

Reproductive Physiology

Lecture 3

Puberty in males and females



DR. MOHAMMED ALOTAIBI

ASSISTANT PROFESSOR OF PHYSIOLOGY

COLLEGE OF MEDICINE

KING SAUD UNIVERSITY

Objectives



By the end of this lecture, you should be able to:

- Define Puberty
- Recognize the physiology of puberty related to changes in hypothalamic-pituitary-gonadal axis
- Describe the physical changes that occur at puberty in males and females
- Describe the pathophysiological conditions associated with puberty

PUBERTY



Definition: 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)

Puberty

ACCELERATED SOMATIC GROWTH

Maturation of *primary sexual characteristics* (gonads)



Appearance of *secondary sexual characteristics* (pubic and axillary hair, female breast development, male voice changes,...)

- **Menstruation** and **spermatogenesis** begin

- Occurs between 8 and 14yrs in **girls**
- Occurs between 9 and 14yrs in **boys**

Puberty – Terms & Events



- **Thelarche:** development of breast
- **Puberache:** development of pubic & axillary hair
- **Menarche:** the first menstrual period
- **Adrenarche:** the onset of an increase in the secretion of androgens; responsible for the development of pubic/axillary hair, body odour and acne.
- **Gonadarche:** maturation of gonadal function

Puberty – hormonal changes



- **Hormonal changes precede physical changes**
- *Increased stimulation of HPG axis:*
 - gradual activation of the GnRH (LHRH)
 - increases frequency and amplitude of LH pulses.
 - gonadotropins stimulate secretion of sex steroids (estrogens and androgens)
 - extragonadal hormonal changes (elevation of IGF-I, and adrenal steroids)

Puberty – hormonal changes



- In young children, LH and FSH levels are insufficient to initiate gonadal function
- Between 9-12 yrs, blood levels of LH, FSH increase.
- High levels of LH, FSH initiate gonadal development
 - ❑ Nocturnal GnRH pulsatility (LH secretion) precedes phenotypic changes by several years
 - ❑ **First phenotypic changes:**
breast development / testicular enlargement

Pulsatile secretion of GnRH



Increased sensitivity of the GnRH receptors in anterior pituitary



Pulsatile secretion of LH and FSH



Appearance of large **nocturnal pulses** of LH during REM sleep.



Secretion of gonadal steroid hormones **testosterone** and **estradiol**



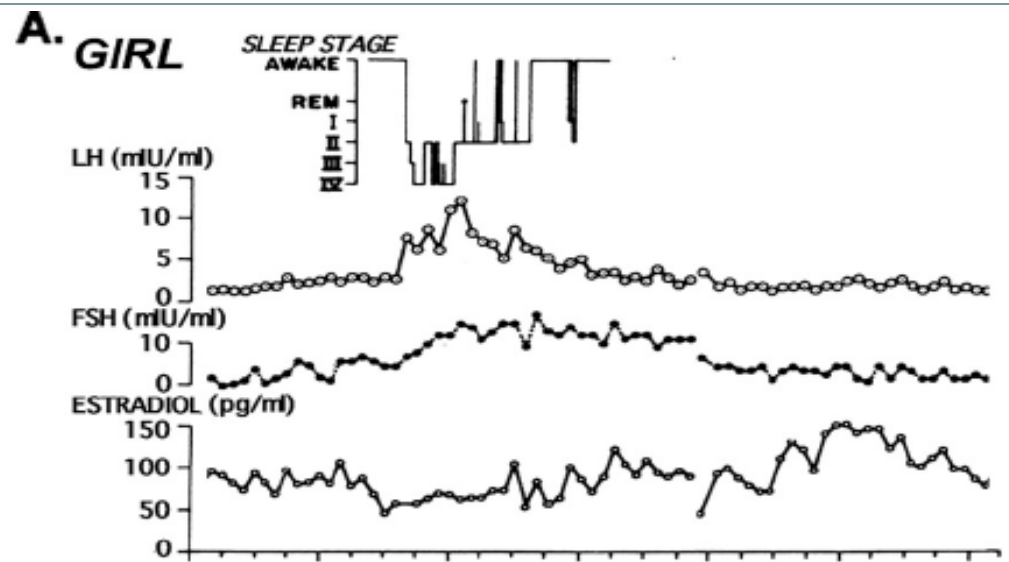
Appearance of the ***secondary sex characteristics*** at puberty

In an early pubertal girl:

LH secretion is minimal during waking hours. Pubertal LH pulsations promptly begin with sleep onset and wane with sleep offset, followed several hours later by increased ovarian estradiol secretion that peaks mid-day.

In an early pubertal boy:

Daytime LH values are low, with minimal testosterone secretion. Pubertal LH pulsations begin promptly with sleep onset and cease with sleep offset; testosterone secretion occurs primarily during sleep, beginning about 2 hours after LH increases and waning on awakening.

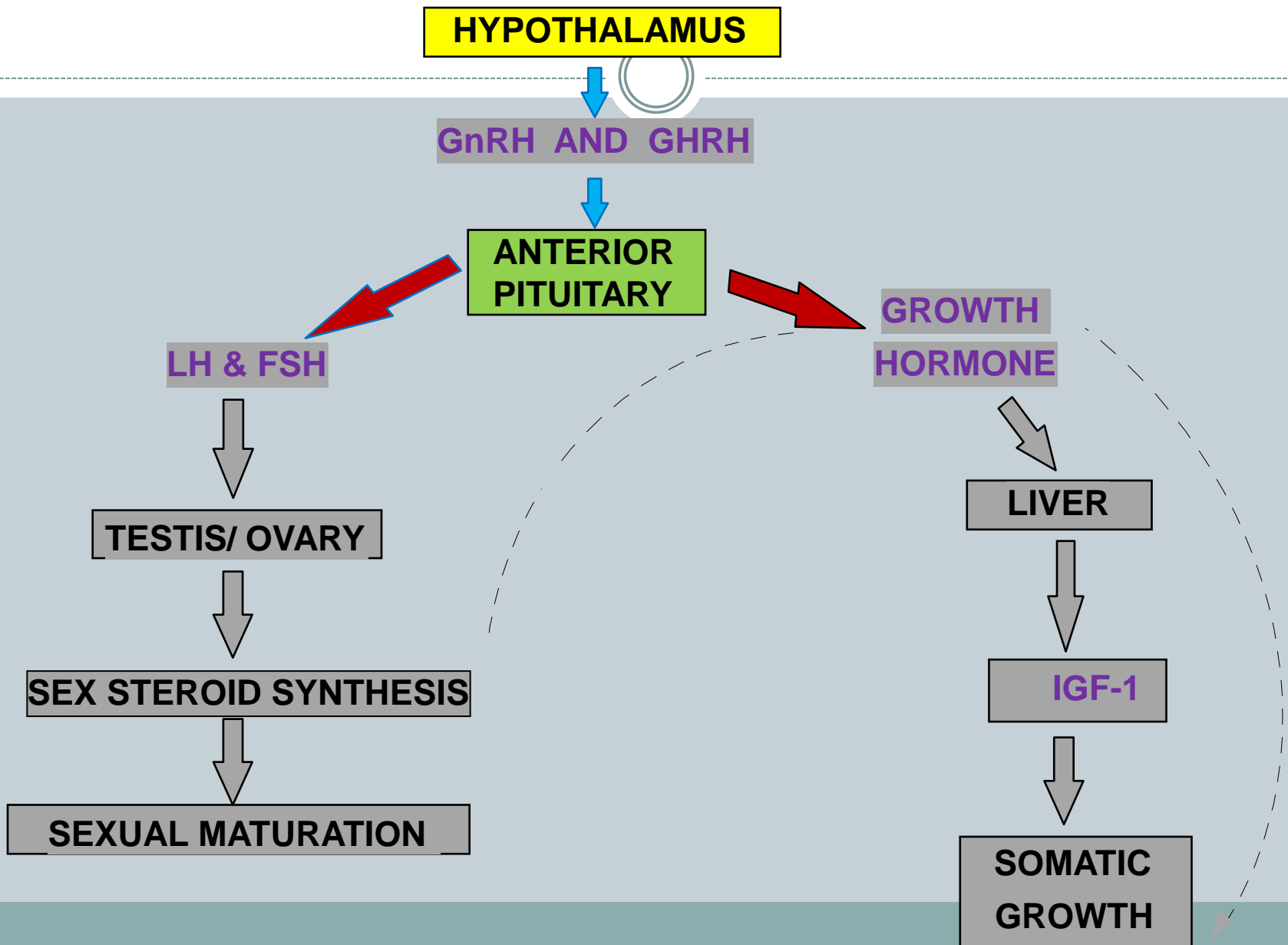


Puberty – hormonal changes



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

Puberty – hormonal changes





Physical Changes during puberty

Physical Changes



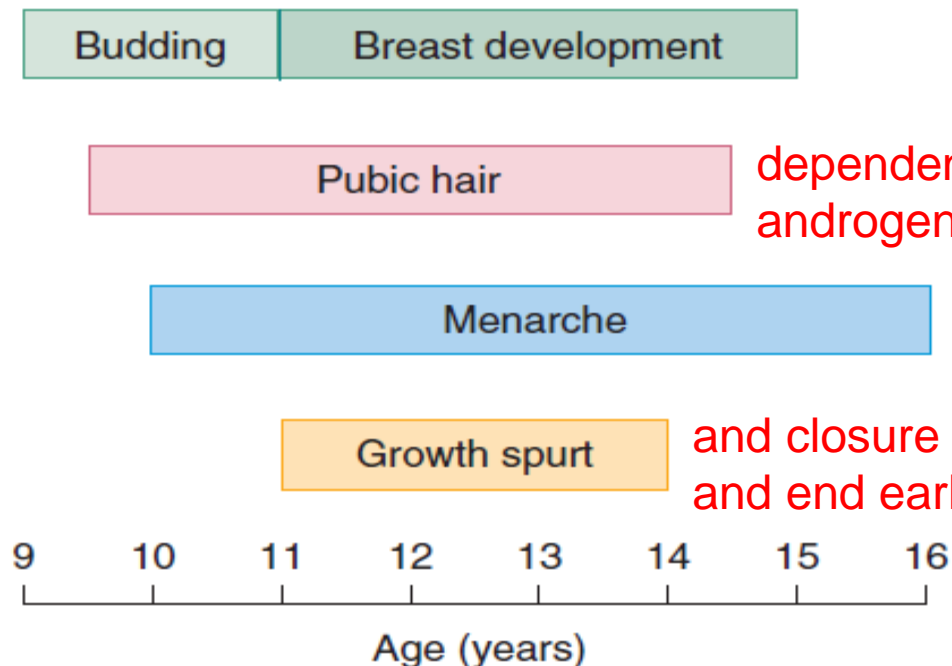
- **5 stages** from childhood to full maturity
- Tanner Scale (P1 – P5)
- Reflect progression in changes of the *external genitalia and sexual hair*
- Secondary sexual characteristics
 - Mean age 10.5yrs in **girls**
 - Mean age 11.5 – 12yrs in **boys**

Puberty: Girls



- Breast enlargement usually first sign (Thelarche)
- Menarche usually 2-3 yrs after breast development

Female



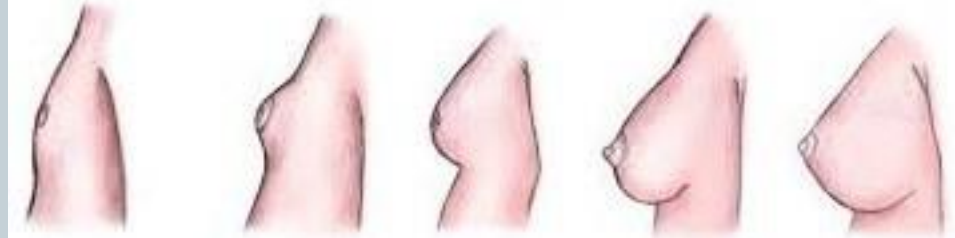
dependent on increased secretion of adrenal androgens (**adrenarche**).

and closure of the epiphyses typically begin and end earlier in girls than in boys.

Pubertal Stages (Tanner)

Girls

Stages of breast development



- **P1** Prepubertal
- **P2** Early development of subareolar breast bud +/- small amounts of pubic and axillary hair
- **P3** Increase in size of palpable breast tissue and areolae, increased pubic/axillary hair
- **P4** Breast tissue and areolae protrude above breast level. Further increased in pubic/axillary hair growth
- **P5** Mature adult breast. Complete pubic/axillary hair growth

Puberty – Boys



- Puberty is associated with activation of the HPG axis.
- Leydig cell proliferation in the testes, and increased synthesis and secretion of testosterone.
- There is growth of the testes, largely because of an increased number of seminiferous tubules.
- There is growth of the sex accessory organs such as the prostate.
- There is a pronounced linear growth spurt.
- As plasma levels of testosterone increase, facial, pubic, and axillary hair appears and there is growth of the penis, lowering of the voice, and initiation of spermatogenesis (**spermarche**).

Pubertal Stages (Tanner)

Boys



- **P1** Prepubertal, testicular volume < 1.5 ml [9 yrs and younger]
- **P2** Testicular volume between 1.6 and 6 ml; skin on scrotum thins. Few pubic hair [9-11 yrs]
- **P3** Testicular volume between 6 and 12 ml, Lengthening of penis. Further growth of testes and scrotum [11-12.5 yrs]
- **P4** Testicular volume between 12 and 20 ml; scrotum enlarges further and darkens. Increased pubic/ axillary hair [12.5-14 yrs]
- **P5** Testicular volume greater than 20 ml. Genitalia adult in size and shape. Completed pubic/axillary hair growth [14+ yrs]

Timing of Puberty



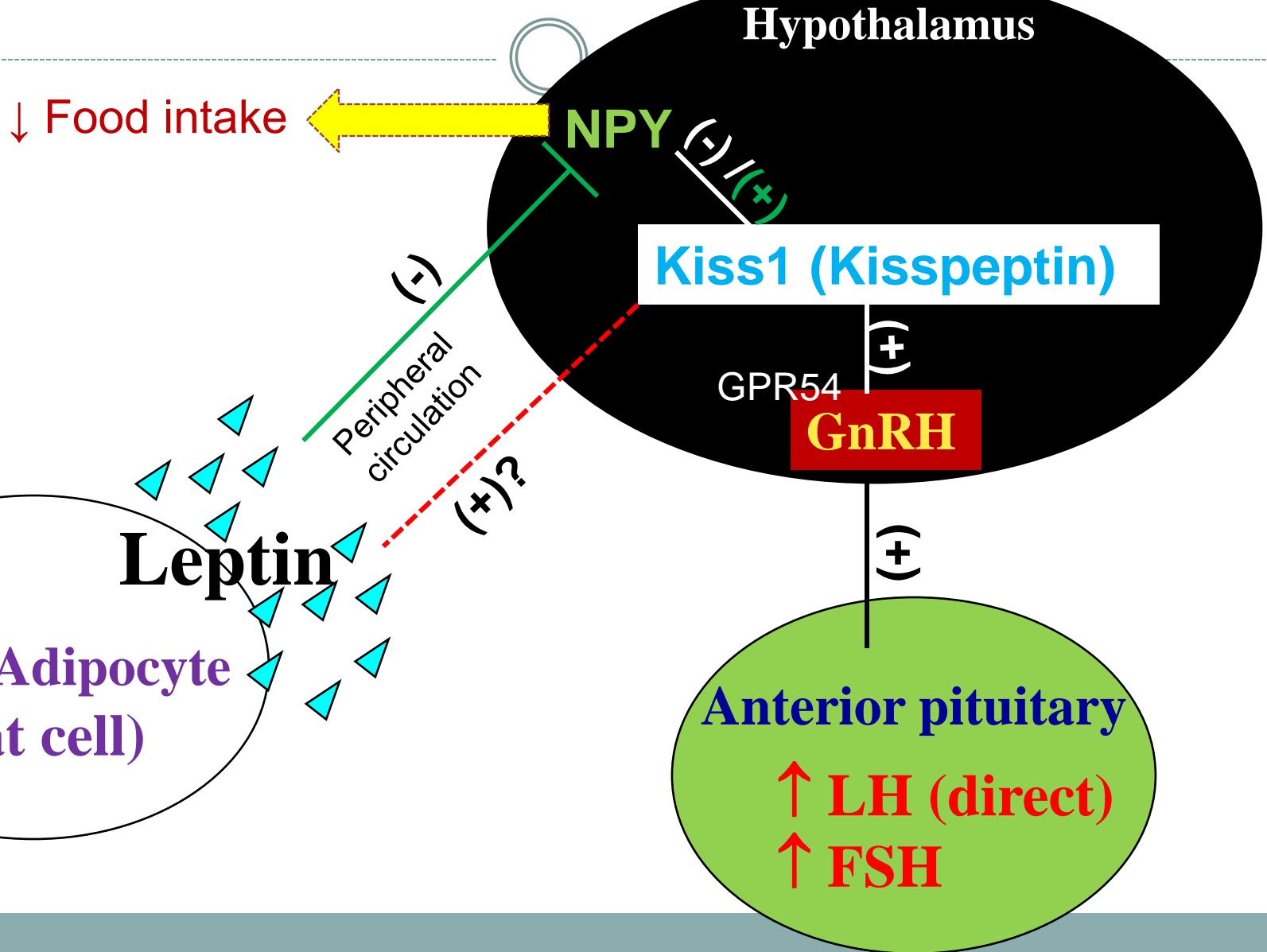
- Trend toward earlier puberty exists within Western Europe and USA
- Puberty usually completed **within 3 - 4 yrs of onset**
- Examination of lifestyle changes may give clues regarding mechanisms inducing onset

Influencing Factors



- **Genetic factors** : 50-80% of variation in pubertal timing.
- **Environmental factors** e.g. extreme stress.
- **Nutritional factors** → e.g. Leptin hormone regulates appetite and metabolism through hypothalamus.
Permissive role in regulating the timing of puberty.

Leptin accelerates the HPG axis



Nutrition



- Critical body weight must be attained before activation of the reproductive system.
- 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 is common in lean female athletes



Disorders of Puberty

Types of puberty disorders?



Early or

Precocious Puberty

- More common in females
- Uncommon in males

Delayed Puberty

PRECOCIOUS PUBERTY



Precocious onset of puberty is defined as occurring younger than 2 yrs before the average age

Girls < 8 years old

Boys < 9 years old

1. Gonadotropin-dependent (central)
2. Gonadotropin-independent (peripheral)

Gonadotropin-dependent precocious puberty



- Premature activation of the (HPG) axis.
- Intra-cranial lesions:
(tumours, hydrocephalus, CNS malformations).
- Gonadotropin secreting tumours in anterior pituitary gland (v. rare).

Gonadotropin-independent precocious puberty



- Precocious pseudopuberty.
- No spermatogenesis or ovarian development.
- FSH & LH suppressed.
- Congenital adrenal hyperplasia (CAH).
- Sex steroid secreting tumours:
 - adrenal or ovarian

Delayed puberty



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**

Pubertal development is inappropriate

- The interval between first signs of puberty and menarche in girls, completion of genital growth in boys is > 5 years

Causes of delayed puberty



- **Gonadal failure** (Hypergonadotropin hypogonadism)
 - Post-malignancy chemo / radiotherapy / surgery (Acquired)
 - Polyglandular autoimmune syndromes
 - **Turner's Syndrome** (Congenital)

Karyotype 45,X (**structural abnormalities of X chromosome**)

Short stature (final height 144-146 cm), Gonadal dysgenesis

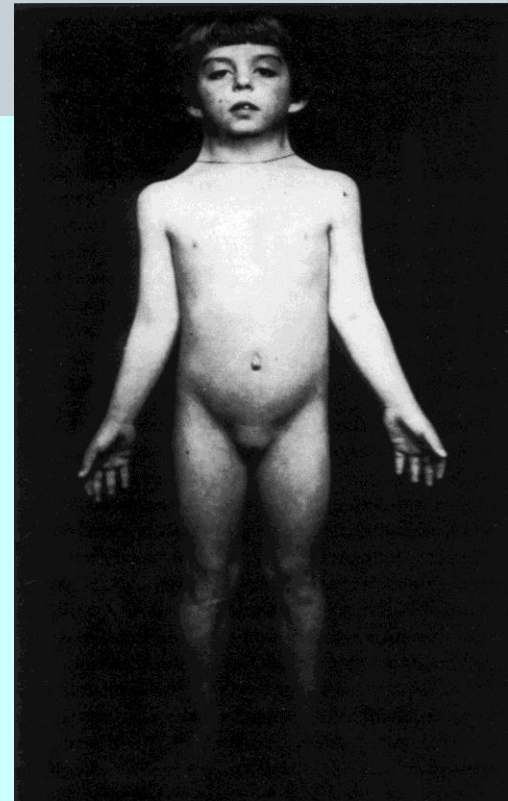
,Skeletal abnormalities, Cardiac and kidney malformation,

Dysmorphic face

No mental defect

Impairment of cognitive function

Therapy: growth hormone, sex hormone substitution



Causes of delayed puberty



- **Gonadal deficiency**
 - Congenital hypogonadotropin hypogonadism
 - Hypothalamic/pituitary lesions (tumours, post-radiotherapy)
 - Rare gene mutations inactivating FSH/LH or their receptors

The End

Thank You