

Puberty in Males' and Females'

Objectives:

- ❖ 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.
-

Color index:

- ❖ **Important.**
- ❖ **Girls slide only.**
- ❖ **Boys slide only.**
- ❖ **Dr's note.**
- ❖ Extra information.



Editing File

Puberty

Puberty (AKA: adolescence) is a physiological transition from childhood (juvenile) to adulthood,

Characteristics Of Puberty

HPG axis matures

The primary sexual organs mature (gonads)

The secondary sexual characteristics develop
It's subsequent to the primary (ما راح يحصل عندك من كندري اذا ما صار)
maturation of primary sexual organs)

The adolescent experiences the adolescent growth spurt

The adolescent achieves the ability to procreate

Terms & Events

Thelarche

Development of breast.

Pubarche

Development of pubic and 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. *In female, puberty depends on estrogen more than progesterone*

Gonadarche

Maturation of gonadal function.

Hormonal Changes

1

Pulsatile secretion of GnRH from the hypothalamus → Increased sensitivity of the GnRH receptors in anterior pituitary.

2

Pulsatile secretion of LH and FSH → Appearance of large nocturnal pulses of LH, during REM sleep. *During puberty the most important gonadotropic hormones is LH (90 times than FSH)*

4

Appearance of the secondary sex characteristics at puberty (pubic and axillary hair, female breast development, male voice changes)

3

Maturation of primary sexual characteristics (gonads) → Secretion of gonadal steroid hormones (testosterone & estradiol)

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

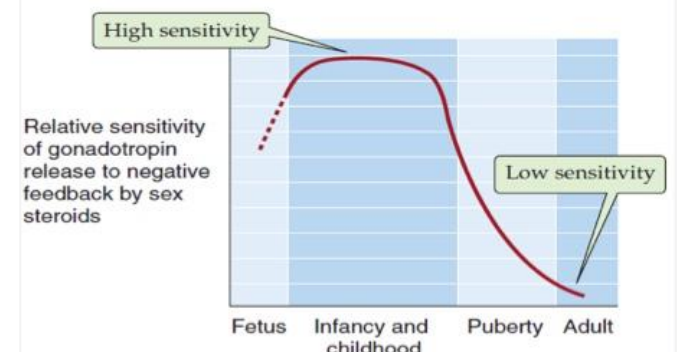
Between 9 -12 yrs, blood levels of LH and FSH increase

High levels of LH and FSH initiate gonadal development (nocturnal GnRH pulsatility LH secretion precedes phenotypic changes by several years).

First phenotypic changes (breast development / testicular enlargement)

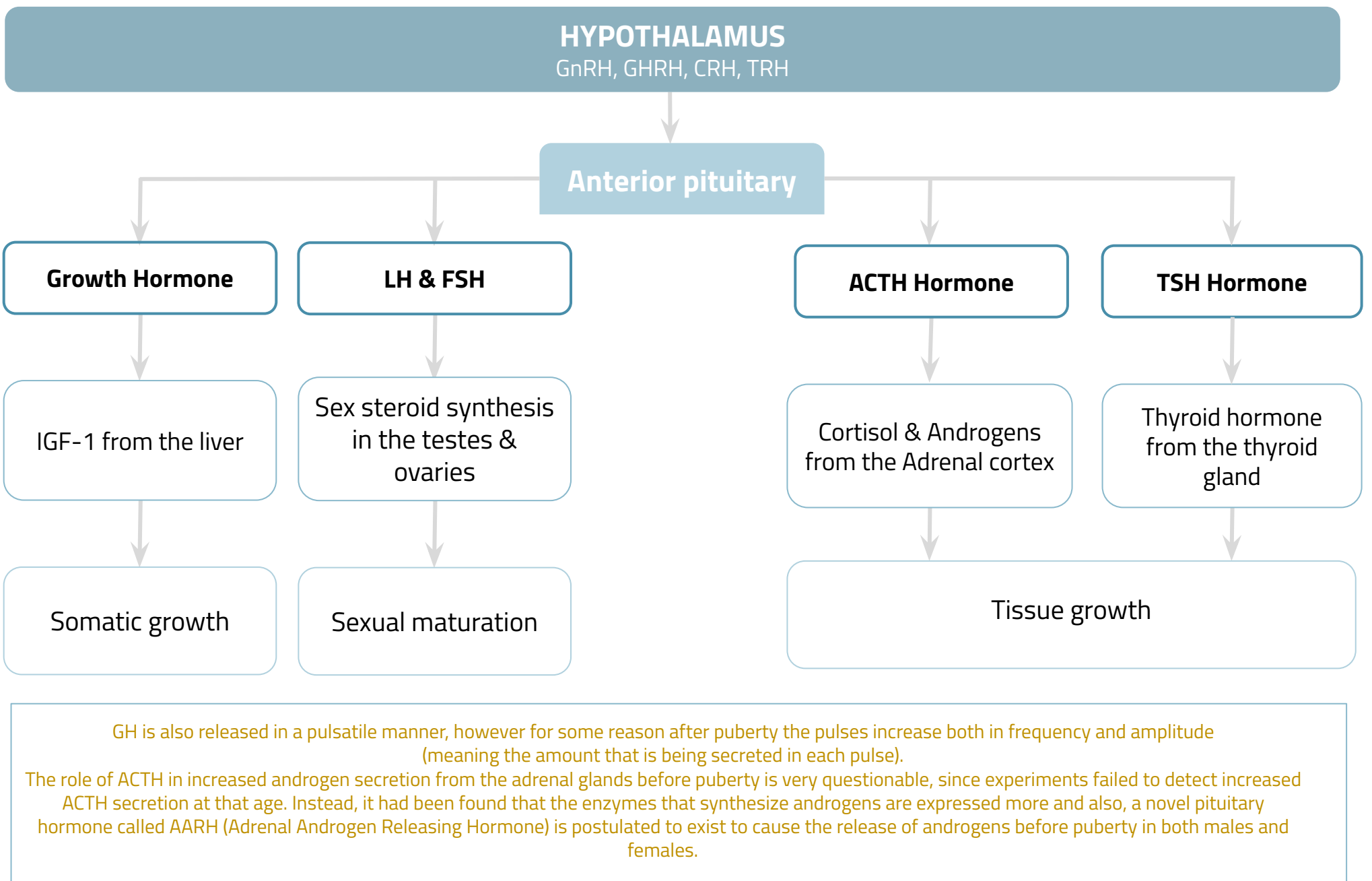
Menstruation begin (between 8-14 years old) in girls - Spermatogenesis begin (between 9-14 years old) in boys

AGE DEPENDENCE OF FEEDBACK SENSITIVITY



At childhood there is a very low concentration of sex hormones. (testosterone, estrogen). The source of sex hormones at childhood is either from the adrenal cortex or fat tissue or anywhere else.

GnRH neuron in the hypothalamus during childhood is very sensitive to low concentration of sex hormones, meaning that low concentration can easily block the GnRH release



Females

- **First sign is thelarche (breast enlargement).**
- Menarche usually occurs 2-3 yrs after thelarche .
- Growth spurt peaks before menarche.
- Pubic hair growth dependent on increased secretion of adrenal androgens (adrenarche).
- Growth spurt and closure of the epiphyses typically begin and end earlier in girls than in boys.

Males

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

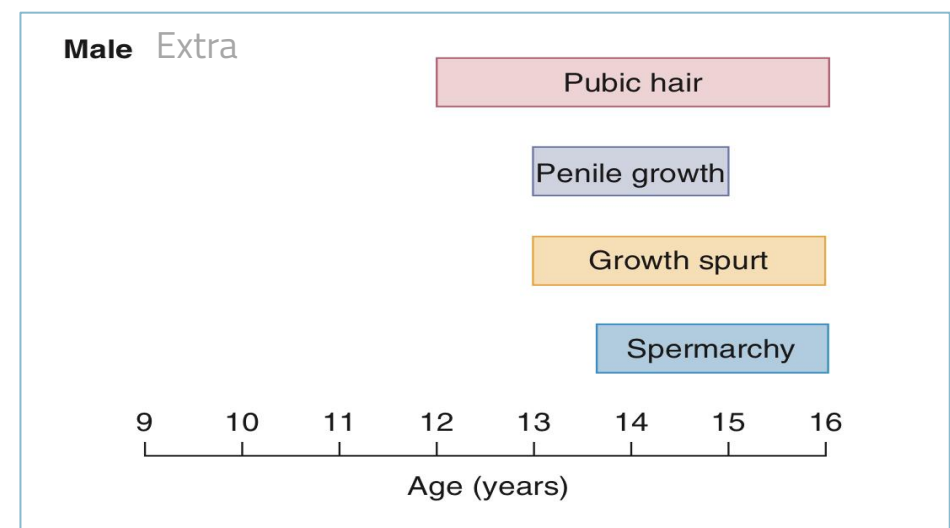
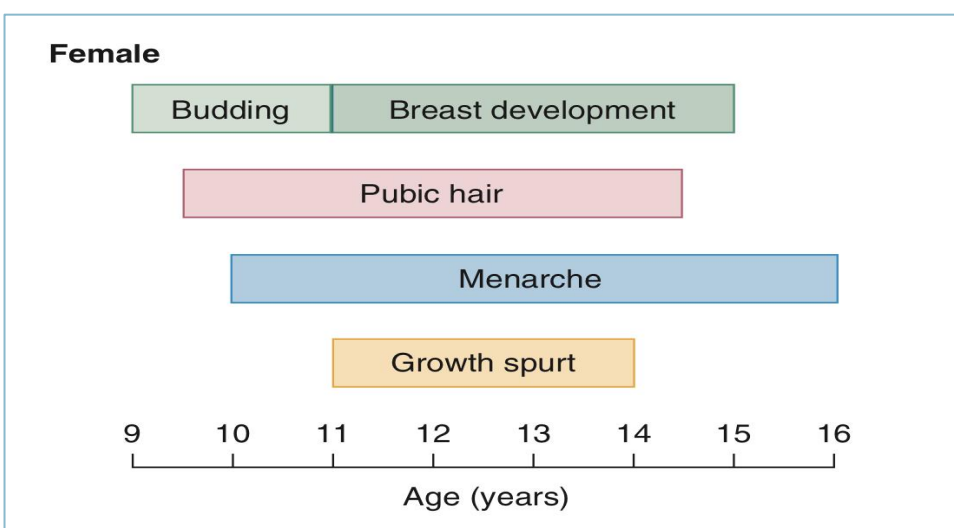


Figure 5-2 Major events of puberty in males and females.

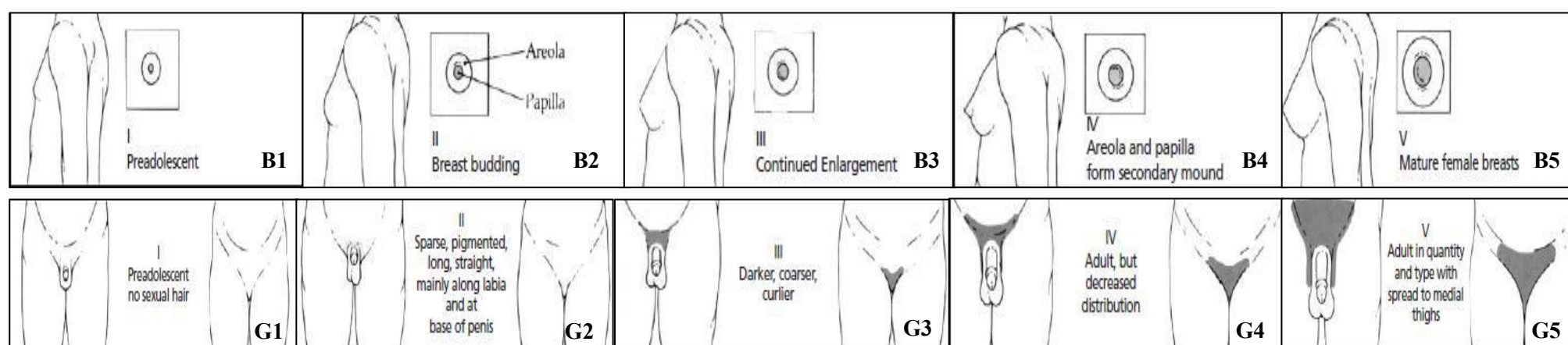
Physical Changes

5 stages from childhood to full maturity.

Tanner Scale (1 – 5) which reflect progression in changes of the external genitalia, breast, and pubic hair.

- Secondary sexual characteristics
 - Mean age 11 years in girls
 - Mean age 11.5 – 12 years in boys

Stage	Physical Development (Girls)	Average age For both genders (extra)	Stage	Physical Development (Boys)
B1 (breast) PH1 (pubic hair)	Prepubertal. No glandular breast tissue palpable, just an elevation of breast papilla (check figures below for an illustration). No pubic hair.	0-15	G1 (genitals) 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)	8-15	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.	10-15	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)	10-17	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 into the inner thigh.	12.5-18	G5 PH5	Testicular volume > 15 mL. Adult genitalia. Terminal hair that extends beyond the inguinal area into the inner thigh.



Breast & Genitals Development

Puberty

Puberty usually completed within 3 - 4 years 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).

Factors that Influence Puberty

Genetics factors

50-80% 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 & metabolism through hypothalamus. Permissive role in regulating the timing of puberty.

Obese children can get into puberty faster than thin children (no leptin = no progress to puberty)

Malnutrition and strenuous physical activity

Delay puberty.

GnRH pulse generators

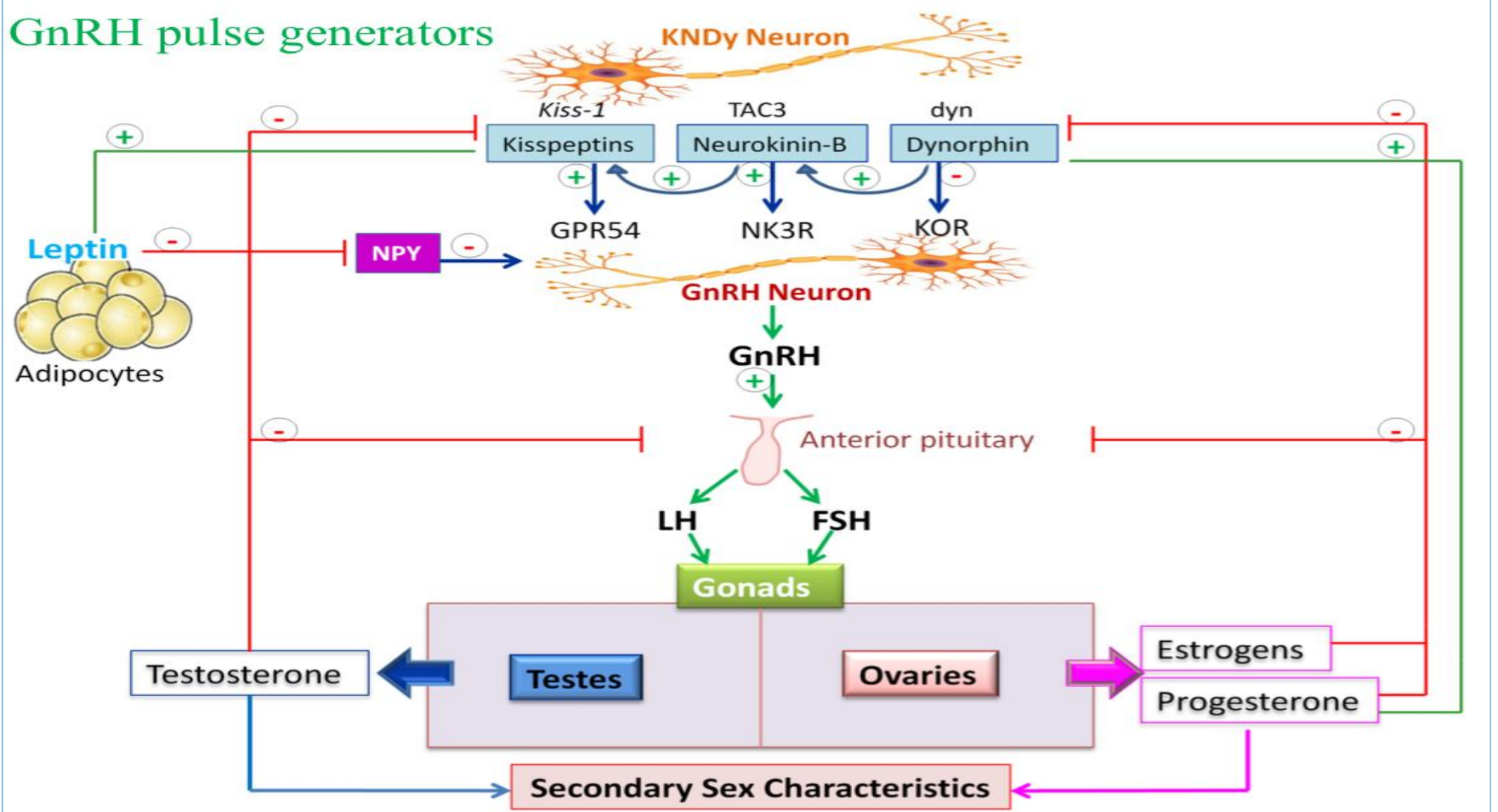


Figure 5-3 Leptin acts in both the hypothalamus and the pituitary (through interneuronal pathways involving Neuropeptide Y and Kisspeptin) to stimulate the release of GnRH, leading to increased secretion of LH & FSH. As a result this will cause decrease food intake and increase thermogenesis and reproduction.

Pubertal Disorders

1- Early / precocious puberty

Precocious onset of puberty is defined as occurring younger than 2 years before the average age, often before 8 years of age in girls and before 9 years of age in boys

Central Precocious Puberty (Gonadotropin- <u>dependent</u>)	Pseudoprecocious (Peripheral) Puberty (Gonadotropin- <u>independent</u>)
<ul style="list-style-type: none"> ○ Idiopathic central precocious puberty. ○ CNS tumours. ○ CNS congenital abnormalities. ○ Infectious or post-infectious conditions of hypothalamus. 	<ul style="list-style-type: none"> ○ Congenital adrenal hyperplasia (CAH). ○ Gonads or adrenal glands tumors ○ FSH and LH are suppressed. ○ No spermatogenesis or ovarian development.

2- 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 genital growth in boys is > 5 years.

Gonadal Failure Hypergonadotropic Hypogonadism	Gonadal Deficiency Hypogonadotropic Hypogonadism
<ul style="list-style-type: none"> ○ Turner syndromes (45, X0), Klinefelter syndrome (47, XXY). ○ Chemo / Radio therapies ○ Gonadal damage secondary to trauma, tumors, surgical removal, and infectious or autoimmune diseases. ○ Congenital gonadal dysgenesis or cryptorchidism. ○ FSH, LH and androgen receptor gene mutations 	<ul style="list-style-type: none"> ○ Idiopathic ○ FSH and LH gene mutations from pituitary gonadotropes. ○ CNS congenital anomalies and panhypopituitarism. ○ Low FSH and LH levels. ○ KiSS-1 or GPR54 gene mutations.

Turner's Syndrome: Hypogonadism also occurs in these patients due to complex mechanisms, however the underlying reason is similar to that of Klinefelter patients, which is basically the genome losing its stability.

Klinefelter's Syndrome: Why Does Having an Extra X Chromosome Precipitates Hypogonadism in These Males? The genome is very tightly regulated, with each gene having an identical copy in the genome. Having an extra chromosome causes a third copy of the gene to be present in the genome, genes influence the expression of other genes and in the case of Klinefelter, the extra copy of the X chromosome causes an abnormality in androgen receptors' expression. This results in hypogonadism.

MCQ & SAQ:

Q1: Which of the following signs of puberty is usually the first to occur in males?

- A. Penile enlargement
- B. Testicular enlargement
- C. Development of pubic hair
- D. Growth of facial hair

Q3: Menarche typically occurs how long after thelarche?

- A. 4 years
- B. 6 years
- C. one year
- D. 2-3 years

Q5: On physical examination, a female has the presence of growing breast tissue but no contour or secondary mound, coarse pigmented pubic hair covering the pubes, and the presence of axillary hair. What is her Tanner stage?

- A. Tanner stage 1
- B. Tanner stage 2
- C. Tanner stage 3
- D. Tanner stage 4

Q2: Which one of the following is the onset of an increase in the secretion of androgens?

- A. Adrenarche
- B. Menarche
- C. Thelarche
- D. Gonadarche

Q4: Which of the following is the most reliable first sign of puberty in females?

- A. Development of breast buds
- B. Development of pubic hair
- C. Accelerated growth
- D. Menarche

Q6: Puberty usually completed within ..

- A. 3-4 years
- B. 1 year of onset
- C. Immediately
- D. None

6: A
5: C
4: A
3: D
2: A
1: B
key:
answer

1- What are the factors that influence the puberty?

2- What are the characteristics of puberty?

3- What is the function of each of these hormones (GH, LH-FSH and ACTH) ?

4- List the pubertal disorders and the causes for each one ?

A1: Genetic Factors, environmental factors, Obesity and Malnutrition and strenuous physical activity

A2: [slide 3](#)

A3: **GH** : Somatic Growth | **LH-FSH** : Sexual Maturation | **ACTH & TSH** : Increased metabolic rate and tissue growth

A4: [Slide 6](#)

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