NORMAL PUBERTAL DEVELOPMENT

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NORMAL PUBERTAL DEVELOPMENT

WHAT IS PUBERTY?

-It is the transitional period between childhood & adulthood

-The physiological changes leading to the development of adult reproductive capacity

-The period of attainment of adult sexual & reproductive characteristic

-It is the transitional period of development during which an individual mature from childhood to sexual & reproductive maturity

NORMAL PUBERTAL DEVELOPMENT

WHAT ARE THE MAJOR CHARECTERISTICS OF THIS PERIOD?

1-Maturation of the 1ry sexual chct ?

Hypothalamic Pituitary Ovarian Axis

2-Development of 2ry sexual chct ?

-Sexual hair

-Breasts

-Genitalia

3-Dramatic growth spurt

4-Phycological changes ⇨ mental & emotional maturity

NORMAL PUBERTAL DEVELOPMENT

-WHAT IS THE AGE OF ONSET OF PUBERTY?

-Females ----8-13

-Males -----9-14

-WHAT IS THE USUAL SEQUANCE OF SOMATIC CHANGES OF PUBERTY?

1-Beast development (mean 10.6 Y)

2-Pubic & axillary hair (11.2)

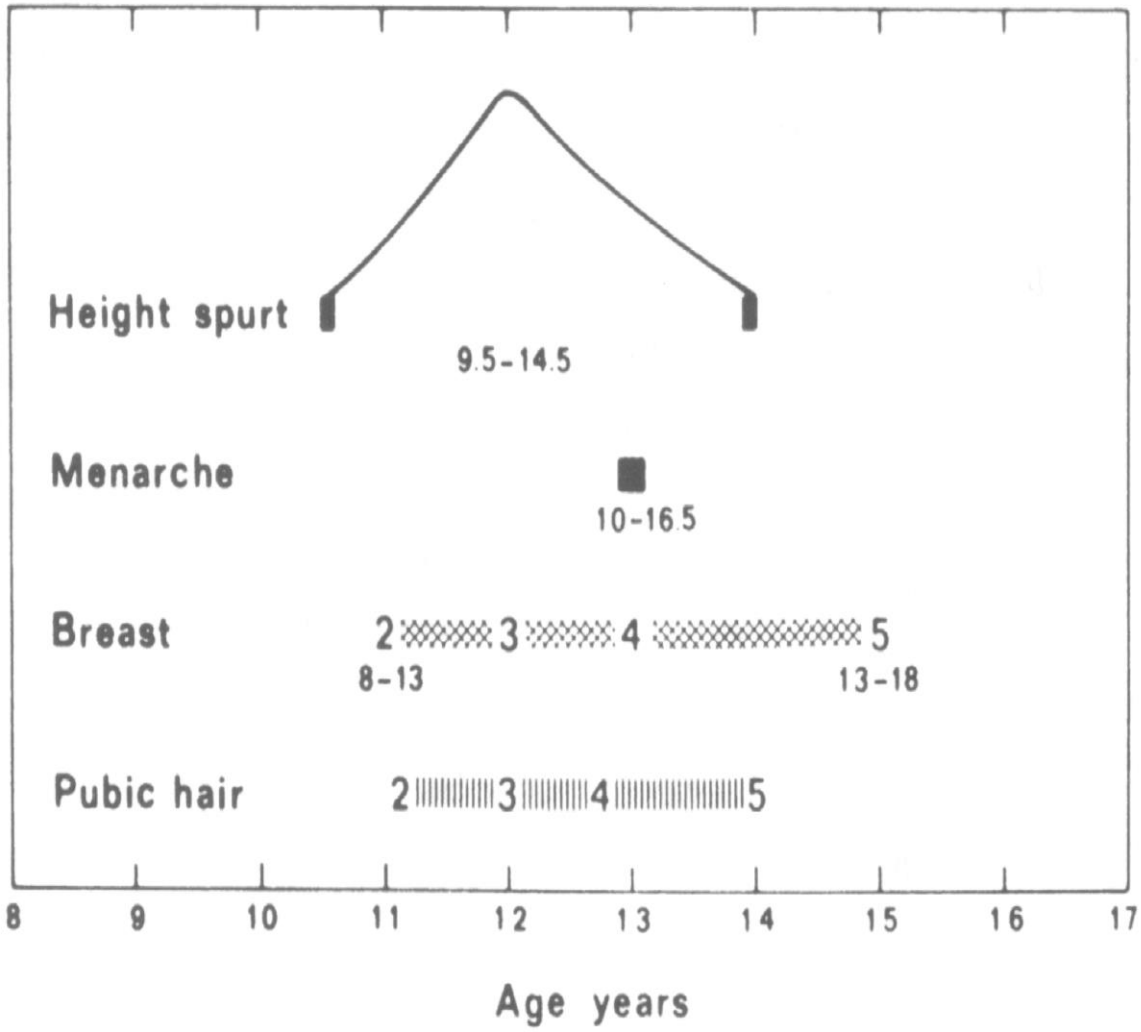
3-Maximal growth velocity (12)

onset of growth spurt (9.6)

4-Menarche (12.7)

The average age of menarche has ↓ over the last 3-4 decades (secular trend) attributed to improved nutrition general health & life style

AGES OF GIRLS AT VARIOUS STAGES OF PUBERTAL DEVELOPMENT



NORMAL PUBERTAL DEVELOPMENT

-WHAT IS THE INTERVAL BETWEEN ONSET OF BREAST DEVELOPMENT & MENARCHE?

2.3 +_1 years

-DOES MENARCHE MARK THE ATTAINMENT OF REPRODUCTIVE MATURITY?

- No, the reproductive system continues to mature for around 3-4 years
- No. of ovulatory cycles ↑ from 10% to 90%
- Duration of menstrual cycle ↓

NORMAL PUBERTAL DEVELOPMENT

-DO GIRLS STOP GROWING AFTER MENARCHE?

No

Growth continues at a decelerating rate for a No. of years

-WHAT IS THE TIME FROM ONSET TO COMPLETION OF PUBERTY?

Average	4.2 Y
Range	1.5-6 Y

ETIOLOGY OF PUBERTY

HYPOTHALAMUS

- GnRH secretion by the arcuate nucleus is modulated by two inhibitory mechanisms :

  1-Intrensic CNS inhibitory mech

  2-Neg feedback of circulating sex steroid

DEVELOPMENT OF THE HPO AXIS

- At fifth month gestation, the ovaries become responsive to gonadotropin ⇨ follicular growth to early antral stage (1-2 mm, followed by atresia) ⇨ estrogen production ⇨ neg feedback
- A functional HPO axis exists in utero
- In utero the fetoplacental unit is the 1ry source of estrogen production ⇨↑ estrogens ⇨ ↓ FSH & LH levels

MATURATION OF THE HPO AXIS

▲ After birth estrogen ↓ dramatically ⇨ ↑ FSH & LH ⇨ ↑ ovarian estrogen production in early infancy

1-THE MAIN MECHANISM CONTROLLING FSH & LH SECRETION IN INFANTS IS THE LEVELOF SEX STEROIDS

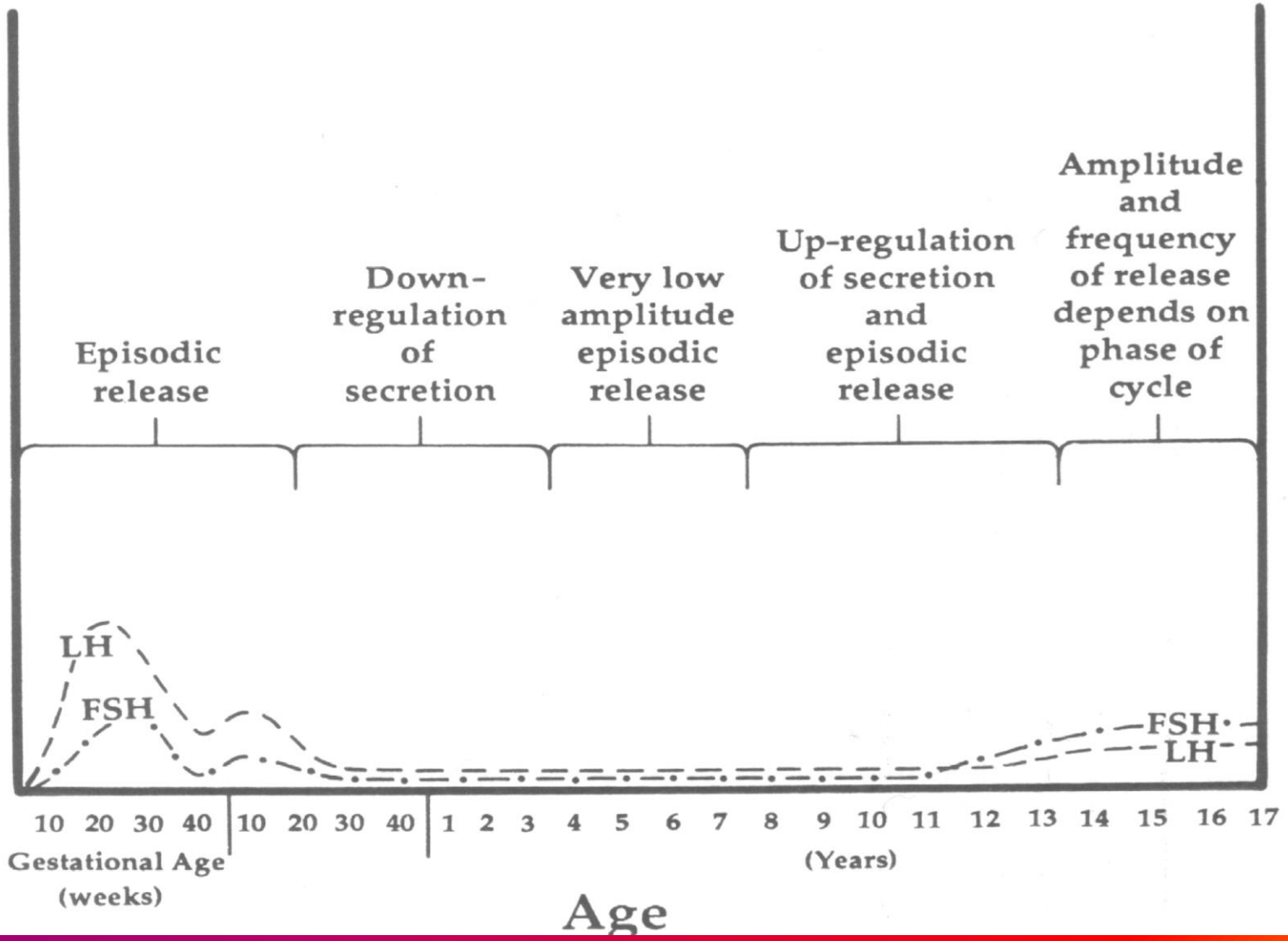
▲Peak FSH & LH ⇨⇨ 1-2 years

2- THE INTRINSIC CNS INHIBITORY MECHANISM

▲Gradually develops with continued growth & maturation of the CNS ⇨⇨ Minimum FSH & LH level ⇨⇨ 6-8 years

▲The principal CNS inhibitor of GnRH is GABA

LEVELS OF LH & FSH DURING FETAL LIFE, INFANCY CHILDHOOD & PUBERTY

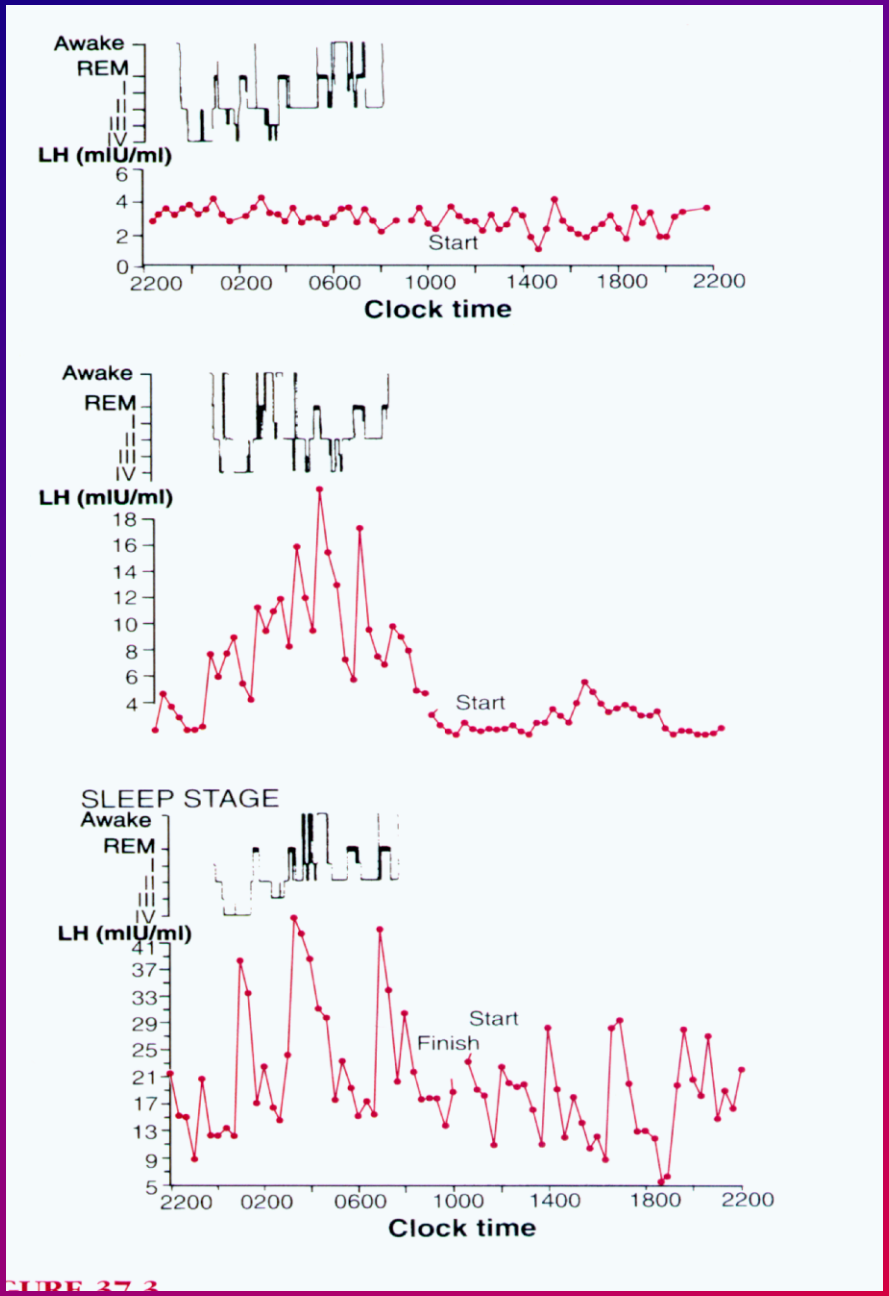


MATURATION OF THE HPO AXIS

THE SEQUENCE OF MATURATION

- At the onset of puberty GnRH pulses occur during sleep ⇨ LH pulses
- The frequency of LH pulses ↑ with further maturation
- LH pulses appear during day time & ↑ in amplitude
- As menarche approaches ⇨ the pulses are detected all the time (no diurnal variation)
- Similar changes occur in FSH pulses
- LH/FSH ratio ↑

PLASMA LH CONC MEASURED EVERY 20 MIN FOR 24 HRS



1-PREPUBERTAL

2-EARLY PUBERTAL

3-LATE PUBERTAL

INITIATION OF PUBERTY

FACTORS RESPONSIBLE FOR THE INITAIATION OF PUBERTY

***UNKNOWN

*FRISCH THEORY

- A critical body fat & body wt are required for the initiation of menarche
- Supported by :

1-Highly competitive athletic training

⇨ delayed puberty

2-Delayed menarche in malnutrition

3-Overwt girls have early menarche

4-Pt with anorexia nervosa revert to prepubertal pattern of gonadotropin secretion as body wt ↓

INITIATION OF PUBERTY

AGAINST THE THEORY

Changes in body composition occurs simultaneously with gonadortopin increase & does not precede it

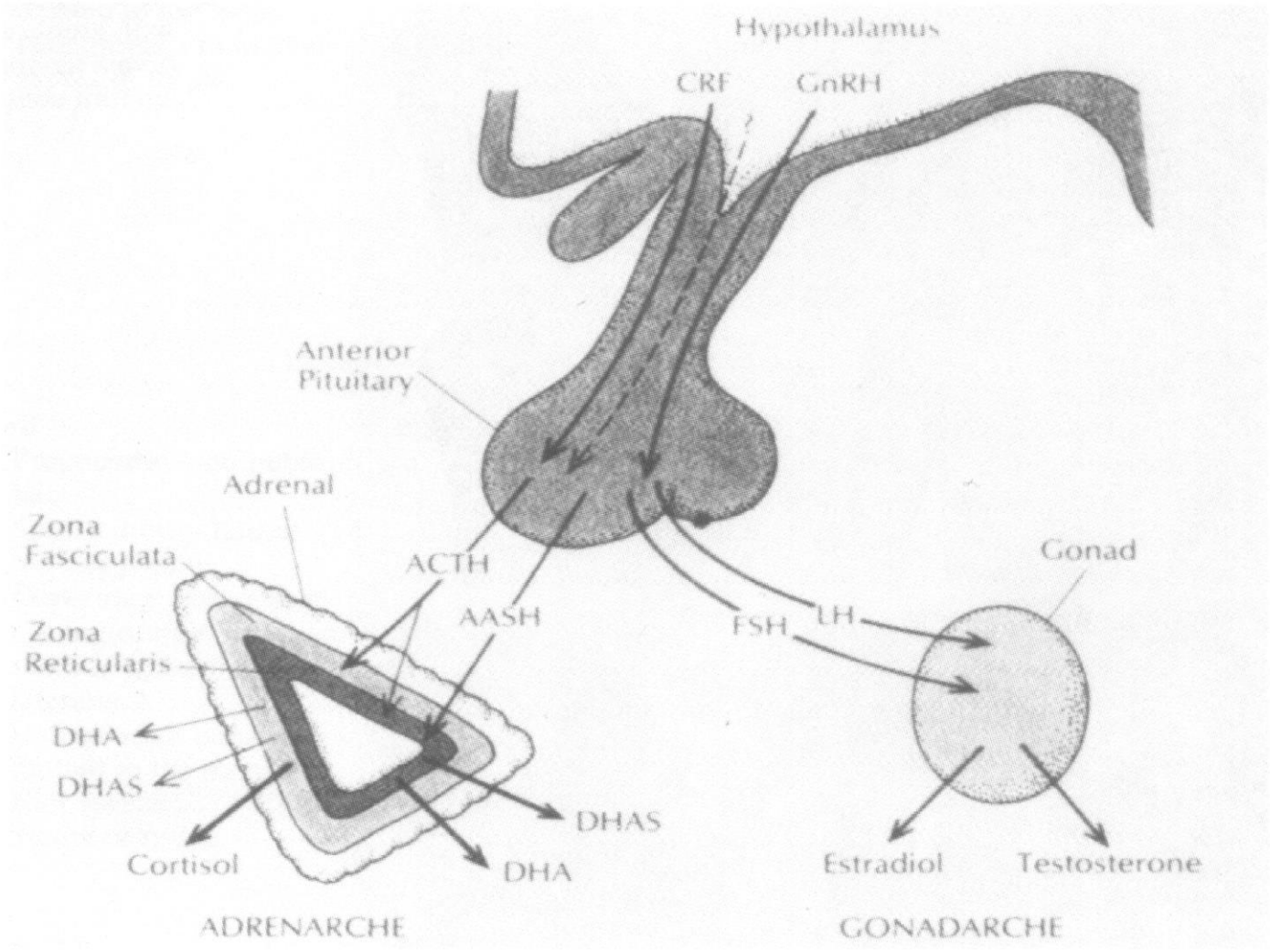
LEPTIN

An adipose derived protein may play a role in the initiation of puberty

INITIATION OF PUBERTY

- Gonadostat begins to loose its sensitivity to the –ve feedback by estrogen ⇨ reactivation of GnRH pulsatility ⇨ puberty
- In late childhood CNS inhibitory influence on the hypothalamus wane ⇨↑ GnRH ⇨↑ FSH & LH ⇨↑ estrogen (gonadarche)
- ↑ sensitivity of the pituitary to GnRH
- ↑ sensitivity of the ovary to LH & FSH ⇨ ↑ esrtogen secretion

ADRENARCHE & GONADARCHE CONTROLED BY DIFFERENT MECHANISMS



Pubertal development involves two temporally associated processes: adrenarche and gonadarche. The

ADRENARCHE

- The maturational ↑ in adrenal androgen secretion
- DHEA , DHEAS, AND
  - ⇨ development of pubic & axillary hair
  - ⇨ adult type body odor
  - ⇨ acne
  - ⇨ oily skin & hair
- DHEAS -----First detected at 7 Y
  -----Maximum at 15 Y
- The mechanism of initiation is unknown
- Adrenal androgens ⇨↑ bone age & linear growth
- Premature adrenarche ⇨ ↓ adult height
- Adrenarche & gonadarche are not associated

GONADARCHE

- The onset of pubertal gonadal activity due to reactivation of HPO axis ⇨ ↑ estrogen

- The process of ovarian follicular growth & atresia is initiated in utero & continues from birth to puberty

  It is independent of gonadotropin secretion & results in only minimal estrogen secretion

- Reactivation of HPO axis ⇨↑ gonadotropin pulses ⇨ sustained follicular development to antral stage ⇨ significant estrogen production
- There is direct relationship between follicular size & estrogen secretion

MENARCHE

- When there is sufficient gonadotropin stimulation of the ovaries ⇨ follicular growth (~16mm) ⇨ ↑ estrogen ⇨ proliferation of the endometrium untill ⇨ it outgrows the estrogen capacity to maintain it or ⇨ the follicle undergo atresia ⇨ ↓ estrogen ⇨ menstruation (MENARCHE)

- Anovulatory cycles occur during the first 6-18 months

"endometrium is not exposed to progestrone" ⇨ irregular unpredictable menstrual flow

OVULATORY MENSTRUAL CYCLES

- Requires further maturation of the HPO axis ⇨ development of the +ve feedback mechanism ⇨ LH surge ⇨ ovulation & corpus luteum formation ⇨ progestron production

- Early ovulatory cycles have short or inadequate luteal phase ⇨ HPO axis has not achieved full maturity

PHYSICAL EVENTS OF PUBERTY

Maturation of the genital organs

PREPUBERTAL

1-UTERUS

-Ratio of corpus : cx ⇨ 1:2

-Tubular shape

-Length --- 2-3 cm

-Volume ----- 0.4-1.6

-Endometrium ⇨ single layer of cuboidal cells

2-OVARIES

-Volume -----0.2-1.6 ml

-Non functional

PUBERTAL ---ADULT

1-UTERUS

-Ratio of corpus :cx ⇨2:1

-Pear shape

-Length ----5-8

-Volume ----- 3-15 ---

-Endometrium ⇨ ↑ thickness

2-OVARIES

-Volume ------2.8-15 ml

-Multicystic

Maturation of the genital organs

PREPUBERTAL

3-VAGINA

-Reddish in color

-Thin atrophic columnar epithelium

-PH ---neutral

-Length—2.5-3.5

PUBERTAL ---ADULT

3-VAGINA

-Thickening of the epithelium

Cornification of the superficial layer ⇨⇨ stratified squamous Epithelium

-Dulling of the reddish color

-PH ----acidic 3.8-4.2

-Secretion of clear whitish discharge ⇨ in the months before menarche

-Length ---7.5 cm

Maturation of the genital organs

EXTERNAL GENITALIA

Under the effect of estrogens ⇨

1-Labia majora & minora ↑ in size & thickness

Rugation & change in color of the labia majora

2-The hymen thickens

3-Clitoris enlarge

4-Vestibular glands begin secretion

Under the effect of adrenal androgens & ovarian androgens

⇨ growth of pubic & axillary hair

BREAST DEVELOPMENT
THELARCHE

- The first visible change of puberty
- Thelarche is induced by estrogen
- Starts at 10.6 completed in ~ 3 years
- Effects of estrogen on the breast
  - 1-Ductal proliferation
  - 2-Site spicific adipose deposition
  - 3- Enlargement of the areola & nipple
- Breast development may be unilateral for several months
- Other hormones that play a role in breast development ⇨ prolactin, glucocoricoids & insulin
- In normal girls the stage of breast development is consonant with the stage of pubic hair development

TANNER STAGING OF BREAST DEVELOPMENT

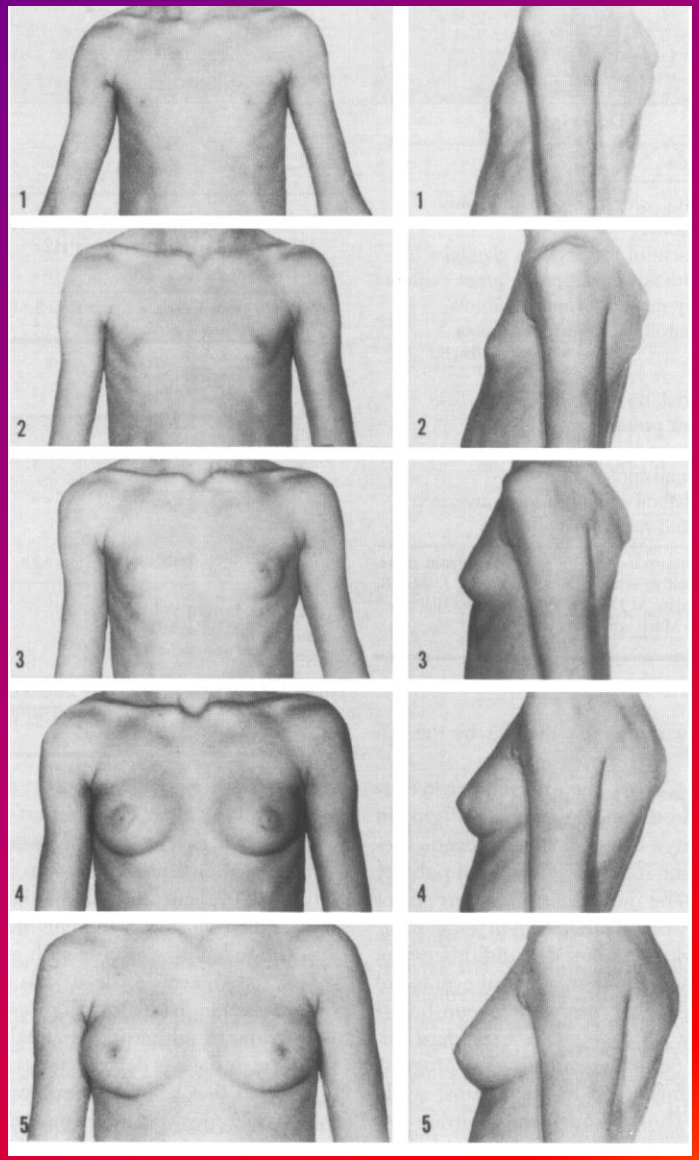
Stage 1 : Prepubertal

Stage 2 : Breast bud

Stage 3 :Enlargement of breast & areola

Stage 4 :Areola &nipple form a mound atop breast tissue

Stage 5 :Adult configuration areola &beast having smooth contour



TANNER STAGING OF PUBIC HAIR DEVELOPMENT

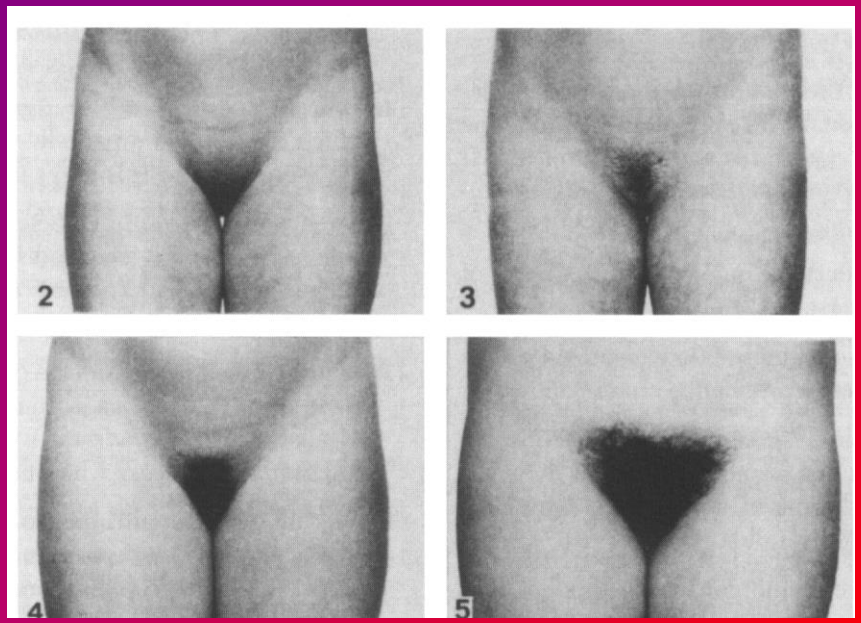
Stage 1 : No pubic hair

Stage 2 : Sparse downy hair on the medial aspect of the labia majora

Stage 3 : Darkening, coarsening & curling of hair which extends upwards & laterally

Stage 4 : Hair of adult consistency limited to the mons

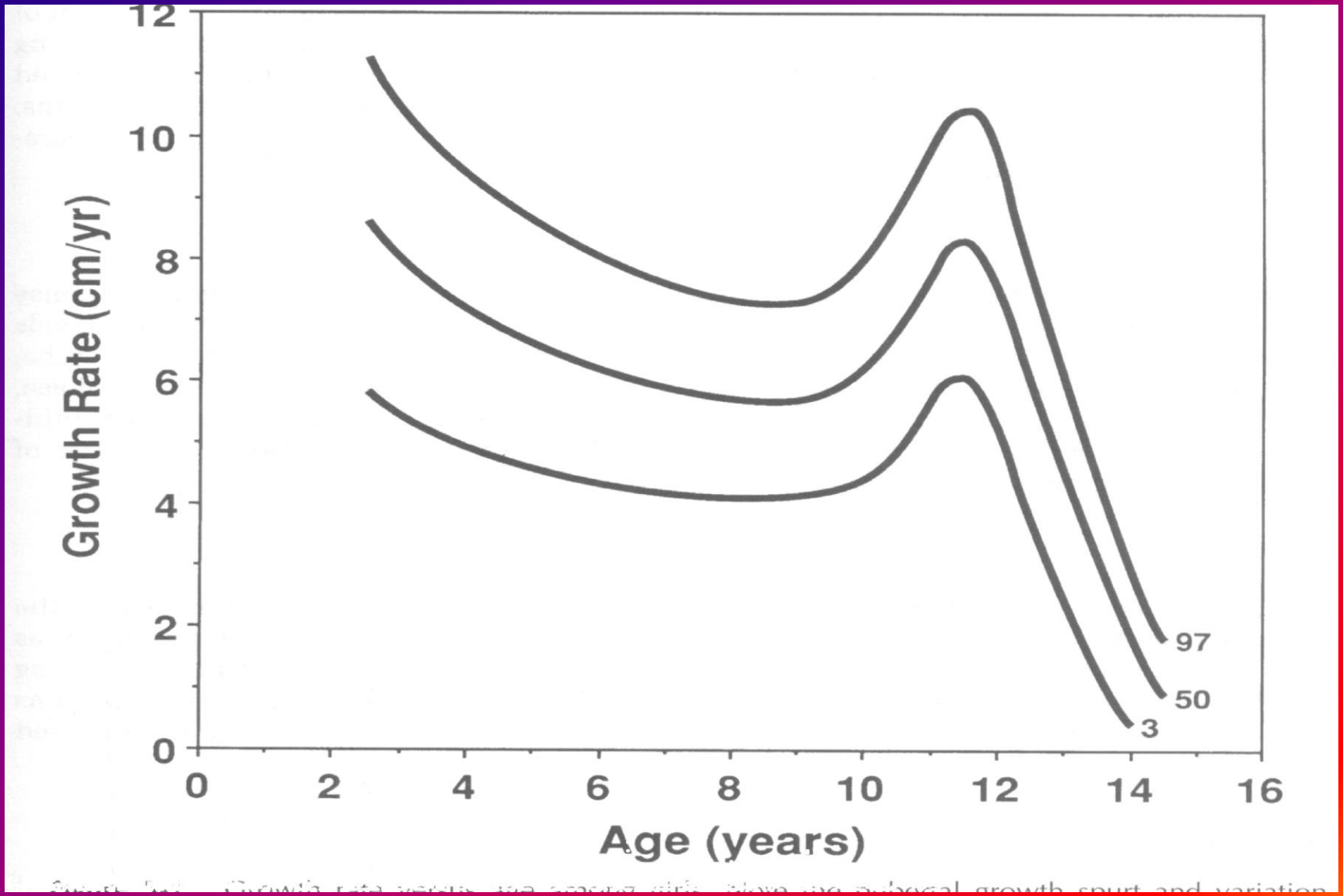
Stage 5 :Hair spreads to medial aspect of thighs



GROWTH SPURT

- A global process involving ↑ skeletal growth rate
  ↑ muscle mass
  growth of all internal organs
- Dependent on mainly on estrogen & growth hormone
  however adrenal androgens also play a role
- Estrogen has :
  - ⇨ direct anabolic effect
  - ⇨ ↑ growth hormone
  - ⇨ ↑ insulin like growth factors
- The onset of growth spurt antedates thelarche & pubarche
- Coincident with ↑ shoe size

GROWTH RATE VERSUS AGE IN GIRLS



GROWTH SPURT

Peak Height Velocity

-8.1 cm/year (before puberty 3-6 cm/y)

-occurs in midpuberty

-by the time PHV is achieved ⇨ 90% of adult height has been achieved

-the average ↑ in height from the onset of growth spurt to cessation of growth 25 cm

-girls who start the growth spurt early will have a shorter adult height

Bone age is more closely correlated with pubertal events than chronological age