Physiology Team 434

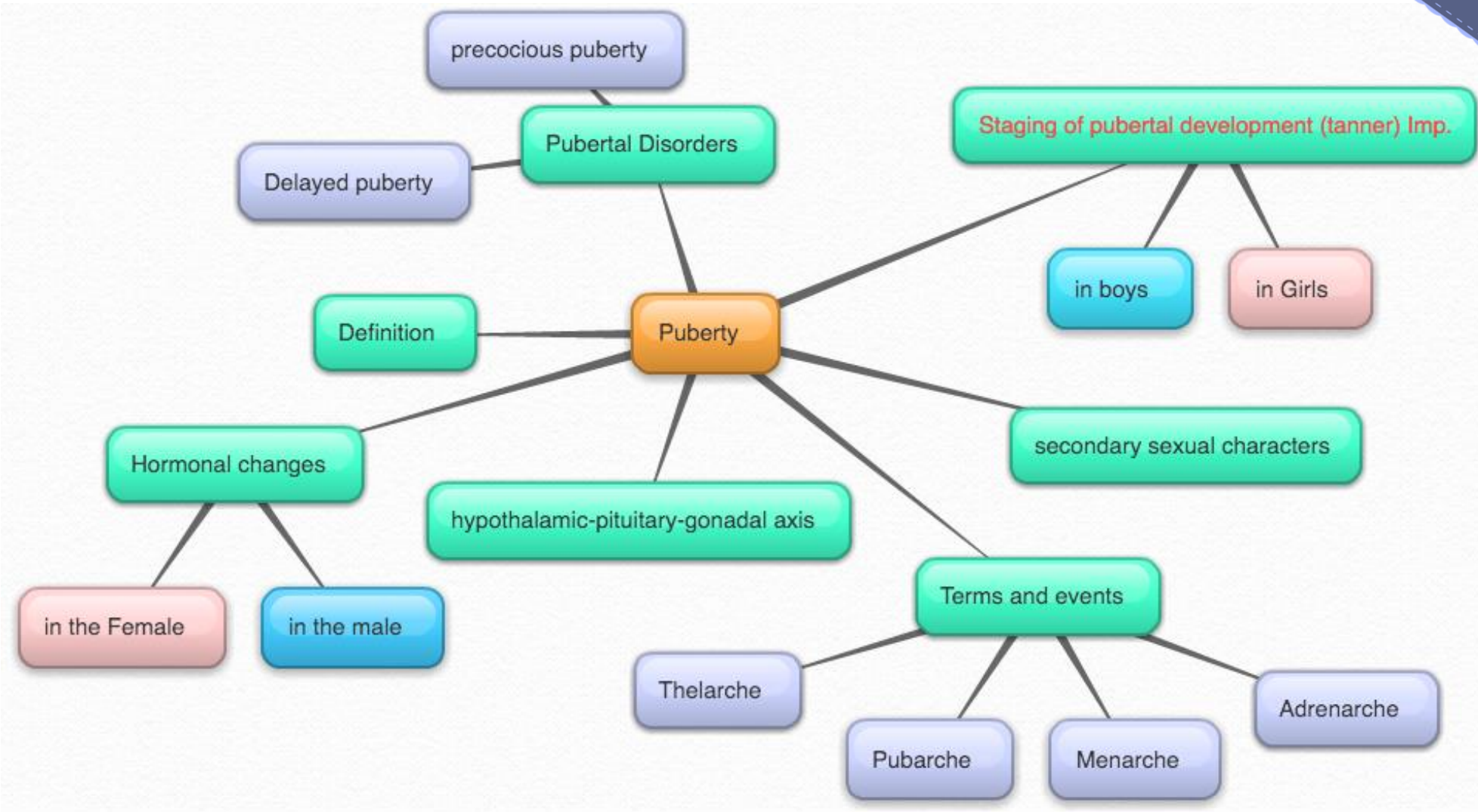
Puberty in Males & Females

Reproductive Block

Please check out this link before viewing the file to know if there are any additions/changes or corrections
Physiology Edit File

• Important • Further explanation • Males' slides

Mindmap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Puberty

A stage of human development when **sexual maturation and growth** are completed and result in ability to reproduce.

(Physiological transition from childhood to reproductive maturity)

- ✓ Accelerated somatic growth
- ✓ Maturation of primary sexual characteristics (gonads and genitals)
- ✓ Appearance of secondary sexual characteristics (pubic and axillary hair, female breast development, male voice changes,...) Primary sex characteristics (or body structures directly concerned with reproduction) that allows us to tell males from females, such as the penis in men and the vagina in women, secondary sex characteristics, on the other hand, are features which appear at puberty (though they later become equally as prominent).
- ✓ Mean Age of secondary sexual characteristics: Girls: age 10.5 yrs while boys: 11.5 – 12yrs
- ✓ Menstruation and spermatogenesis begin.

Terms & Events "Important"

- ✧ **Thel*arche***: Development of breast.
- ✧ **Pube*rache***: Development of axillary & pubic hair.
- ✧ **Men*arche***: The first menstrual period.
- ✧ **Adren*arche***: The onset of an increase in the secretion of androgens, responsible for development of pubic and axillary hair, body odour and acne.
- ✧ **Gonad*arche***: Maturation of gonadal function.

Note: ***arche*** is a Greek word means "beginning".

Hormonal Changes

Increased stimulation of hypothalamo-pituitary-gonadal axis

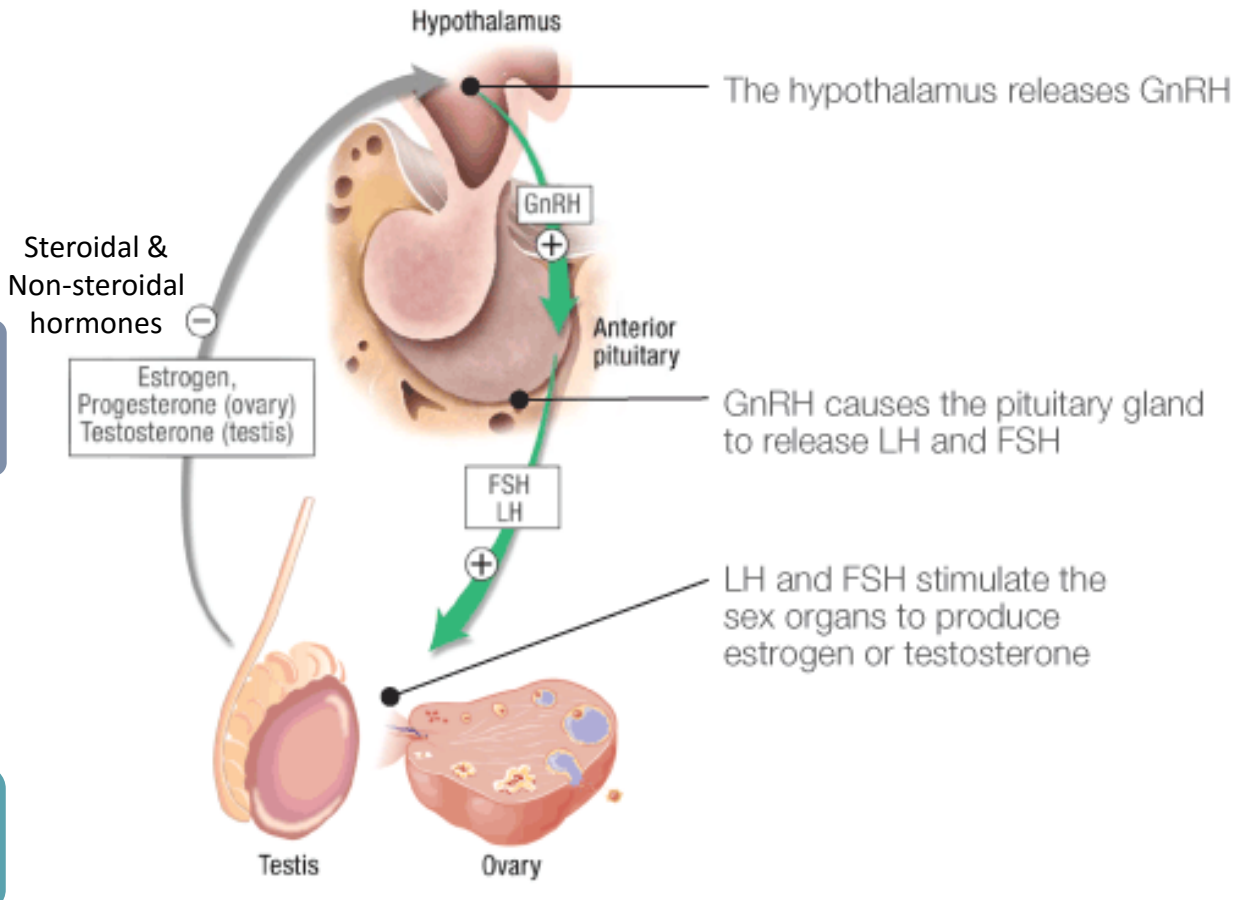
Gradual activation of the GnRH* (LHRH) [1]

Increases frequency and amplitude of ***LH pulses.***

Gonadotropins stimulate secretion of sexual steroids (estrogenes and androgenes)

+

Extragonadal hormonal changes (elevation of IGF-I, and adrenal steroids)



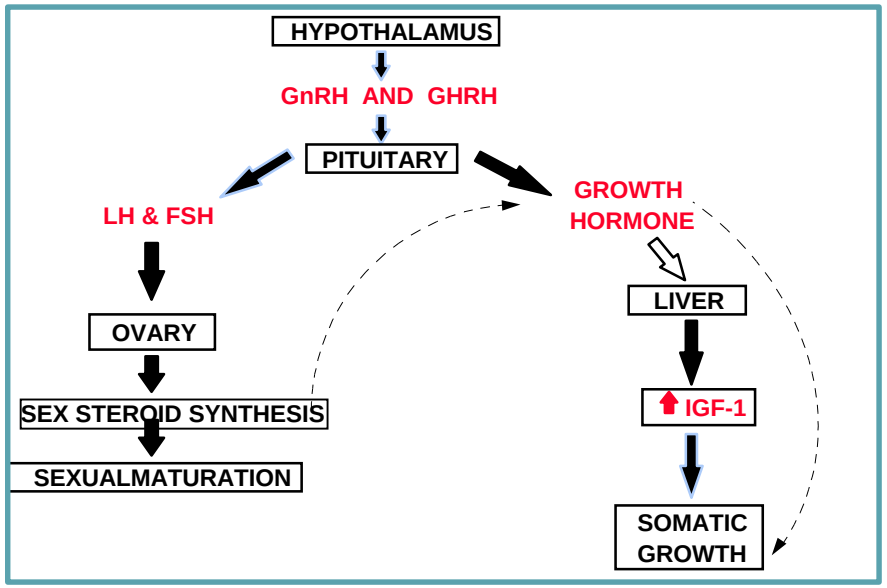
* Nocturnal (during sleep) GnRH pulsatility (LH & FSH secretion) precedes phenotypic changes by several years.

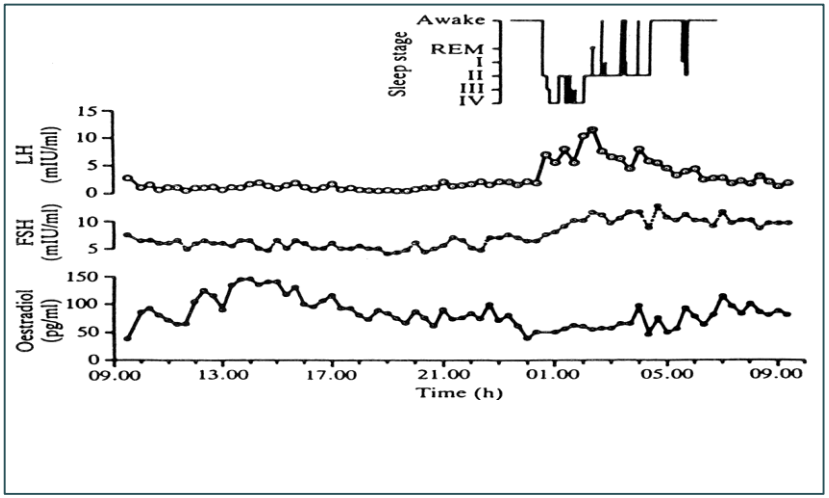
1: GnRH referred to LHRH as LH plays an important role in puberty.

Hormonal Changes cont.

- ✧ In young children, LH and FSH levels *insufficient* to initiate gonadal function.
- ✧ Between 9-12 years old, blood levels of LH, FSH start to increase.
- ✧ High levels of FSH and LH initiate gonadal development
- ✧ Amplitude of pulses increases, especially during sleep notice the importance of sleep in children.
- ✧ GH secretion from pituitary also increases. -stimulate growth-
- ✓ TSH secretion from pituitary increases in both sexes:
  - Increases metabolic rate
  - Promotes tissue growth

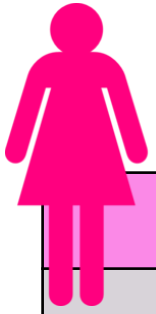
- ✧ **First phenotypic changes**: -Hormonal changes precede physical changes-
- ✓ Breast development
- ✓ Testicular enlargement





Sleep dependent nocturnal rise in LH

Puberty in Males vs Females

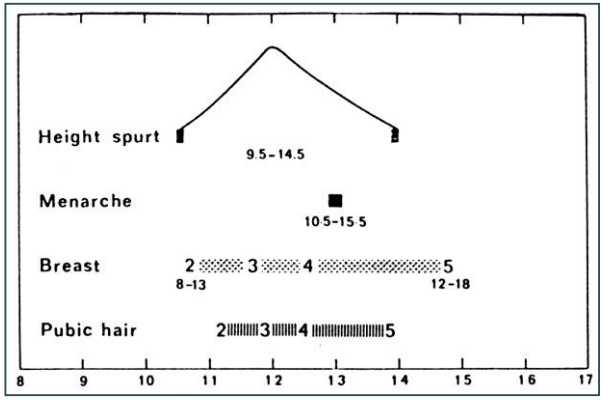


In Females	In Males
Hormonal Changes	
○ Surge of LH release initiates 1st ovarian cycle. ✓ Usually not sufficient to cause ovulation during 1st cycle ○ Brain and endocrine systems mature soon thereafter. ○ **Estrogen** levels in blood increase, due to growing follicles. ✓ **Estrogen** induces secondary sex characteristics: • Growth of pelvis • Deposit of subcutaneous fat • Growth of internal reproductive organs and external genitalia ✓ **Androgen** release by adrenal glands increases - not as much as in male-: • Growth of pubic hair • Lowering of voice • Growth of bone • Increased secretion from sebaceous glands[1].	○ LH and FSH release increases around 10 years of age. ○ Spermatogenesis due to **androgen** secretion ○ Adrenals also secrete androgens. ○ **Androgens** initiate growth of: ✓ Male secondary sex characteristics: • Facial hair • Growth of larynx ✓ Sex accessory structures: • Prostate ○ **Androgens** causes retention of minerals in body to support bone and muscle growth. ○ Sertoli cells also secrete some *estrogen*.

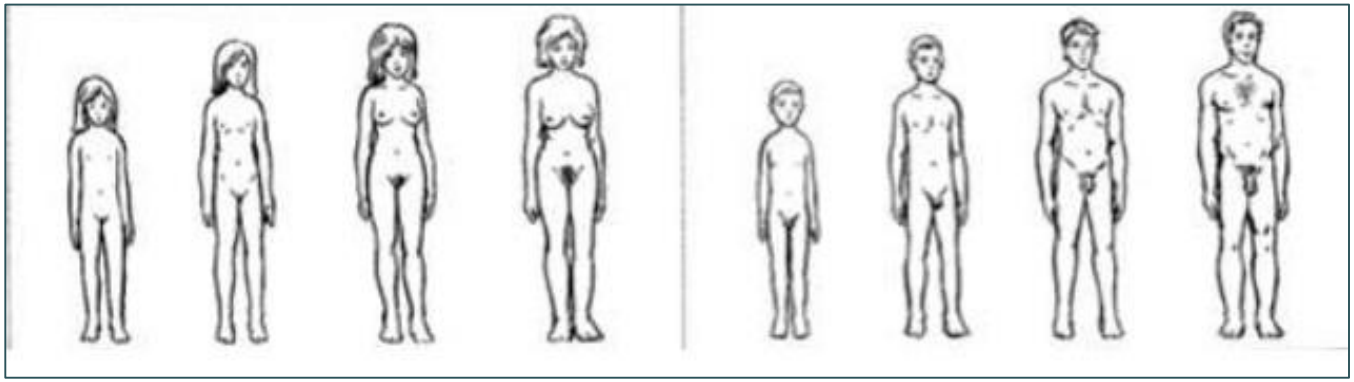
1: Small glands in the skin which secrete a lubricating oily matter (sebum) into the hair follicles to lubricate the skin and hair.

Puberty in Males vs Females

In Girls	In Boys
Physical Changes	
Reflect progression in changes of the external genitalia and of sexual hair.	
1. Breast enlargement usually first sign. 2. Thelarche (Development of breast) 3. Menarche usually 2-3 yrs after breast development. 4. Growth spurt[1] peaks before menarche. 5. Pubic and axillary hair growth: sign of adrenal androgen secretion. 6. Starts at similar stage of apocrine gland sweat production and associated with adult body odour[2].	1. First signs often go unnoticed. 2. Testicular enlargement (12-13 yrs) 3. Prepubertal testis – 2 mls diameter 4. Puberty begins when volume reaches 4 mls 5. Penile and scrotal enlargement occur approximately 1 year after testicular enlargement. 6. Pubic hair appears at same time, 7. Begins of spermatogenesis; androgen secretion.



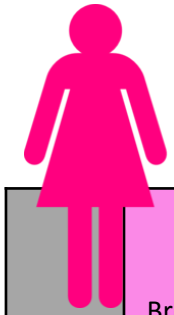
Sequence of normal puberty in girls



1: Sudden and forceful stream. 2:رائحة

Staging of Pubertal Development (Tanner)

Pubertal development is classified according to the Tanner standard – 5 different stages (P1 – P5) from childhood to full maturity according to Marshall and Tanner.



✧ **Monitoring of The Pubertal Growth Acceleration**
- ✓ Growth velocity is 2-3 times greater than prepubertal
- ✓ Sexual dimorfism in pubertal growth

	In Females Breast (B1-5) ➔ Pubic hair (Pu1-5)➔ Axillary hair (A1-5)➔ Menarche.	**In Males** Testicular volume > 4 ml (Te) ➔ Penis enlargement (G1-5) ➔ Pubic hair (Pu1-5)➔ Axillary hair (A1-5) ➔ Spermarche.
P1	Prepubertal (Before puberty)	Prepubertal, testicular volume < 2mls.
P2	Early development of subareolar breast bud +/- small amounts of pubic and axillary hair.	Enlargement of scrotum and penis, Scrotum slightly pigmented and Few pubic hairs.
P3	Increase in size of palpable breast tissue and areolae, increased pubic/axillary hair.	Lenghtening of penis, Further growth of testes and scrotum and Pubic hair darker.
P4	Breast tissue and areolae protrude above breast level. Further increased pubic/axillary hair growth.	Penis increases in length and thickness, Increased pigmentation of scrotum and Increased pubic/axillary hair.
P5	Mature adult breast. Complete pubic/axillary hair growth.	Genitalia adult in size and shape and Completed pubic/axillary hair growth

Important might be asked in SAQs

✧ Normal Pubertal Development

	Age of start (yrs)	**First sign of puberty**	**Growth velocity (cm/yr)**	**Duration of puberty (yrs)**
Boys	12,5 (10 – 14)	G2 (testicular volume > 4 ml)	10,3 (Tanner III-IV)	3,2 ± 1,8 (adult size testis)
Girls	11,5 (9 – 13)	B2	9,0 (Tanner II-III)	2,4 ± 1,1 (menarche)

Timing of Puberty

✦ Trend toward earlier puberty exists within Western Europe and USA because of the body weight

✦ examination of lifestyle changes may give clues regarding mechanisms inducing onset

✦ Puberty usually completed within 3 - 4 years of onset

✦ One of the contributing factors: Nutrition

Influencing Factors

✦ Genetics: 50-80% of variation in pubertal timing

✦ One of the contributing factors: Nutritional status

✦ Leptin → regulates appetite and metabolism through hypothalamus. Permissive role in regulating the timing of puberty

Nutrition

✦ Critical body weight must be attained before activation of the reproductive system.

✦ Even though age of menarche is decreasing, the average body weight of menarche remains the same

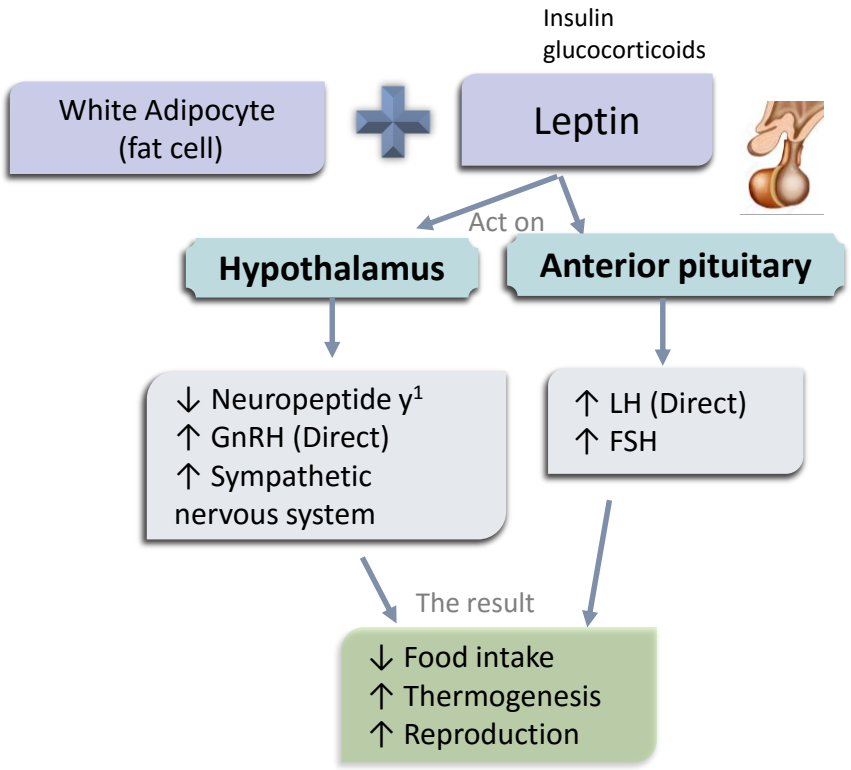
✦ Earlier puberty due to improvement of nutrition, living conditions, healthcare.

✦ Evidence supporting hypothesis

- obese girls go through early menarche
- malnutrition is associated with delayed menarche
- primary amenorrhea common in lean female athletes
- "body fat" set point very noticeable in girls with fluctuating body weight due to anorexia nervosa

Potential Involvement of Leptin:

Leptin accelerates the HPG axis



Normally, leptin is secreted from white adipocytes in considerable amount during eating and its signals travelled through the bloodstream to the hypothalamus to inhibit the NPY (a protein of hunger).
thereby, leptin eventually inhibits further eating. In obese children (mainly girls), the amount of leptin secreted is very high resulting in insensitivity of NPY receptors and children would continue eating as this protein (NPY) cannot be inhibited by leptin. As GnRH is located in hypothalamus, it would be stimulated continually by leptin (in obese children), resulting in premature activation of HPG axis and initiation of early puberty.
Insulin and glucocorticoids are linked to obesity in some cases and they are found to increase leptin secretion from the adipose tissues and further activation of GnRH and LH.

So the message we deliver to society is to protect our children from being obese as possible.

1: NPY is a potent stimulator of food intake, has an inhibitory effect on GnRH secretion.

Pubertal Disorders

Pubertal Disorders

Precocious (Early) Puberty

- Precocious onset of puberty is defined as occurring younger than 2 years before the average age
- Girls <8 years old / Boys <9 years old
- More common in **females.**
- Uncommon in males (usually pathological).
- Maybe associated with a growth spurt.

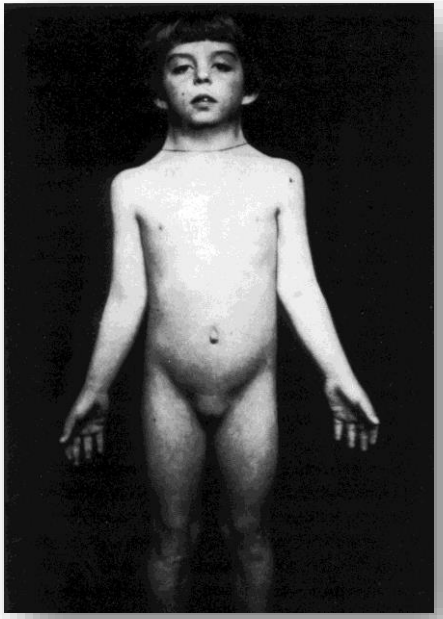
Delayed Puberty

- **1-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
- **2-Pubertal development is inappropriate:**
  - The interval between first signs of puberty and menarche in girls, completion of genital growth in boys is > 5 years

Gonadotrophin-**dependent** (true / central)	Gonadotrophin-**independent** (Precocious pseudopuberty)	Gonadal Failure (**Hyper**gonadotrophic **hypo**gonadism)	Gonadal deficiency
➢ Premature activation of the (HPG) axis ➢ Intra-cranial lesions[2] (tumours, hydrocephalus, CNS malformations) ➢ Gonadotrophin secreting tumours[3] – v. rare	➢ No spermatogenesis or ovarian development ➢ FSH & LH suppressed ➢ Congenital adrenal hyperplasia (CAH) ➢ Sex steroid secreting tumours - adrenal or ovarian	➢ **Turner's Syndrome** (Congenital) ➢ Post-malignancy chemo/Radiotheraby/Surgery[4] (Acquired) ➢ Polyglandular autoimmune syndrome	➢ Congenital **Hypo**gonadotrophic **Hypo**gonadism (+anosmia) ➢ Hypothalamic/pituitary lesion (Tumours, post-radiotheraby) ➢ Rare gene mutations inactivating FSH/LH or their receptors.

2: Lead to changes in the anatomy and also will affect the pituitary gland → ↑ Gonadotropic hormones
3: Stimulate the ovaries or testes to produce large amount of sex hormones which lead to early puberty.
4: Lead to destruction of the gonads (ovaries or testes)

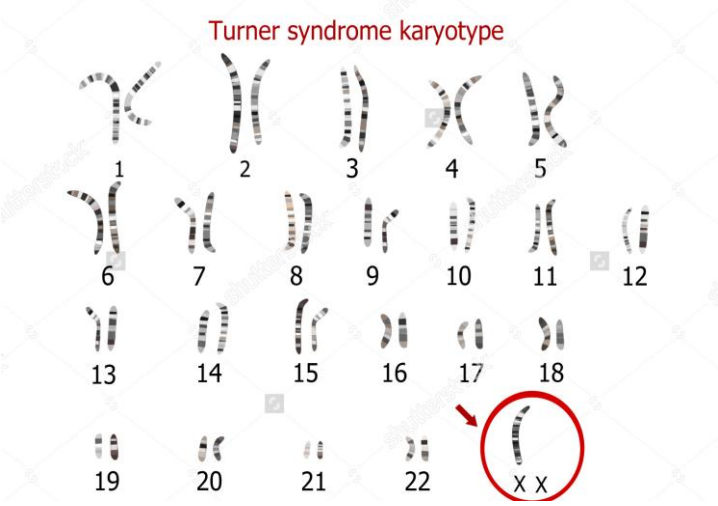
Turner's Syndrome[5]



- Karyotype **45,X** (45,X/46,XX, structural abnormalities of **X chromosome**)

- The Characteristic :
  - Short stature (final height 144-146 cm)
  - Gonadal dysgenesis
  - Skletal abnormalities
  - Cardiac and kidney malformation
  - Dysmorfic face
  - No mental defect (Impairment of cognitive function)

- Therapy: growth hormone, sex hormone substitution



5:In turner syndrome : the pituitary & hypothalamus are normal

MCQs

1- (P2) in male tanner stages is responsible for:

A- Lenghtening of penis
B- Prepubertal
C- Enlargement of scrotum and penis

2- Pubic and axillary hair growth: sign of

A- adrenal androgen secretion.
B- Growth Hormone secretion.
C- Thyroid Hormone secretion.

3- What does Menarche mean :

A- development of breast
B- development of axillary & pubic hair
C- the first menstrual period

4- Puberty usually completed within:

A- 5-6 years of onset
B- 3-4 years of onset
C- 1-2 years of onset

5- Precocious (Early) puberty more common in :

A- Female
B- Male
C- Both sexes

6- In turner syndrome, the defect is:

A- structural abnormalities of **Y** chromosome.
B- Numerical abnormalities.
C- structural abnormalities of **X** chromosome.

Answers: 1-C / 2-A / 3-C / 4-B / 5-A / 6- C

SAQs

Q1: List the pubertal stages (tanner) in males

Ans: **P1 :** Prepubertal
P2 : Enlargement of scrotum and penis
P3 : Lengthening of penis. Further growth of testes and scrotum. Pubic hair darker
P4 : Penis increases in length and thickness. Increased pigmentation of scrotum. Increased pubic/ axillary hair
P5: Genitalia adult in size and shape. Completed pubic/axillary hair growth

Q2: Mention some of the Gonadotrophin-**dependent** precocious puberty causes.

Ans: 1. Intra-cranial lesions (tumours, hydrocephalus, CNS malformations)
2. Gonadotrophin secreting tumours – v. rare

Q3: Enumerate the causes of delayed puberty.

Ans: Gonadal failure (Hypergonadotrophic hypogonadism) eg: Turner's Syndrome
Gonadal deficiency eg: Congenital hypogonadotrophic hypogonadism

Q4: Mention three characteristic of turner syndrome.

Ans: Short stature , Gonadal dysgenesis , Cardiac and kidney malformation

Q5: Define the following terms :

Ans: Thelarche: development of breast
Puberache: development of axillary & pubic hair
Menarche: the first menstrual period
Adrenarche: the onset of an increase in the secretion of androgens, responsible for development of pubic and axillary hair, body odor and acne.

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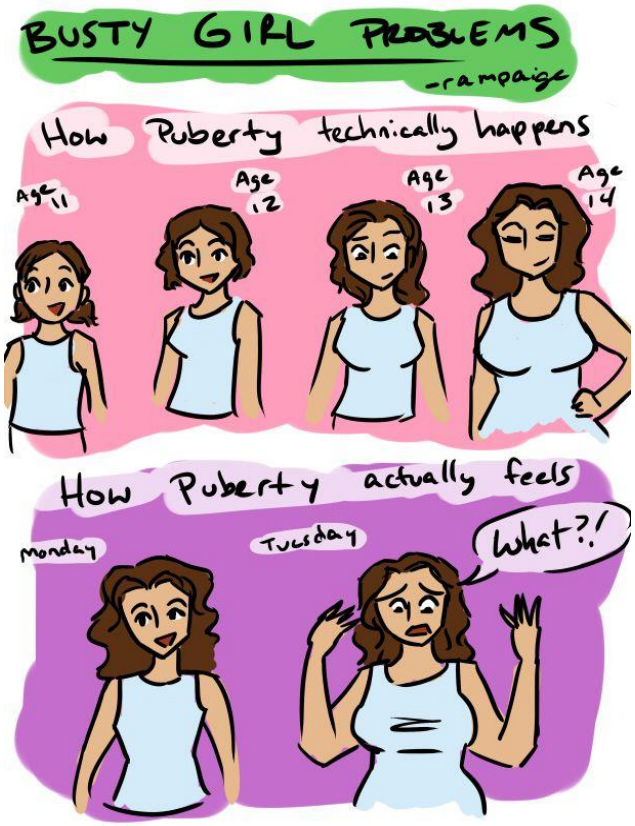

Thank you for checking our work

Best Wishes..