

2 Biological Foundations



LEARNING OBJECTIVES

- 2.1 Describe the functions of the hormones in the feedback loop of the endocrine system and how they initiate puberty.
- 2.2 Explain how the growth spurt differs for girls and boys, and identify the order in which body parts experience rapid growth.
- 2.3 Describe how physical functioning changes during puberty, and contrast physical functioning in adolescence and emerging adulthood.
- 2.4 Explain the difference between primary and secondary sex characteristics, and provide the typical order of development of secondary sex characteristics in boys and girls.
- 2.5 Explain how culture influences the timing of puberty.
- 2.6 Identify the rates of prevalence of puberty rituals across cultures, and explain the function of these rituals.
- 2.7 Describe how cultural influences shape responses to menarche and semenarche among adolescents.
- 2.8 Summarize the gender differences in how boys and girls respond to reaching puberty relatively early or late.
- 2.9 Compare and contrast passive, evocative, and active genotype → environment effects.
- 2.10 Explain why genotype → environment effects change over time.

“I had my first period at twelve, knew about it before and wasn’t scared. I thought I was feeling pretty good, because then I would know I was growing up to be a lady, you know. And I really had a nice feeling.” *African American adolescent girl (Konopka, 1976, p. 48)*

“I didn’t know about [menstruation]. [My mother] never told me anything like that. I was scared, I just started washing all my underclothing hoping that my mother won’t find out but she came in and caught me washing it, and she started laughing at me. But she never did tell me what it was. . . . I mean she told me it wasn’t anything to worry about, it’s something that happens, you know, but she didn’t tell me what it meant and stuff like that.” *Latina adolescent girl (Konopka, 1976, pp. 47–48)*

“Since I’ve gotten more physically mature I get a lot of stares when I go out. Sometimes it feels nice or funny when I’m with my friends, especially when it’s someone nice. But when it’s some weirdo or when some older man says something like “Ooooooh,” then it’s scary and I want to say, ‘I’m only twelve, leave me alone.’” *Denise, age 12 (Bell, 1998, p. 24)*

“I can’t stand what I look like right now! Sometimes I just want to put a bag over my head to hide my face. It’s all broken out with zits and oily places. I can wash it ten times a day and it’s still the same.” *Pablo, age 15 (Bell, 1998, p. 10)*

“Pubic hair scared the shit out of me. I saw all these little bumps and I didn’t know what they were. I thought maybe I had [a sexually transmitted infection] but I hadn’t even had sex.” *Juan (Bell, 1998, p. 20)*

“[The first time I ejaculated] I’m almost positive that it was a wet dream. The problem was that I didn’t know what it was. I was surprised that I had wet my bed—what did I do? I only found out a year later what it was.” *White American adolescent boy (Stein & Reiser, 1993, p. 377)*

THESE EXAMPLES ILLUSTRATE THE WIDE range of reactions that adolescents have to the events that indicate the development of physical and sexual maturity. They also suggest the ways that cultures influence young people’s interpretations of the biological events of puberty, in part by informing them—or neglecting to inform them—about the changes that will be taking place in their bodies.

Although adolescence is a culturally constructed period of life, the biological changes of puberty are a central part of development during adolescence in all cultures. Many changes occur, and they are often dramatic. There you are, growing at a more or less steady rate through childhood, and then suddenly the metamorphosis begins—growth spurt, pubic hair, underarm hair, acne, changes in body shape, breast development and menarche in girls, first ejaculation and facial hair in boys, and much more. The changes are often exciting and joyful, but adolescents experience them with other emotions as well—fear, surprise, annoyance, and anxiety. Reaching the key changes earlier or later than most peers is especially a source of anxiety.

The biological changes of puberty are similar across cultures, but in this chapter we will see that biological events interact with cultural influences. Culture influences the timing of biological events, and cultures respond in a variety of ways to the biological changes that signify adolescents’ attainment of physical—and sexual—maturity. Adolescents, in turn, rely on information provided by their cultures for interpreting the changes taking place within their bodies and in their physical appearance.

In this chapter we will begin with a description of the hormonal changes of puberty. This will be followed by a description of the bodily changes of puberty, including changes in height, weight, muscle-to-fat ratio, and strength. Next will be a description of primary sex characteristics (sperm and egg production) and secondary sex characteristics (such as the growth of pubic hair and the development of breasts). Then we will examine cultural, social, and psychological responses to puberty, including the different experiences of adolescents who mature relatively early or relatively late. The chapter closes with an examination of the relation between genetic and environmental influences.

The Biological Revolution of Puberty

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- 2.2 Explain how the growth spurt differs for girls and boys, and identify the order in which body parts experience rapid growth.
- 2.3 Describe how physical functioning changes during puberty, and contrast physical functioning in adolescence and emerging adulthood.
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The word **puberty** is derived from the Latin word *pubescere*, which means “to grow hairy.” But adolescents do a lot more in puberty than grow hairy. After developing gradually and steadily during childhood, at puberty the body undergoes a biological revolution that dramatically changes the adolescent’s anatomy, physiology, and physical appearance. By the time adolescents enter emerging adulthood, they look much different than before puberty, their bodies function much differently, and they are biologically prepared for sexual reproduction. These changes all begin with events that occur in the endocrine system during puberty.

The Endocrine System

The **endocrine system** consists of glands in various parts of the body. These glands release chemicals called **hormones** into the bloodstream, and the hormones affect the development and functioning of the body. Let us take a look at each of the glands that are part of the endocrine system and at the hormones they secrete during puberty (see **Figure 2.1**).

The Initiation of Puberty in the Hypothalamus The hormonal changes of puberty begin in the **hypothalamus**, a bean-sized structure located in the lower part of the brain, beneath the cortex. The hypothalamus has profound and diverse effects on physiological and psychological motivation and functioning in areas such as eating, drinking, and sexuality. In addition to these functions, the hypothalamus stimulates and regulates the production of hormones by other glands. To initiate puberty, the hypothalamus begins to increase its production of **gonadotropin-releasing hormone (GnRH)**, releasing GnRH in pulses at intervals of about 2 hours (DeRose &

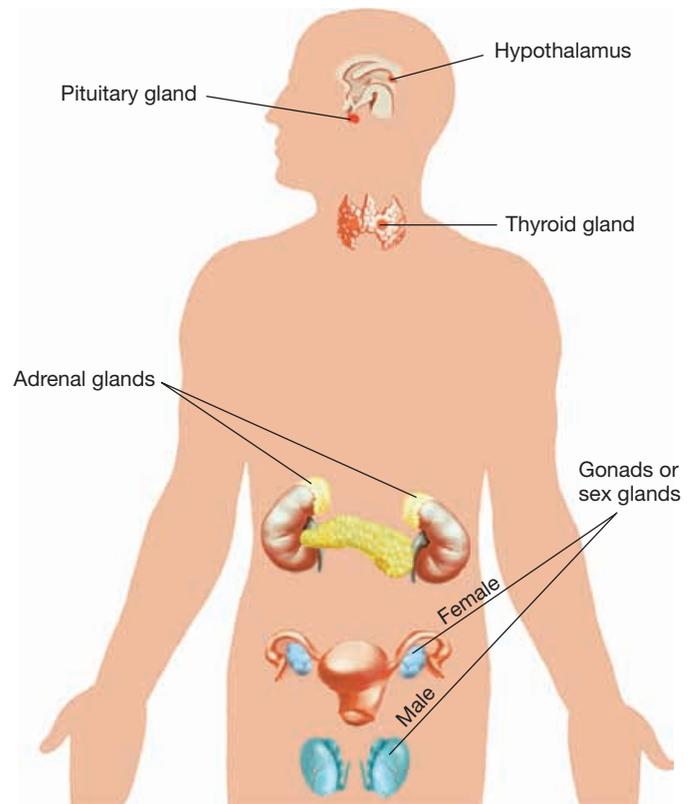


FIGURE 2.1 The major glands involved in pubertal change.

Brooks-Gunn, 2006). The increase in GnRH begins in middle childhood, at least a year or two before even the earliest bodily changes of puberty.

But what causes the hypothalamus to increase GnRH production? Recent evidence indicates that this increase occurs once a threshold level of body fat is reached (Alsaker & Flammer, 2006). During middle childhood the proportion of fat in the body gradually increases, and once the threshold level is reached the increase in GnRH is triggered in the hypothalamus. Fat cells produce a protein, **leptin**, that provides the signal to the hypothalamus (Shalatin & Philip, 2003). Consequently, for adolescents who are excessively thin due to illness, extreme exercise, or malnutrition, puberty is delayed.

The Pituitary Gland and the Gonadotropins The increase in GnRH affects the **pituitary gland**, a gland about half

puberty The changes in physiology, anatomy, and physical functioning that develop a person into a mature adult biologically and prepare the body for sexual reproduction.

endocrine system A network of glands in the body. Through hormones, the glands coordinate their functioning and affect the development and functioning of the body.

hormones Chemicals, released by the glands of the endocrine system, that affect the development and functioning of the body, including development during puberty.

hypothalamus The “master gland,” located in the lower part of the brain beneath the cortex, that affects a wide range of physiological and psychological functioning and stimulates and regulates the production of hormones by other glands, including the ones involved in the initiation of puberty.

gonadotropin-releasing hormone (GnRH) Hormone released by the hypothalamus that causes gonadotropins to be released by the pituitary.

leptin A protein, produced by fat cells, that signals the hypothalamus to initiate the hormonal changes of puberty.

pituitary gland A gland about half an inch long located at the base of the brain that releases gonadotropins as part of the body’s preparation for reproduction.

an inch long located at the base of the brain. GnRH is appropriately named gonadotropin-releasing hormone, because that is what it does when it reaches the pituitary gland—it causes hormones called **gonadotropins** to be released. The two gonadotropins are **follicle-stimulating hormone (FSH)** and **luteinizing hormone (LH)**. FSH and LH stimulate the development of **gametes**—egg cells in the ovaries of the female and sperm in the testes of the male. FSH and LH also influence the production of sex hormones by the ovaries and testes, which will be described in more detail below.

The Gonads and the Sex Hormones The ovaries and testes are also known as the **gonads**, or sex glands. In response to stimulation from the FSH and LH released by the pituitary gland, the gonads increase their production of the **sex hormones**. There are two classes of sex hormones, the **estrogens** and the **androgens**. With respect to pubertal development, the most important estrogen is **estradiol**, and the most important androgen is **testosterone** (Shirtcliff et al., 2009). Increases in these hormones are responsible for most of the observable bodily changes of puberty, such as breast growth in females and facial hair in males.

Estradiol and testosterone are produced in both males and females, and throughout childhood the levels of these hormones are about the same in boys and girls (DeRose & Brooks-Gunn, 2006). However, once puberty begins, the balance changes dramatically, with females producing more estradiol than males and males producing more testosterone than females (**Figure 2.2**). By the mid-teens, estradiol production is about eight times as high in females as it was before puberty, but only about twice as high in males (Nottelmann et al., 1987; Susman, 1997). Similarly, in males testosterone production is about 20 times as high by the mid-teens as it was before puberty, but in females it is only about four times as high (Nottelmann et al., 1987; Susman, 1997).

Androgens are produced not only by the sex glands but also by the adrenal glands. At puberty, the pituitary gland increases production of a hormone known as **adrenocorticotropic hormone (ACTH)**, which causes the adrenal glands to increase androgen production (Archibald, Graber, & Brooks-Gunn, 2003). The androgens released by the adrenal gland have the same effects as the androgens

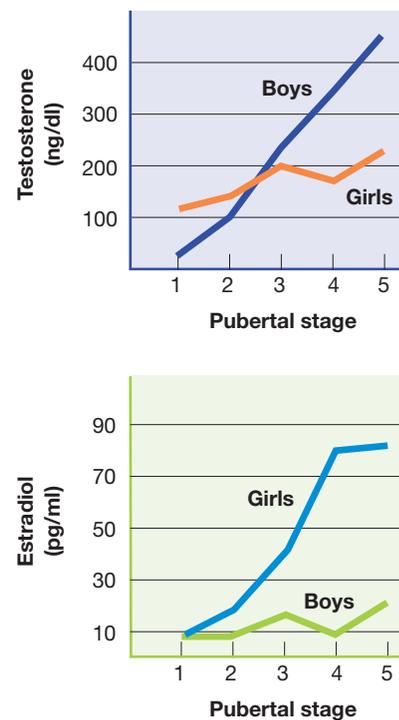


FIGURE 2.2 Sex differences in hormonal changes during puberty.

Source: Nottelmann et al. (1987).

released by the testes, contributing to changes such as the development of increased body hair.

The Feedback Loop in the Endocrine System From infancy onward, a **feedback loop** runs between the hypothalamus, the pituitary gland, the gonads, and the adrenal glands, that monitors and adjusts the levels of the sex hormones (**see Figure 2.3**). The hypothalamus monitors the levels of androgens and estrogens in the bloodstream, and when the sex hormones reach an optimal level, called the **set point**, the hypothalamus reduces its production of GnRH. The pituitary responds to the reduction in GnRH by reducing its production of FSH, LH, and ACTH; the gonads and adrenal glands, in turn, respond to lower levels of FSH and LH by reducing the amount of sex hormones they produce.

gonadotropins Hormones (FSH and LH) that stimulate the development of gametes.

follicle-stimulating hormone (FSH) Along with LH, stimulates the development of gametes and sex hormones in the ovaries and testes.

luteinizing hormone (LH) Along with FSH, stimulates the development of gametes and sex hormones in the ovaries and testes.

gametes Cells, distinctive to each sex, that are involved in reproduction (egg cells in the ovaries of the female and sperm in the testes of the male).

gonads The ovaries and testicles. Also known as the sex glands.

sex hormones Androgens and estrogens that cause the development of primary and secondary sex characteristics.

estrogens The sex hormones that have especially high levels in females from puberty onward and are mostly responsible for female primary and secondary sex characteristics.

androgens The sex hormones that have especially high levels in males from puberty onward and are mostly responsible for male primary and secondary sex characteristics.

estradiol The estrogen most important in pubertal development among girls.

testosterone The androgen most important in pubertal development among boys.

adrenocorticotropic hormone (ACTH) The hormone that causes the adrenal glands to increase androgen production.

feedback loop System of hormones involving the hypothalamus, the pituitary gland, and the gonads, which monitors and adjusts the levels of the sex hormones.

set point Optimal level of sex hormones in the body. When this point is reached, responses in the glands of the feedback loop cause the production of sex hormones to be reduced.

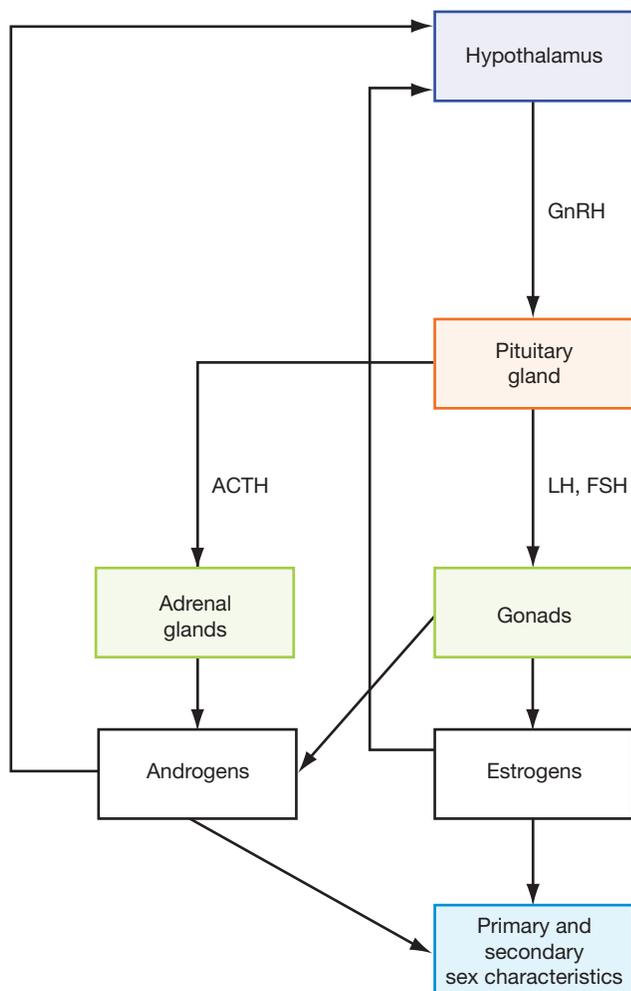


FIGURE 2.3 The feedback loop.

Source: Adapted from Grumbach et al. (1974).

A commonly used metaphor for the set point is a thermostat. If you set the thermostat at 70 degrees, when the temperature falls below that level the furnace comes on. As the furnace heats the rooms, the temperature rises, and when it reaches 70 degrees again the furnace turns off. In your body, when the levels of the sex hormones fall below their set points, their production by the gonads increases. Once the levels rise again to the set points, their production decreases.

When puberty begins, the set points for androgens and estrogens rise in the hypothalamus, with the set point for androgens rising higher in males than in females and the set point for estrogens rising higher in females than in males. In other words, during childhood the gonads produce only a relatively small amount of sex hormones before the set point of the hypothalamus is reached and the hypothalamus signals the gonads to decrease production of the sex hormones. As puberty begins, however, and the set

points for the sex hormones rise in the hypothalamus, the gonads can produce an increasing amount of the sex hormones before the hypothalamus instructs them to decrease production. To return to the thermostat metaphor, it is as if the thermostat were set at 40 degrees during childhood, so that the “heat” of sex hormone production is triggered only occasionally. In the course of puberty, it is as if the thermostat rises to 80, and the “heat” of sex hormone production rises accordingly.

Physical Growth During Puberty

The increases in the levels of the sex hormones discussed in the previous section result in a variety of dramatic changes in the bodies of adolescents. One of these changes is the rate of physical growth. After proceeding at an even pace since early childhood, growth suddenly surges when puberty arrives. In fact, one of the earliest signs of puberty for both girls and boys is the **adolescent growth spurt**. Figure 2.4 shows the typical rate of growth in height from birth through age 19, including the adolescent growth spurt. At **peak height velocity**, when the adolescent growth spurt is at its maximum, girls grow at about 3.5 inches (9.0 cm) per year, and boys grow at about 4.1 inches (10.5 cm) per year (Huang, Biro, & Dorn, 2009; Tanner, 1971). For both girls and boys, the rate of growth at peak height velocity is the highest it has been since they were 2 years old.



Girls typically reach their growth spurt 2 years earlier than boys.

adolescent growth spurt The rapid increase in height that takes place at the beginning of puberty.

peak height velocity The point at which the adolescent growth spurt is at its maximum rate.

asynchronicity Uneven growth of different parts of the body during puberty.

extremities The feet, hands, and head.

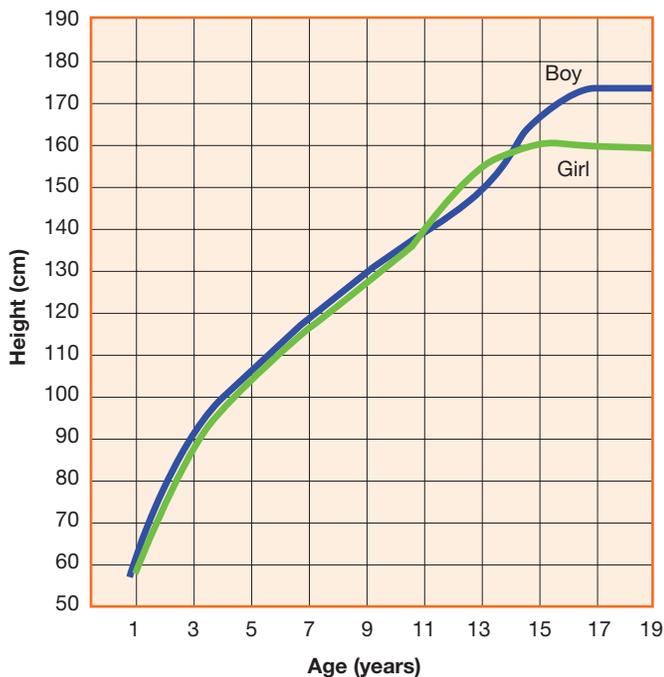


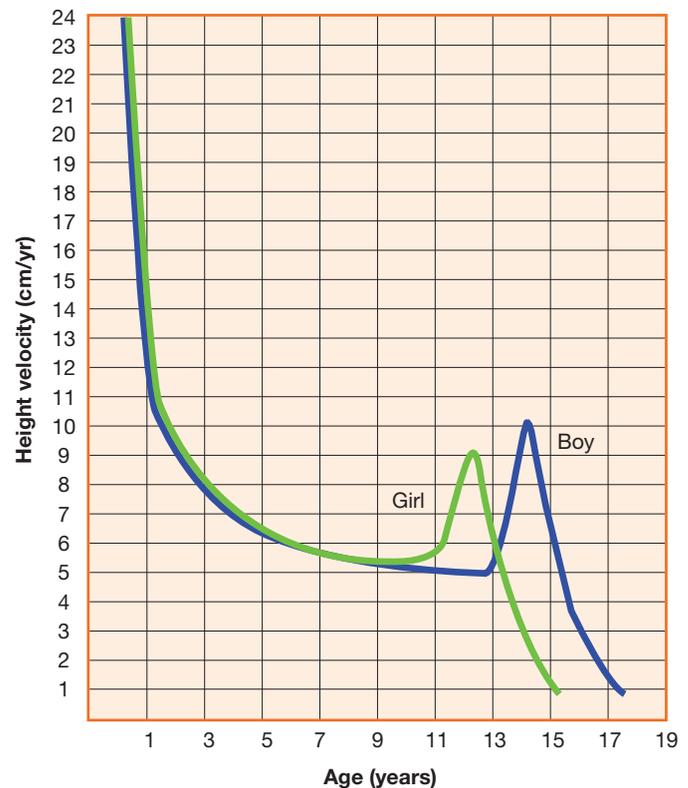
FIGURE 2.4 Growth in height and height velocity for average males and females.
Source: Adapted from Marshall (1978).

As Figure 2.4 shows, girls typically reach the beginning of their growth spurt as well as their peak height velocity about 2 years earlier than boys. This is true of other aspects of physical development in puberty as well: Girls mature about 2 years ahead of boys. Until the growth spurt begins, throughout childhood boys are slightly taller on average than girls of the same age (DeRose & Brooks-Gunn, 2006). Girls become taller on average for about 2 years in early adolescence, from ages 11 to 13, the 2 years when they have hit their growth spurt but boys have not. However, the earlier maturation of girls contributes to their smaller adult height, because the adolescent growth spurt also marks the beginning of the end of growth in height. Because girls begin their growth spurt earlier, they also reach their final height earlier—about age 15, on average, compared with about age 17 for boys (Archibald et al., 2003).

thinking critically

What are some of the social and psychological consequences of the fact that girls mature about 2 years earlier than boys during puberty?

During the adolescent growth spurt, not all parts of the body grow at the same pace. A certain amount of **asynchronicity** in growth during this time explains why some



adolescents have a “gangly” look early in puberty, as some parts of the body grow faster than others. The **extremities**—feet, hands, and head—are the first to hit the growth spurt, followed by the arms and legs (Archibald et al., 2003). Some parts of the head grow more than others. The forehead becomes higher and wider, the mouth widens, the lips become fuller, and the chin, ears, and nose become more prominent (Mussen et al., 1990). The torso, chest, and shoulders are the last parts of the body to reach the growth spurt and therefore the last to reach the end of their growth.

In addition to the growth spurt, a spurt in muscle growth occurs during puberty, primarily because of the increase in testosterone (Son'kin, 2007; Tanner, 1971). Because boys experience greater increases in testosterone than girls do, they also experience greater increases in muscle growth. As **Figure 2.5** shows, before puberty girls and boys are very similar in their muscle mass.

Levels of body fat also surge during puberty, but body fat increases more for girls than for boys, as Figure 2.5 shows. As a consequence of these sex differences in muscle and fat growth, by the end of puberty boys have a muscle-to-fat ratio of about 3:1, whereas the muscle-to-fat ratio for girls is 5:4 (Biro et al., 2010; Grumbach et al., 1974). Other sex differences in body shape also develop during puberty. Hips and shoulders widen among both girls and boys, but hips widen more than shoulders in girls and shoulders widen more than hips in boys.

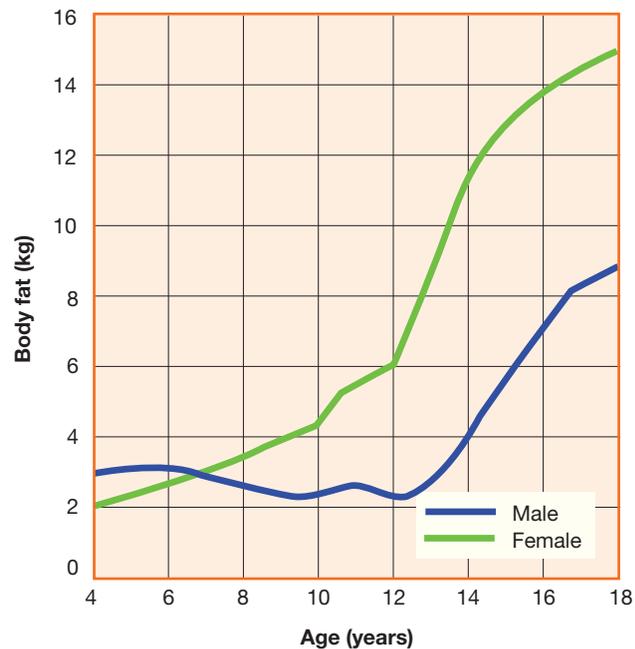
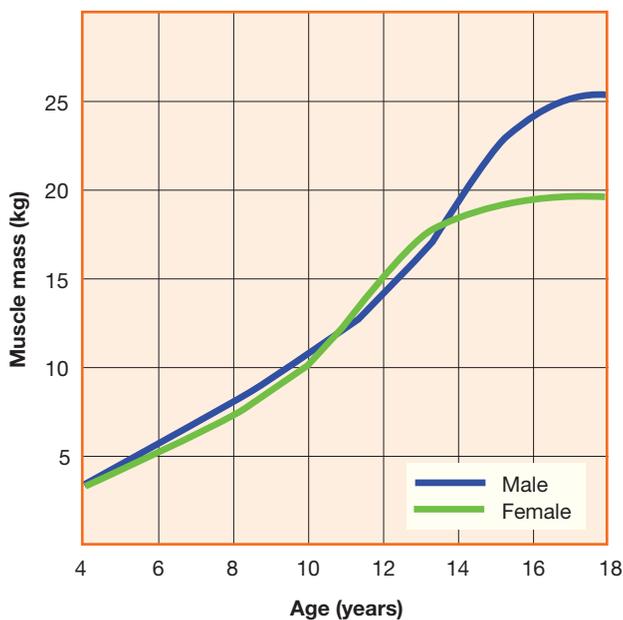


FIGURE 2.5 Sex differences in muscle mass and body fat during puberty.
Source: Adapted from Grumbach et al. (1974).

thinking critically

Given that girls naturally gain substantially more body fat than boys during puberty, why do some cultures create physical ideals that demand thinness in females once they reach puberty?

In both boys and girls, the heart becomes larger during puberty—on average, its weight almost doubles—and the heart rate falls, but boys' hearts grow more than girls' hearts do and their heart rates fall to a lower level (Litt & Vaughan, 1987). By age 17, the average girl's heart rate is about five beats per minute faster than the average boy's (Neinstein, 1984). A similar change takes place in the growth of the lungs. A measure of lung size called **vital capacity**, which means the amount of air that can be exhaled after a deep breath, increases rapidly for both boys and girls during puberty, but increases more for boys than for girls (Litt & Vaughan, 1987).

These sex differences in physical growth and functioning result in sex differences in strength and athletic ability during adolescence and beyond. Before puberty boys and girls are about equal in strength and athletic performance, but during puberty boys overtake girls, and the difference remains throughout adulthood (DeRose & Brooks-Gunn, 2006).

Gender differences also exist in cultural expectations for physical activity in many cultures, with adolescent girls sometimes being discouraged from participating in sports in order to conform to cultural ideas of what it means to be "feminine." Boys are more likely to exercise in adolescence,

and this gender difference contributes to the difference in athletic performance between adolescent boys and girls. This has remained true even in recent years, despite an increase in organized athletic activities for girls from childhood onward (Johnston, Delva, & O'Malley, 2007a). A World Health Organization survey of 15-year-olds in 26 Western countries found that in every country, boys were more likely than girls to say they exercised vigorously at least twice a week outside of school (Smith, 2000). Across countries, about three-fourths of boys exercised at least twice a week, compared with about one-half of girls. In studies that take amount of exercise into account, the muscle-to-fat ratio is still higher for boys than for girls, but the difference is not as large as in studies that do not take exercise into account (DeRose & Brooks-Gunn, 2006).

Obesity Although it is normal and healthy for young people to gain some weight during puberty, for many young people their weight gain goes well beyond what is healthy. Obesity has become a major health problem in developed countries and is becoming a problem in developing countries as well (Werner & Bodin, 2007; Zhaohui et al., 2010). Obesity is defined as exceeding a specific **body mass index (BMI)**, which is a ratio of height to weight (Davies & Fitzgerald, 2008). The BMI thresholds for obesity are determined by medical authorities and vary depending on age group (The et al., 2010). Across countries, rates of overweight and obesity are highest in the most affluent regions (North America and Europe) and lowest in the poorest regions (Africa and Southeast Asia) (Wang & Lobstein, 2006). Among developed countries, rates

vital capacity The amount of air that can be exhaled after a deep breath, which increases rapidly during puberty, especially for boys.

maximum oxygen uptake (VO₂ max) A measure of the ability of the body to take in oxygen and transport it to various organs; peaks in the early 20s.

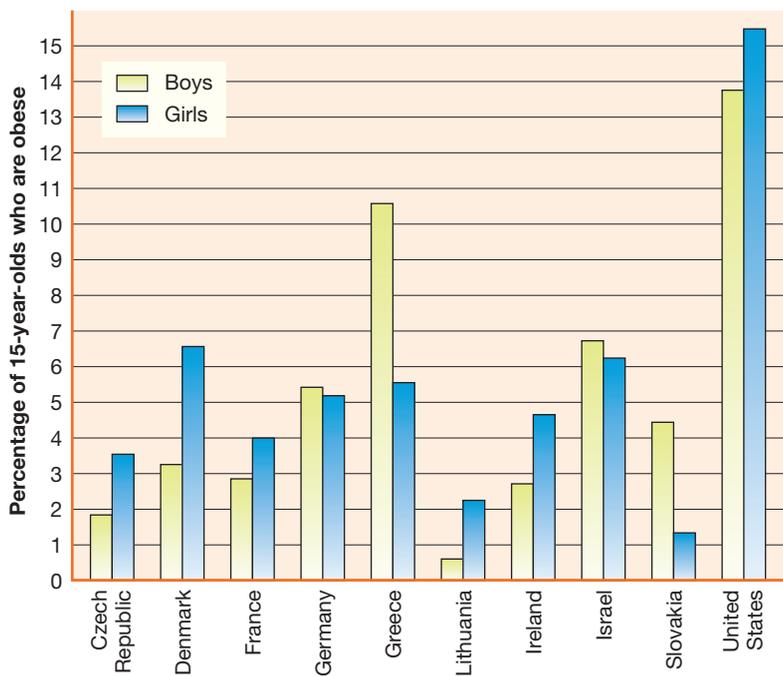


FIGURE 2.6 Rates of obesity among adolescents in selected countries. Why are rates of obesity so high among adolescents in the United States?
Source: Bowman et al. (2004).

of obesity are especially high in the United States. As **Figure 2.6** shows, the proportion of 15-year-olds who are obese is far greater in the United States than in other developed countries (Lissau et al., 2004; Wang, Monteiro, & Popkin, 2002). About 14% of American adolescents ages 12 to 17 are classified as obese, a sharp rise from 5% during the period 1966 to 1980 (Fleming & Towey, 2003; National Center for Health Statistics, 2000). The problem is especially severe among African Americans and Latinos, whose obesity rates in adolescence are about 50% higher than the rate for Whites (Fleming & Towey, 2003). Obese adolescents have higher leptin levels, so it may be that increased obesity has contributed to the earlier onset of puberty among African American and Latino girls in recent decades (Shalitin, 2003; Sun et al., 2005).

What is responsible for the disturbing trends in obesity among American adolescents? Not surprisingly, diet and exercise are implicated. Nearly one-third of American adolescents eat at least one fast-food meal per day, and fast food tends to be extremely high in calories, loaded with fat and sugar (Bowman et al., 2004). Furthermore, fast-food portions have increased dramatically in recent years, as the burgers and drinks and French fry portions have become “supersized.” The American lifestyle is more automobile-oriented than in most other developed countries, so American adolescents ride in cars more and walk or bike-ride less. American adolescents exercise less than medical experts recommend, and African American females have especially low rates of exercise.

One recent study found a steep decline in physical activity from age 9 to 15 (Nader et al., 2008). Rather than using reports of physical activity from the participants or their parents, the researchers had the participants wear an “accelerometer,” a device that measures movement, for one week. At age 9, children engaged in about 3 hours of physical activity a day on both weekdays and weekends. However, from age 9 to 15 the rate of physical

activity declined steadily, and at age 15 physical activity was down to less than an hour on weekdays and just a half-hour on weekends. The study did not investigate the reasons for the decline.

Time watching television has been found to be related to obesity (Dowda et al., 2001), but American adolescents watch about the same amount of television as adolescents in other industrialized countries (Flammer, Alsaker, & Noack, 1999), so television-watching cannot explain the cross-national difference in obesity. Computer games have also been blamed (Davies & Fitzgerald, 2008), but again, computer games are popular in countries with widely different rates of adolescent obesity. Similarly, obesity has been found to run in families—when parents are obese, adolescents are at higher risk for obesity (Corrado et al., 2004; Davies & Fitzgerald, 2008; Dowda et al., 2001)—which suggests that heredity may be involved, but this cannot explain the steep increase in obesity in recent decades.

One trend that does shed light on the recent increase in obesity in the United States is the increased presence of soft drink and junk food machines in schools. Only one fourth of American elementary schools allow vending machines, but this proportion rises to two thirds in middle school and nearly 90% in high schools (Johnston, Delva, & O’Malley, 2007b). Often, soft drink companies pay schools in return for being allowed to place their vending machines there, and cash-hungry schools are usually easy to persuade. Soft drink companies also offer money to after-school youth organizations such as the Boys and Girls Clubs of America and the YMCA in return for being able to market to the adolescents who attend their programs (Boyle, 2004). Some have begun to criticize this practice, but like the schools, few youth organizations have been able to resist the money.

Obesity in adolescence is a source of concern not just because it is unhealthy during the teen years but because it predicts long-term health problems (Davies & Fitzgerald, 2008; The et al., 2010). About 80% of obese adolescents remain obese in adulthood (Engeland et al., 2004). A variety of health risks result from obesity in adulthood, including diabetes, stroke, and heart disease (Corrado et al., 2004). To address the problem, medical professionals have developed interventions intended to reduce obesity during childhood and adolescence, usually through the schools. Successful programs have a variety of components, including nutrition education, dietary assessment, modifications of meals offered in the school, and efforts to increase physical activity (Stice, Shaw, & Marti, 2006). However, such programs also face barriers, especially resistance from adolescents who see no need to change and parents who are disinclined to become more involved.

Physical Functioning in Emerging Adulthood Although most people reach their maximum height by the end of adolescence, in other ways emerging adulthood rather than adolescence is the period of peak physical functioning. Even after maximum height is attained, the bones continue to grow in density, and peak bone mass is reached in the 20s (Zumwalt, 2008). A measure of physical stamina called **maximum oxygen uptake, or VO_2 max**, which reflects the ability of the body to take in oxygen and transport it to various organs, also



For most people, the peak of their physical functioning comes during emerging adulthood. Here, the American swimmer Michael Phelps at the 2008 Summer Olympics.

peaks in the early 20s (Parker et al., 2007). Similarly, **cardiac output**, the quantity of blood flow from the heart, peaks at age 25 (Lakatta, 1990). Reaction time is also faster in the early 20s than at any other time of life. Studies of grip strength among men show the same pattern, with a peak in the 20s followed by a steady decline (Aldwin & Spiro, 2006). All together, for most people emerging adulthood is the time of life when they are at the zenith of their health and strength.

One way to demonstrate this is at the extreme, in terms of peak performances in athletic activity. Several studies have been conducted on the ages of athletes' best performances (Ericsson, 1990; Schultz & Curnow, 1988; Stones & Kozma, 1996; Tanaka & Seals, 2003). The peak ages have been found to vary depending on the sport, with swimmers youngest (the late teens) and golfers oldest (about age 31). However, for most sports the peak age of performance comes during the 20s.

Emerging adulthood is also the period of the life span with the least susceptibility to physical illnesses (Keyes & Grzywacz, 2002). This is especially true in modern times, when vaccines and medical treatments have dramatically lowered the risk of diseases such as polio that used to strike mainly during these years (Hein, 1988). Emerging adults are no longer vulnerable to the illnesses and diseases of childhood, and with rare exceptions they are not yet vulnerable to diseases such as cancer and heart disease that rise in prevalence later in adulthood. The immune system is at its most effective during the emerging adult years. Consequently, the late teens and early 20s are the years of fewest hospital stays and fewest days spent sick in bed at home (Keyes & Grzywacz, 2002). In many ways, then, emerging adulthood is an exceptionally healthy time of life.

This is not the whole story, however. The lifestyles of many emerging adults often include a variety of factors that undermine health, such as poor nutrition, lack of sleep, and the high stress of trying to juggle school and work or multiple jobs (Ma et al., 2002; Steptoe & Wardle, 2001). Longitudinal studies in the United States and Finland have found that physical activity, sports participation, and exercise decline from adolescence through emerging adulthood (Gordon-Larsen et al., 2004; Telama et al., 2005).

Furthermore, in the United States and other developed countries the late teens and early 20s are the years of highest incidence of a variety of types of disease, injury, and death due to behavior. Automobile accidents are the leading cause of death among emerging adults in developed countries, and injuries and deaths from automobile accidents are higher in the late teens and early 20s than at any other period of the life span (National Highway Traffic Safety Administration, 2011). Homicide is another common cause of death in developed countries during emerging adulthood (McCall, Land, & Parker, 2011). Rates of contracting sexually transmitted infections, including HIV, are highest in the early 20s (Wenstock et al., 2004). Most kinds of substance use and abuse also peak in the early 20s (Bachman et al., 2008).

We will discuss the causes of these problems in Chapter 13. For now, it is worth noting that in recent decades health experts have reached a consensus that the source of most physical health problems in the teens and early 20s is in young people's behavior. As a result, programs emphasizing **health promotion** during these years have become more common. Programs in health promotion tend to emphasize prevention of problems through encouraging changes in the behaviors that put young people at risk (e.g., driving at high speeds, having unprotected sex, engaging in binge drinking). Many of these programs focus on the early adolescent years, in the belief that these are the years when patterns of behavior are being established that may endure into late adolescence, emerging adulthood, and beyond.

The success of such programs has been mixed so far, as we will see in more detail in Chapter 13. However, some programs work better than others. Child Trends, a nonprofit research center on children and families, published an extensive review of programs intended to encourage healthy behavior and lifestyles among adolescents (Hatcher & Scarpa, 2001). After reviewing 230 studies, it was concluded that the most successful programs take a multifaceted approach (taking into consideration the adolescent, family members, peers, and the community); focus on changing behavior rather than on distributing information; and include follow-up sessions to reinforce the effects of the intervention.

cardiac output A measure of the quantity of blood pumped by the heart.

health promotion Efforts to reduce health problems in young people through encouraging changes in the behaviors that put young people at risk.

primary sex characteristics The production of eggs and sperm and the development of the sex organs.

secondary sex characteristics Bodily changes of puberty not directly related to reproduction.

ovum Mature egg that develops from follicle in ovaries about every 28 days.

spermarche Beginning of development of sperm in boys' testicles at puberty.



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Primary Sex Characteristics

In addition to the changes in physical growth and functioning described so far, two other kinds of changes take place in the adolescent's body in response to increased sex hormones during puberty. **Primary sex characteristics** involve the production of eggs and sperm and the development of the sex organs. **Secondary sex characteristics** are other bodily changes of puberty, not including the ones related directly to reproduction.

Egg and Sperm Production As noted, increases in the sex hormones at puberty cause eggs to develop in the ovaries of females and sperm to be produced in the testes of males. The development of the gametes is quite different for the two sexes. Females are born with about 400,000 immature eggs in each ovary (Norman, 2008). By puberty, this number has declined to about 80,000 in each ovary. Once a girl reaches **menarche** (her first menstrual period) and begins having menstrual cycles, one egg develops into a mature egg, or **ovum** (plural: ova), every 28 days or so. Females release about 400 eggs over the course of their reproductive lives.

In contrast, males have no sperm in their testes when they are born, and they do not produce any until they reach puberty. The first production of sperm in boys is called **spermarche**, and it takes place on average at age 12 (Bancroft, 2006; Finkelstein, 2001c). Once spermarche arrives, boys produce sperm in astonishing quantities. There are between 30 and 500 million sperm in the typical male ejaculation, which means that the average male produces millions of sperm every day. If you are a man, you will probably produce over a million sperm during the time you read this chapter—even if you are a fast reader!

Why so many? One reason is that the environment of the female body is not very hospitable to sperm. The female's immune system registers sperm as foreign bodies and begins attacking them immediately. A second reason is that sperm have, in relation to their size, a long way to go to reach the ovum. They have to make their way along and through the

"I was about six months younger than everyone else in my class, and so for about six months after my friends had begun to develop (that was the word we used, develop), I was not particularly worried. I would sit in the bathtub and look down at my breasts and know that any day now, any second now, they would start growing like everyone else's. They didn't... . 'Don't worry about it,' said my friend Libby some months later, when things had not improved. 'You'll get them after you're married.' 'What are you talking about?' I said. 'When you get married,' Libby explained, 'Your husband will touch your breasts and rub them and kiss them and they'll grow.'"

—Nora Ephron 2000, *Crazy Salad*, pp. 2–4

various structures of the female reproductive anatomy. So it helps to have a lot of sperm wiggling their way toward the ovum, because this increases the likelihood that some of them may make it to the ovum at the right time for fertilization to take place.

The Male and Female Reproductive Anatomy The changes of puberty prepare the body for sexual reproduction, and during puberty the sex organs undergo a number of important changes as part of that preparation. In males, both the penis and the testes grow substantially (King, 2005). The penis doubles in length and diameter. In its mature form, the flaccid (limp) penis averages 3 to 4 inches in length and about 1 inch in diameter. The tumescent (erect) penis averages 5½ to 6 inches in length and 1½ inches in diameter. The growth of the testes during puberty is even more pronounced—they increase 2½ times in length and 8½ times in weight, on average. The dramatic growth of the testes reflects the production of the many millions of sperm.

In females, the external sex organs are known as the **vulva**, which includes the **labia majora** (Latin for “large lips”), the **labia minora** (Latin for “small lips”), and the **clitoris**. The vulva grows substantially in puberty (King, 2005). The ovaries also increase greatly in size and weight. Just as the testes grow as a consequence of sperm production, the growth of the ovaries reflects the growth of maturing ova. Furthermore, the uterus doubles in length during puberty, growing to a mature length of about 3 inches, about the size of a closed fist. The vagina also increases in length, and its color deepens.

As noted earlier, an ovum is released in each monthly cycle. The two ovaries typically alternate months, with one releasing an ovum and then the other. The ovum moves along the fallopian tube and travels to the uterus. During this time, a lining of blood builds up in the uterus in preparation for the possibility of receiving and providing nutrients for the fertilized egg. If the ovum becomes fertilized by a sperm during its journey to the uterus, the fertilized egg begins dividing immediately. When it reaches the uterus it implants in the wall of the uterus and continues developing. If the ovum is not fertilized, it is evacuated during menstruation along with the blood lining of the uterus.

Although menarche is a girl’s first menstruation, it is not the same as the first ovulation. On the contrary, the *majority* of a girl’s menstrual cycles in the first 2 years after menarche do not include ovulation, and in the third and fourth years only about one third to one half of cycles include ovulation (Finkelstein, 2001d). It is only after 4 years of menstruation that girls consistently ovulate with each menstrual cycle. This early inconsistency leads some sexually active adolescent girls to believe they are infertile, but this is an unfortunate misunderstanding. Fertility may be inconsistent and unpredictable during the first 4 years after menarche, but it is certainly possible. Whether boys experience a similar lag between spermarche and the production of sperm capable of fertilizing an egg is not known.

Secondary Sex Characteristics

All the primary sex characteristics are directly related to reproduction. In addition to these changes, numerous other bodily changes take place as part of puberty but are not directly related to reproduction. These changes are known as *secondary sex characteristics*.

Some secondary sex characteristics develop for only males or only females, but for the most part the changes that happen to one sex also happen to the other, to some degree. Both males and females grow hair in their pubic areas and underneath their arms. Both also grow facial hair—you knew that males do, but you may not have realized that females also grow hair, just a slight amount, on their faces during puberty. Similarly, increased hairiness on the arms and legs is more pronounced in males, but females also grow more hair on their limbs at puberty. Boys also begin to grow hair on their

chest, and sometimes on their shoulders and backs as well, whereas girls typically do not.

Both males and females experience various changes in their skin (Tanner, 1971). The skin becomes rougher, especially around the thighs and upper arms. The sweat glands in the skin increase production, making the skin oilier and more prone to acne, and resulting in a stronger body odor. Males and females both experience a deepening of the voice as the vocal cords lengthen, with males experiencing a steeper drop in pitch.

Even breast development, though obviously a secondary sex characteristic that occurs in females, also occurs in a substantial proportion of males. About one fourth of boys experience enlargement of the breasts midway through puberty (Bell, 1998; Tanner, 1970). This can be a source of alarm and anxiety for adolescent boys, but for the majority of them the enlargement recedes within a year.

For girls, the breasts go through a series of predictable stages of development (**Figure 2.7**). The earliest indication of breast development, a slight enlargement of the breasts known as **breast buds**, is also one of the first outward signs of puberty in most girls (Tanner, 1971). During this early stage, there is also an enlargement of the area surrounding the nipple, called the **areola**. In the later stages of breast development, the breasts continue to enlarge, and the areola first rises with the nipple to form a mound above the breast, then recedes to the level of the breast while the nipple remains projected (Archibald et al., 2003).

Table 2.1 provides a summary of the physical changes in males and females during puberty.

thinking critically

Puberty involves the development of sexual maturation. Among the secondary sex characteristics described here, which are viewed in your culture as enhancing sexual interest and attractiveness between males and females? Which are not?

The Order of Pubertal Events

Puberty is composed of many events and processes, typically stretching out over several years (**Table 2.2**). A great deal of variability exists among individuals in the timing of pubertal events. Among young people in developed countries the first pubertal events may occur as early as age 8 in girls and age 9 or 10 in boys, or as late as age 13 (Ge et al., 2007; Herman-Giddens, Wang, & Koch, 2001; Sun et al., 2005). The duration between the initiation of the first pubertal event and full pubertal maturation can be as short as a year and a half or as long as six years (Tanner, 1962). Consequently, in the early teens some adolescents

vulva External female sex organs, including the labia majora, the labia minora, and the clitoris.

labia majora Part of vulva; Latin for “large lips.”

labia minora Part of vulva; Latin for “small lips.”

clitoris Part of vulva in which females’ sexual sensations are concentrated.

breast buds The first slight enlargement of the breast in girls at puberty.

areola Area surrounding the nipple on the breast; enlarges at puberty.

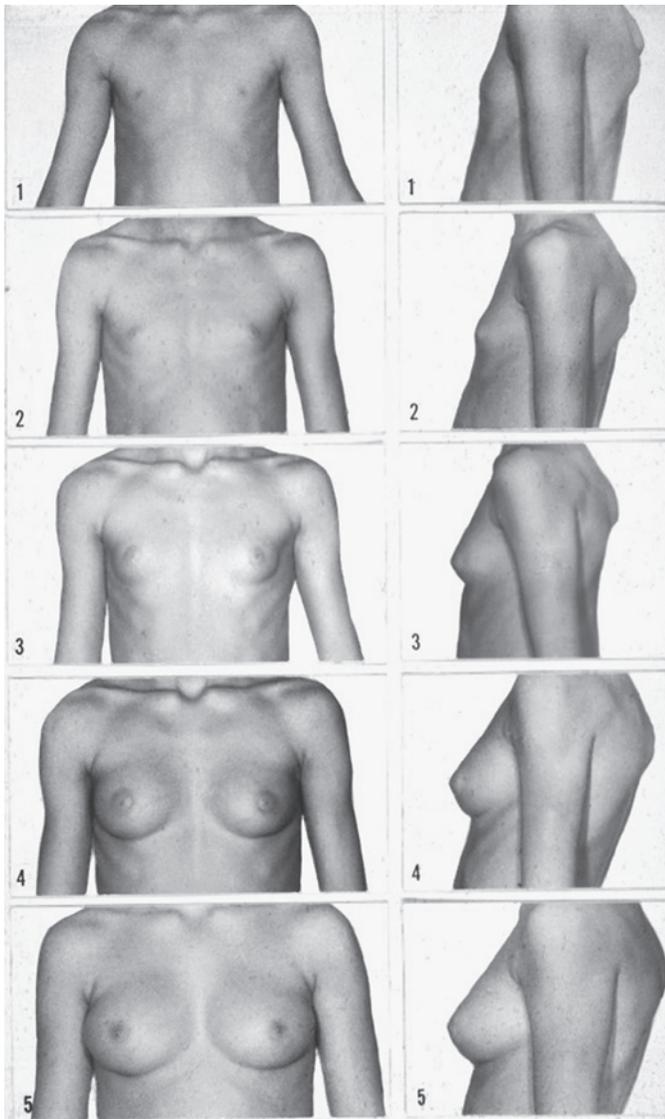


FIGURE 2.7 Stages of breast development.

Source: Marshall and Tanner (1970).

TABLE 2.1 Physical Changes During Adolescence

| Both Sexes | Males Only | Females Only |
|--|--|--|
| Pubic hair | Sperm production | Ovulation/ menstruation |
| Underarm hair | Wider shoulders and chest | Breast development |
| Facial hair | Increased proportion of muscle to fat | Broader hips/pelvis |
| Arm and leg hair | Chest hair | Increased proportion of fat to muscle |
| Rougher skin (especially thighs, upper arms) | Shoulder and back hair | |
| Oilier skin, stronger body odor | | |
| Harder bones | | |
| Lower voice | | |
| Growth spurt | | |
| Larger forehead | | |
| Wider mouth | | |
| Fuller lips | | |
| More prominent chin, ears, nose | | |

may have nearly finished their pubertal development while others have barely begun. Because adolescents experience the first events of puberty at different ages and proceed through puberty at different rates, age alone is a very poor predictor of an adolescent's pubertal development (Archibald et al., 2003).

More consistency can be seen in the order of pubertal events than in the ages they begin or the amount of time it takes to complete them (Finkelstein, 2001c). For girls, downy pubic hair is often the first sign of the beginning of puberty, followed closely by the appearance of breast

TABLE 2.2 The Sequence of Physical Changes at Puberty

| Boys | | Girls | |
|-----------------------------------|---------------------------------|--------------------------------------|---------------------------------|
| Characteristic | Age of first appearance (years) | Characteristic | Age of first appearance (years) |
| 1. Growth of testes, scrotal sac | 9½–13½ | 1. Growth of pubic hair | 8–14 |
| 2. Growth of pubic hair | 10–15 | 2. Growth of breasts | 8–13 |
| 3. Growth spurt | 10 ½–16 | 3. Growth spurt | 9½–14½ |
| 4. Growth of penis | 10½–14½ | 4. Menarche | 10–16½ |
| 5. Change in voice | 11–15 | 5. Underarm hair | 10–16 |
| 6. Spermarche | 12–14 | 6. Oil and sweat production, acne | 10–16 |
| 7. Facial and underarm hair | 12–17 | | |
| 8. Oil and sweat production, acne | 12–17 | | |

Source: Adapted from Goldstein (1976).

buds (for about 20% of girls, breast buds precede the first sign of pubic hair). The next event for girls is usually the growth spurt, along with the growth of the sexual and reproductive organs (vulva, uterus, and vagina). Menarche, the development of underarm hair, and the secretion of increased skin oil and sweat occur relatively late in puberty for most girls.

For boys, the first outward sign of puberty is usually the growth of the testes, along with or closely followed by the beginning of pubic hair (Archibald et al., 2003). These events are followed (usually about a year later) by the initiation of the growth spurt and the increased growth of the penis, along with the beginning of the deepening of the voice. Spermatogenesis takes place at age 12 to 14 for most boys. In boys as in girls, the growth of underarm hair and the secretion of increased skin oil and sweat take place relatively late in puberty. For boys, facial hair is also one of the later developments of puberty, usually beginning about 2 years after the first outward events of puberty.

Virtually all the studies we have been considering in this section have been conducted with White adolescents in the West (Alsaker & Flammer, 2006). In fact, the main source of our information about physical growth and functioning in adolescence remains the studies by J.M. Tanner and his colleagues (see the Research Focus box), which were mostly conducted 40 to 50 years ago on British adolescents who were in foster homes. Tanner's findings have been verified in numerous studies of White adolescents in the United States (Archibald et al., 2003; Susman et al., 2003), but we do not have similarly detailed information on other ethnic and cultural groups around the world.

Three studies demonstrate the variations that may exist in other groups. Among the Kikuyu, a culture in Kenya, boys show the first physical changes of puberty *before* their female peers (Worthman, 1987), a reversal of the Western pattern. In a study of Chinese girls, Lee, Chang, and Chan (1963) found that pubic hair began to develop in most girls about 2 years after the development of breast buds, and only a few months before menarche. This is a sharp contrast to the pattern for the girls in Tanner's studies, who typically began to develop pubic hair at about the same time they developed breast buds, usually 2 years before menarche (Tanner, 1971). Also, in an American study (Herman-Giddens et al., 1997; Herman-Giddens et al., 2001), many African American girls were found to begin developing breast buds and pubic hair considerably earlier than White girls. At age 8, nearly 50% of the African American girls had begun to develop breasts or pubic hair or both, compared with just 15% of the White girls. This was true even though Black and White girls were similar in their ages of menarche.

Similarly, pubic hair and genital development began earlier for African American boys than for White boys. Studies such as these indicate that it is important to investigate further cultural differences in the rates, timing, and order of pubertal events.

Given a similar environment, variation in the order and timing of pubertal events among adolescents appears to be due to genetics. The more similar two people are genetically, the more similar they tend to be in the timing of their pubertal events, with identical twins the most similar of all (Ge et al., 2007; van den Berg, 2007). However, the key phrase here is "given a similar environment." In reality, the environments adolescents experience differ greatly, both within and between countries. These differences have profound effects on the timing of puberty, as we will see in detail in the following section.

WHAT HAVE YOU LEARNED?

1. How does the metaphor of the thermostat apply to the functioning of the feedback loop in the endocrine system?
2. What explains why most top athletes are in their twenties?
3. What are the key differences between the development of ova in females and the development of sperm in males?
4. Which secondary sex characteristics usually develop earliest in girls and in boys?

Cultural, Social, and Psychological Responses to Puberty

- 2.5 Explain how culture influences the timing of puberty.
- 2.6 Identify the rates of prevalence of puberty rituals across cultures, and explain the function of these rituals.
- 2.7 Describe how cultural influences shape responses to menarche and spermatogenesis among adolescents.
- 2.8 Summarize the gender differences in how boys and girls respond to reaching puberty relatively early or late.

Whatever their culture, all humans go through the physical and biological changes of puberty. However, even here culture's effects are profound. Cultural diets and levels of health and nutrition influence the timing of the initiation of puberty. Perhaps more importantly, cultures define the meaning and significance of pubertal change in different ways. These cultural definitions in turn influence the ways that adolescents interpret and experience their passage through puberty. We will look at culture and pubertal timing first, and then at culture and the meaning of puberty. Next we will examine social and personal responses to puberty, with a focus on differences between adolescents who mature relatively early and adolescents who mature relatively late.

secular trend A change in the characteristics of a population over time.

Culture and the Timing of Puberty

How do cultures influence the timing of the initiation of puberty? The definition of culture includes a group’s technologies. Technologies include food production and medical care, and the age at which puberty begins is strongly influenced by the extent to which food production provides for adequate nutrition and medical care provides for good health throughout childhood. In general, puberty begins earlier in cultures where good nutrition and medical care are widely available (Archibald et al., 2003).

Persuasive evidence for the influence of technologies on pubertal timing comes from historical records showing a steady decrease in the average age of menarche in Western countries over the past 150 years. This kind of change in a population over time is called a **secular trend** (Bullough, 1981). As you can see from **Figure 2.8**, a secular trend downward in the age of menarche has occurred in every Western country for which records exist. Menarche is not a perfect indicator of the initiation of puberty—as we have discussed, the first outward signs of puberty appear much earlier for most girls, and of course menarche does not apply to boys. However, menarche is a reasonably good indicator of when other events have begun, and it is a reasonable assumption that if the downward secular trend in the age of puberty has occurred for females, it has occurred for males as well. Menarche is also the only aspect of pubertal development for which we have records going back so many decades. Scholars believe that the secular trend in the age of menarche is due to improvements in nutrition and medical care that have taken place during the past 150 years (Archibald et al., 2003; Bullough, 1981). As medical advances have reduced illnesses and advances in food production have enhanced nutrition, puberty has come sooner.

Further evidence of the role of nutrition and medical care in pubertal timing comes from cultural comparisons in the present. When we look around the world, we find that the average age of menarche is lowest in developed countries, where adequacy of nutrition and medical care is highest (Eveleth & Tanner, 1990; McDowell et al., 2007; Susman & Rogol, 2004). For girls in the United States, the average age of menarche is currently 12.5 (McDowell et al., 2007; Susman et al., 2003). In contrast, the average is higher in developing countries, where nutrition may be limited and medical care is often rare or nonexistent (Stathopulu, Hulse, & Canning, 2003). In countries that have undergone rapid economic development in recent decades, such as China and South Korea, a corresponding decline in the average age of menarche has been recorded (Park, Shim, Kim, & Eun, 1999; Tang et al., 2004).

One illuminating contrast is between African girls in Africa and African American girls in the United States. In African countries the average age of menarche varies widely, but in none of them is it as low as for girls in the United States, and in some African countries the average age of menarche is as high as 15,

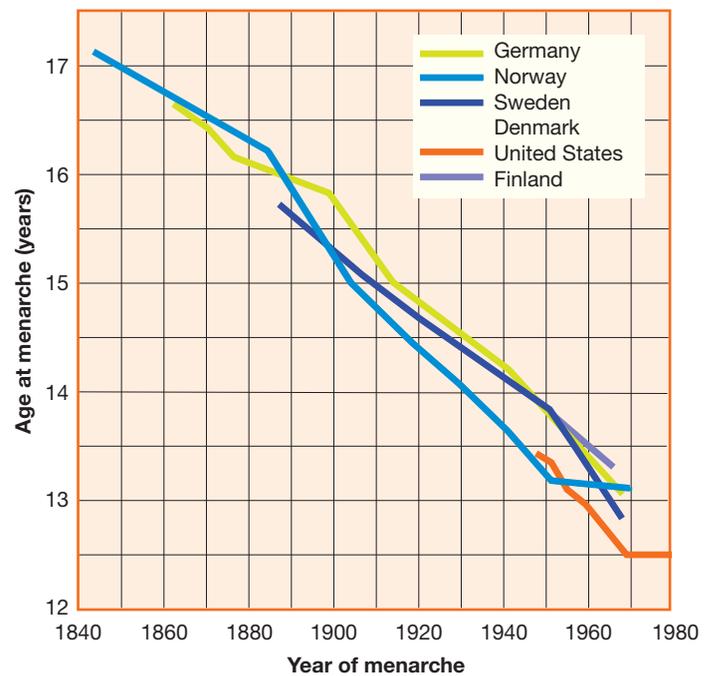


FIGURE 2.8 The decline in the age of menarche in Western countries. Source: Adapted from Eveleth & Tanner (1990).

16, or even 17 years old (Eveleth & Tanner, 1990). In contrast, the average age of menarche for African American girls is just 12.2 (Herman-Giddens et al., 1997). The lower age of menarche for African American girls compared with African girls is very likely due to African American girls’ considerably better nutrition and medical care.

Studies also show that within countries, as you can see in **Figure 2.9**, adolescent girls from affluent families tend to

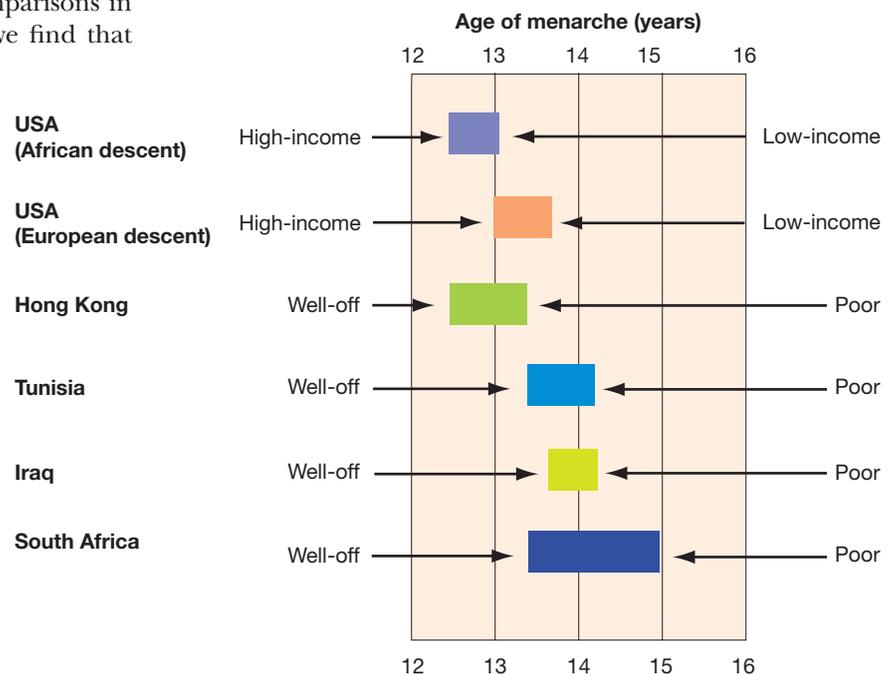


FIGURE 2.9 Age of menarche in relation to socioeconomic status (SES) in various countries. Why is age of menarche inversely related to wealth? Source: Adapted from Eveleth & Tanner (1990).

RESEARCH focus Tanner's Longitudinal Research on Pubertal Development

J. M. Tanner was a British biologist who studied the pattern and sequence of various aspects of physical development during puberty (Marshall & Tanner, 1969, 1970; Tanner, 1962, 1971, 1991). His research took place mainly during the 1960s and 1970s and involved White boys and girls who were living in state-run foster homes in Great Britain. Through the use of direct physical evaluations and photographs, he made careful assessments of growth and development during puberty. By following adolescents over a period of many years, he was able to establish the typical ages at which various processes of pubertal development begin and end, as well as the range of variation for each process. His work on adolescents' physical development is widely accepted by scholars on adolescence; in fact, the stages of various aspects

of pubertal development are known as "Tanner stages," as shown in the examples for breast development in females (see Figure 2.7) and genital development in males (see accompanying photo).

Tanner and his colleagues focused on specific aspects of physical development during puberty: the growth spurt, the development of pubic hair, genital maturity in boys, the development of breasts and menarche in girls (Figure 2.10). For breast development (girls), genital maturity (boys), and pubic hair, Tanner described a sequence of five stages. Stage 1 is the prepubertal stage, when no physical changes have appeared. Stage 5 is the stage when maturity has been reached and growth is completed. Stages 2, 3, and 4 describe levels of development in between. In addition to the stages, Tanner described other

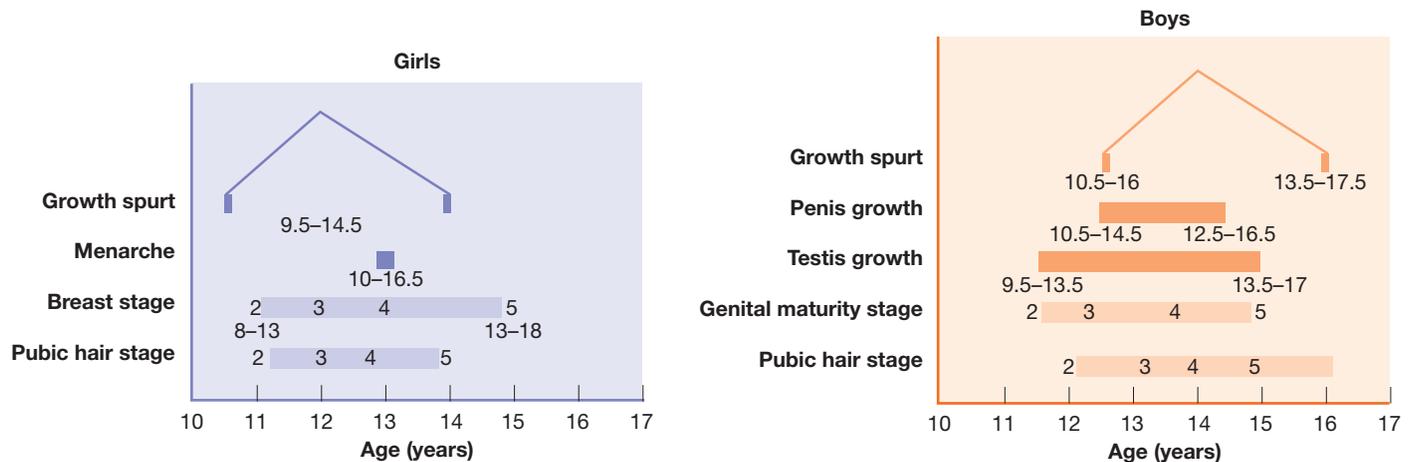


FIGURE 2.10 Typical age ranges for pubertal development.

Source: Adapted from Marshall & Tanner (1970), p. 22.

menstruate earlier than girls from poorer families, in places as diverse as Hong Kong, Tunisia, Iraq, South Africa, and the United States (Eveleth & Tanner, 1990). Again, we can infer that economic differences result in differences in the nutrition and medical care these girls receive, which in turn influence the timing of menarche.

With respect to nutrition in particular, substantial evidence shows that girls who are involved in activities in which there is a great deal of pressure to keep down their weight, such as ballet and gymnastics, experience later menarche and have inconsistent periods once they begin to menstruate (Robert-McComb, 2008). The body responds to their low weight as a nutritional deficiency and delays menarche.

reaction range Term meaning that genes establish a range of possible development and environment determines where development takes place within that range.

thinking critically

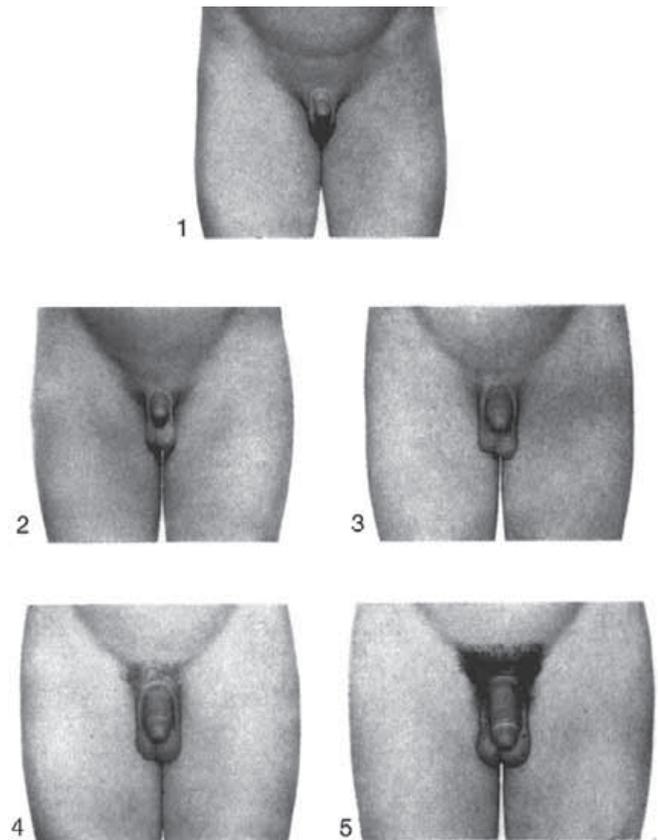
In your view, what potential social and psychological problems may develop as a consequence of girls showing signs of reaching puberty (such as initial breast development) as early as 8 or 9 years old?

Given that the secular trend in the age of menarche was steadily downward for over a century in developed countries, will girls someday begin menstruating in middle childhood or even earlier? Apparently not. In most developed countries, the median age of menarche has been more or less stable since about 1970 (Herman-Giddens et al., 1997; McDowell et al., 2007; Susman et al., 2003). Although there is some evidence that a downward secular trend for breast development and pubic hair may have continued since that time (Herman-Giddens et al., 2001), human females appear to have a genetically established **reaction range** for the age of menarche. This means that

bodily changes such as muscle growth and the composition of the blood (Tanner, 1971).

The adolescents Tanner studied were mainly from low SES families, and many of them probably did not receive optimal physical care during childhood (Marshall & Tanner, 1970). They were living in foster homes, which indicates that there had been problems of some kind in their families. Thus, the adolescents in Tanner's studies were not selected randomly and were in many ways not truly representative of the larger population of adolescents, even the larger population of White British adolescents. Nevertheless, Tanner's description of development in puberty has held up very well. Studies of normal White American adolescents have found patterns very similar to the ones Tanner described (Brooks-Gunn & Reiter, 1990; Susman et al., 2003). Since his original studies, Tanner and his colleagues have also researched development during puberty in other countries in various parts of the world (Eveleth & Tanner, 1990).

Tanner's research was longitudinal. A *longitudinal study* is a study in which the same individuals are followed across time, and data on them are collected on more than one occasion. The range of time involved can vary from a few weeks to an entire lifetime. This kind of study is different from a *cross-sectional study*, which examines individuals at one point in time. Both kinds of studies are valuable, but there are certain kinds of information that can be gained only with a longitudinal study. For example, in Tanner's research, the only way to find out how long it typically takes for females to develop from Stage 1 to Stage 5 of breast development is through a longitudinal study. If breast development were assessed with a cross-sectional study, it would be difficult to tell for each girl how long it had taken for her to develop to that stage and how long it would take for her to



Photos of boys' genital maturity from Tanner's studies.

develop to the next stage. With a longitudinal study, this can be assessed quite precisely.

genes establish a range of possible times when menarche may begin, and environment determines the actual timing of menarche within that range.

In general, the healthier the environment, the lower the timing of menarche. However, the reaction range has boundaries: Even under relatively unhealthy conditions, most girls will eventually reach menarche, and even in conditions of optimal health there is a lower boundary age that menarche is unlikely to fall below. Because the timing of menarche in developed countries has changed little in recent decades, it appears that girls in these countries have reached the lower boundary age of their reaction range for menarche.

Cultural Responses to Puberty: Puberty Rituals

Puberty has been marked with rituals in many cultures through history as the departure from childhood and the entrance into adolescence, particularly in traditional cultures. Not all traditional cultures have such rituals, but they are quite common, especially for girls. Schlegel and Barry (1991)

analyzed information on adolescent development across 186 traditional cultures and reported that the majority of them had some kind of ritual initiation into adolescence at the beginning of puberty: 68% had a puberty ritual for boys, 79% for girls (Schlegel & Barry, 1991).

For girls, menarche is the pubertal event that is most often marked by ritual (Uksul, 2004). In many cultures, menarche initiates a monthly ritual related to menstruation that lasts throughout a woman's reproductive life. It is remarkably common for cultures to have strong beliefs concerning the power of menstrual blood. Such beliefs are not universal, but they have been common in all parts of the world, in a wide variety of cultures. Menstrual blood is often believed to present a danger to the growth and life of crops, to the health of livestock, to the success of hunters, and to the health and well-being of other people, particularly the menstruating woman's husband (Buckley & Gottlieb, 1988; Marvan & Trujillo, 2010). Consequently, the behavior and movement of menstruating women are often restricted in many domains, including food preparation and consumption, social activities, religious practices, bathing, school attendance, and sexual activities (Crumbly, 2006).



Menarche is often marked by a ritual in traditional cultures. Here, girls of the N'Jembe tribe of West Africa prepare for their initiation.

The views of cultures toward menstrual blood are not uniformly negative, however (Buckley & Gottlieb, 1988; Howie & Shail, 2005). Often, menstrual blood is viewed as having positive powers as well. For example, it is sometimes seen as promoting fertility and is used in fertility rituals. Some cultures use menstrual blood in the treatment of medical conditions, and some use it to make love potions (Ladurie, 1979). Sometimes both positive and negative beliefs about menstruation exist within the same culture.

An example of cultural ambivalence toward menstruation can be found among the Asante, a culture in the African nation of Ghana (Buckley & Gottlieb, 1988). Among the Asante, menstruating women are subject to numerous stringent regulations concerning where they may go and what they may do, and the penalty for violating these taboos can be death. However, the Asante also celebrate girls' menarche with an elaborate ritual celebration. The menarcheal girl sits in public view under a canopy (a symbol of honor usually reserved for royalty), while others come before her to congratulate her, present her with gifts, and perform songs and dances in her honor. Thus, on this occasion menstruation is celebrated, even though the rest of the time it is viewed with a great deal of dread and fear.

Practices among Orthodox Jews show a similar ambivalence, with a shift toward a more positive balance in recent decades. Traditionally, when girls told their mothers they had reached menarche, mothers responded with a sudden ritualistic slap on the face (Brumberg, 1997). This gesture was intended to inform the daughter of the future difficulties awaiting her in her life as a woman. Following menarche, each time they menstruated Orthodox women

were obliged to have a ritual bath called **mikveh** a week after their period was finished, as a way of cleansing themselves of the impurity believed to be associated with menstruation. Today, the slap has been retired. The mikveh still exists, but today the bath has more positive connotations. Orthodox Jewish women report that it makes them feel connected to other Jewish women—their current Jewish friends as well as Jewish women of history (Kaufman, 1991). Also, because sexual intercourse is prohibited among Orthodox Jewish couples from the time a woman begins her period until the time she completes mikveh, mikveh also marks the woman's readiness for resuming lovemaking with her husband, and consequently it has connotations of sexual anticipation (Kaufman, 1991).

Puberty rituals for males do not focus on a particular biological event comparable to menarche for females, but the rites for males nevertheless share some common characteristics. In particular, they typically require the young man to display courage, strength, and endurance (Gilmore, 1990). Daily life in traditional cultures often requires these capacities from young men in warfare, hunting, fishing, and other tasks, so the rituals could be interpreted as letting them know what will be required of them as adult men and testing whether they will be up to adulthood's challenges.

The rituals for boys have often been violent, requiring boys to submit to and sometimes engage in bloodletting of various kinds. Among the Sambias of New Guinea, for example, a boy climbs onto the back of a "sponsor," who runs through a gauntlet of older men who beat the boy on his



Puberty rituals for boys often require them to endure physical pain. Here, the traditional stick fight between adolescents in the Xhosa tribe of southern Africa.

CULTURAL focus Coming of Age in Samoa

One interesting example of a puberty ritual for both males and females comes from the islands of Samoa, in the Pacific Ocean near New Zealand. Samoa became known to many Americans early in the 20th century when the anthropologist Margaret Mead wrote a book about Samoan adolescence, *Coming of Age in Samoa* (1928), that was widely read in the United States (and, in fact, all over the world). Many people were fascinated by the stark contrast between adolescence in Samoa and adolescence in the West.

One of the ways Samoa differed from the West was in having a ritual to mark the beginning of adolescence. The traditional rite of passage into adolescence involved an elaborate process of tattooing sometime between ages 14 and 16 (Coté, 1994). The tattoos were made in elaborate geometric patterns and extended from the waist to the knees (see accompanying photo). Having the tattoos put on was painful, especially for males, whose tattoos were more elaborate than the ones for females and usually took 2 to 3 months to complete, whereas the tattoos for females took only 5 to 6 days. But the young men experienced it together and took satisfaction in sharing the ordeal of it and supporting one another. In spite of the pain, few young men or young women declined to take part in it because being tattooed was considered essential to sexual attractiveness and to being accepted as a legitimate candidate for full adult status.

This tattooing ritual has been profoundly affected by the globalization of adolescence. In the past 100 years, Samoan culture has changed a great deal (Coté, 1994; McDade & Worthman, 2004). Christian missionaries arrived and sought to stamp out a variety of native practices they considered immoral, including the ritual of tattooing. The rise of secondary education and the widening of economic opportunities for Samoans who immigrated to nearby New Zealand undermined the traditional economy and caused the tattooing ritual to be viewed as irrelevant or even shamefully “primitive” by some Samoans. By now, most Samoans have abandoned their cooperative, traditional ways for participation in the wage labor of the global economy.

Recently, however, tattooing for young men has undergone a revival. Currently, the majority of young men get tattoos in their teens to demonstrate their pride in the traditional ways of their culture, as part of an explicit attempt to resist the total absorption of their indigenous culture into the global culture.



Tattooing is a traditional rite of passage for Samoan adolescents.

back until it is bloody (Herdt, 1987). Among the Amhara of Ethiopia, boys were forced to take part in whipping contests in which they faced off and lacerated each other's faces and bodies (LeVine, 1966). Some boys went further in proving their fortitude by scarring their arms with red-hot embers. Among the Tewa people of New Mexico (also known as the Pueblo Indians), at some point between the ages of 12 and 15 boys were taken away from their homes, purified in ritual ceremonies, and then stripped naked and lashed on the back with a whip that drew blood and left permanent scars. In many African and Asian tribal cultures, boys were publicly circumcised when they reached puberty (Gilmore, 1990).

Although these rituals may sound cruel if you have grown up in the West, adults of these cultures have believed that the rituals are necessary for boys to make the passage out of childhood toward manhood and be ready to face life's challenges. In all these cultures, however, with globalization the rituals have become less frequent or have disappeared altogether in recent decades (see the Cultural Focus box). Because traditional cultures are changing rapidly in response to globalization, the traditional puberty rituals no longer seem relevant to young people's futures (Schlegel, 2010). However, public circumcision for boys is still maintained as a puberty ritual in many African cultures (Vincent, 2008).

thinking critically

Are there any rituals in Western cultures that are comparable to the puberty rituals in traditional cultures? Should people in Western cultures recognize and mark the attainment of puberty more than they do now? If so, why, and how?

Social and Personal Responses to Puberty

I first menstruated when I was 13 and a half. The first thing I did was go to my mom. I wasn't sure exactly if I had begun to menstruate or not, but my mom knew. She had explained to me in great detail what would happen. She gave me a hug and I remember her saying, "Now my little girl is a woman." I remember thinking at the time how corny it was that she said that, but it made me feel a little better. My mother promised not to tell my dad, since I made her swear, although she told my grandmother, who sympathized with my plight by calling it "the curse." My grandmother told me how ignorant she was when she got hers and how she had asked my great grandmother if her brother Ed would get it, too.

—Erin, age 20 (Arnett, unpublished data)

The West does not have puberty rituals like those of traditional cultures. Nevertheless, in the West as in traditional cultures, the people in adolescents' social environment respond to the changes in adolescents' bodies that signify puberty and the development of sexual maturity. Adolescents in turn form their personal responses to puberty based in part on the information provided by the people in their social environment. First, let's look at the adjustments that take place in parent-adolescent relations when puberty begins, then at adolescents' personal responses to puberty.

Parent-Adolescent Relations and Puberty When young people reach puberty, the metamorphosis that takes place affects not only them personally but their relations with those closest to them, especially their parents. Just as adolescents have to adjust to the changes taking place in their bodies, parents have to adjust to the new person their child is becoming.

How do parent-adolescent relations change at puberty? For the most part, studies of adolescents and their parents in the American majority culture find that relations tend to become cooler when pubertal changes become evident (Ellis et al., 2011; Paikoff & Brooks-Gunn, 1991). Conflict increases and closeness decreases. Parents and adolescents

incest taboo The prohibition on sexual relations between family members. Believed to be biologically based, as children born to closely related parents are at higher risk for genetic disorders.

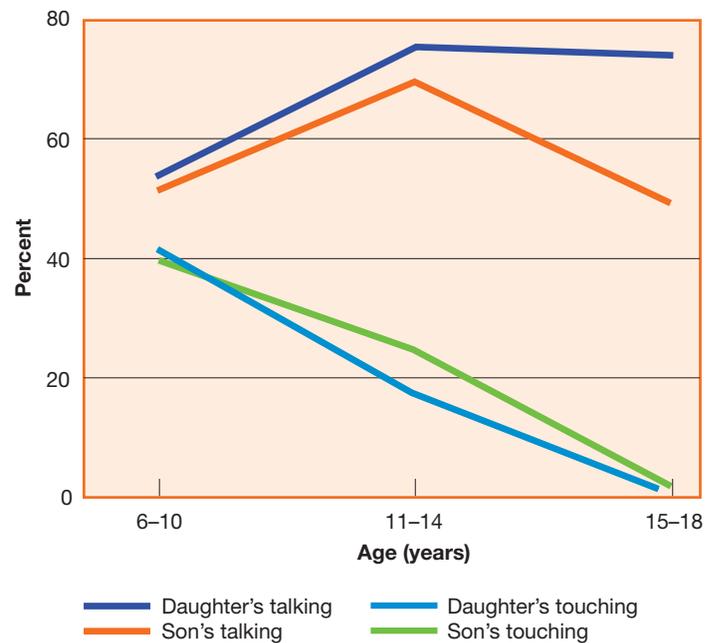


FIGURE 2.11 Frequency of adolescent-mother touching and talking.

Source: Montemayor & Flannery (1989).

seem to be less comfortable in each other's presence when puberty is reached, especially in their physical closeness. In one especially creative study demonstrating this change, researchers went to a shopping mall and an amusement park and observed 122 pairs of mothers and children ages 6 to 18 (Montemayor & Flannery, 1989). For each pair, the researchers observed them for 30 seconds and recorded whether they were talking, smiling, looking at, or touching each other. The most notable result of the study is shown in **Figure 2.11**. Early adolescents (ages 11–14) and their mothers were much less likely than younger children and their mothers to touch each other, and late adolescents (ages 15–18) and their mothers touched even less. Mothers and early adolescents talked more than mothers and younger children, suggesting that parent-child communication styles shift toward talking and away from touching as puberty is reached.

Other studies have found that the physical changes of puberty, not age alone, lead to the change in parent-adolescent relations (Ellis et al., 2011). If a child reaches puberty relatively early, relations with parents change relatively early; if a child reaches puberty relatively late, relations with parents change relatively late. For example, one study of 10- to 15-year-olds found that regardless of age, those who had reached puberty felt less close to their mothers and less accepted by their fathers (Steinberg, 1987a, 1988). Studies have also found that conflict with parents tends to be especially high for adolescents who mature early (Ellis et al., 2011; Sagestrano et al., 1999).

What is it about reaching puberty that causes parent-child relations to change? At this point, the answer is uncertain. Various explanations have been proposed, centering mostly on how the biologically-based **incest taboo** between parents and children becomes activated once children reach

sexual maturity, resulting in more distant relations (Belsky et al., 2007). If this explanation were true, however, one would expect to find distancing between adolescents and their parents in nearly all cultures, but this is not the case. In fact, the studies that have found distancing to take place at puberty have been mainly of two-parent White American families and one study of African American families (Sagestrano et al., 1999). Distancing is not as common in Latino families or in divorced mother-headed families (Anderson, Hetherington, & Clingempeel, 1989; Molina & Chassin, 1996).

Distancing is also not typical in traditional cultures. Schlegel and Barry's (1991) survey of traditional cultures found that girls in traditional cultures often grow closer to their mothers during adolescence because they often spend much of their days side by side in shared labor. Furthermore, in nearly all cultures, adolescents of both sexes tend to be closer to their mothers than to their fathers (McKinney & Renk, 2011). If increased distance in adolescence were due to the incest taboo, one would expect adolescent sons to be closer to fathers, not mothers. Thus, the unanswered question appears to be, what is it about the American majority culture that leads to greater distancing between parents and children when children reach puberty?

Another finding with regard to parents and puberty is that puberty tends to begin earlier for girls in families with a stepfather or other adult male not biologically related to the girl (Belsky et al., 2007). This has been found to occur in other mammals as well: Exposure to unrelated adult males causes females to reach puberty (Miracle, Miracle, & Baumeister, 2003). Why unrelated males would stimulate puberty in girls is not clear. It has also been found that family stress and conflict are related to early puberty in girls (Ellis & Garber, 2000; Moffitt et al., 1992). Again, the reason for this is not known.

Personal Responses to Menarche and Semenarche Although menarche occurs relatively late in pubertal development for most girls, their responses to it have received a great deal of attention from researchers. This may be because menarche is a more momentous event than other female pubertal changes. The growth of pubic hair, the development of breasts, and most other pubertal changes occur gradually, almost imperceptibly from one day to the next, whereas menarche is suddenly there one day, when there was nothing to herald it the day before. Similarly, menarche is easier for scientists to measure—it is easier to identify when menarche begins than to pinpoint the beginning of other more gradual changes. Menarche also holds a special significance in that it signifies that ovulation is beginning and reproductive maturity is arriving. Of course, boys' first ejaculation holds a similar significance, but it has received far less research, perhaps because of its relation to masturbation, a taboo topic in the West as it is in most cultures (Laquer, 2004).

How do girls respond to menarche? Almost all the research on this topic has been conducted on girls in the American majority culture, and for them the short answer

“Each time I have a period ... I have the feeling that in spite of all the pain, unpleasantness, and nastiness, I have a sweet secret and that is why, although it is nothing but a nuisance to me in a way, I always long for the time that I shall feel that secret within me again.”

—Anne Frank (1942/1997), *Diary of a Young Girl*, p. 117

would be: positively for the most part but with shades of ambivalence. In a study of over 600 girls, Brooks-Gunn and Ruble (1982) found that girls often reported that menarche made them feel more “grown up.” Many girls also indicated that they welcomed menarche because it allowed them to catch up to peers who had already begun menstruating and signified their capacity to bear children. Studies that follow girls over time find that menarche is followed by increases in social maturity, prestige with peers, and self-esteem (Archibald et al., 2003).

Not all reactions to menarche are positive, however. Both culture and biology may shade girls' reactions. Cultures may provide girls with no information to help them anticipate it, or with a view that leads them to anticipate it in a negative way. During the 19th century in American society, many girls knew nothing about menarche before it occurred, and they often responded with shock and fear when they were one day surprised by it (Brumberg, 1997; see the Historical Focus box). Across cultures, evidence from anthropological studies in cultures as diverse as rural Turkey, Malaysia, and Wales suggests that even today girls often are provided with no information at all to prepare them for menarche, with the result that it is experienced with fear and dismay (Howie & Shail, 2005). The following is an example from an Egyptian woman's memoir:

It would be difficult for anyone to imagine the panic that seized hold of me one morning when I woke to find blood trickling down beneath my thighs . . . I was obliged to overcome the fear and shame which possessed me and speak to my mother. I asked her to take me to a doctor for treatment. To my utter surprise she was calm and cool and did not seem to be affected by her daughter's serious condition. She explained that this was something that happened to all girls and that it recurs every month for a few days. On the last day when the flow ceased, I was to cleanse myself of this ‘impure blood’ by having a hot bath. . . . I was therefore to understand that in me there was something degrading which appeared regularly in the form of this impure blood, and that it was something to be ashamed of, to hide from others. (Saadawi, 1980, p. 45)

One review of 14 studies across a variety of cultures concluded that most girls have talked about menstruation with their mothers before menarche arrives, or received information from friends or from school, but girls who are unprepared for menarche experience it more negatively (Chang, Hayter, & Wu, 2010). Girls who mature earlier than others are more

likely to be unprepared for menarche. Because it takes place earlier for them than for other girls, they are less likely to yet have learned about it from peers, and their mothers may not yet have told them about it (Lien, Haavet, & Dalgard, 2010).

Even when girls receive information in advance of menarche, in some cultures it may be information that shapes their views of menstruation in negative ways. For example, in a Chinese study, a majority of premenarcheal girls expected menstruation to be annoying, embarrassing, and confusing, whereas only 10% expected to feel happy or excited (Yeung, 2005). Negative expectations of menarche were especially high among girls who accepted traditional Chinese beliefs about menstruation, such as beliefs that menstruation brings bad luck, that women should not wash hair or eat cold food while menstruating, and that it is easier to get sick during or after menstruation. A study of Mexican premenarcheal girls found similarly negative expectations for menarche, based in similarly negative cultural views of menstruation (Marván et al., 2007). Research also indicates that girls whose mothers, peers, or other sources have led them to expect menstruation to be unpleasant report greater discomfort once menarche occurs (Brooks-Gunn & Ruble, 1982; Tang, Yeung, & Lee, 2004; Teitelman, 2004).

The results of studies of girls' responses to menarche indicate vividly that the degree to which cultures provide knowledge and shape expectations for menarche can have important effects on how girls experience it. However, studies also indicate that most girls and women experience a certain amount of biologically based discomfort associated with menstruation. Among adolescent girls, most report some degree of **premenstrual syndrome (PMS)**, the combination of behavioral, emotional, and physical symptoms that occur in the week before menstruation (Dean et al., 2006). Various studies have found that from one-half to three-fourths of adolescent girls experience discomfort related to their menstrual cycles, with symptoms including cramps, backaches, headaches, fatigue, and depression, as well as general discomfort (Meaden, Hartlage, & Cook-Karr, 2005; Yonkers et al., 2006). The most common source of discomfort is cramps, experienced by 30–50% of girls and women (Finkelstein, 2001d). Even among girls whose experience of menarche is mostly positive, many dislike the messiness of dealing with menstrual blood and the obligation of carrying around supplies to deal with it every month (Brooks-Gunn & Ruble, 1982; Tang, Yeung, & Lee, 2003). Also, some girls report disliking the limits menstruation places on their activities.

Seen in this light, it is easier to understand the ambivalence girls often experience when they begin menstruating. They like the confirmation that they are developing normally toward reproductive maturity, but they may not like the discomfort and practical requirements that accompany menstruation each month. However, adolescent girls and adult women experience a great range of physical responses

to menstruation. At the extreme, a very small proportion of girls and women experience premenstrual symptoms that are severe enough to interfere with their daily functioning; on the other hand, some experience no symptoms at all, and there is a great deal of variability in between these two extremes (Dean et al., 2006; Yonkers et al., 2008). Poor diet, high stress, alcohol use, insufficient sleep, and lack of exercise all make PMS symptoms more severe, but orgasms relieve premenstrual cramps for many women (Carroll & Wolpe, 1996). Ibuprofen and other medications are also effective treatments for cramps (Finkelstein, 2001d).

For boys, perhaps the closest analogue to menarche is first ejaculation, sometimes known as **semenarche** (not to be confused with spermarche, which was described earlier in this chapter). Very little research has taken place on this topic. Two small studies (Gaddis & Brooks-Gunn, 1985; Stein & Reiser, 1993) found that boys' reactions to semenarche were mostly positive. They enjoyed the pleasurable sensations of it, and, like girls' experience of menarche, it made them feel more grown up. However, ambivalence existed for boys as well. Many reported that surprise or fear was part of the experience. Most girls in Western countries now receive some information about menarche before it happens, but parents rarely talk to their boys about semenarche (Frankel, 2002).

Culture certainly influences boys' interpretation of semenarche. It may occur through "wet dreams" or masturbation, and there is a long history of shame and censure associated with masturbation in the West (Frankel, 2002; Laquer, 2004). Perhaps for this reason, American boys tend to tell no one after they experience semenarche (Gaddis & Brooks-Gunn, 1985). In contrast, a study of boys in Nigeria found that boys tended to tell their friends about semenarche soon after it took place (Adegoke, 1993), perhaps reflecting less of a stigma associated with masturbation in Nigerian culture.

thinking critically

What kind of preparation for menarche/semenarche would you recommend be provided for today's adolescents? At what age? If schools provide information on menarche/semenarche, should that information include a discussion of the relation between these events and sexuality?

Early and Late Pubertal Timing

Everybody thought there was something wrong with me because I still looked like a ten-year-old until I was fifteen or sixteen. That has been really a bad experience for me, because everybody was changing around me and I was standing still. I was changing in my head but not my body. My parents were even going to take me to the doctor

premenstrual syndrome (PMS) The combination of behavioral, emotional, and physical symptoms that occur in some females the week before menstruation.

semenarche A male's first ejaculation.

HISTORICAL focus Menarche as a Taboo Topic

Some traditional cultures have harbored false beliefs about menstruation, such as the belief that menstrual blood has magical power that can cause crops to fail. However, false beliefs about menstruation are not exclusive to traditional cultures. In the United States, erroneous and even bizarre beliefs about menstruation were widespread until relatively recent times. Furthermore, menarche has been shrouded in shame and secrecy, leaving many girls entirely ignorant of it until they suddenly found themselves bleeding incomprehensibly. The history of American beliefs about menstruation and menarche is described in *The Body Project: An Intimate History of American Girls* by Joan Jacobs Brumberg (1997).

Throughout the 19th century, menstruation and menarche were regarded as taboo topics in most middle-class American families. An 1895 study of Boston high school girls indicated that 60% had no knowledge of menarche before it occurred. A popular 1882 advice book for mothers railed against the “criminal reserve” and “pseudo-delicacy” that led mothers to fail to prepare their girls for menarche. Another 19th-century advice writer reported that “numbers of women” had written to tell her that they were totally unprepared for menarche, including one who wrote, “It has taken me nearly a lifetime to forgive my mother for sending me away to boarding school without telling me about it.” A Cornell professor and author of books for young people reported that many college girls believed they were internally wounded when menarche arrived. At the time, menarche occurred later than it does now (typically age 15 or 16) and college entrance was earlier (16 or 17), so many girls experienced menarche at college.

Why such secrecy? Because middle-class Americans of that era believed they had a duty to protect girls’ “innocence” for as long as they could. Children who grew up on farms learned a lot about the facts of life by observing and caring for farm animals, but parents in the urban middle class sought to protect their children from such raw realities. They associated menarche

with budding sexuality, and they were zealous about protecting girls’ virginity until marriage. As part of this effort, they often attempted to delay menarche by having girls avoid sexually “stimulating” foods such as pickles! Menarche came anyway, pickles or not, but they believed it was best to keep girls in ignorance of menarche—and sexuality—for as long as possible.

In the course of the 20th century, as the sexual restrictiveness of the 19th century faded, menarche and menstruation gradually became more openly discussed. The Girl Scouts were among the first organizations to discuss menstruation openly. Beginning in the 1920s, attaining the Health Winner merit badge required young Girl Scouts to read about menarche and talk to their troop leader about it. A substantial amount of information was communicated through the media. In the 1920s, as mass-produced “sanitary napkins” became popular (previously, cotton rags or cheesecloth had been typically used to stanch menstrual blood), ads for sanitary napkins helped to open up discussion of menstruation. Companies making sanitary napkins distributed pamphlets on menstruation to girls through mothers, teachers, and the Girl Scouts during the 1930s and 1940s. In the 1940s a cartoon produced by the Disney Company, “The Story of Menstruation,” was seen by 93 million American school girls. Magazines for girls, such as *Seventeen*, provided advice on how to handle menstruation while remaining active.

Today, it is rare for an American girl to experience menarche in total ignorance of what is happening to her body. Perhaps because menarche now takes place at around age 12, cultural beliefs in American society no longer associate menarche with sexuality but rather with health and hygiene. It may be that dissociating menarche from sex has been important in allowing it to be discussed more openly. As we will see in later chapters, however, open discussions of adolescent sexuality remain rare in American society.



Mothers in the 19th century rarely discussed menarche with their daughters.

to see if I was deformed or something like that, but they didn't, and finally last year I started to grow. My voice started changing and everything, so I guess I'm normal after all, but I think it's going to be awhile before I stop feeling like I'm different from everybody else.

—Steven, age 17 (quoted in Bell, 1998, p. 14)

In some respects, social and personal responses to puberty are intertwined. That is, one factor that determines how adolescents respond to reaching puberty is how others respond.

In industrialized societies, one aspect of others’ responses that adolescents seem to be acutely aware of concerns perceptions of whether they have reached puberty relatively early or relatively late compared with their peers.

Within cultures, the timing of puberty appears to be based mainly on genetic factors (Anderson et al., 2007). Mothers’ age of menarche strongly predicts their daughters’ (Belsky et al., 2007). Sisters’ ages of menarche are highly correlated, and correlations are especially high between identical twin sisters (Ge et al., 2007; van den Berg, 2007).



Adolescents of the same age have many different levels of physical maturity. How does age-grading of schools accentuate these differences?

However, as noted earlier in the chapter, there is some evidence that environmental factors such as stress may trigger earlier puberty (DeRose & Brooks-Gunn, 2006).

The timing of puberty is especially important in developed countries. One interesting feature of puberty rites in traditional cultures is that eligibility for the rites is not typically based on age but on pubertal maturation. This is obvious with regard to rites related to menarche; a girl participates the first time she menstruates. However, boys' participation in puberty rites is also based on maturation rather than age. Typically, the adults of the community decide when a boy is ready, based on his level of physical maturation and on their perceptions of his psychological and social readiness (Schlegel & Barry, 1991). Consequently, the precise age of reaching puberty matters little; everyone gets there eventually.

In contrast, chronological age has much more significance in developed countries, as reflected in the fact that the school systems are **age-graded**—that is, children are grouped on the basis of age rather than developmental maturity. As

“A girl could claim to have her period for months and nobody would ever know the difference. Which is exactly what I did. All you had to do was make a big fuss over having enough nickels for the Kotex machine and walk around clutching your stomach and moaning for three to five days a month about the Curse and you could convince anybody... ‘I can’t go. I have cramps.’ ‘I can’t do that. I have cramps.’ And most of all, gigglingly, blushing: ‘I can’t swim. I have cramps.’ Nobody ever used the hard-core word. Menstruation. God, what an awful word. Never that. ‘I have cramps.’”

—Nora Ephron 2000, *Crazy Salad*, pp. 2–3

a result, the 7th grade, for example, includes children who are all 12 or 13 years old, but their pubertal development is likely to vary widely, from those who have not experienced any pubertal changes to those who are well on the way to full maturity. Grouping them together in the same classrooms for many hours each day adds to the intensity of comparisons between them and makes them highly aware of whether they are early, late, or “on time,” compared with others.

A great deal of research has been conducted on early versus late maturation among adolescents in the West, extending back over a half century. The results are complex. They differ depending on gender, and the short-term effects of maturing early or late appear to differ from the long-term effects. The effects also differ depending on the area of development considered: body image, popularity, school performance, or behavior problems. To help clarify these differences, we will look at the results of these studies separately for girls and boys.

Early and Late Maturation Among Girls The effects of early maturation are especially negative for girls. Findings from a variety of Western countries concur that early-maturing girls are at risk for numerous problems, including depressed mood, negative body image, eating disorders, substance use, delinquency, aggressive behavior, school problems, and conflict with parents (Lynne et al., 2007; Mendle, Harden, & Brooks-Gunn, 2010; Westling et al., 2008).

Why is early maturation such a problem for girls in the West? One reason involves cultural values about physical appearance. Because early maturation typically leads to a shorter and heavier appearance, it is a disadvantage in Western cultures that value thinness in females' appearance. This helps explain why early-maturing girls have higher rates of depressed mood, negative body image, and eating disorders (Lien et al., 2007; Mendle et al., 2007). Notably, African American and Latina girls do not show these effects of early maturation, perhaps because these cultures are less likely to have a tall, thin physique as the female ideal (Ge, Elder, Regnerus, & Cox, 2001; Hayward, Gotlib, Schraedley, & Litt, 1999).

A second reason for the problems of early-maturing girls is that their early physical development draws the attention of older boys, who then introduce them to an older group of friends and to substance use, delinquency, and early sexual activity (Graber, Nichols, & Brooks-Gunn, 2010; Weichold et al., 2003). So when early-maturing girls have higher rates of these behaviors than other girls their age, it may be because they are behaving more like their friends who are older than they are.

Late-maturing girls share few of early-maturing girls' problems, although they suffer from teasing and negative body image during the years when other girls have begun to develop and they have not (Weichold et al., 2003). By their late teens, however, they tend to have a more favorable body image than other girls (Simmons & Blyth, 1987), probably because they are more likely to end up with the lean body build that tends to be regarded as attractive in Western majority cultures.

Studies on the long-term effects of early maturation for girls are mixed. Some studies find that most of the negative effects diminish by the late teens (Posner, 2006; Weichold et al., 2003). However, one British study (Sandler, Wilcox, & Horney, 1984) and one Swedish study (Stattin & Magnusson, 1990) found that early-maturing girls entered marriage and parenthood earlier. Also, an American study reported that at age 24, women who had been early maturers had more psychological and social problems than women who had reached puberty “on time” (Graber, Seeley, Brooks-Gunn, & Lewinsohn, 2004). So, more research into the long-term consequences of early maturation seems warranted.

thinking critically

In the light of the difficulties often experienced by early-maturing girls, can you think of anything families, communities, or schools could do to assist them?

Early and Late Maturation Among Boys In contrast to girls, for whom early maturation has overwhelmingly negative effects, the effects of early maturation for boys are positive in some ways and negative in others. Early-maturing boys tend to have more favorable body images and to be more popular than other boys (Graber et al., 2010; Weichold et al., 2003). This may be because early-maturing boys get their burst of growth and muscular development before other boys do, which gives them a distinct advantage in the sports activities that are so important to male prestige in middle school and high school. Also, the earlier development of facial hair, lowered voice, and other secondary sex characteristics may make early-maturing boys more attractive to girls. Early-maturing boys may also have a long-term advantage. One study that followed early-maturing adolescent boys 40 years later found that they had achieved greater success in their careers and had higher marital satisfaction than later-maturing boys (Taga et al., 2006).

However, not everything about being an early-maturing boy is favorable. Like their female counterparts, early-maturing boys tend to become involved earlier in delinquency, sex, and substance use (Graber et al., 2010; Silbereisen & Kracke, 1997; Westling et al., 2008). Some studies report that early-maturing boys have higher rates of emotional distress (Ge, Conger, & Elder, 2001), despite their more positive body images. Late-maturing boys also show evidence of problems. Compared to boys who mature “on time,” late-maturing boys have higher rates of alcohol use and delinquency (Andersson & Magnusson, 1990; Williams & Dunlop, 1999). They also have lower grades in school (Weichold et al., 2003). There is some evidence that late-maturing boys have elevated levels of substance use and deviant behavior well into emerging adulthood (Biehl et al., 2007; Graber et al., 2004).

In sum, the effects of early and late maturation differ considerably between girls and boys. For girls, early maturation puts them at risk for a host of problems, but

“I think it’s disgusting that you all pick on me because I’m big!” Laura said, sniffing . . .

“Don’t you think I know all about you and your friends? Do you think it’s any fun to be the biggest kid in the class?”

“I don’t know,” I said. “I never thought about it.”

“Well, try thinking about it. Think about how you’d feel if you had to wear a bra in fourth grade and how everybody laughed and how you always had to cross your arms in front of you. And about how the boys called you dirty names just because of how you looked.”

I thought about it. “I’m sorry, Laura,” I said.

“I’ll bet!”

“I really am. If you want to know the truth . . . well, I wish I looked more like you than like me.”

“I’d gladly trade places with you.”

—From *Are You There, God? It’s Me, Margaret* by Judy Blume (1970)

late maturation does not. For boys, both early and late maturation make them at risk for problems, but early maturation also includes some benefits. The problems of early-maturing girls appear to be due in part to their associations with older boys, but the sources of the problems of early- and late-maturing boys are not clear.

As you read about these studies of early- and late-maturing boys and girls, keep in mind that each of these groups displays a great deal of variance. Although early and late maturation are related to certain kinds of general outcomes on a group level, the effects for individuals will naturally depend on their particular experiences and relationships.

Also keep in mind that, so far, nearly all the studies conducted on pubertal timing have involved adolescents in the majority cultures of Western countries (Güre et al., 2006; Lien et al., 2006). I suggested earlier that the effects of maturing early or late may be due to the age-grading in these countries, but right now we do not know how adolescents respond to pubertal timing in cultures where no age-graded schooling exists.

WHAT HAVE YOU LEARNED?

1. What does the secular trend in the timing of puberty indicate about cultural changes that have taken place in the lives of adolescents over the past century?
2. Why do puberty rituals for boys often involve tests of strength and endurance?
3. How do cultural beliefs influence whether girls experience menarche positively or negatively?
4. What are the long-term effects of reaching puberty relatively early or late?

Biological Development and the Environment: The Theory of Genotype → Environment Effects

- 2.9 Compare and contrast passive, evocative, and active genotype → environment effects.
- 2.10 Explain why genotype → environment effects change over time.

For many decades in the social sciences, scholars have debated the relative importance of biology and the environment in human development. In this **nature–nurture debate**, some scholars have claimed that human behavior can be explained by biological factors (nature) and that environment matters little, whereas others have claimed that biology is irrelevant and that human behavior can be explained by environmental factors (nurture). In recent years, most scholars have reached a consensus that both biology and environment play key roles in human development, although they continue to debate the relative strength of nature and nurture (Dodge, 2007; Lerner, 2006; Pinker, 2004).

Given the profound biological changes that take place in adolescence and emerging adulthood, nature–nurture issues are perhaps especially relevant to these periods of life. One influential theory of the relation between nature and nurture that I will be relying on occasionally in this book is the **theory of genotype → environment effects** (Plomin, 2009; Scarr, 1993; Scarr & McCartney, 1983). According to this theory, both genotype (a person’s inherited genes) and environment make essential contributions to human development. However, the relative strengths of genetics and the environment are difficult to unravel because our genes actually influence the kind of environment we experience. That is the reason for the arrow in the term *genotype → environment effects*. Based on our genotypes, we *create our own environments*, to a considerable extent. These genotype → environment effects take three forms: passive, evocative, and active.

Passive genotype → environment effects occur in biological families because *parents provide both genes and environment for their children*. This may seem obvious, but it has profound implications for how we think about development. Take this father–daughter example: Dad has been good at drawing things ever since he was a boy, and now he makes a living as a commercial illustrator. One of the first birthday presents he gives to his little girl is a set of crayons and colored

pencils for drawing. She seems to like it, and he provides her with increasingly sophisticated materials as she grows up. He also teaches her a number of drawing skills as she seems ready to learn them. By the time she reaches adolescence, she’s quite a proficient artist herself and draws a lot of the art for school clubs and social events. She goes to college and majors in architecture, and then goes on to become an architect. It is easy to see how she became so good at drawing, given an environment that stimulated her drawing abilities so much—right?

Not so fast. It is true that Dad provided her with a stimulating environment, but he also provided her with half her genes. If there are any genes that contribute to drawing ability—such as genes that promote spatial reasoning and fine motor coordination—she may well have received those from Dad, too. The point is that in a biological family, it is very difficult to separate genetic influences from environmental influences because *parents provide both*, and they are likely to provide an environment that reinforces the tendencies they have provided to their children through their genes.

So you should be skeptical when you read studies about parents and adolescents in biological families claiming that the behavior of parents is the cause of the characteristics of adolescents. Remember from Chapter 1: Correlation is not necessarily causation! Just because a *correlation* exists between the behavior of parents and the characteristics of adolescents does not mean the parents *caused* the adolescents to have those characteristics. Maybe causation was involved, but in biological families it is difficult to tell. The correlation could be due to the similarity in genes between the biological parents and their adolescents rather than to the environment the biological parents provided.

One good way to unravel this tangle is through adoption studies. These studies avoid the problem of **passive genotype → environment effects** because one set of parents provided the adolescents’ genes, but a different set of parents provided the environment. So when adolescents are more similar to their adoptive parents than to their biological parents, it is possible to make a strong case that this similarity is due to the environment provided by the adoptive parents, and when adolescents are more similar to their biological parents than to their adoptive parents it is likely that genes played a strong role. We will examine specific adoption studies in future chapters.

Evocative genotype → environment effects occur when a person’s inherited characteristics evoke responses from others

nature–nurture debate Debate over the relative importance of biology and the environment in human development.

theory of genotype → environment effects Theory that both genetics and environment make essential contributions to human development but are difficult to unravel because our genes actually influence the kind of environment we experience.

passive genotype → environment effects Situation in biological families that parents provide both genes and environment for their children, making genes and environment difficult to separate in their effects on children’s development.

evocative genotype → environment effects Occur when a person’s inherited characteristics evoke responses from others in the environment.

active genotype → environment effects Occur when people seek out environments that correspond to their genotypic characteristics.

in their environment. If you had a son who started reading at age 3 and seemed to love it, you might buy him more books; if you had a daughter who could sink 20-foot jump shots at age 12, you might arrange to send her to basketball camp. Did you ever babysit or work in a setting where there were many children? If so, you probably found that children differ in how sociable, cooperative, and obedient they are. In turn, you may have found that you reacted differently to them, depending on their characteristics. That is what is meant by **evocative genotype** → **environment effects**—with the crucial addition of the assumption that characteristics such as reading ability, athletic ability, and sociability are at least partly based on genetics.

Active genotype → **environment effects** occur when people seek out environments that correspond to their genotypic characteristics. The child who reads easily may ask for books as birthday gifts; the adolescent with an ear for music may ask for piano lessons; the emerging adult for whom reading has always been slow and difficult may choose to begin working full time after high school rather than going to college. The idea behind **active genotype** → **environment effects** is that people are drawn to environments that match their inherited abilities.

Genotype → Environment Effects Over Time

The three types of genotype → environment effects operate throughout childhood, adolescence, and emerging adulthood, but their relative balance changes over time (Scarr, 1993). In childhood, passive genotype → environment effects are especially pronounced, and active genotype → environment effects are relatively weak. This is because the younger a child is, the more parents control the daily environment the child experiences and the less autonomy the child has to seek out environmental influences outside the family. However, with age, especially as children move through adolescence and emerging adulthood, the balance changes (Plomin, 2009). Parental control diminishes, so passive genotype → environment effects also diminish. Autonomy increases, so active genotype → environment effects also increase. Evocative genotype → environment effects remain relatively stable from childhood through emerging adulthood.

The theory of genotype → environment effects is by no means universally accepted by scholars on human development. In fact, it has been the source of vigorous debate in the field (Pinker, 2004). Some scholars question the theory's claim that characteristics such as sociability, reading ability, and athletic ability are substantially inherited (Lerner, 2006). However, it is currently one of the most important new theories of human development, and you should be familiar with it as part of your understanding of development during adolescence and emerging adulthood. I find the theory provocative and illuminating, and I will be referring to it in the chapters to come.

 **Watch the video**
Biological Development and the environment: the theory of genotype–environment interactions at MyDevelopmentLab



When adolescents have skills or interests similar to their parents, is the similarity due to environment or genetics?

applying your knowledge

Think of one of your abilities in relation to the genes and environment your parents have provided to you, and describe how the various types of genotype → environment effects may have been involved in your development of that ability.

VIDEO GUIDE: Twins

1. List at least 3 similarities that Elyse and Paula had in common as described in this video.
2. Describe Elyse's views on nature vs. nurture. Then describe your own views on nature vs. nurture.
3. Take the example that both women were editors of their high school newspapers & describe how this could have been impacted differently by nature as well as nurture.



SUMMING UP

This chapter has presented the biological changes that take place during puberty as well as the cultural, social, and personal responses that result from these changes. Here are the main points we have covered in this chapter:

- During puberty, a set of remarkable transformations takes place in young people's bodies. Hormonal changes lead to changes in physical functioning and to the development of primary and secondary sex characteristics.
- The hormonal changes of puberty begin in the hypothalamus, initiated when a threshold level of leptin is reached. The chain of events in the endocrine system runs from the hypothalamus to the pituitary gland to the gonads and adrenal glands to the hypothalamus again, in a feedback loop that monitors the levels of the sex hormones (androgens and estrogens). The set points for the sex hormones rise in the course of puberty.
- Physical growth during puberty includes the growth spurt as well as increases in muscle mass (especially in boys) and body fat (especially in girls). The heart and lungs also grow dramatically, especially in boys.
- Obesity has become a serious public health problem in developed countries, especially the United States, and the prevalence of this problem increases sharply during adolescence. The increase in obesity in recent years is due mainly to increases in consumption of foods high in fat and sugar (especially fast food) and a decrease in rates of exercise.
- In many respects, emerging adulthood is a time of peak physical functioning for most people, when athletic performance peaks and susceptibility to illness and disease is at its nadir. However, emerging adults are at higher risk than people of other ages for certain problems due to lifestyle and behavior, including automobile fatalities, homicide, and sexually transmitted infections.
- Primary sex characteristics are related directly to reproduction. Females are born with all their eggs already in their ovaries, but males produce sperm only once they reach puberty.
- Secondary sex characteristics develop at puberty but are not directly related to reproduction. Girls show the first development of secondary sex characteristics about 2 years earlier than boys. The order of pubertal events is quite predictable, but adolescents vary greatly in the ages the events begin and how long it takes to complete them.
- Cultures influence the timing of puberty through cultural technologies in nutrition and medical care. The initiation of puberty is earlier when nutrition and medical care are good; consequently the age of beginning puberty decreased steadily in developed countries during the 20th century and is now decreasing in developing countries.
- Many traditional cultures have rituals that give meaning to pubertal changes, usually focused on menarche for girls and on tests of courage, strength, and endurance for boys.
- Cultures influence adolescents' experiences of puberty by providing or failing to provide young people with information about what is happening to their bodies. Menarche can be traumatic when girls are unprepared for it, but girls today typically know about it long before it arrives.
- In developed countries, the cultural practice of age-graded schooling means that the timing of puberty has important consequences for adolescents who begin puberty relatively early or relatively late. Early maturation is especially problematic for girls.
- According to the theory of genotype → environment effects, the influences of genetics and the environment are difficult to separate because in some ways genes shape the kind of environment we experience. During adolescence and emerging adulthood, passive genotype → environment effects decrease and active genotype → environment effects increase.

Perhaps the most notable single fact in this chapter is that the typical age of reaching puberty has declined steeply in developed countries over the past 150 years, so that now the first evident changes of puberty take place between ages 10 and 12 for most adolescents in these countries, sometimes even earlier. Reaching puberty means reaching sexual maturity, and in many ways the cultural beliefs and practices of developed countries still have not adjusted to the fact that young people now reach the threshold of sexual maturity at such an early age. Parents are often unsure of when or how to talk to children about their changing bodies and their sexual feelings. School officials are often equally unsure about what to communicate to children. Adolescent peers exchange information among themselves, but what they tell each other is not always accurate or healthy. Consequently, adolescents often experience their biological changes with limited information about the psychological and social implications of what is happening to their bodies.

In this area even more than in most of the areas we will discuss in this book, we know little about the experiences of young people outside of the middle-class majority cultures of Western countries. How do young people in traditional cultures respond to the biological changes of puberty? And what about adolescents in minority cultures in Western societies? In the decades to come, research on these questions may provide us with better information about the different ways that cultures may enhance young people's passage through the dramatic transformations of puberty.

KEY TERMS

- puberty 34
endocrine system 34
hormones 34
hypothalamus 34
gonadotropin-releasing hormone (GnRH) 34
leptin 34
pituitary gland 34
gonadotropins 35
follicle-stimulating hormone (FSH) 35
luteinizing hormone (LH) 35
gametes 35
gonads 35
sex hormones 35
estrogens 35
androgens 35
estradiol 35
testosterone 35
adrenocorticotropic hormone (ACTH) 35
- feedback loop 35
set point 35
adolescent growth spurt 36
peak height velocity 36
asynchronicity 37
extremities 37
vital capacity 38
maximum oxygen uptake (VO_2 max) 39
cardiac output 40
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