Puberty

Puberty is the process through which a child matures and becomes capable of sexual reproduction.

LEARNING OBJECTIVE

• Differentiate between male and female pubertal changes

KEY POINTS

• In boys, testosterone initiates puberty and is responsible for the secondary sex characteristics.

• In girls, estradiol initiates puberty and is responsible for the female secondary sex characteristics.

• The first menstrual bleeding is referred to as menarche.

• Puberty is initiated in the hypothalamus, where GnRH signals induce pulsed secretions of LH.

• The secretion of LH and FSH cause the release of estradiol in females and testosterone in males, which in turn leads to development of the secondary sex characteristics.

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TERMS

• testosterone
  Steroid hormone produced primarily in the testes of the male; it is responsible for the development of secondary sex characteristics.

• menarche
  Menarche is the first menstrual cycle, or first menstrual bleeding, in female human beings.

• puberty
  The age at which a person is first capable of sexual reproduction.

Puberty is the process of physical changes by which a child's body matures into an adult body capable of sexual reproduction to enable fertilization. It is initiated by hormonal signals from the brain to the gonads; the ovaries in a girl, the testes in a boy. In response to the signals, the gonads produce hormones that stimulate libido and the growth, function, and transformation of the brain, bones, muscle, blood, skin, hair, breasts, and sexual organs.

The major landmark of puberty for males is the first ejaculation, which occurs on average at age 13. For females, it is menarche, the onset of menstruation, which occurs on average between ages 12 and 13.
Puberty that starts earlier than usual is known as precocious puberty. Puberty that starts later than usual is known as delayed puberty.

Notable among the morphologic changes in size, shape, composition, and functioning of the pubertal body, is the development of secondary sex characteristics, the "filling in" of the child's body; from girl to woman, from boy to man. Derived from the Latin "puberatum" (age of maturity), the word puberty describes the physical changes to sexual maturation, not the psychosocial and cultural maturation denoted by the term "adolescent development."

Although there is a wide range of normal ages, girls typically begin the process of puberty at age 10 or 11; boys at age 12 or 13. Girls usually complete puberty by ages 15–17, while boys usually complete puberty by ages 16–18. Any increase in height beyond the post-pubertal age is uncommon. Girls attain reproductive maturity about four years after the first physical changes of puberty appear. In contrast, boys accelerate more slowly, but continue to grow for about six years after the first visible pubertal changes.

For boys, an androgen called testosterone is the principal sex hormone. While testosterone produces all boys' changes characterized as virilization, a substantial product of testosterone metabolism in males is estradiol. The conversion of testosterone to estradiol depends on the amount of body fat and estradiol levels in boys are typically much lower than in girls. The male "growth spurt" also begins later, accelerates more slowly, and lasts longer before the epiphyses fuse. Although boys are on average 2 cm shorter than girls before puberty begins, adult men are on average about 13 cm (5.2 inches) taller than women. Most of this sex difference in adult heights is attributable to a later onset of the growth spurt and a slower progression to completion, a direct result of the later rise and lower adult male levels of estradiol.

The hormone that dominates female development is an estrogen called estradiol. While estradiol promotes growth of breasts and uterus, it is also the principal hormone driving the pubertal growth spurt and epiphyseal maturation and closure. Estradiol levels rise earlier and reach higher levels in women than in men.

Normal puberty is initiated in the hypothalamus. GnRH signals from the hypothalamus induce pulsed secretion of LH (and to a lesser degree, FSH) at roughly one to two hour intervals. Early stages of male hypothalamic maturation seem to be very similar to the early stages of female puberty, though occurring about one to two years later. LH stimulates the Leydig cells of the testes to make testosterone and blood levels begin to rise. For females, as the amplitude of LH pulses increases, the theca cells of the ovaries begin to produce testosterone and smaller amounts of progesterone. Much of the testosterone moves into nearby cells called granulosa cells. Smaller increases of FSH induce an increase in the aromatase activity of these granulosa cells, which converts most of the testosterone to estradiol for secretion into the circulation. The remaining testosterone, together with adrenal androgens is responsible for the typical androgenic changes of female puberty: pubic hair, other androgenic hair as outlined above, body odor, and acne.
Under the influence of androgens, the voice box, or larynx, grows in both sexes. This growth is far more prominent in boys, causing the male voice to drop and deepen, sometimes abruptly but rarely "over night," about one octave, because the longer and thicker vocal folds have a lower fundamental frequency.

By the end of puberty, adult men have heavier bones and nearly twice as much skeletal muscle. Some of the bone growth (e.g. shoulder width and jaw) is disproportionately greater, resulting in noticeably different male and female skeletal shapes. The average adult male has about 150% of the lean body mass of an average female, and about 50% of the body fat. This muscle develops mainly during the later stages of puberty, and muscle growth can continue even after boys are biologically adult.

Hormone feedbacks in males and females stimulating puberty

Puberty, and sexual maturity thereafter, is regulated by a series of hormones and feedbacks in the body, illustrated here. Hormones include: 1 Follicle-stimulating hormone - FSH. 2 Luteinizing hormone - LH. 3 Progesterone. 4 Estrogen. 5 Hypothalamus. 6 Pituitary gland. 7 Ovary. 8 Pregnancy - hCG (Human chorionic gonadotropin). 9 Testosterone. 10 Testicle. 11 Incentives. 12 Prolactin - PRL.