

Reproductive Physiology



Puberty in males and females

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Objectives



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

Define Puberty

Recognize the physiology of puberty related to changes in hypothalamic-pituitary-gonadal axis

Describe the physical changes that occur at puberty in boys and girls

Recognize the influencing factors leading to puberty

Describe the pathophysiological conditions associated with puberty

PUBERTY



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

At puberty:

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 surges** 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

Puberache: development of pubic & axillary hair

Menarche: the first menstrual period

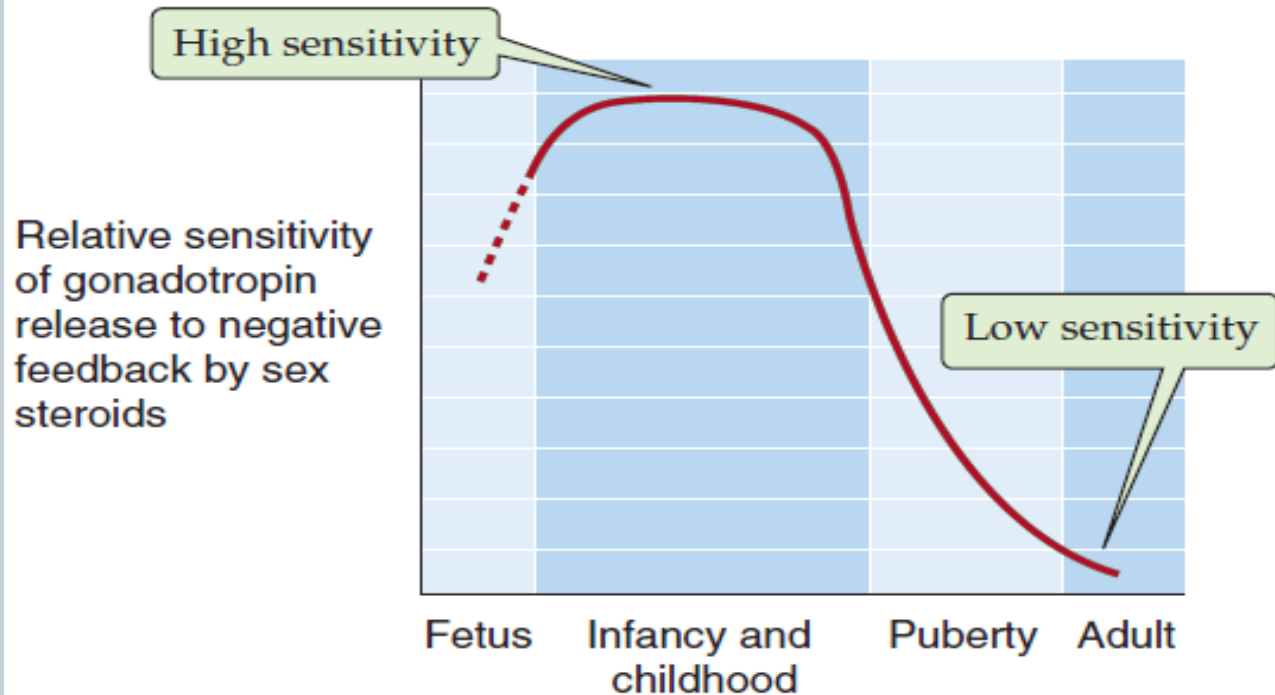
Adrenarche: the onset of an increase in the secretion of androgens; responsible for the development of pubic/axillary hair, body odour and acne.

Gonadarche: maturation of gonadal function

Increased sensitivity of the GnRH receptors to very low gonadotropins before puberty



AGE DEPENDENCE OF FEEDBACK SENSITIVITY



Puberty – hormonal changes



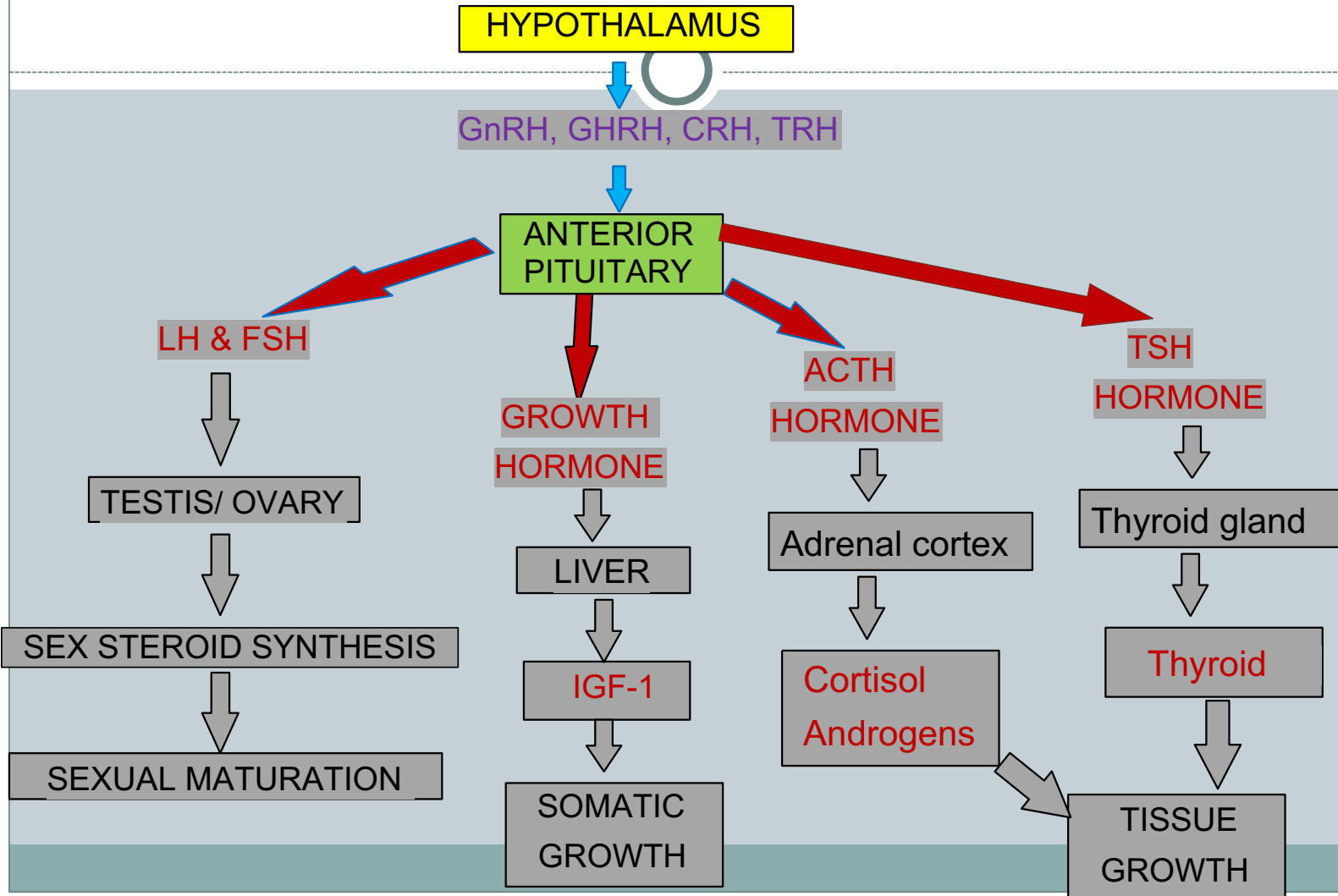
In young children, low gonadotropins and increased sensitivity of GnRH receptors to low gonadotropins cannot initiate gonadal function

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

Puberty – hormonal changes





Physical *Changes* during puberty

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**

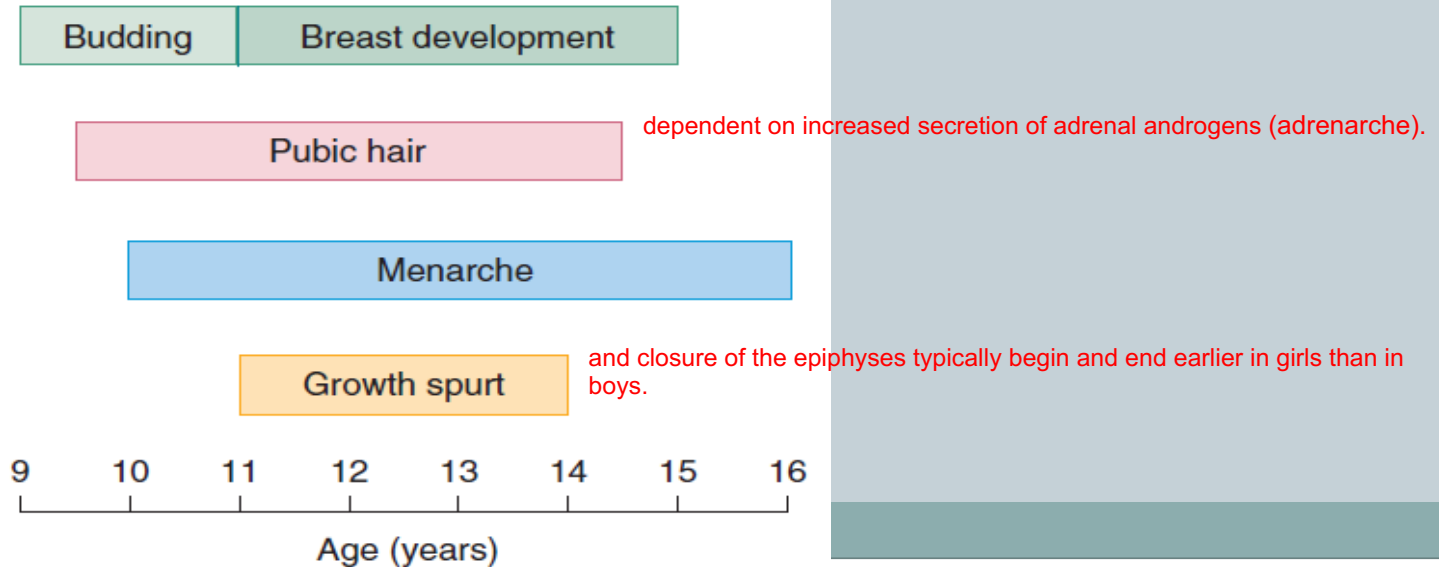
? Mean age 11.5 – 12yrs in **boys**

Puberty: Girls



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

Female



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 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		G2 PH2	
B3 PH3		G3 PH3	
B4 PH4	Darkening of areola and papilla to form a "dark spot".	G4 PH4	Testicular volume 10-15 mL. Penis lengthening.
B5 PH5	Areola and papilla form a "dark spot".	G5 PH5	Testicular volume 15-20 mL. Penis lengthening.

Puberty



Puberty 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



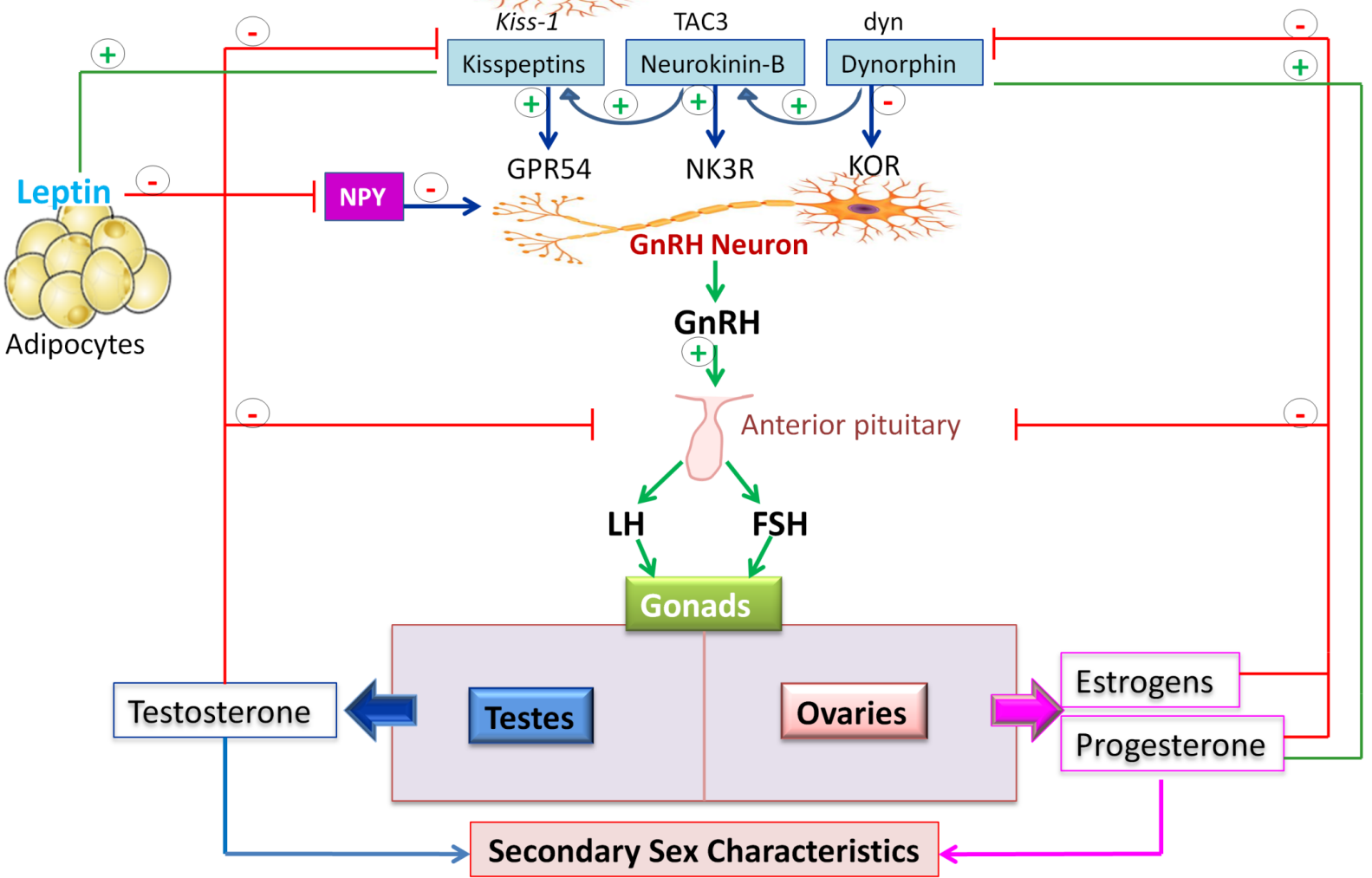
Genetic factors : 50-80% of variation in pubertal timing.

Environmental factors: (Geographical differences, psychosocial stresses, endocrine disruptors from pollutants, and exposure to chemical and industrial compounds).

Obesity→ e.g. Leptin hormone regulates appetite and metabolism through hypothalamus. Permissive role in regulating the timing of puberty.

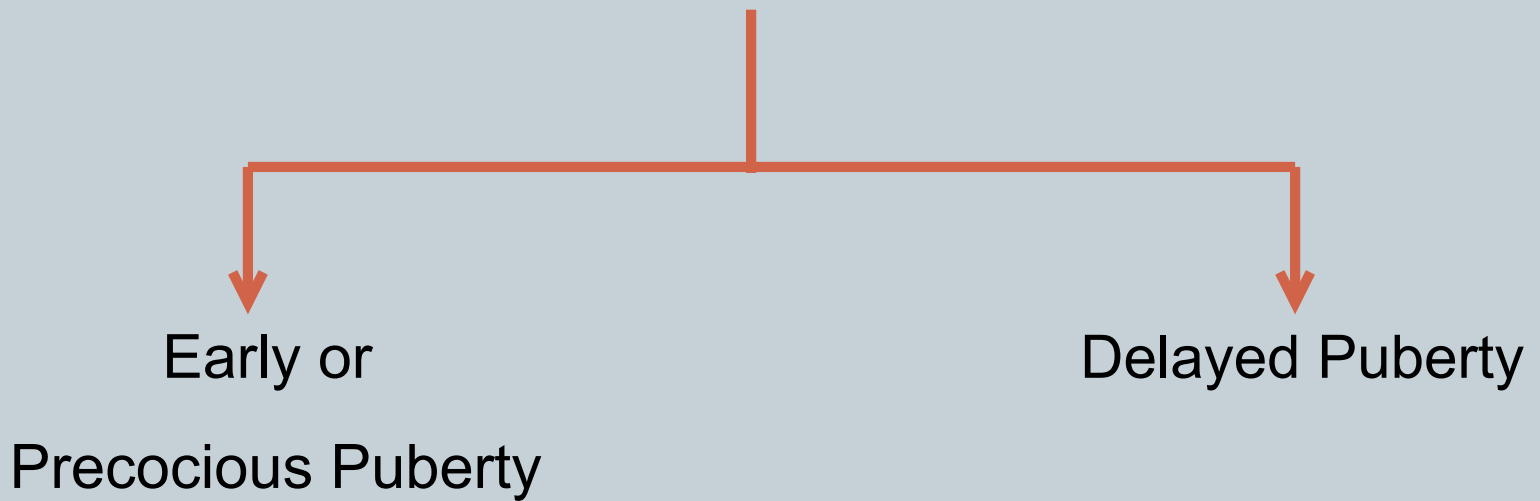
Malnutrition and strenuous physical activity: delay puberty.

GnRH pulse generators





Disorders of Puberty



PRECOCIOUS PUBERTY



Precocious onset of puberty is defined as occurring younger than 2 yrs before the average age

Girls < 8 years old

Boys < 9 years old

(1) Central Precocious Puberty

[Gonadotropin-dependent]

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

PRECOCIOUS PUBERTY

(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:

- 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
- KiSS-1 or GPR54 gene mutations
- CNS congenital anomalies and panhypopituitarism

The End

Thank You