



Puberty and pubertal disorders

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Definition

- Puberty from Latin 'pubes" meaning hair.
- Refers to the process of physical changes by which a child's body becomes an adult body capable of reproduction.
- Transitional stage from childhood to adulthood manifested by physiological changes & development of SSC .

The normal age of puberty :

1- in male : about 14 years

2- in female : about 12 years



- **Menarche**

the first menstrual period; the establishment of menstruation.

- **thelarche:**

the beginning of development of the breasts in the female.


- **Pubarche:**


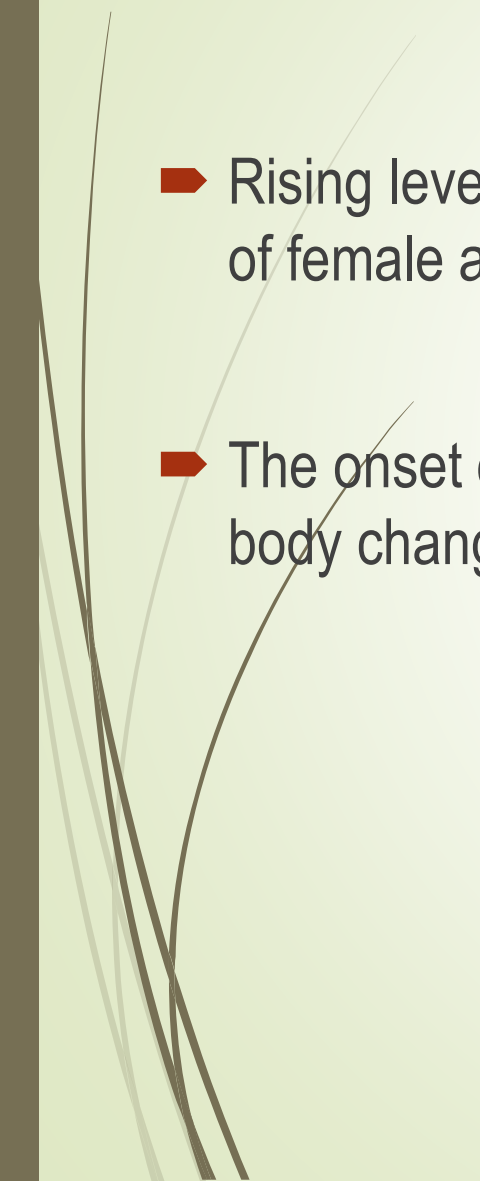
The onset of puberty, particularly as manifested by the appearance of pubic hair.


- **Adrenarche** is the term for the maturational increase in adrenal androgen production → appearance of pubic hair, axillary hair, acne, adult type body odor or oily hair.

physiology

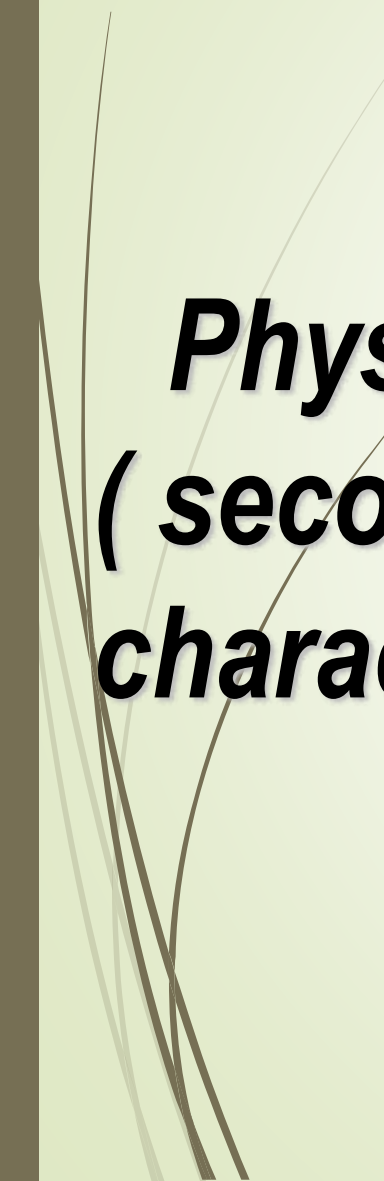
- The cause of this GnRH rise is complex. Puberty begins at around 47 kg for girls and 55 kg for boys.
- This dependence on bodyweight makes leptin a good candidate for causing GnRH rise
- .
- The levels of leptin change in line with the onset of puberty, and then decline to adult levels.

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- A simple description of hormonal puberty is :
 - The brain's hypothalamus begins to release pulses of GnRH.
 - Cells in the anterior pituitary respond by secreting LH and FSH into the circulation.
 - The ovaries or testes respond to the rising amounts of LH and FSH by growing and beginning to produce estradiol and testosterone

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- Rising levels of estradiol and testosterone produce the body changes of female and male puberty.
 - The onset of this neurohormonal process may precede the first visible body changes by 1-2 years.
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***Physical changes in males
(secondary sexual
characteristics)***



1-Testicular size, function, and fertility

- In boys, testicular enlargement is the first physical sign of puberty (more than 4 ml in size and 2.5 cm in length)
- Testes in prepubertal boys change little in size from about 1 year of age to the onset of puberty, averaging about 2–3 cc in volume and about 1.5-2 cm in length.
- Testicular size continue to increase throughout puberty, reaching maximal adult size about 6 years later.
- While 18-20 cc is an average adult size, there is wide variation in the normal population
- Growth spurt begins at stage III , maximal at genital stage IV-V, typically between 13 and 14 yr of age, 2 yrs later than in females.



➤ The testes have two primary functions:

1- to produce hormones, by Leydig cells


2- to produce sperms, by Sertoli cells.

➤ The Leydig cells produce testosterone , which in turn produces most of the changes of male sexual maturation and maintains libido .

➤ However, most of the increasing bulk of testicular tissue is spermatogenic tissue.

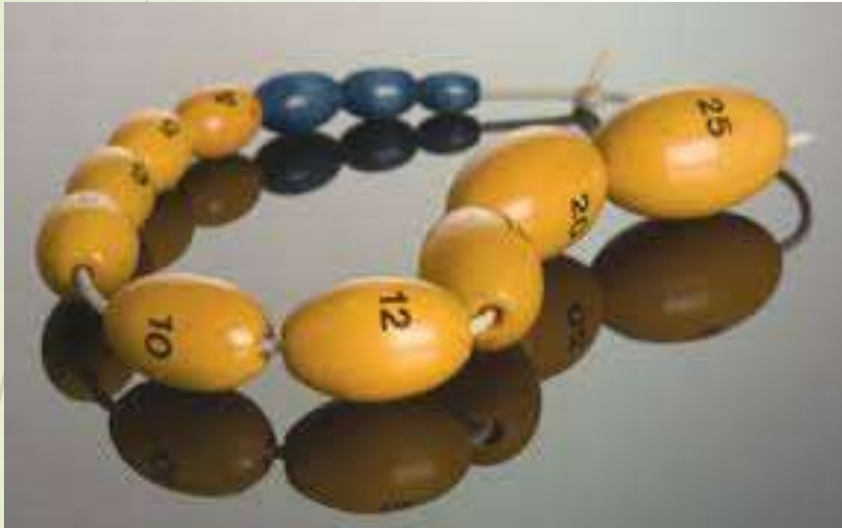
➤ Testosterone modulates LH secretion.

➤ Inhibin B produced by the Sertoli cells exerts a negative feedback effect on FSH secretion.

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- ➔ Sperm can be detected in the morning urine of most boys after the first year of pubertal changes
 - ➔ Potential fertility is reached at about 13 years old in boys, but full fertility will not be gained until 14-16 years of age.


Orchidometer

Testicular size beads






2-Pubic hair

- Pubic hair often appears shortly after the genitalia begin to grow..
 - the hair growing continue till it spread the thighs and upward towards the umbilicus as part of the developing abdominal hair.
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3-Body and facial hair

- Other areas of skin which respond to androgens develop heavier hair (androgenic hair) in roughly the following sequence: axillary hair, perianal hair, upper lip hair, preauricular hair, and the rest of the body area.
- There is a large range in amount of body hair among adult men, and significant differences in timing and quantity of hair growth among different ethnic groups



4-Voice changes

- Under the influence of androgens, hypertrophy of the laryngeal mucosa and enlargement of larynx occurs
- Voice may start cracking for a period of time but gradually change into the typical adult voice








5-muscle development and body shape

- By the end of puberty, adult men have heavier bones and nearly twice as much as skeletal muscle.
- Arms, legs, hands, and feet may grow faster than rest of body.
- Grow taller and shoulders grow broader.
- Muscles get bigger.
- Gain more weight

6-Body odor, skin changes, acne

- Rising levels of androgens can change the fatty acid composition of perspiration, resulting in a more "adult" body odor.
- Skin becomes more oily , and more thickness
- Body will sweat more.
- Acne may develop

Tanner staging for males

I		3	<2,5
II		4	2,5-3,2
III		10	3,6
IV		16	4,1-4,5
V		25	>4,5


Stage I: prepubertal; testicular size less than 4 cc in volume and 2.5 cm in longest dimension

Stage II: enlargement of scrotum and testes; scrotal skin reddens and changes in texture; growth of testes to 4 cc or greater in volume

Stage III: enlargement of penis (length at first); further growth of testes


Stage IV: increased size of penis with growth in breadth and development of glans; testes and scrotum larger, scrotal skin darker

Stage V: adult genitalia

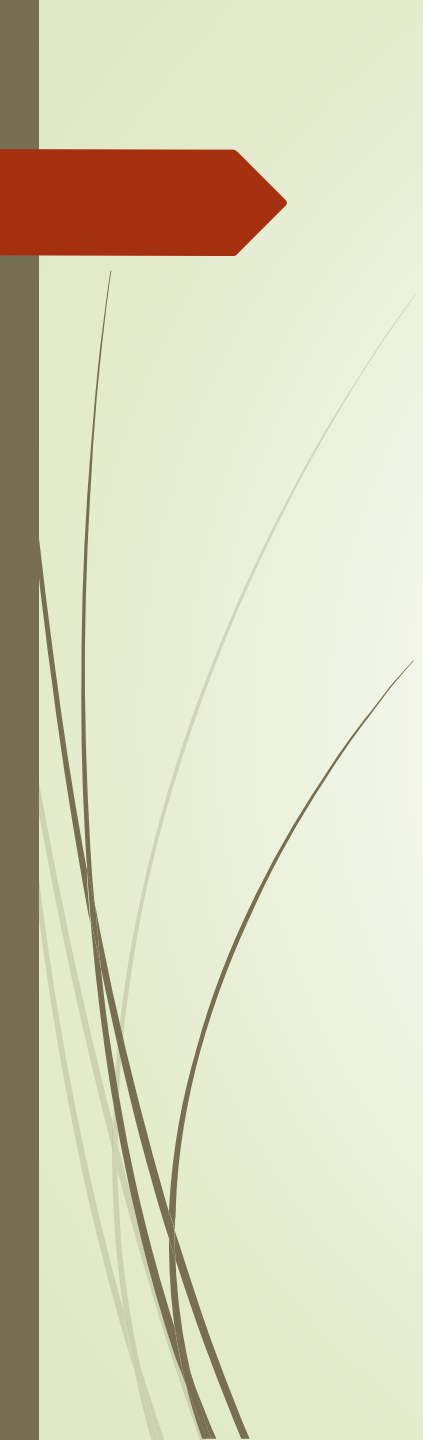


Increase testicular size and thinning of the scrotum →
penile length → pubic hair

increase



Physical changes in females

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- LH stimulates proliferation of follicular and theca cells, and during the follicular phase of the menstrual cycle induces androgen secretion by theca cells.
 - FSH induces proliferation of granulosa cells; enhances aromatase activity so that androstenedione is converted to oestradiol (E₂); and increases progesterone (P) production.
 - E₂ induces secondary sexual development.

1-Breast development

- The first physical sign of puberty in females is usually a firm, tender lump under the center of the areola of one or both breasts, occurring on average at about 10 years of age. (breast budding)
- Within six to 12 months, the swelling has clearly begun in both sides, softened, and can be felt and seen extending under the edges of the areola .
- By another 12 months , the breasts are becomes mature size and shape .there is so much variation in sizes and shapes of adult breasts
- Peak height velocity occurs early (at breast stage II–III, typically between 11 and 12 yr of age) in girls and always precedes menarche.



2-Hair:


- *increased activity of the suprarenal cortex at puberty with increased production of adrenal androgens which lead to appearance of pubic and axillary hair*
- Hair growth begins shortly after breast development .

3- Vagina, uterus, ovaries

- The mucosal surface of the vagina also changes in response to increasing levels of estrogen, becoming thicker and a more pink in color
- Whitish secretions are a normal effect of estrogen as well.
- The uterus and ovaries increase in size, and follicles in the ovaries reach larger sizes.

4- Menstruation and fertility

- The first Menses is referred to as menarche.
- Menses are not always regular and occurs monthly and last from 3 to 7 days .
- Ovulation is necessary for fertility, but may or may not present in The first Menses.
- The mean age of menarche is about $12\frac{3}{4}$ yr.



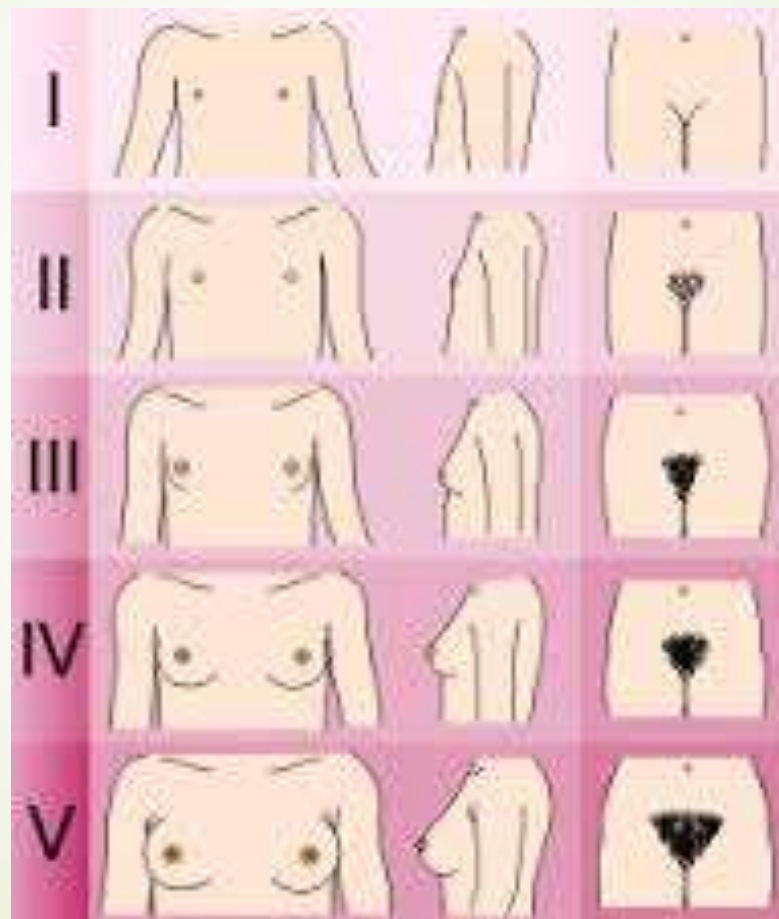
4- Body shape, fat distribution, and body composition

- During this period, also in response to rising levels of estrogen, the lower part of the pelvis and hips widen.
- Fat tissue increases to a greater percentage of the body composition than in males, especially in the typical female distribution of breasts, hips, buttocks, thighs, upper arms, and pubis.

5- Body odor, skin changes, and acne

- Rising levels of estrogen can change the fatty acid composition of perspiration, resulting in a more "adult" body odor.
- Skin becomes more oily.
- Body will sweat more.
- Acne may develop

Tanner staging for females





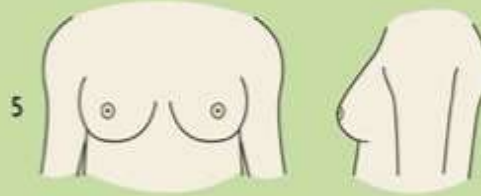
Stage 2: The first sign of breast development has appeared. This stage is sometimes referred to as the breast budding stage. Some palpable breast tissue under the nipple, the flat area of the nipple (areola) may be somewhat enlarged.



Stage 3: The breast is more distinct although there is no separation between contours of the two breasts.

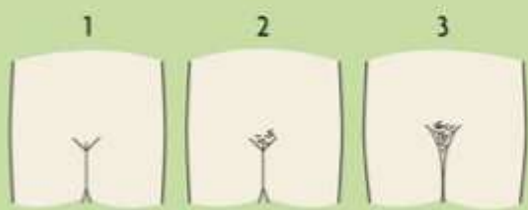


Stage 4: The breast is further enlarged and there is greater contour distinction. The nipple including the areola forms a secondary mound on the breast.



Stage 5: Size may vary in the mature stage. The breast is fully developed. The contours are distinct and the areola has receded into the general contour of the breast.

Pubic Hair



Stage 1: No pubic hair.
Stage 2: There is a small amount of long pubic hair chiefly along the vaginal lips.
Stage 3: The hair is darker, coarser, and curlier and spreads sparsely over the skin around the vaginal lips.



Stage 4: The hair is now adult in type, but the area covered is smaller than in most adults. There is no pubic hair on the inside of the thighs.
Stage 5: The hair is adult in type, distributed as an inverse triangle. There may be hair on the inside of the thighs.



In females

Breast budd → pubic hair → menarche (2-2.5 years post breast budd)

Emotional Changes: In both sexes

- Start to care more about what others think.
- Want to be accepted and liked.
- Often begin to separate from parents and identify more with friends.
- May become self conscious about these growth changes (too tall, too short, too fat, too thin).

Precocious puberty

- appearance of any of the secondary sexual characters before the age of:

8 years in females

9 years in males



In females

- Is usually idiopathic or familial and follows the normal sequence of puberty.
- the organic causes are rare and are associated with :
 - dissonance when the sequence of pubertal changes is abnl , eg: isolated pubic hair with virilisation of the genitalia , suggesting excess androgen
 - rapid onset
 - neurological symptoms and signs , eg : neurofibromatosis



In males

- ▶ this is uncommon and usually has an organic cause.
- ▶ examination of the testes may be helpful :
 - ▶ bilateral enlargement suggest gonadotrophin release
 - ▶ small testes suggest an adrenal cause
 - ▶ a unilateral enlarge testis suggest a gonadal tumor

Causes of precocious puberty:

1) Gonadotrophin dependent = (central , true) (inc LH, FSH)

- familial /idiopathic
- CNS abnormalities
- congenital anomalies , eg: hydrocephalus
- acquired , eg: post irradiation , infections
- Hypothyroidism (why?????)

2) Gonadotropin independent = (peripheral , false) (dec LH, FSH)

- adrenal disorders - tumors, congenital adrenal hyperplasia
- ovarian tumors
- testicular tumors

NORMAL VARIANTS

- ▶ Premature Thelarche:

isolated breast development before 8 years

- ▶ Exaggerated Thelarche

increased growth rate and bone age

FSH, LH, E2

Pelvic Us

Bone Age

Height, looking for growth spurt



▶ Premature Adrenarche

- Adrenarche is the onset of the adrenal androgen production
- Premature adrenarche occurs before 8 years of age.
 - is more common in girls than boys.
 - Usually overweight and taller.
 - Dx requires exclusion of other causes of androgen excess.
 - Usually no need for treatment.

- DHEAS (high), bone age, height (accelerated growth), puberty.
Link to polycystic ovarian syndrome or insulin resistance



Investigations

- Basal LH with sensitive assays (>0.3 -0.6 u/l in Central PP)
- FSH
- Estradiol > 10pg/mL
- GnRh stimulation test : LH(> 5 units/L in central pp) , FSH and on second day E2 (>50 pg/mL).
- Pelvic US in girls: enlargement of the ovaries and the uterus (uterine length > 3.8 cm. ovary >1.6 -3 ml) .
- Pituitary MRI ?
- Adrenal CT / MRI?



Rx

➤ In Central PP

The object of treatment is:

- to prevent early epiphyseal closure to maintain the height
- To decrease psychological distress to the girl and her family.

Treatment with GnRH agonist



Rx

➤ In peripheral PP

- Androgen receptor blockers—cyproterone acetate, flutamide and spironolactone
- 5 alpha-reductase inhibitors
- Testosterone biosynthesis inhibitors—ketoconazole
- Aromatase inhibitors—testolactone, anastrozole, letrozole
- Estrogen receptor blocker-----Tamoxifen

Delayed puberty

- The absence of pubertal development by 14 years of age in males,,,

- and by 13 years in females if no SSC appeared or by 15 if SSC appeared but menses is still absent.

- In contrast to precocious puberty , the problem is common in males , in whom it is mostly due to constitutional delay.



Causes of delayed puberty :

1) **constitutional delay** of growth and puberty

2) **High gonadotrophin secretion**

(hypergonadotropic hypogonadism)

- chromosomal abnormalities (klinefelters syndrome,turner syndrome)—primary gonadal failure.
- steroid hormone enzyme deficiencies.
- acquired gonadal damage -primary gonadal failure



3) **Low gonadotrophin secretion** (hypogonadotropic hypogonadism)

- Systemic disease (functional): cystic fibrosis , severe asthma , crohns disease , anorexia nervosa
- Hypothalamic-pituitary disorders (organic): panhypopituitarism , intracranial tumors,
- kallmanns syndrome (LHRH deficiency and anosmia)



Thank you