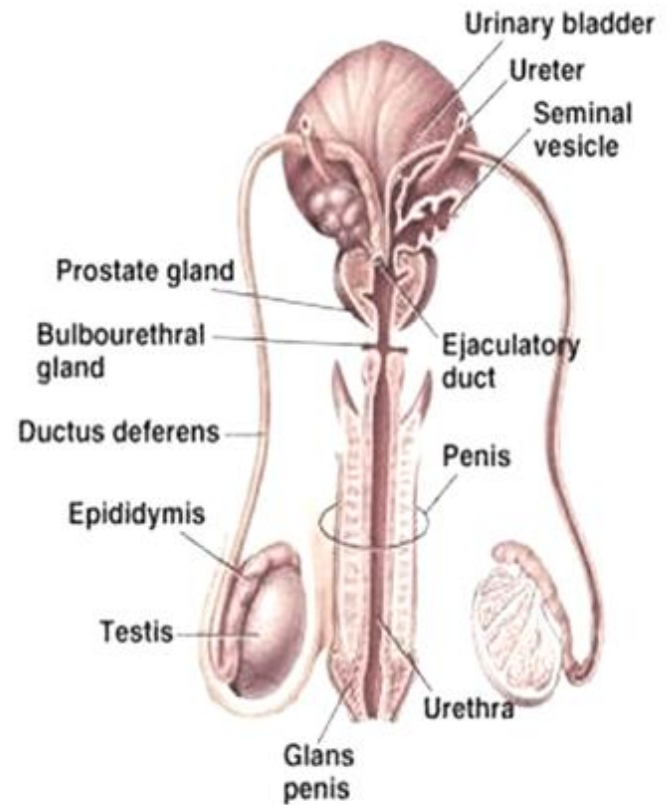
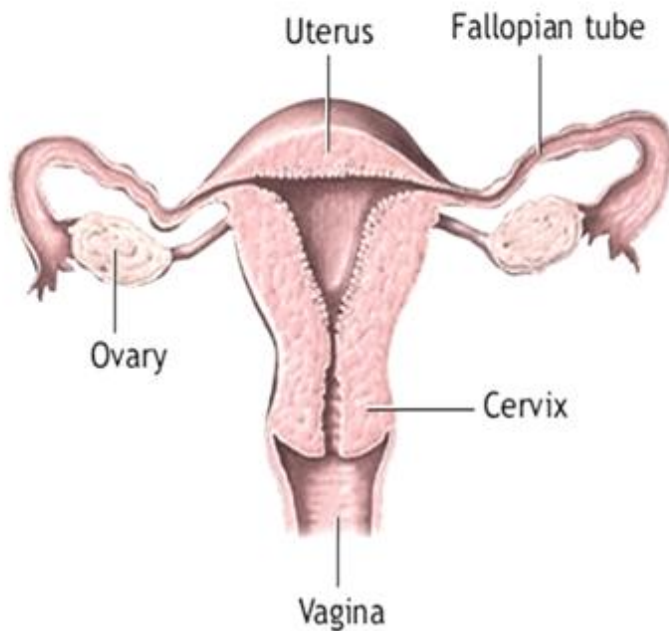


## 4<sup>th</sup> Lecture Puberty



**PHYSIOLOGY TEAM – 430**

**This Lecture is done by:**

Shahad Al-Muhanna

Sulaiman Al-Faraj

## Puberty

### – Definition:

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

### – Stages:

- Accelerated somatic growth. (Growth of the body, exclusive of gametes)
- Maturation of primary sexual characteristics (gonads and genitals)
- Appearance of secondary sexual characteristics (pubic and axillary hair, female breast development, male voice changes, etc..)
- Menstruation and spermatogenesis begin.

#### Terms:

- Thelarche: development of breast.
- Puberarche: development of axillary and pubic hair.
- Menarche: the first menstrual period.
- Adrenarche: the onset of an increase in the secretion of androgens.

### – Hormonal changes:

**Hormonal** changes = **physical** changes. (When a person sleeps well he will grow faster)

A. Increased stimulation of hypothalamo-pituitary-gonadal axis: ( not only LH and FSH also TSH and GH ):

- Gradual activation of the GnRH (LHRH)
- 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)

B. **Nocturnal GnRH** pulsation (LH secretion) precedes **phenotypic changes** by several years.

#### First phenotypic changes:

- Breast development
- Testicular enlargement

C. In **young children**, LH and FSH levels **insufficient** to initiate gonadal function, between **9-12** yrs

1. blood levels of LH, FSH increase
2. amplitude of pulses increases, especially during sleep

High levels of **LH, FSH** initiate **gonadal development**.

1. GH secretion from pituitary also increases.
2. TSH (thyroid stimulating hormone) secretion from pituitary increases in both sexes:
  - increases metabolic rate
  - promotes tissue growth

– **Female 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. (wide pelvic)
  - Deposit of subcutaneous fat. (breast, thigh, hip)
  - Growth of internal reproduces organs (uterus, ovaries) , external genitalia(vagina)
  - Androgen release by adrenal glands increases which leads to growth of pubic hair, lowering of voice, growth of bone, increased secretion from **sebaceous glands**( increase acne)

– **Male hormonal changes:**

LH and FSH release increases **~10 yrs of age**

- Spermatogenesis; androgen secretion.
- adrenals also secrete androgens:

Androgens initiate growth of sex accessory structures (e.g. prostate), male secondary sex characteristics (facial hair, growth of larynx), also androgens causes retention of minerals in body to support bone and muscle growth.

- Sertoli cells also secrete some estrogen. (Sertoil cell is a 'nurse' cell of the testes that is part of a seminiferous tubule)

– **Staging of pubertal development (Tanner): not important as doctor said!**

Pubertal development is classified according to the Tanner standard –5 different stages

- Girls: breast (B1-5), pubic hair (Pu1-5), axillary hair (A1-5), menarche
- Boys: testicular volume >4 ml (Te), penis enlargement (G1-5), pubic hair (Pu1-5), axillary hair (A1-5), spermarche

Monitoring of the pubertal growth acceleration:

- Growth velocity is 2-3 times greater after puberty.
- Sexual dimorphism in pubertal growth (Sexual dimorphism is a phenotypic difference between males and females of the same species. Examples of such differences include differences in morphology, ornamentation, and behavior)

– **Normal pubertal development:**

	Boys	Girls
Age of start (yrs)	12.5 (10-14)	11.5 (9-13)
1 <sup>st</sup> sign of puberty	G2 (testicular volume up to 4 ml)	B2 (breast)
Growth velocity (cm\yr)	10,3 (Tanner III-IV)	9,0 (Tanner II-III)
Duration of puberty (yrs)	3,2 ± 1,8 (adult size of testis )	2,4 ± 1,1 (menarché)

– **Timing of puberty:**

Trend toward earlier puberty exists within Western Europe and USA.

Examination of lifestyle changes may give clues regarding mechanisms inducing onset, one of the contributing factors 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:**

It's an adipose derived hormone

- Leptin acts on receptors in the hypothalamus of the brain where it inhibits appetite by counteracting the effects of neuropeptide Y (a potent feeding stimulant secreted by cells in the gut and in the hypothalamus)
- Increase reproduction by increasing GnRH.
- Thrombogenesis by increasing sympathetic activity.

## – Pubertal disorders:

- A. Precocious puberty
- B. Delayed puberty

### A- Precocious puberty:

Precocious onset of puberty is defined as occurring younger than 2SD before the average age.  
(puberty before 2 years from the average age among people)

Girls < 8 years old / Boys < 9 years old

- 1- Gonadotrophin-dependent (true / central ) ( high FSH and LH):
  - Intra-cranial lesions (tumors) ( hypothalamus, pituitary)
  - Gonadotrophin secreting tumors v. rare (extra-cranial)
- 2- Gonadotrophin-independent (sex hormones e.g.: estrogen high)
  - Precocious **pseudopuberty**:
    - No spermatogenesis or ovarian development
    - FSH and LH suppressed
- 1- Congenital adrenal hyperplasia (CAH)
- 2- Sex steroid secreting tumors: adrenal or ovarian

### B- Delayed puberty: (2 years late)

Initial physical changes (secondary sex characteristics) of puberty are not present or incomplete.

- 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 >5 years  
Completion genital growth in boys is >5 years.

## – Causes of Delayed puberty:

### 1- Hypergonadotrophic hypogonadism (43%)

- Gonadal Failure e.g. Turner's Syndrome.
- Defective development of ovaries or Testes ( or receptors don't respond)
- Associated with excess pituitary gonadotropin secretion
- Results in delayed Sexual Development and growth delay

Etiology:

#### A- Gonads deficient in sex hormone production:

- 1- Testes produce less testosterone
- 2- Ovaries produce less estrogen

#### B- Hypothalamus and pituitary responds :

- 1- Increased gonadotropin release (FSH, LH)

## 2- Hypogonadotrophic hypogonadism (31%)

- Hypothalamic/pituitary lesions (tumors, post-radiotherapy)
- Rare gene mutations inactivating FSH/LH or their receptors.

(Hypogonadism is when the sex glands produce little or no hormones. In men, these glands (gonads) are the testes. In women, they are the ovaries.

Hypogonadotropic hypogonadism is a form of hypogonadism that is due to a problem with the pituitary or hypothalamus glands)

## 3- Eugonadism (26%)

- Mullerian agenesis
- **Müllerian agenesis is a congenital malformation in women characterized by a failure of the müllerian ducts to develop, resulting in a missing uterus and fallopian tubes and variable malformations of the upper portion of the vagina.**
- Constitutional delay (short stature and normal
- Fertility )

### – Turner syndrome:

- Karyotype 45,X (45, X / 46, XX = structural abnormalities of X chromosome)
- Short stature (final height 144-146 cm)
- Gonadal dysgenesis
- Skeletal abnormalities
- Cardiac and kidney malformation
- Dimorphic face (**malformed or misshaped**)
- No mental defect only Impairment of cognitive function

### – Therapy:

Growth hormone, sex hormone substitution