

PUBERTY



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Competency

- ▶ PY9.2 Describe and discuss puberty: onset, progression, stages, early and delayed puberty and outline adolescent clinical and psychological association



INDEX

1. Define puberty and adolescence
2. Hormonal regulation of puberty onset
3. Stages of puberty – characteristic changes in male and female at puberty
4. Precocious puberty, Delayed puberty



PUBERTY

- ▶ Transition from a noncyclic, relatively quiescent reproductive endocrine system to a state of cyclic reproductive function that allows procreation
- ▶ Appearance of secondary sexual characteristics, adolescent growth spurt
- ▶ The total period of growth spurt ranges between 3 and 5 years.



Onset of Puberty

- ▶ It starts from the age of 8 years.
- ▶ The average age of onset of puberty is 12 years in girls and 14 years in boys.
- ▶ Age : 8 - 13yrs for girls
9 - 14yrs for boys



Puberty refers to the stage of gonadal development and maturation to the point where reproduction is possible for the first time.

Adolescence refers to the period of sudden spurt of physical growth between childhood and adulthood.

Since these two phases (adolescence and puberty) of growth are overlapping, hence the terms are interchangeable.

Physiology of Puberty

- Activation of the hypothalamic – pituitary – gonadal axis
 - Induces and enhances progressive ovarian and testicular sex hormone secretion
 - Responsible for the profound biological, morphological and psychological changes which adolescents experience



Physiology of puberty

- ▶ Prepubertal stage:
 - ▶ – Early childhood to 8–9yrs
 - ▶ – Hypothalamic – pituitary – gonadal axis dormant
 - ▶ – LH, Estrogen and testosterone are undetectable
- ▶ Peripuberty:–
 - ▶ – 1–3yrs before puberty
 - ▶ – Low LH during sleep and pulsatile
- ▶ Early puberty :–
 - ▶ – sustained effect
- ▶ Mid Puberty :–
 - ▶ – LH pulse present in a day and night
 - ▶ – occur at interval of 90–130minutes



HORMONAL REGULATION OF PUBERTY ONSET

- **Birth to preadolescent age** –
 - GnRH secretion has increased sensitivity hypothalamus & pituitary
 - low plasma FSH & LH levels with high FSH:LH ratio
- **At the time of puberty (10 - 12yrs)–**
 1. Hypothalamic-pituitary-gonadal negative feedback system sensitivity decreases
 2. Intrinsic CNS inhibition of GnRH pulse generator in median basal hypothalamus



Molecular level Regulation

- ▶ Positive feedback mechanism



- ▶ Increase level of hypothalamic GnRH



- ▶ Reveals in pulsatile manner so,
- ▶ GnRH Pulse Generator " will form



- Pulsatile LH & FSH secretion
- High LH:FSH ratio
- Nocturnal LH peak

- Increased responsiveness of gonadal target cells to LH :
 - In males – increased testosterone
 - In females – increased estrogen
- Increased Inhibin in response to increased FSH



- *Awakening of hypothalamus.* Hypothalamus at puberty is also positively stimulated (awakening of hypothalamus) by the critical body mass, visual, external, olfactory and other sensory stimuli.

- *Role of leptin.* Leptin (a Greek word meaning thin) is a circulating protein formed in the fat cells. It acts on the hypothalamus by feedback control mechanism. Therefore, leptin acts as a link between critical body weight and onset of puberty.



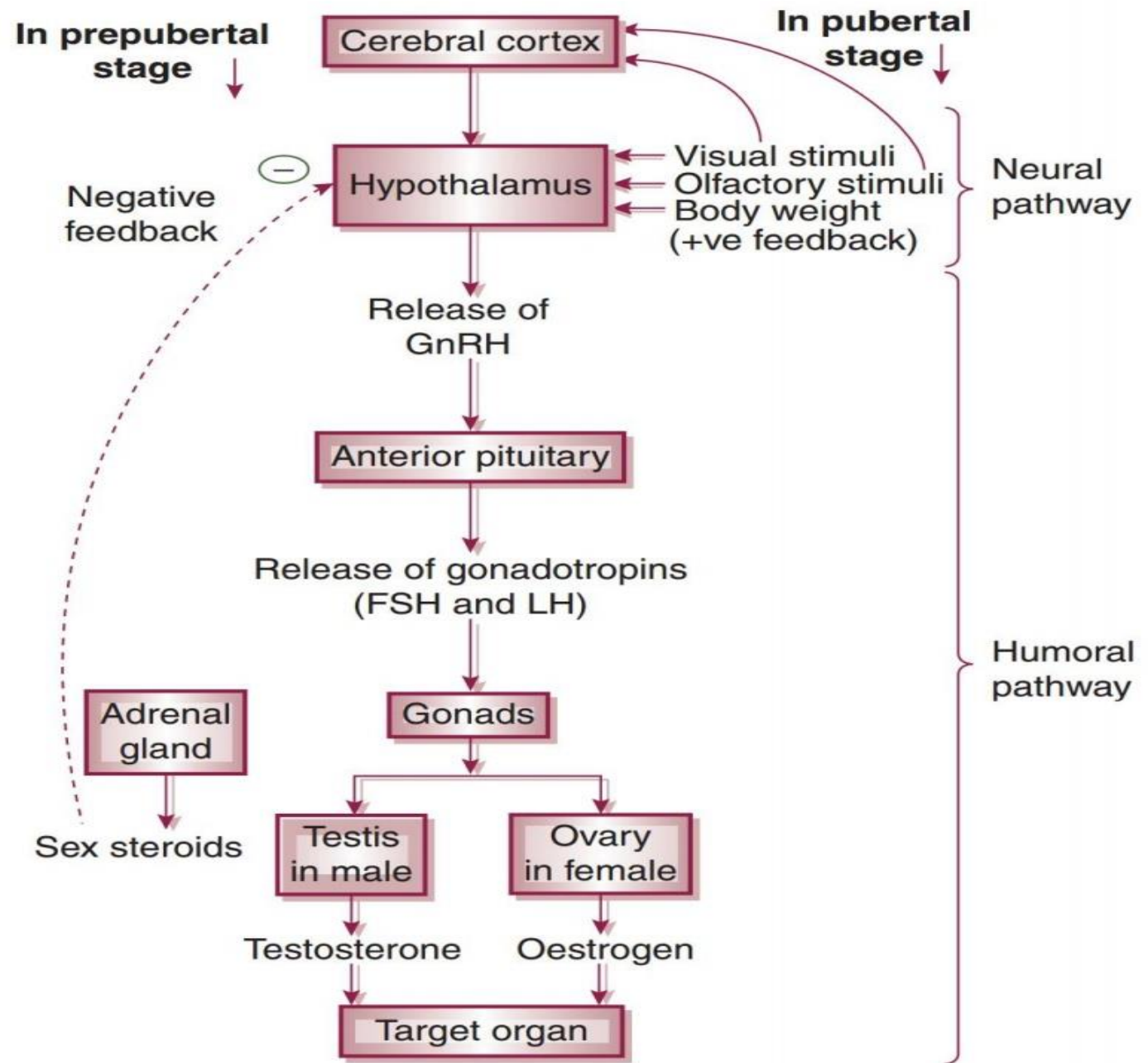


Fig. 9.1-12 Neurohormonal mechanism of onset of puberty.



Other influential factors

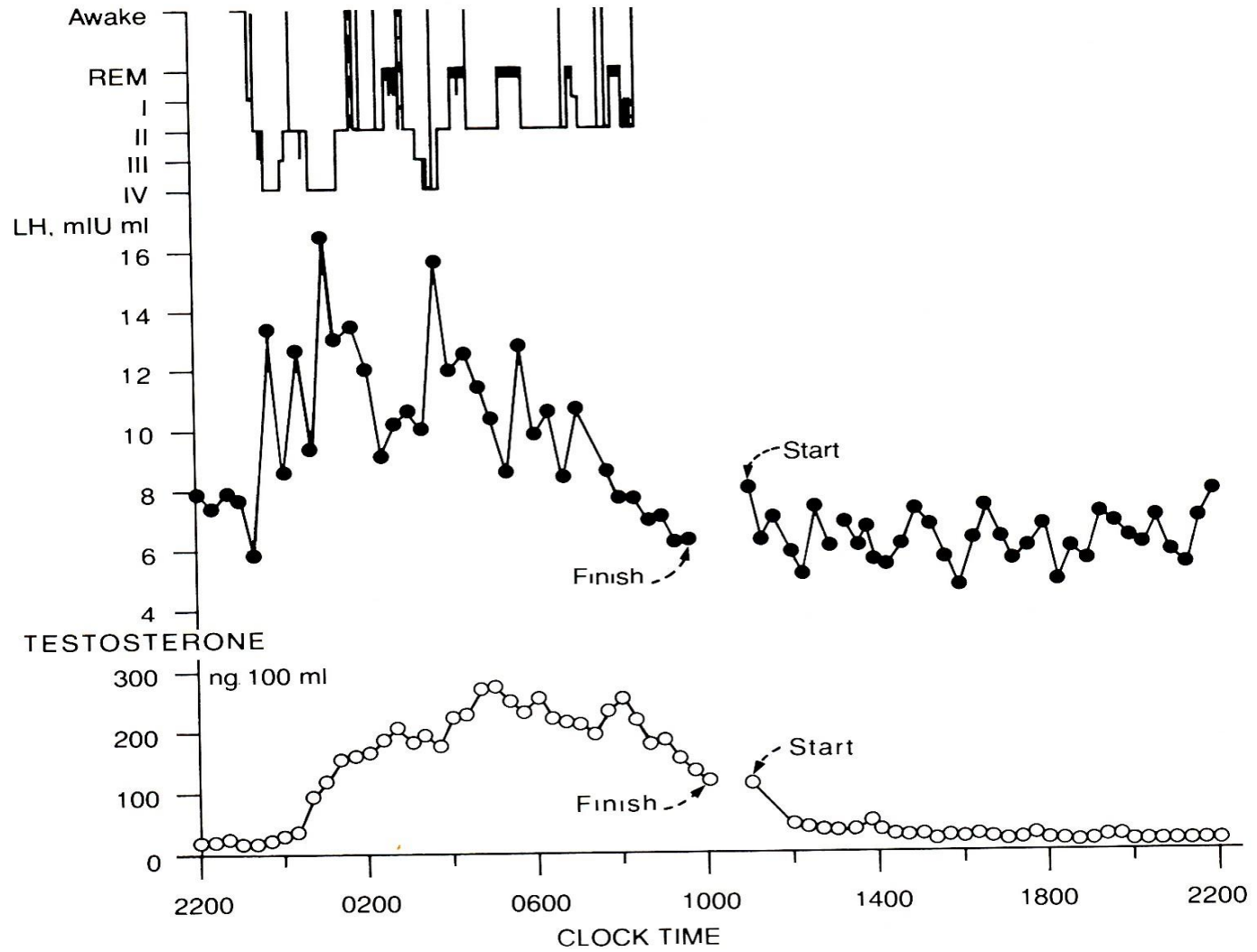
- Limbic system influences
- Genetic predisposition : GPR54 gene
 - direct genetic influences account for at least 46%
 - stronger association between mother & daughter
- Environmental factors :
 - early onset : distance from equator & lower altitudes
- Nutritional influence :
 - late onset : typical veg. diet
calcium & vit.D deficiency
- Environmental hormones & chemicals



- Physical activity & exercise
- Physical illness
- Maturation of GnRH neurons→pulsatile release of GnRH
- Reduced nocturnal melatonin secretion
- Adrenal androgen secretion : DHEA & DHEAS followed within 1-2yrs by increased androstenedione



SLEEP STAGE



↑ CNS activation/inhibition ratio



↑ frequency and amplitude of LHRH secretion



↑ amplitude and frequency of LH (initially at night)



↑ LH response to intravenous LHRH



↑ estradiol secretion in girls
↑ testosterone secretion in boys



↑ GH secretion



➤ GH :

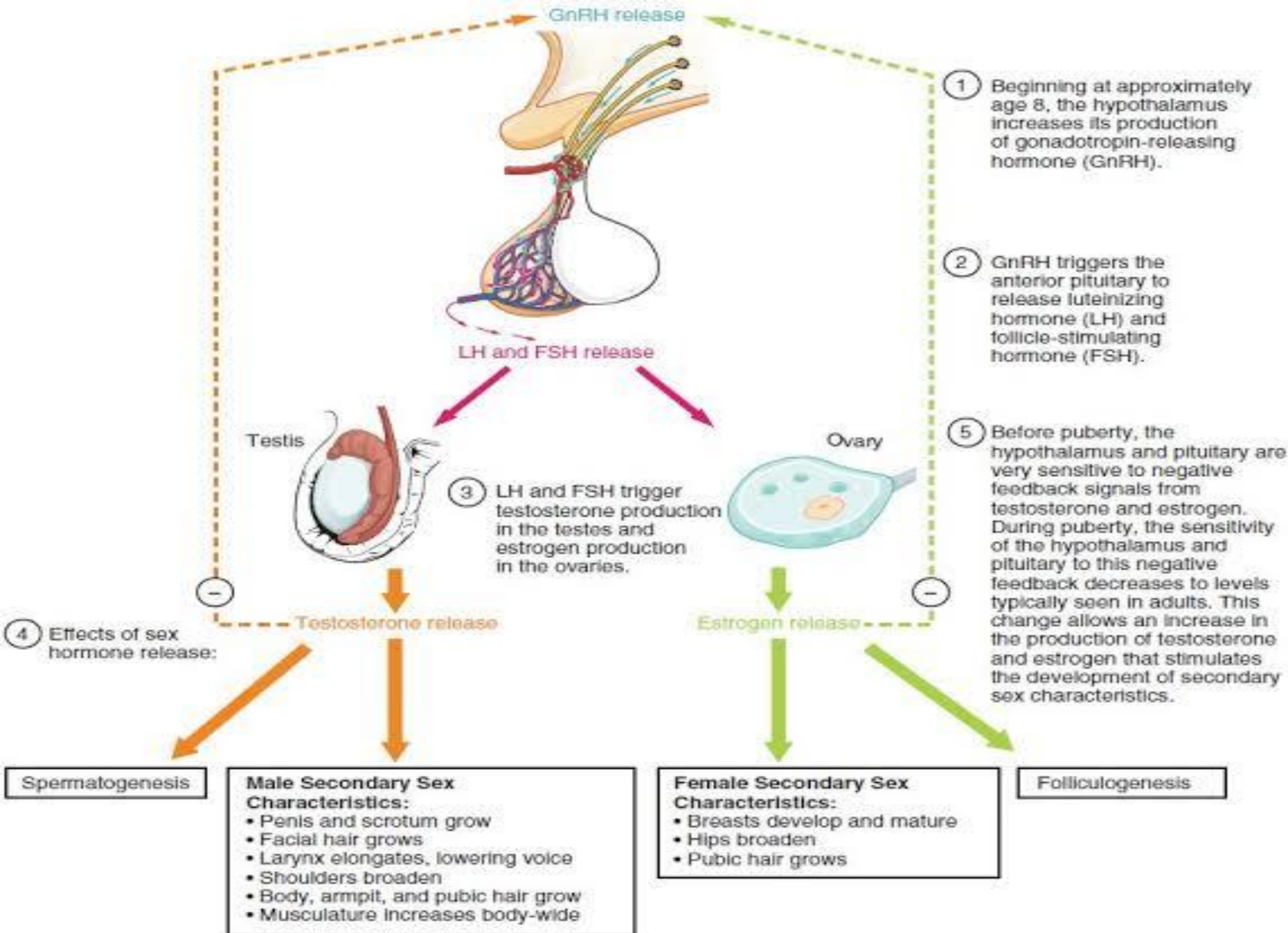
- stimulates FSH induced differentiation of granulosa cells directly
- increased ovarian level of IGF-1
- amplify ovarian response to gonadotropins

➤ IGF-1 :

- enhances gonadotropin effect on granulosa cell
- local production of GH & IGF-1 exerts an intraovarian paracrine control on steroidogenesis

➤ GHRH & GH increase at puberty, mainly at night





STAGES OF PUBERTY

By Tanner

► In females :

1. Thelarche : median age 9.8yrs
2. Pubarche : median age 10.5yrs
3. Menarche : median age 12.8yrs

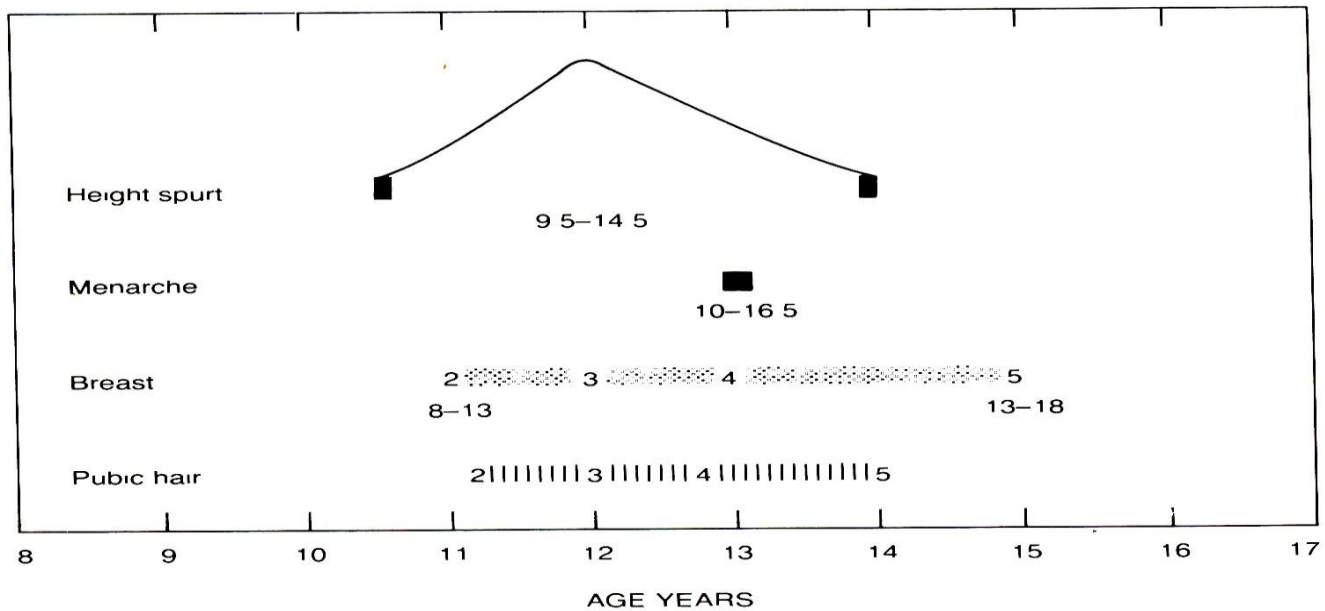
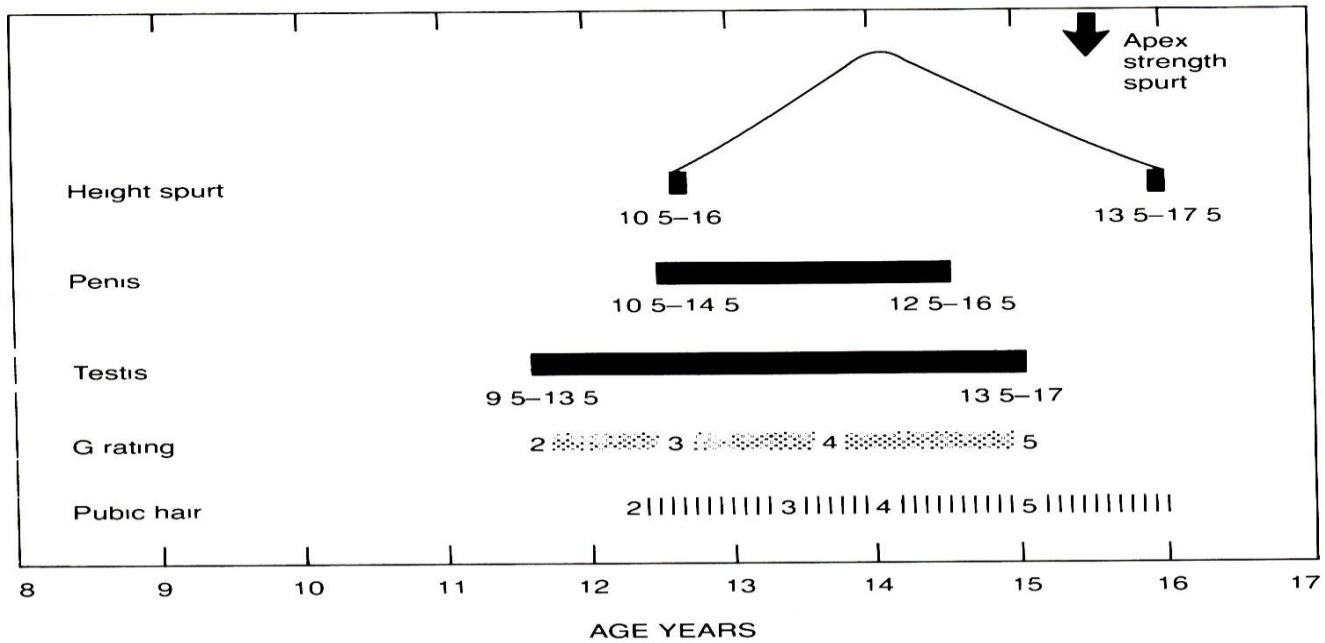


Stage of puberty (bone age)	In Boys	In Girls
1. Stage 1 (upto 7.5 years)	Preadolescent stage or stage of childhood.	Preadolescent stage.
2. Stage 2 (12 years boys & 10.5 years girls)	Genital development begins by enlargement of the testes.	Appearance of 'breast bud' (thelarche) Note: Regular ovulation (page 828) usually appears about a year later.
3. Stage 3 (14 years boys & 11.5 years girls)	Pubic and axillary hair begin, penis enlarges.	Pubic and axillary hair begin, (pubarche) elevation and enlargement of the breasts, gain in height (height spurt).
4. Stage 4 (15.5 years boys & 13 years girls)	Further growth of external and internal genitalia occurs with peak gain in height (height spurt).	Projection of areolas, appearance of the menses (menarche).
5. Stage 5 (16.5 years boys and 14 years girls)	Adult genitalia with secondary sexual characteristics which include:	Adult genitalia with secondary sexual characteristics which include:
(i) Body configuration	Broad shoulders, more muscular body.	Narrow shoulders, broad hips, thighs that converge and arms that diverge (wide carrying angle), female distribution of fat in the breast and hips giving the characteristic curves to the body.



(ii) Hair growth	Hair appears all over body, in axilla, over the pubis, face and chest; hairline on scalp recedes anterolaterally; male pattern of pubic hair (triangle with apex up).	Appearance of hair in the axilla and pubis; less body hair and more scalp hair; hair in pubic region concave upwards (female <i>flat-topped</i> pattern of distribution of hair caused by local conversion of weak androgens from the ovary and adrenal cortex to testosterone).
(iii) Voice	Larynx enlarges, vocal cords increase in length and thickness, therefore, voice becomes deep and breaks.	Larynx does not enlarge to that extent as in males, therefore, voice becomes high pitch.
(iv) External genitalia	Penis increases in length and width, scrotal skin thickens, becomes pigmented and rugose.	Clitoris increases in length and width, labia majora and minora enlarge.
(v) Internal genitalia	Seminal vesicles, prostate and bulbourethral glands enlarge and secrete.	Ovaries, uterus and vaginal growth increases and their activity increases.
(vi) Skin changes	Acne (pimples) appears due to increased secretion from sebaceous glands by the action of androgens.	Acne and formation of comedones (<i>black heads</i>) is less as oestrogen antagonizes the action of androgen on sebaceous glands.
(vii) Psychological changes	Aggressive, active attitude, interest in opposite sex develops.	Changes in mental and emotional behaviour; shyness; interest in opposite sex develops.





APPLIED ASPECTS

- Precocious Puberty :
 - True
 - Precocious Pseudopuberty
- Delayed Puberty :
 - Constitutional
 - Gonadotropin Failure
 - Primary Testicular Diseases



True Precocious Puberty

1. *Definition:* Early development of secondary sexual characters **with** gametogenesis. It is due to an early but otherwise normal pubertal pattern of gonadotrophin secretion from the pituitary (Fig. 10.1.12).

2. Causes

(a) Constitutional – more common in females.

(b) Interruption of neural pathways that produce inhibition of GnRH due to:

(i) cerebral disorders (infection, tumours, developmental abnormalities) involving posterior (ventral) hypothalamus near the infundibulum;

(ii) pineal tumours which damage the hypothalamus;



Pseudo Precocious Puberty

1. *Definition:* Early development of secondary sexual characters **without** gametogenesis (no spermatogenesis or ovarian development). It is due to abnormal exposure of immature males to androgen or females to oestrogens.

2. Causes

(a) Adrenal

(i) congenital virilizing adrenal hyperplasia (page 800);

(ii) androgen secreting tumours (in males);

(iii) oestrogen secreting tumours (in females).

(b) Gonal

(i) Interstitial cell tumours of testis.

(ii) Granulosa cell tumours of ovary.

Delayed or absent puberty

- ⌚ Puberty is considered to be pathologically delayed in case of -
 - ⌚ - female, if menarche does not occur by 17 years of age, or
 - ⌚ - male, testicular development and maturation fails to
 - ⌚ occur by the age of 20 years.
- ✓ more commonly observed in boys than in the girls.
- ✓ Causes:-
 - ⌚ 1. Failure of hypothalamus/pituitary to secrete
 - ⌚ gonadotropins, as in panhypopituitarism.

- ⌘ 2. Primary gonadal failure.
 - ⌘ (mental failure or gonadal dysgenesis)
 - ⌘ Klinefelter syndrome in males
 - ⌘ Turner's syndrome in females.

- ⌘ Features of delayed or absent puberty are:
 - 1. Lack of pubertal development,
 - 2. Short stature (dwarf),
 - 3. Presence of associated features of other endocrinal abnormalities and
 - 4. Low levels of gonadotropins.

Assignment

1. Define and Describe puberty: onset, progression, characteristics of stages. Add note on early and delayed puberty
 2. Explain hormonal regulation of puberty onset
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Thankyou