

Reproductive Physiology



Puberty in males and females

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Objectives



By the end of this lecture, you should be able to:

- Recognize the onset of puberty related to changes in hypothalamic-pituitary-gonadal axis
- Explain the hormonal and physical changes that occur at puberty in boys and girls
- Recognize the influencing factors leading to puberty
- Describe the pathological disorders associated with puberty

PUBERTY



- **Definition:** Physiological transition from childhood (juvenile) to adulthood.

Characteristics of puberty:

- HPG axis matures.
- The primary sexual organs mature (gonads).
- The secondary sexual characteristics develop.
- The adolescent experiences the adolescent growth spurt.
- The adolescent achieves the ability to procreate.

Pulsatile secretion of *GnRH*



Increased sensitivity of the **GnRH receptors** in anterior pituitary



Pulsatile secretion of *LH* and *FSH*



Appearance of large **nocturnal pulses** of LH during REM sleep.



Maturation of *primary sexual characteristics* (gonads)

Secretion of gonadal steroid hormones **testosterone** and **estradiol**



Appearance of the *secondary sex characteristics* at puberty

Puberty



Appearance of *secondary sexual characteristics* (pubic and axillary hair, female breast development, male voice changes,...)

- ***Menstruation and spermatogenesis*** begin

- Occurs between 8 and 14yrs in **girls**
- Occurs between 9 and 14yrs in **boys**

Puberty – Terms & Events

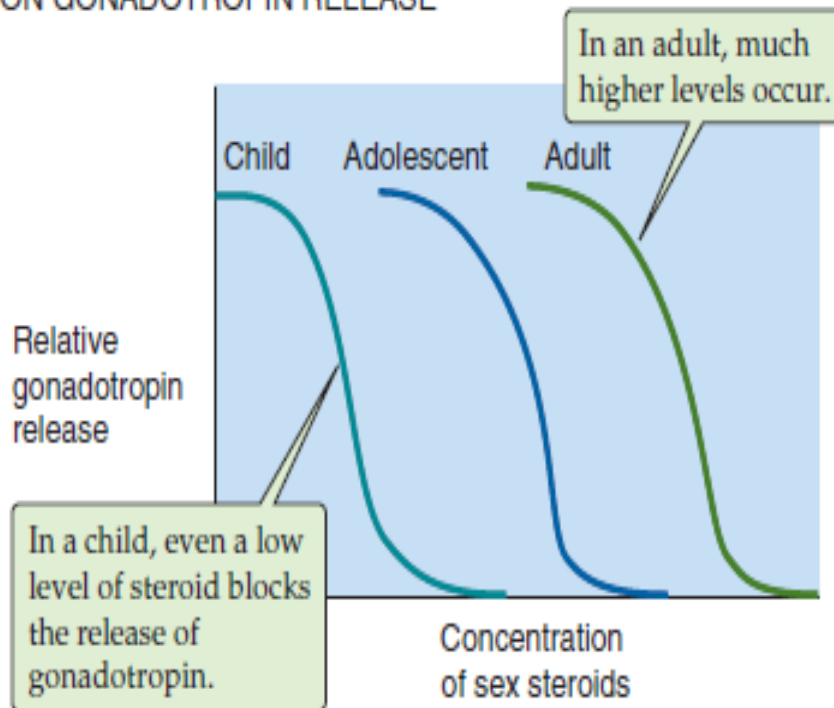


- **Thelarche:** development of breast
- **Pubarche:** development of pubic & axillary hair
- **Menarche:** the first menstrual period
- **Adrenarche:** the onset of an increase in the secretion of androgens; responsible for the development of pubic/axillary hair, body odour and acne.
- **Gonadarche:** maturation of gonadal function

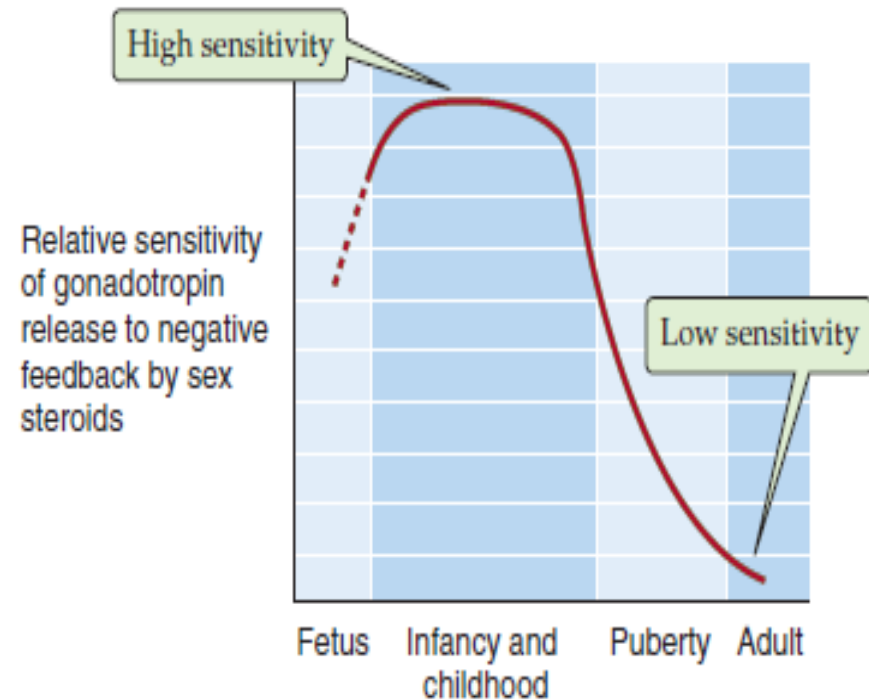
Puberty – hormonal changes

- In young children, increased sensitivity of GnRH receptors to low gonadotropins cannot initiate gonadal function

B NEGATIVE FEEDBACK OF ESTROGENS ON GONADOTROPIN RELEASE



C AGE DEPENDENCE OF FEEDBACK SENSITIVITY



Puberty – hormonal changes



- Between 9-12 yrs, blood levels of LH, FSH increase.
- High levels of LH, FSH initiate gonadal development
 - ❑ Nocturnal GnRH pulsatility (LH secretion) precedes phenotypic changes by several years
 - ❑ **First phenotypic changes:**
breast development / testicular enlargement



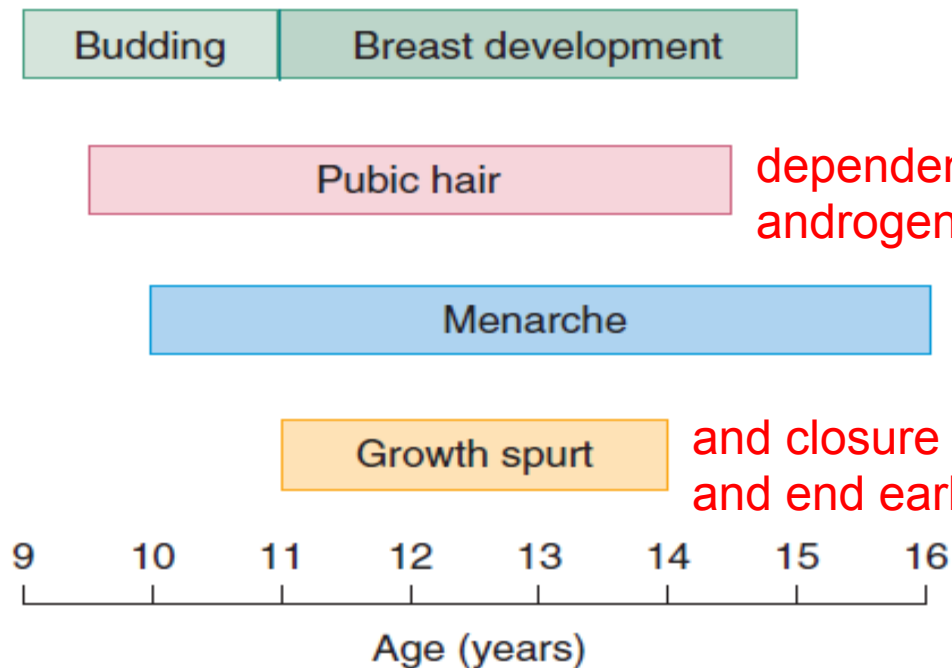
Physical Changes during puberty

Puberty: Girls



- Thelarche is usually the first sign in most girls.
- Menarche usually occurs 2-3 yrs after Thelarche.

Female



dependent on increased secretion of adrenal androgens (**adrenarche**).

and closure of the epiphyses typically begin and end earlier in girls than in boys.

Puberty: Boys



- Puberty is associated with activation of the HPG axis.
- Leydig cell proliferation in the testes, and increased synthesis and secretion of testosterone.
- There is growth of the testes, largely because of an increased number of seminiferous tubules.
- There is growth of the sex accessory organs such as the prostate.
- There is a pronounced linear growth spurt.
- As plasma levels of testosterone increase, facial, pubic, and axillary hair appears and there is growth of the penis, lowering of the voice, and initiation of spermatogenesis (**spermarche**).

Physical Changes



- **5 stages** from childhood to full maturity
- **Tanner Scale** (1 – 5)
- Reflect progression in changes of the *external genitalia/breast and pubic hair*
- Secondary sexual characteristics
 - Mean age 11yrs in **girls**
 - Mean age 11.5 – 12yrs in **boys**

Stage	Physical development (Girls)	Stage	Physical development (Boys)
B1 PH1	(Prepubertal). No glandular breast tissue palpable. Just an elevation of breast papilla. No pubic hair.	G1 PH1	(Prepubertal). Testicular volume < 3 mL. No pubic hair.
B2 PH2	Breast budding with elevation of breast and papilla as a small mound [1st pubertal sign in girls]. Downy soft pubic hair. Growth spurt (between stage 2-3)	G2 PH2	Enlargement of testicular volume (3-6 mL) [1st pubertal sign in boys]. Little or no change in penile size. Downy soft pubic hair.
B3 PH3	Further enlargement of breast and areola. Darker, coarser and curled hair.	G3 PH3	Testicular volume 8-12 mL. Penile lengthening. Darker, coarser, and curled hair. Growth spurt (between stage 3-4)
B4 PH4	Projection of areola and papilla to form a “double mound” above the level of the breast. More dense hair that fills the entire triangle overlying the pubic region and external genitalia and no spread to the inner thigh. Menarche (between stage 4-5)	G4 PH4	Testicular volume 12-15 mL. Penile lengthening and broadening. Terminal hair that fills the entire triangle overlying the pubic region and external genitalia and no spread to the inner thigh.
B5 PH5	Mature breast. Loss of double mound due to the projection of papilla only and recession of the areola to the level of the breast. Dense hair that extends beyond the inguinal area onto the inner thigh.	G5 PH5	Testicular volume > 15 mL. Adult genitalia. Terminal hair that extends beyond the inguinal area onto the inner thigh.

Puberty



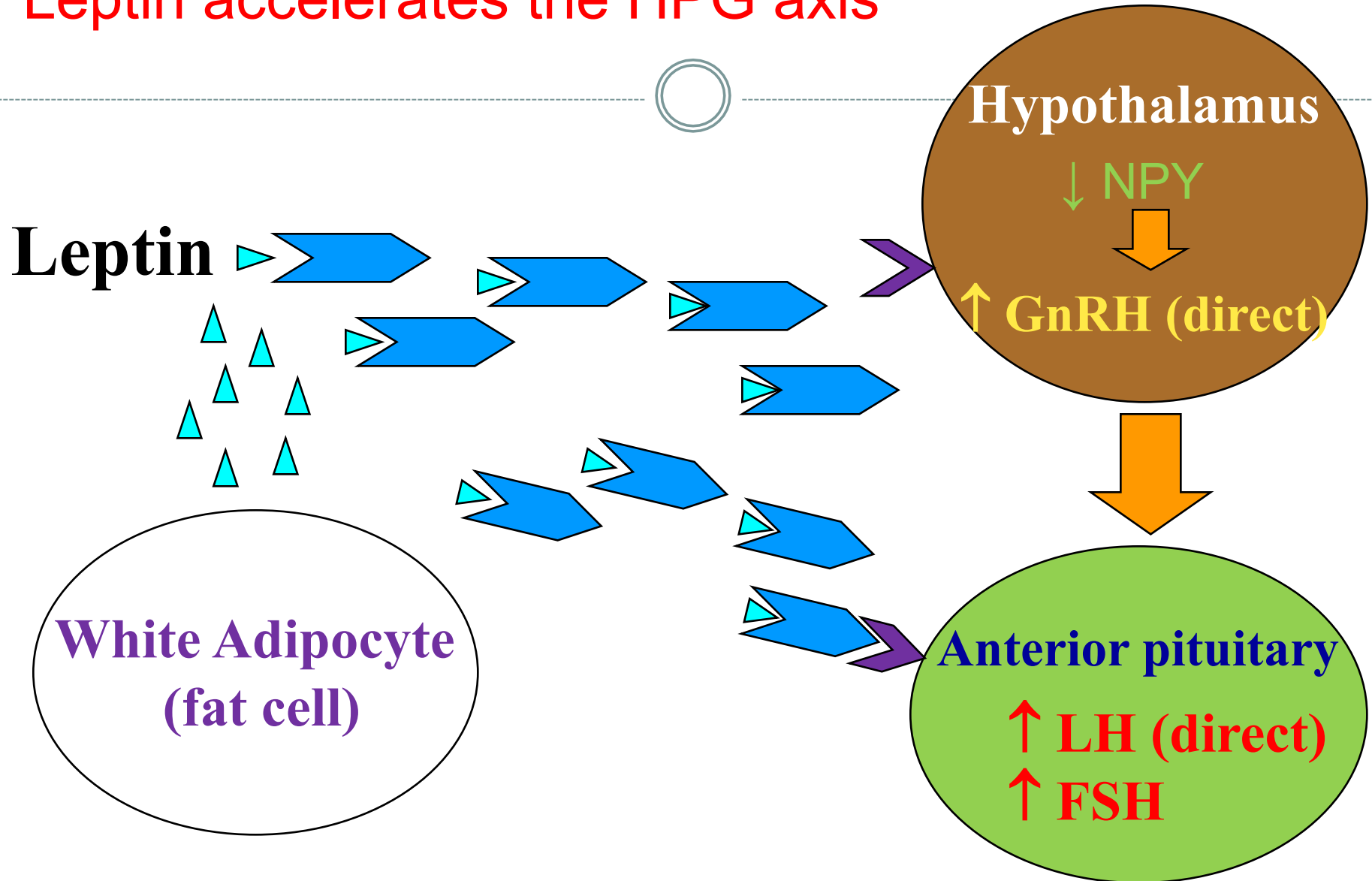
- Puberty is usually completed within 3 - 4 yrs of onset.
- *Timing* of puberty describes how mature a child is relative to his/her peers at the same age and sex (early, on time, or delayed).
- *Tempo* describes how quickly or slowly a child progresses throughout the stages of puberty to the complete development (slow, average, or fast).

Influencing Factors



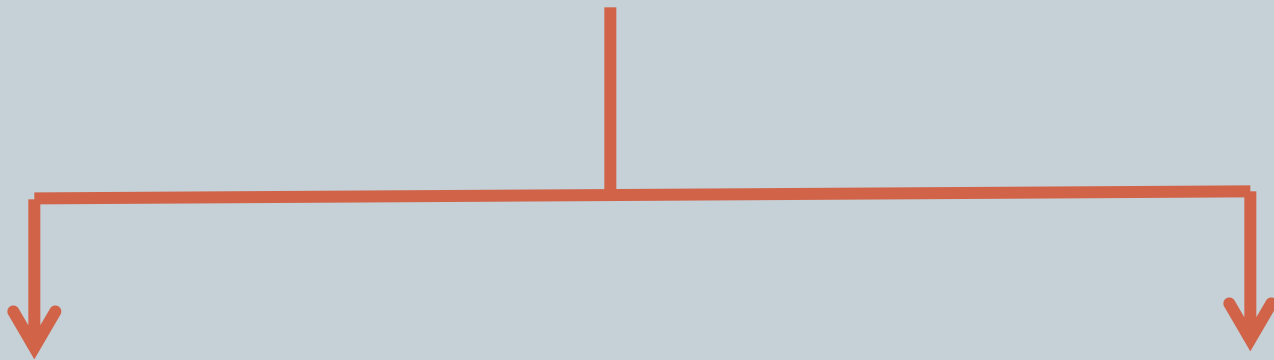
- **Genetic factors** : 50-80% of variation in pubertal timing.
- **Environmental factors**: (Geographical differences, psychosocial stresses, endocrine disruptors from pollutants, and exposure to chemical and industrial compounds).
- **Malnutrition and strenuous physical activity**: delays puberty.
- **Obesity** → e.g. Leptin hormone regulates appetite and metabolism through hypothalamus. Permissive role in regulating the timing of puberty.

Leptin accelerates the HPG axis





Disorders of Puberty



Early (precocious) Puberty

Delayed Puberty

Early (Precocious) Puberty



Precocious puberty refers to early pubertal development, often before 8 years of age in **girls** and before 9 years of age in **boys**.

PRECOCIOUS PUBERTY

(1) Central Precocious Puberty

[Gonadotropin-dependent]

- Idiopathic central precocious puberty
- CNS tumours
- CNS congenital abnormalities
- Infectious or post-infectious conditions of hypothalamus

(2) Pseudoprecocious (Peripheral) Puberty

[Gonadotropin-independent]

- Congenital adrenal hyperplasia (CAH)
- Gonads or adrenal gland tumours
- FSH and LH are suppressed
- No spermatogenesis or ovarian development

Delayed PUBERTY



Initial physical changes of puberty are not present

- by age 13 years in **girls** (or primary amenorrhea at 15.5-16y)
- by age 14 years in **boys**

Pubertal development is inappropriate

- The interval between first signs of puberty and menarche in girls, completion of genital growth in boys is > 5 years

DELAYED

PUBERTY

(1) Gonadal Failure

Hypergonadotropic hypogonadism:

- Klinefelter & Turner syndromes
- Chemo/radio therapies
- Congenital gonadal dysgenesis or Cryptorchidism
- FSH, LH and androgen receptor gene mutations
- Gonadal damage secondary to trauma, tumours, surgical removal, and infectious or autoimmune diseases.

(2) Gonadal Deficiency

Hypogonadotropic hypogonadism:

- Idiopathic
- FSH and LH gene mutations from pituitary gonadotropes
- Low FSH and LH levels
- CNS congenital anomalies and panhypopituitarism

The End

Thank You