23.7: Adolescence and Puberty

Risk Takers

The surfing teens in Figure 1 are tempting fate by trying to surf as close to each other as they can. Collisions with other surfers or surfboards cause the greatest number of surfing-related injuries. Surfing is risky enough without making it more dangerous by doing stunts like this. Taking unnecessary risks is usually thought to be a hallmark of adolescence.

![Surfing Teenagers](image)

Figure 1: Surfing Teenagers

Defining Adolescence

Adolescence is the period of transition between childhood and adulthood. It is generally considered to start with puberty, during which sexual maturation occurs and adolescents go through a spurt in growth. In many children,
however, puberty actually begins during the stage called pre-adolescence, which covers the ages 11 to 12 years. Puberty may begin before adolescence, but it usually continues for several years, well into the adolescent stage, which ends during the late teens. Besides the physical changes of puberty, adolescence is also a time of significant cognitive and psychosocial changes. Many of these changes continue through the end of adolescence after most of the physical changes of puberty have already taken place.

Puberty

**Puberty** is the period during which humans become sexually mature. Besides maturation of the primary sex organs (those involved directly in reproduction), secondary sex characteristics also emerge during puberty. Adolescents with a high level of testosterone in their blood develop masculine traits (such as facial hair), and adolescents with a high amount of estrogen in their blood develop feminine traits (such as breasts). In addition, there is a period of rapid body growth during puberty, which results in sexual dimorphism in adult body size, composition, and shape.

When does puberty occur? The timing of puberty depends in part on biological sex, with puberty typically occurring earlier in the female sex than male sex. Besides biological sex, the timing of puberty is influenced by genetic and environmental factors. Although there is considerable individual variation in the age of onset, duration, and tempo of the physical changes of puberty, the sequence of these changes is relatively consistent among individuals.

Hormonal Control of Puberty

As shown in Figure \(\PageIndex{2}\), the changes of puberty are triggered by the hypothalamus in the brain. For unknown reasons, the hypothalamus starts releasing pulses of gonadotropin-releasing hormone (GnRH). This hormone travels directly to the anterior pituitary gland and stimulates it to secrete hormones that target the gonads (testes and ovaries). The main pituitary hormones are follicle-stimulating hormone (FSH) and luteinizing hormone (LH). FSH stimulates the testes to produce sperm and follicles in the ovaries to mature and secrete estrogen. LH stimulates the testes to secrete testosterone and the ovaries to secrete estrogen. Testosterone and estrogen, in turn, stimulate the development of primary and secondary sex characteristics and contribute to the spurt in physical growth.

Figure \(\PageIndex{2}\): **Hormonal regulation of the male reproductive system**: GnRH stimulates the production of FSH and LH, which act on the testes to begin spermatogenesis and to develop secondary sex characteristics. In turn, the testes’ production of testosterone (in Leydig cells) and the hormone inhibin inhibit the release of GnRH, FSH, and LH in a negative feedback loop.

https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_(Wakim_and_Grewal)/23%3A_Human_Gro...
Puberty in Male sexes

Figure 3: Changes in the external genitalia in the male sexes during puberty are classified into five stages shown here. The penis and scrotum enlarge with stage. You can also see a gradual darkening of the scrotum and growth of pubic hair during stages III, IV, and V.

In the United States, puberty in the biological male sex generally begins between the ages of 11 and 12 years and is usually over by the age of 18. During puberty, the testes and scrotum start to increase in size first, followed by the penis. At the same time that the penis is growing, the seminal vesicles, prostate, and bulbourethral glands are also growing and developing. Secondary sex characteristics, such as pubic hair, also develop. Additional physical changes that occur in boys during puberty include the appearance of facial and body hair and deepening of the voice as the vocal cords increase in size. Visible changes in the external male genitalia are illustrated in Figure 3. The stages show the sequence in which the changes occur. Stage I represents the pre-pubertal stage at about age 11, and stage V represents the adult stage after the completion of puberty at about ages 16 to 18 years. The first ejaculation generally occurs by the age of 13 years. Even this early in puberty, the semen may contain some sperm. Although full fertility may not be gained for another year or two, boys are generally fertile before they have completed their adolescent growth and achieved an adult appearance.

Puberty in Females

Puberty in the biological female sexes typically begins a couple of years earlier than puberty in the biological males. In the United States, females begin puberty between the ages of nine and ten. Visible, external changes begin first,
including the growth and development of the breasts and pubic hair. As shown in Figure \(\PageIndex{4}\), changes in these traits are traditionally divided into five stages, where stage I is the child stage prior to the start of puberty (around age eight or nine years) and stage V is the adult stage at the end of puberty (around age 14 to 16 years). About two years after breast development begins, the internal reproductive organs — including the uterus and vagina — start to grow and develop.

![Visible physical changes in female breasts and pubic hair occur during puberty in the stages shown here.](https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_(Wakim_and_Grewal)/23%3A_Human_Gro…)

Figure \(\PageIndex{4}\): Visible physical changes in female breasts and pubic hair occur during puberty in the stages shown here. The is a gradual increase in breast size from stage II to V. Pubic hair appears in stage II, and it gradually becomes dense with age and stages.

One of the most significant changes in females during puberty is menarche, which is the first menstrual period. It marks the beginning of menstruation. In the United States, menarche occurs at an average age of 12.4 years. However, there is considerable variation in this age, with menarche at any age between eight and 16 considered normal.

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**Adolescent Growth Spurt**

The period of rapid growth in body size that occurs during puberty is called the adolescent growth spurt (AGS). Both height and weight increase at a rate that is faster than at any time since early childhood. There are also significant changes in body composition and body proportions. The adolescent growth spurt is controlled by hormones, including growth, thyroid, and sex hormones.

**Growth in Height**

Average growth rates in height for boys and girls are represented by the graph in Figure \(\PageIndex{5}\). The average boy and girl do not differ significantly from each other in growth rate before the AGS begins. However, by the time they have attained their final adult height, the average female is about 13 cm (5.1 in.) shorter than the average male. One
reason is that the AGS occurs earlier in girls than in boys, so girls experience a shorter period of childhood growth, making them shorter, on average, when they begin the AGS in height. Another reason is that the peak height velocity (maximum rate of growth in height) is lower for the average girl than it is for the average boy.

Figure \( \PageIndex{5} \): The 50th percentile for the rate of increase (mm/month) in height is shown in this graph separately for males (blue) and females (red) from birth to age 20 years. The 50th percentile is the height below which 50 percent of individuals in a population fall. The graph also clearly shows the Adolescent growth spurt (AGS) for each biological sex. Growth during the AGS is almost as rapid as it was during the toddler years (1-3 years), although not as rapid as it was during infancy (0-1 year).

In boys, the AGS in height usually starts at about the age of 11 years. The peak height velocity in boys occurs at about age 13.5 when growth in height is about 10.3 cm (4 in.) per year on average. Growth in height in boys ceases by about age 18 (or a bit later) when the ends of the long bones finally ossify at the epiphyses, so additional growth in height is no longer possible.

In girls, the AGS in height usually starts by the age of roughly 9.5 years. The peak height velocity in girls occurs at about age 11.5 years when growth in height is about 9 cm (3.5 in.) per year on average. Growth in height in girls is completed by about 16 years (if not earlier) when the closure of the epiphyses prevents any additional growth in height.

The accelerated rate of growth during the AGS happens at different times for various parts of the body, but it occurs in the same predictable sequence for both sexes. Generally, the extremities — including the head, hands, and feet — experience rapid growth first, followed by the arms and legs, and then by the trunk and shoulders. This non-uniform growth may make the adolescent body seem awkward and disproportionate until growth is completed.

**Growth in Weight**

Growth in weight shows a similar spurt during adolescence as growth in height. Growth in weight occurs partly because of the growth in height, but growth in muscle, bone, and (for girls especially) body fat also contributes to the growth in weight. In boys, the AGS in weight lags behind the AGS in height by about three months, whereas in girls the lag time is about six months.

**Development of Sexual Dimorphism in Adult Body Composition and Shape**

During the adolescent growth spurt, greater growth in muscles and bones occurs in males than females, and especially in the upper body. In males, the shoulders and chest broaden relative to the hips, whereas the reverse occurs in females: the pelvis and hips widen relative to the shoulders and chest. Male muscles may continue to grow and gain in
strength for a year or more after growth in height is finished. Females also experience a major increase in body fat during adolescence, especially in the breasts and hips. All of these sex differences in growth during puberty account for the sexual dimorphism in adult human body composition and shape. Please note that the terms males and females refer to only biological sexes. A biological female may identify as a male and a biological male may identify as a female. Most children at this age fully understand their gender identity (see Chapter 22). Some start transitioning before puberty and never go through biological puberty.

Growth in Other Body Systems

The circulatory and respiratory systems also undergo rapid growth and development during the adolescent growth spurt. Both the heart and lungs increase in size and capacity. These and other changes lead to increased strength and tolerance for exercise and tend to occur to a greater degree in males than females.

Cognitive and Psychosocial Changes During Adolescence

Most of the physical changes of puberty occur relatively early in adolescence. Many other changes — including cognitive and psychosocial changes — occur throughout adolescence.

Changes in the Brain and Cognition

The brain does not increase in size very much during adolescence. Instead, most of the increase in brain size after birth occurs early in childhood. By the age of six, the brain has already attained about 90 percent of its adult size. The brain does, however, become significantly more complex during adolescence. In particular, the number of folds in the cerebral cortex of the brain increases. A process called “synaptic pruning” also occurs. In this process, unused pathways are eliminated. At the same time, myelination increases. Overall, the brain becomes more efficient and functional during adolescence, which in turn brings about major cognitive changes.

Adolescence is a time of rapid cognitive development. By the age of 15 or so, many adolescents have basic thinking abilities comparable to those of adults. They demonstrate similar levels of attention, memory, processing speed, and organization. Cognitive development may continue into the early 20s, as increasing capacity for insight and judgment develops through experience.

Some of the most significant changes in the brain during adolescence occur in the prefrontal cortex (PFC), which is the part of the cerebral cortex that covers the front part of the frontal lobes (see Figure \(\PageIndex{6}\)). This part of the brain is involved in such functions as decision making, information processing, abstract reasoning, problem-solving, evaluating risks and rewards, planning ahead, and controlling impulses. These are the so-called executive functions of the brain, and they mature throughout adolescence as the PFC develops.
Psychosocial Changes

The psychological and social changes that occur during adolescence are almost as marked as the physical changes associated with puberty. During adolescence, most teens develop a stronger sense of personal identity and start to develop their own system of moral and ethical values. Teens also generally develop a greater perception of their feelings of self-esteem and an increased awareness of body image. Most teens become more separated emotionally from their parents, and they may try to test the limits on their independence by breaking rules. At the same time, they generally spend much more time with their peers, and peer influence and acceptance are very important, especially early in adolescence. As a consequence, most teens exhibit a strong desire to conform to their peer group.

During adolescence, as sexual maturation progresses, there is an increased awareness of sexuality. This is typically the time when young people (like the couple in Figure 7) become involved in romantic relationships for the first time. By late adolescence, a romantic relationship with a significant other may become more important than relationships with other peers.

The age at which adolescents go through the physical changes of puberty may have an important influence on their psychosocial development. Going through puberty early can lead to poor body image, low self-esteem, and unhealthy behaviors (such as frequent dieting). They are more likely to engage in other unhealthy behaviors, such as smoking, drinking alcohol, and early involvement in sexual activity. Late puberty tends to be more difficult than early puberty. Those who mature later than their peers may feel physically inferior and develop poor body image and low self-esteem.
Why Are Teens Risk-Takers?

During adolescence, teens develop the ability to think like adults, including the ability to evaluate risks and rewards in similar ways as adults. If this is the case, then why do adolescents tend to be risk-takers? One possible answer is that adolescents have different values than adults, and therefore make different decisions about risky behaviors. For example, they may give more weight to social rewards and peer pressure when evaluating risks and rewards.

Another possible answer is that adolescents are genetically programmed to be risk-takers. Some scientists have suggested that there might be an evolutionary benefit to an increased propensity for risk-taking in adolescence. The scientists argue that without a willingness to take risks, adolescents might not have the motivation or confidence to leave their family of origin and start a family of their own.

Feature: Myth vs. Reality

There are many commonly held ideas about teens that are not backed up by scientific evidence. It is important for teens, their parents, and their teachers and coaches to be aware of these misconceptions.

Myth: Teens can eat anything and still not gain weight because they are growing so rapidly.

Reality: Many teens eat too much food or the wrong foods and end up gaining too much weight. In fact, the rate of obesity in teenagers has tripled since 1980.

Myth: Teens listen only to their friends.

Reality: Teens actually report that their parents or the other caring adults in their lives are the greatest influences on their behavior. This is especially the case when it comes to sexual behavior.

Myth: Teens engage in arguments with their parents because they like to “push their buttons.”

Reality: Adults tend to take arguments personally and therefore interpret teen behavior in this way. However, adolescents are more likely to view arguments as a means of self-expression. Teens may argue with their parents in order to help establish their own sense of identity, rather than to annoy the adults.

Review

1. Define adolescence.
2. What is puberty, and what happens during puberty?
3. What causes puberty to begin, and what causes most of the physical changes of puberty?
4. When does puberty begin in boys and girls? What are some of the obvious physical changes that occur first?
5. What is the adolescent growth spurt?
6. Relate sex differences in the adolescent growth spurt to adult sexual dimorphism.
7. Describe changes in the brain that occur during adolescence, and relate these changes to cognitive development in teens.
8. Outline psychosocial changes that occur during adolescence.
9. How does early puberty tend to affect girls, and how does late puberty tend to affect boys?

10. If adolescents develop the ability to evaluate risks and rewards as adults do, why might teens be more likely than adults to take risks?

11. True or False: Sex hormones are involved in sexual maturity, but not overall physical growth.

12. True or False: In both sexes, the hands are some of the first areas to undergo the adolescent growth spurt.

13. What is one secondary sex characteristic that develops during puberty in both males and females?

14. Do you think that an individual boy can start puberty earlier than an individual girl? Why or why not?

15. When does puberty generally end in males and females?

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Explore More

https://bio.libretexts.org/link?17808#Explore_More

Adolescence is often a time of intense emotions. Watch this video to learn more about the biology behind this phenomenon and other features of the teenage brain that make it different from that of children and adults.

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