelvis normally is its largest plane and the one of greatest diameter</td>
</tr>
<tr>
<td>Outlet</td>
<td>≥ 8 cm</td>
</tr>
<tr>
<td></td>
<td>Transverse diameter (inter- tuberous diameter) (birschial)</td>
</tr>
<tr>
<td></td>
<td>The outlet presents the smallest plane of the pelvic canal</td>
</tr>
</tbody>
</table>

x-ray films. However, radiographic examination is rarely done during pregnancy because the x-rays may damage the developing fetus.

Soft tissues
The soft tissues of the passageway include the distensible lower uterine segment, cervix, pelvic floor muscles, vagina, and introitus. Before labor begins, the uterus is composed of the uterine body (corpus) and cervix (neck). After labor has begun, uterine contractions cause the uterine body to have a thick and muscular upper segment and a thin-walled, passive, muscular lower segment. A physiologic retraction ring separates the two segments (Fig. 11-10). The lower uterine segment gradually distends to accommodate the intrauterine contents as the wall of the upper segment thickens and its accommodating capacity is reduced. The contractions of the uterine body thus exert downward pressure on the fetus, pushing it against the cervix.

The cervix effaces (thins) and dilates (opens) sufficiently to allow the first fetal portion to descend into the vagina. As the fetus descends, the cervix is actually drawn upward and over this first portion.

The pelvic floor is a muscular layer that separates the pelvic cavity above from the perineal space below. This structure helps the fetus rotate anteriorly as it passes through the birth canal. As noted earlier, the soft tissues of the vagina develop throughout pregnancy until at term the vagina can dilate to accommodate the fetus and permit passage of the fetus to the external world.

<table>
<thead>
<tr>
<th>TABLE 11-2 Comparison of Pelvic Types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GYNECOD (50% OF WOMEN)</strong></td>
</tr>
<tr>
<td>Brim</td>
</tr>
<tr>
<td>Depth</td>
</tr>
<tr>
<td>Sidewalls</td>
</tr>
<tr>
<td>lshial spines</td>
</tr>
<tr>
<td>Sacrum</td>
</tr>
<tr>
<td>Subpubic arch</td>
</tr>
<tr>
<td>Usual mode of birth</td>
</tr>
</tbody>
</table>

Powers
Involuntary and voluntary powers combine to expel the fetus and the placenta from the uterus. Involuntary uterine contractions, called the primary powers, signal the beginning of labor. Once the cervix has dilated, voluntary bearing-down efforts by the woman, called the secondary powers, augment the force of the involuntary contractions.

Primary powers
The involuntary contractions originate at certain pacemaker points in the thickened muscle layers of the upper uterine segment. From the pacemaker points, contractions move downward over the uterus in waves, separated by short rest periods. Terms used to describe these involuntary contractions include frequency (the time from the beginning of one contraction to the beginning of the next), duration (length of contraction from the beginning to the end), and intensity (strength of contraction).

The primary powers are responsible for the effacement and dilation of the cervix and descent of the fetus. Effacement of the cervix means the shortening and thinning of the cervix during the first stage of labor. The cervix, normally 2 to 3 cm long and about 1 cm thick, is obliterated or "taken up" by a shortening of the uterine muscle bundles during the thinning of the lower uterine segment that occurs in advancing labor. Only a thin edge of the cervix can be palpated when effacement is complete. Effacement generally is advanced in first-time term pregnancy before more than slight dilation occurs. In subsequent pregnancies, effacement and
dilation of the cervix tend to progress together. Degree of effacement is expressed in percentages from 0 to 100% (e.g., a cervix is 50% effaced) (Fig. 11-11, A-C).

Dilation of the cervix is the enlargement or widening of the cervical opening and the cervical canal that occurs once labor has begun. The diameter of the cervix increases from less than 1 cm to full dilation (approximately 10 cm) to allow birth of a term fetus. When the cervix is fully dilated (and completely retracted), it can no longer be palpated (Fig. 11-11, D).

Full cervical dilation marks the end of the first stage of labor. Dilation of the cervix occurs by the drawing upward of the musculofibrous components of the cervix, caused by strong uterine contractions. Pressure exerted by the amniotic fluid while the membranes are intact or by the force applied by the presenting part also can promote cervical dilation. Scarring of the cervix as a result of prior infection or surgery may slow cervical dilation.

In the first and second stages of labor, increased intrauterine pressure caused by contractions exerts pressure on the descending fetus and the cervix. When the presenting part of the fetus reaches the perineal floor, mechanical stretching of the cervix occurs. Stretch receptors in the posterior vagina cause release of endogenous oxytocin that triggers the maternal urge to bear down, or the Ferguson reflex.

Uterine contractions are usually independent of external forces. For example, laboring women who are paraplegic will have normal but painless uterine contractions (Cunningham et al., 2005). However, uterine contractions may decrease temporarily in frequency and intensity if narcotic analgesic medication is given early in labor. Studies of effects of epidural analgesia have demonstrated prolonged length of labor for nulliparas both in the active phase of first stage labor and in the second stage (Alexander, Sharma, McIntire, & Leveno, 2002; Sharma & Leveno, 2003).

Secondary powers

As soon as the presenting part reaches the pelvic floor, the contractions change in character and become expulsive. The laboring woman experiences an involuntary urge to push. She uses secondary powers (bearing-down efforts) to aid in expulsion of the fetus as she contracts her diaphragm and abdominal muscles and pushes. These bearing-down efforts result in increased intraabdominal pressure that compresses
the uterus on all sides and adds to the power of the expulsive forces.

The secondary powers have no effect on cervical dilation, but they are of considerable importance in the expulsion of the infant from the uterus and vagina after the cervix is fully dilated. Studies have shown that pushing in the second stage is more effective and the woman is less fatigued when she begins to push only after she has the urge to do so rather than beginning to push when she is fully dilated without an urge to do so (Roberts, 2002; 2003).

When and how a woman pushes in the second stage is a much-debated topic. Studies have investigated the effects of spontaneous bearing-down efforts, directed pushing, Valsalva maneuver (closed glottis and prolonged bearing down), and open-glottis pushing (Hansen, Clark, & Foster, 2002; Mayberry et al., 2000; Minato, 2000/2001; Petrou, Coyle, & Fraser, 2000). Although no significant differences have been found in the duration of second-stage labor, adverse effects of certain types of pushing techniques have been reported. Fetal hypoxia and subsequent acidosis have been associated with prolonged breath holding and forceful pushing efforts (Roberts, 2002). Perineal tears have been associated with directed pushing (Fraser et al., 2000). Continued study is needed to determine the effectiveness and appropriateness of strategies used by nurses to teach pushing techniques, the suitability and effectiveness of various pushing techniques related to nonreassuring fetal heart patterns, and the standards for length of duration of pushing in terms of maternal and fetal outcomes (Roberts, 2003).

Position of the Laboring Woman
Position affects the woman’s anatomic and physiologic adaptations to labor. Frequent changes in position relieve fatigue, increase comfort, and improve circulation (Gupta & Nikodem, 2001). Therefore a laboring woman should be encouraged to find positions that are most comfortable for her (Fig. 11-12, A).

An upright position (walking, sitting, kneeling, or squatting) offers a number of advantages. Gravity can promote the descent of the fetus. Uterine contractions are generally stronger and more efficient in effacing and dilating the cervix, resulting in shorter labor (Gupta & Nikodem, 2001; Simkin & Ancheta, 2000).

An upright position also is beneficial to the mother’s cardiac output, which normally increases during labor as...
Fig. 11-12  Positions for labor and birth. A, Positions for labor. B, Positions for birth.
PROCESS OF LABOR

The term labor refers to the process of moving the fetus, placenta, and membranes out of the uterus and through the birth canal. Various changes take place in the woman’s reproductive system in the days and weeks before labor begins. Labor itself can be discussed in terms of the mechanisms involved in the process and the stages the woman moves through.

Signs Preceding Labor

In first-time pregnancies, the uterus sinks downward and forward about 2 weeks before term, when the fetus’s presenting part (usually the fetal head) descends into the true pelvis. This settling is called lightening, or “dropping,” and usually happens gradually. After lightening, women feel less congested and breathe more easily, but usually more bladder pressure results from this shift, and consequently a return of urinary frequency occurs. In a multiparous pregnancy, lightening may not take place until after uterine contractions are established and true labor is in progress.

The woman may complain of persistent low backache and sacroiliac distress as a result of relaxation of the pelvic joints. She may identify strong and frequent but irregular uterine (Braxton Hicks) contractions.

The vaginal mucous becomes more profuse in response to the extreme congestion of the vaginal mucous membranes. Brownish or blood-tinged cervical mucus may be passed (bloody show). The cervix becomes soft (ripenes) and partially effaced and may begin to dilate. The membranes may rupture spontaneously.

Other phenomena are common in the days preceding labor: (1) loss of 0.5 to 1.5 kg in weight, caused by water loss resulting from electrolyte shifts that in turn are produced by changes in estrogen and progesterone levels; and (2) a surge of energy. Women speak of having a burst of energy that they often use to clean the house and put everything in order. Less commonly, some women have diaphoresis, nausea, vomiting, shortness of breath, and indigestion. Box 11-1 lists signs that may precede labor.

Onset of Labor

The onset of true labor cannot be ascribed to a single cause. Many factors, including changes in the maternal uterus, cervix, and pituitary gland, are involved. Hormones produced by the normal fetal hypothalamus, pituitary, and adrenal cortex probably contribute to the onset of labor. Progressive uterine distention, increasing intrauterine pressure, and aging of the placenta seem to be associated with increasing myometrial irritability. This is a result of increased concentrations of estrogen and progesterone levels. The mutually coordinated effects of these factors result in the occurrence of strong, regular, rhythmic uterine contractions that move the fetus out of the uterus and into the birth canal.
Stages of Labor

Labor is considered “normal” when the woman is at or near term, no complications exist, a single fetus presents by vertex, and labor is completed within 18 hours. The course of normal labor, which is remarkably constant, consists of (1) regular progression of uterine contractions, (2) effacement and progressive dilation of the cervix, and (3) progress in descent of the presenting part. Four stages of labor are recognized. These stages are discussed in greater detail, along with nursing care for the laboring woman and family, in Chapter 14.

The first stage of labor is considered to last from the onset of regular uterine contractions to full dilation of the cervix. Commonly the onset of labor is difficult to establish because the woman may be admitted to the labor unit just before birth, and the beginning of labor may be only an estimate. The first stage is much longer than the second and combined. Great variability is the rule, however, depending on the factors discussed previously in this chapter. Full dilation may occur in less than 1 hour in some multiparous pregnancies. In first-time pregnancy, complete dilation of the cervix can take up to 20 hours. Variations may reflect differences in the patient population (e.g., risk status, age) or in clinical management of the labor and birth (Albers, 1999).

The first stage of labor has been divided into three phases: a latent phase, an active phase, and a transition phase. During the latent phase, there is more progress in effacement of the cervix and little increase in descent. During the active phase and the transition phase, there is more rapid dilation of the cervix and increased rate of descent of the presenting part.

The second stage of labor lasts from the time the cervix is fully dilated to the birth of the fetus. The second stage takes an average of 20 minutes for a multiparous woman and 50 minutes for a nulliparous woman. Labor of up to 2 hours has been considered within the normal range for the second stage. Epidural anesthesia will likely prolong the second stage (Zhang, Yancy, Klebanoff, Schwartz, & Schweitzer, 2001). Ethnicity may shorten the length of the second stage of labor for African-American and Puerto Rican women (Diegmann, Andrews, & Niemczura, 2000).

Simkin and Ancheta (2000) described the latent and active phases of second-stage labor. The latent phase is a period that begins about the time of complete dilation of the uterus, when the contractions are weak or not noticeable and the woman is not feeling the urge to push, resting, or exerting only small bearing-down efforts with contractions. The active phase is a period when contractions resume, the woman is making strong bearing-down efforts, and the fetal station is advancing.

The second stage of labor lasts from the birth of the fetus until the placenta is delivered. The placenta normally separates with the third or fourth strong uterine contraction after the infant has been born. After it has separated, the placenta can be delivered with the next uterine contraction. The duration of the third stage may be as short as 3 to 5 minutes, although up to 1 hour is considered within normal limits. The risk of hemorrhage increases as the length of the third stage increases (Cunningham et al., 2005).

The fourth stage of labor arbitrarily lasts about 2 hours after delivery of the placenta. It is the period of immediate recovery, when homeostasis is reestablished. It is an important period of observation for complications, such as abnormal bleeding (see Chapter 25).

Mechanism of Labor

As already discussed, the female pelvis has varied contours and diameters at different levels, and the presenting part of the passenger is large in proportion to the passage. Therefore for vaginal birth to occur, the fetus must adapt to the...
EVIDENCE-BASED PRACTICE

BACKGROUND
• A frequent complaint of the hospital birthing experience is the focus on technology. What some have called the “cascade of interventions” that some women feel grows out of their control. One outcome of the consumer movement has been a demand for a more homelike birthing environment, with a focus on the natural process of birthing. In the 1970s and 1980s many women in the United States chose to give birth at home, attended by lay midwives or nurse-midwives. Hospitals responded to this with a mid-level solution: homelike birthing centers, staffed by professionals and in close proximity to specialty emergency services. Women at low risk for complications could be seen antenatally and could labor, give birth, and recover in the same environment, accompanied by family. Some birthing centers are owned and staffed by the institution; others are affiliated with a hospital but staffed independently. Birthing centers share a philosophy that many women can labor and deliver without medication and technology, if only they have the appropriate preparation and support. Birthing center staff feel that the pain cycle of fear—pain can be broken by having the woman in a safe, supportive, familiar environment. Low risk obstetrics is lucrative for hospitals, and most have responded to the competition by offering attractive homelike birthing centers.

OBJECTIVES
• The reviewers planned to compare the maternal and fetal outcomes of birthing center to conventional hospital births. They hoped to compare hospital-based centers to free-standing centers. The intervention was labor and delivery at a birthing center, and the control was conventional hospital care. Outcomes of interest were intrapartal medical interventions, complications, method of delivery, perinatal death, maternal satisfaction, neonatal health, and adjustment to parenting.

METHODS
Search Strategy
• The authors looked for randomized or quasi-randomized, controlled trials in Cochrane, MEDLINE, and Zetoc, a weekly awareness service of 37 relevant journals. Search keywords were not noted.
• The reviewers selected six trials, involving 8677 women, from the United Kingdom, Sweden, Canada, and Australia, published 1984 to 2000.

Statistical Analyses
• Similar data were pooled. Reviewers calculated relative risks for dichotomous (categoric) data, and weighted mean differences for continuous data. The reviewers accepted results outside the 95% confidence intervals as significant differences.

FINDINGS
• The birthing center group used less pain medication and less labor augmentation than the hospitalized group. The women were more mobile during labor. There were fewer fetal heart abnormalities and fewer operative deliveries (forceps, vacuum extraction, or cesarean birth). Episiotomy was less frequent, but perineal tears were more frequent. All of these differences were significant. There was no difference between groups in the number that had discontinued breastfeeding by 6 to 8 weeks postpartum. One trial noted significantly more sore nipples and mastitis in the birthing center group. There was a trend toward increased perinatal mortality rate in the birthing center group across three trials, but it did not reach the level of significance. No data were available on the type of caregivers or the continuity of care.

LIMITATIONS
• Substantial numbers of women (29% to 77%) in the birthing center group used less pain medication and labor augmentation than the hospitalized group. The decreased use of pain medication and labor augmentation reflects their limited access in birthing centers. Electronic fetal monitors are not commonly used at birthing centers. Electronic fetal monitoring would be fewer reports of fetal heart abnormalities, and women are freer to move around without monitors or intraartenous lines. Many of the results mirror other evidence of the benefits of continuous support during labor and delivery (see “Evidence-Based Practice: Continuous Labor Support,” Chapter 14). Hospitals would be wise to focus more on the benefits of continuous care for women in childbirth than on the decor of the environment.

• The trend toward increased perinatal mortality rate, although not significant, was consistent across three trials. The focus on normality may cause caregivers to miss subtle early warnings of problems or to delay action. All staff members need to be alert to trouble and able to expedite transfer to hospital care without delay.

CONCLUSIONS
• Women who give birth in a birthing center have fewer interventions than women who give birth in a hospital. Their outcomes are similar to the birth outcomes of women who give birth in a hospital.

IMPLICATIONS FOR PRACTICE
• The decreased use of pain medication and labor augmentation reflects their limited access in birthing centers. Electronic fetal monitors are not commonly used at birthing centers. Electronic fetal monitoring would be fewer reports of fetal heart abnormalities, and women are freer to move around without monitors or intraartenous lines. Many of the results mirror other evidence of the benefits of continuous support during labor and delivery (see “Evidence-Based Practice: Continuous Labor Support,” Chapter 14). Hospitals would be wise to focus more on the benefits of continuous care for women in childbirth than on the decor of the environment.

• The trend toward increased perinatal mortality rate, although not significant, was consistent across three trials. The focus on normality may cause caregivers to miss subtle early warnings of problems or to delay action. All staff members need to be alert to trouble and able to expedite transfer to hospital care without delay.

IMPLICATIONS FOR FURTHER RESEARCH
• Solving the bias problem would be a significant step toward generalizable results. This includes randomization, dropouts, and addressing the inevitable transfers. Cost is a major driving force in policy and choice, yet it was not addressed in these trials. Further exploration of the perinatal mortality trend is warranted.

birth canal during the descent. The turns and other adjustments necessary in the human birth process are termed the mechanism of labor (Fig. 11-13). The seven cardinal movements of the mechanism of labor that occur in a vertex presentation are engagement, descent, flexion, internal rotation, extension, external rotation (restitution), and finally birth by expulsion. Although these movements are discussed separately, in actuality a combination of movements occurs simultaneously. For example, engagement involves both descent and flexion.

Engagement

When the biparietal diameter of the head passes the pelvic inlet, the head is said to be engaged in the pelvic inlet (Fig. 11-13, A). In most nulliparous pregnancies, this occurs before the onset of active labor because the firmer abdominal muscles direct the presenting part into the pelvis. In multiparous pregnancies, in which the abdominal musculature is more relaxed, the head often remains freely movable above the pelvic brim until labor is established.

Asynclitism. The head usually engages in the pelvis in a synclitic position—one that is parallel to the anteroposterior plane of the pelvis. Frequently asynclitism occurs (the head is deflected anteriorly or posteriorly in the pelvis), which can facilitate descent because the head is being positioned to accommodate to the pelvic cavity (Fig. 11-14). Extreme asynclitism can cause cephalopelvic disproportion, even in a normal-size pelvis, because the head is positioned so that it cannot descend.

Descent

Descent refers to the progress of the presenting part through the pelvis. Descent depends on at least four forces: (1) pressure exerted by the amniotic fluid, (2) direct pressure exerted by the contracting fundus on the fetus, (3) force of the contraction of the maternal diaphragm and abdominal muscles in the second stage of labor, and (4) extension and straightening of the fetal body. The effects of these forces are modified by the size and shape of the maternal pelvic planes and the size of the fetal head and its capacity to mold.

The degree of descent is measured by the station of the presenting part (see Fig. 11-6). As mentioned, little descent occurs during the latent phase of the first stage of labor. Descent accelerates in the active phase when the cervix has dilated to 5 to 7 cm. It is especially apparent when the membranes have ruptured.

![Fig. 11-13](image-url)
In a first-time pregnancy, descent is usually slow but steady; in subsequent pregnancies descent may be rapid. Progress in descent of the presenting part is determined by abdominal palpation (Leopold maneuvers) and vaginal examination until the presenting part can be seen at the introitus.

**Flexion**

As soon as the descending head meets resistance from the cervix, pelvic wall, or pelvic floor, it normally flexes, so that the chin is brought into closer contact with the fetal chest (see Fig. 11-13, B). Flexion permits the smaller suboccipitobregmatic diameter (9.5 cm) rather than the larger diameters to present to the outlet.

**Internal rotation**

The maternal pelvic inlet is widest in the transverse diameter; therefore the fetal head passes the inlet into the true pelvis in the occipitotransverse position. The outlet is widest in the anteroposterior diameter; for the fetus to exit, the head must rotate. Internal rotation begins at the level of the ischial spines but is not completed until the presenting part reaches the lower pelvis. As the occiput rotates anteriorly, the face rotates posteriorly. With each contraction, the fetal head is guided by the bony pelvis and the muscles of the pelvic floor. Eventually the occiput will be in the midline beneath the pubic arch. The head is almost always rotated by the time it reaches the pelvic floor (see Fig. 11-13, C).

**Extension**

When the fetal head reaches the perineum for birth, it is deflected anteriorly by the perineum. The occiput passes under the lower border of the symphysis pubis first, and then the head emerges by extension: first the occiput, then the face, and finally the chin (see Fig. 11-13, D).

**Restitution and external rotation**

After the head is born, it rotates briefly to the position it occupied when it was engaged in the inlet. This movement is referred to as restitution (see Fig. 11-13, E). The 45-degree turn realigns the infant’s head with her or his back and shoulders. The head can then be seen to rotate further. This external rotation occurs as the shoulders engage and descend in maneuvers similar to those of the head (see Fig. 11-13, F). As noted earlier, the anterior shoulder descends first. When it reaches the outlet, it rotates to the midline and is delivered from under the pubic arch. The posterior shoulder is guided over the perineum until it is free of the vaginal introitus.

**Expulsion**

After birth of the shoulders, the head and shoulders are lifted up toward the mother’s pubic bone and the trunk of the baby is born by flexing it laterally in the direction of the symphysis pubis. When the baby has completely emerged, birth is complete, and the second stage of labor ends.

**Physiologic Adaptation to Labor**

In addition to the maternal and fetal anatomic adaptations that occur during birth, physiologic adaptations must occur. Accurate assessment of the laboring woman and fetus requires knowledge of these expected adaptations.

**Fetal Adaptation**

Several important physiologic adaptations occur in the fetus. These changes occur in fetal heart rate (FHR), fetal circulation, respiratory movements, and other behaviors.

**Fetal heart rate**

FHR monitoring provides reliable and predictive information about the condition of the fetus related to oxygenation. The average FHR at term is 140 beats/min. The normal range is 110 to 160 beats/min. Earlier in gestation the FHR is higher, with an average of approximately...
Maternal Physiologic Changes during Labor

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Both objective and subjective symptoms (Box 11-2). These changes include the following:

- Cardiac output increases 10%-15% in first stage; 30%-50% in second stage.
- Heart rate increases slightly in first and second stages.
- Systolic blood pressure increases during uterine contractions in first stage; systemic and diastolic pressures increase during uterine contractions in second stage.
- White blood cell count increases.
- Respiratory rate increases.
- Temperature may be slightly elevated.
- Proteinuria may occur.
- Gastric motility and absorption of solid food is decreased; nausea and vomiting may occur during transition to second-stage labor.
- Blood glucose level decreases.

**Cardiovascular changes**

During each contraction, an average of 400 ml of blood is emptied from the uterus into the maternal vascular system. This increases cardiac output by about 12% to 31% in the first stage and by about 50% in the second stage. The heart rate increases slightly (Monga, 2004).

Changes in the woman’s blood pressure also occur. Blood flow, which is reduced in the uterine artery by contractions, is redirected to peripheral vessels. As a result, peripheral resistance increases, and blood pressure increases (Monga, 2004). During the first stage of labor, uterine contractions cause systolic readings to increase by about 10 mm Hg; assessing blood pressure between contractions therefore provides more accurate readings. During the second stage, contractions may cause systolic pressures to increase by 30 mm Hg and diastolic readings to increase by 25 mm Hg, with both systolic and diastolic pressures remaining somewhat elevated even between contractions (Monga, 2004). Therefore the woman already at risk for hypotension is at increased risk for complications such as cerebral hemorrhage.

Supine hypotension (see Fig. 14-5) occurs when the ascending vena cava and descending aorta are compressed. The laboring woman is at greater risk for supine hypotension if the uterus is particularly large because of multifetal pregnancy, hydradnamnios, or obesity or if the woman is dehydrated or hypovolemic. In addition, anxiety and pain, as well as some medications, can cause hypotension.

The woman should be discouraged from using the Valsalva maneuver (holding one’s breath and tightening abdominal muscles) for pushing during the second stage. This activity increases intrathoracic pressure, reduces venous return, and increases venous pressure. The cardiac output and blood pressure increase and the pulse slows temporarily. During the Valsalva maneuver, fetal hypoxia may occur. The process is reversed when the woman takes a breath.

The white blood cell (WBC) count can increase (Pagana & Pagana, 2003). Although the mechanism leading to this increase in WBCs is unknown, it may be secondary to physical or emotional stress or to tissue trauma. Labor is strenuous, and physical exercise alone can increase the WBC count.

Some peripheral vascular changes occur, perhaps in response to cervical dilation or to compression of maternal vessels by the fetus passing through the birth canal. Flushed cheeks, hot or cold feet, and eversion of hemorrhoids may result.

**Respiratory changes**

Increased physical activity with greater oxygen consumption is reflected in an increase in the respiratory rate. Hyperventilation may cause respiratory alkalosis (an increase in pH), hypoxia, and hypocapnia (decrease in carbon dioxide). In the unmedicated woman in the second stage, oxygen consumption almost doubles. Anxiety also increases oxygen consumption.
Renal changes
During labor, spontaneous voiding may be difficult for various reasons: tissue edema caused by pressure from the presenting part, discomfort, analgesia, and embarrassment. Proteinuria of +1 is a normal finding because it can occur in response to the breakdown of muscle tissue from the physical work of labor.

Integumentary changes
The integumentary system changes are evident, especially in the great distensibility (stretching) in the area of the vaginal introitus. The degree of distensibility varies with the individual. Despite this ability to stretch, even in the absence of episiotomy or lacerations, minute tears in the skin around the vaginal introitus do occur.

Musculoskeletal changes
The musculoskeletal system is stressed during labor. Diaphoresis, fatigue, proteinuria (+1), and possibly an increased temperature accompany the marked increase in muscle activity. Backache and joint ache (unrelated to fetal position) occur as a result of increased joint laxity at term. The labor process itself and the woman’s pointing her toes can cause leg cramps.

Neurologic changes
Sensorial changes occur as the woman moves through phases of the first stage of labor and as she moves from one stage to the next. Initially she may be euphoric. Euphoria gives way to increased seriousness, then to amnesia between contractions during the second stage, and finally to elation or fatigue after giving birth. Endogenous endorphins (morphinelike chemicals produced naturally by the body) raise the pain threshold and produce sedation. In addition, physiologic anesthesia of perineal tissues, caused by pressure of the presenting part, decreases perception of pain.

Gastrointestinal changes
During labor, gastrointestinal motility and absorption of solid foods are decreased, and stomach-emptying time is slowed. Nausea and vomiting of undigested food eaten after onset of labor are common. Nausea and belching also occur as a reflex response to full cervical dilation. The woman may state that diarrhea accompanied the onset of labor, or the nurse may palpate the presence of hard or impacted stool in the rectum.

Endocrine changes
The onset of labor may be triggered by decreasing levels of progesterone and increasing levels of estrogen, prostaglandins, and oxytocin. Metabolism increases, and blood glucose levels may decrease with the work of labor. Accurate assessment of the mother and fetus during labor and birth depends on knowledge of these expected adaptations so that appropriate interventions can be implemented.

Key Points
- Labor and birth are affected by the five Ps: passenger, passageway, powers, position of the woman, and psychologic responses.
- Because of its size and relative rigidity, the fetal head is a major factor in determining the course of birth.
- The diameters at the plane of the pelvic inlet, midpelvis, and outlet, plus the axis of the birth canal, determine whether vaginal birth is possible and the manner in which the fetus passes down the birth canal.
- Involuntary uterine contractions act to expel the fetus and placenta during the first stage of labor; these are augmented by voluntary bearing-down efforts during the second stage.
- The first stage of labor lasts from the time dilation begins to the time when the cervix is fully dilated. The second stage of labor lasts from the time of full dilation to the birth of the infant. The third stage of labor lasts from the infant’s birth to the expulsion of the placenta. The fourth stage is the first 2 hours after birth.
- The cardinal movements of the mechanism of labor are engagement, descent, flexion, internal rotation, extension, restitution, and external rotation, and expulsion of the infant.
- Although the events precipitating the onset of labor are unknown, many factors, including changes in the maternal uterus, cervix, and pituitary gland, are thought to be involved.
- A healthy fetus with an adequate uterofetalplacental circulation will be able to compensate for the stress of uterine contractions.
- As the woman progresses through labor, various body systems adapt to the birth process.
Answer Guidelines to Critical Thinking Exercise

Second Stage of Labor

1. Yes, there is sufficient evidence to draw conclusions about what action should be implemented for this patient in second-stage labor.

2. a. There are variations in when a woman feels the initial urge to push. These are related to the fetal station and position of the presenting part. Second-stage labor has an early phase when the woman may not feel an urge to push; the uterine contractions may be weak. The active or last phase is when the woman feels a strong urge to push, usually when the fetal head has advanced to the pelvic floor and the Ferguson reflex is triggered. Passive descent and rotation of the fetal head (i.e., not encouraging the woman to push with contractions) in the early phase may prevent maternal and fetal complications. Pushing may also be more effective if the woman begins to push only after she has an urge to do so.

b. Nulliparas who have an epidural are more likely to have a longer second-stage labor than nulliparas who do not have an epidural, but research has not demonstrated harmful effects on the mother or fetus. With epidurals, the woman may not feel her contractions and may not feel an urge to push. A period of “laboring down” (not pushing with contractions) allows the fetus to descend and rotate and is one approach to managing patients with epidurals in second-stage labor.

c. Directed bearing down (pushing in a manner that the care provider thinks is effective or is based on the appearance of contractions on the electronic monitor) may trigger the Valsalva maneuver, which can cause an increase in maternal blood pressure and nonreassuring fetal heart rate patterns. The woman with an epidural may be directed to push too soon and may become tired before the contractions are strong again. Directed pushing also has been associated with perineal tears. Delayed or spontaneous pushing has been shown to have fewer effects on maternal blood pressure and fetal status. Fewer interventions (e.g., episiotomies and forceps or vacuum assistance) are needed. Delayed pushing for women with epidurals (i.e., laboring down) allows fetal descent and rotation before pushing is initiated. Even though there is evidence to support this practice, it is not yet widely practiced in labor and birth units.

d. Use of prolonged strenuous pushing during contractions can affect maternal and fetal status. Maternal cardiac output may decrease, resulting in decreased blood flow to the uterus and decreased fetal oxygenation, resulting in fetal hypoxia and acidosis. This practice has been found to be harmful or ineffective and should be discouraged.

3. The nursing priority is to help the woman have a safe and effective second stage of labor with no maternal or fetal complications. Assessments for maternal and fetal effects of directed pushing are needed. Prolonged pushing need to be made. Explanations about the positive effects of delayed pushing are needed. The woman’s mother needs to be included in the discussion about delayed pushing so that she becomes a better support for her daughter. When pushing is needed, demonstration of and encouragement for taking cleansing breaths as the contraction starts, pushing with the greatest force of the contraction, and taking breaths between heaving down efforts during the contraction are appropriate interventions. Continued nursing support, coaching, and encouragement for the patient and her mother during the second stage are needed.

4. Yes, there is evidence to support these conclusions about delayed second-stage pushing for nulliparous women with epidurals (Fraser, 2000; Hansen, Clark, & Foster, 2002; Mayberry, 2000.)

5. According to some researchers, there is no significant difference in the length of second-stage labor whether or not the woman delays pushing. If the patient wants to keep pushing, she should be encouraged to use the open-glottis method rather than the closed-glottis method.

Resources

Alexian Brothers Medical Center (information on stages of labor and other labor and birth topics)
Elk Grove, IL
847-417-5100
www.alexian.org/progress/babies/babytoo.html

Baby Center (source for expectant parents)
www.babycenter.com/pregnancy

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

Childbirth Graphics
P.O. Box 21207
Waco, TX 76702
800-229-3366

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

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