

Puberty, Menarche

MBBS/BDS

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Reproduction

- 1. How and where are the gametes produced?
- 2. Where are they brought into contact?
- 3. What happens to the union?

Course objectives

- At the end of this lecture, students should be able to:
 1. understand the meaning of puberty and important terms/events during puberty
 2. understand the physiologic mechanisms involved in the onset of puberty
 3. understand secondary sexual characteristics/features of puberty in male and female
 4. Highlight some abnormalities of puberty

Puberty

- ✓ **Physiological transition from childhood to reproductive maturity**
- ✓ **Onset of adult sexual life**
- ✓ **A stage of human development when sexual maturation and growth are completed and result in ability to reproduce.**

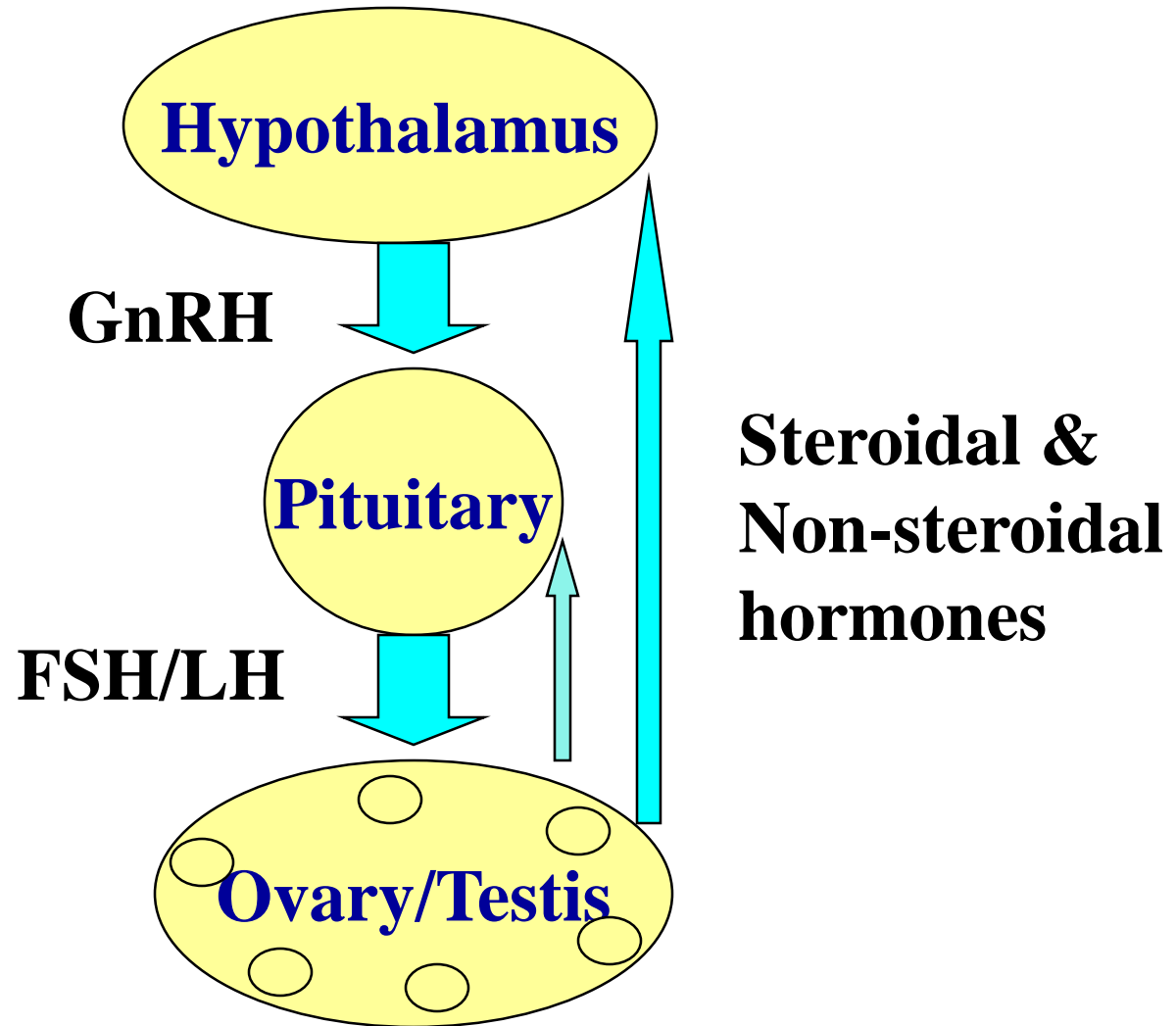
Associated with:

- **Accelerated *somatic growth* (*Growth spurt*)**
- **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**
- **Occurs between 8 and 14yrs in girls**
- **Occurs between 9 and 14yrs in boys**

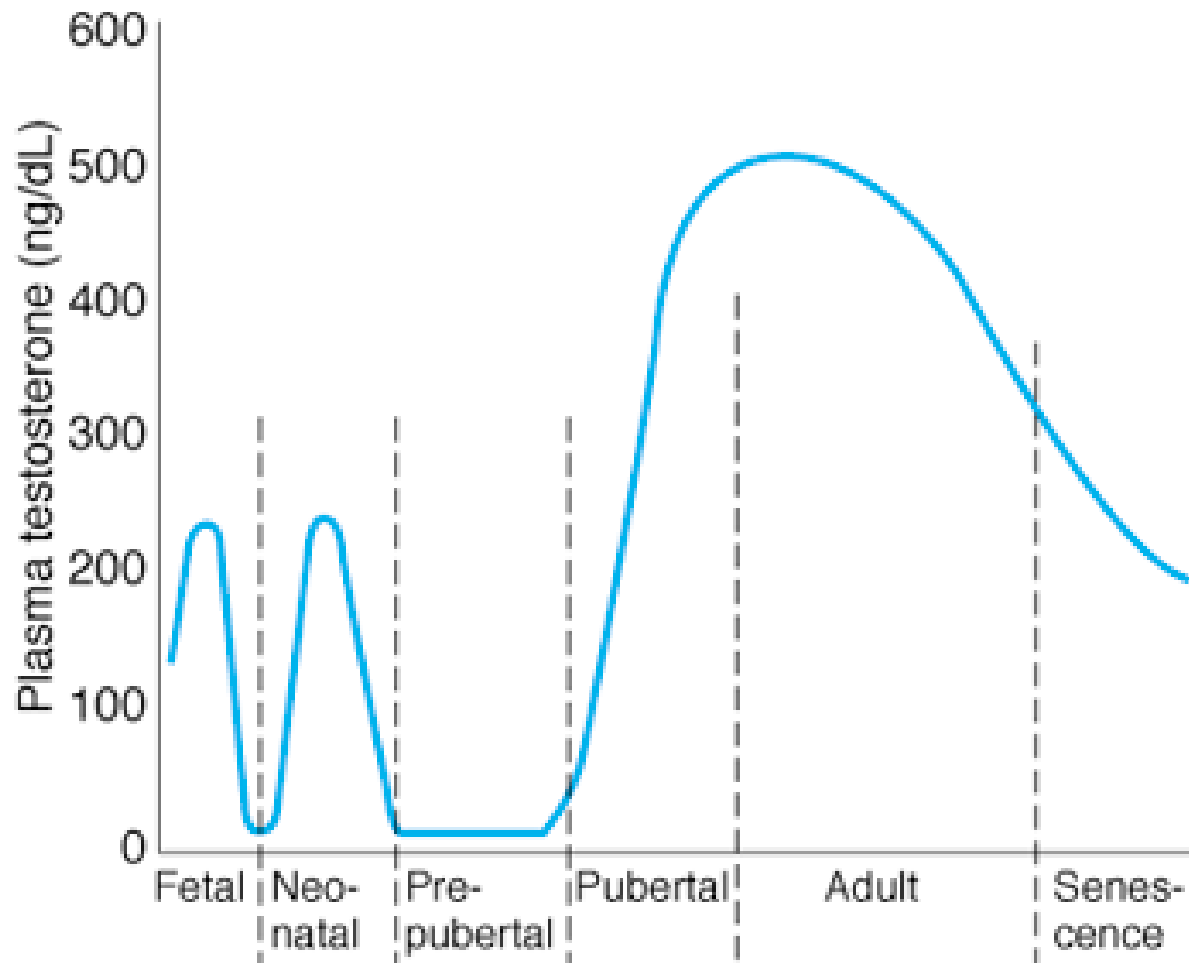
Puberty-Some Terms and Events

- Thelarche: development of breast
- Pubarche: development of axillary & pubic hair
- Menarche: the first menstrual period
- Adrenarche: the onset of an increase in the secretion of androgens
- Menopause: the period during which the sexual cycles of the female cease and the ovarian hormones fall to minimal levels.

Onset of Puberty: Hypothalamic-Pituitary-Gonadal Axis



Plasma testosterone levels at various ages in human males



Normal Puberty: Endocrine control

- Onset of puberty is signalled by the secretion of pulses of Gonadotrophin Releasing Hormone (GnRH)
- Prior to puberty: hormonal feedback / central neural suppression of GnRH release suppresses onset of puberty
- Hypothalamo-pituitary-gonadal axis starts working in foetus. After birth, sex hormones and gonadotrophins (FSH, LH) are found in adult levels
- Levels reduce in months after birth; pulsatile GnRH reduces in childhood and increases in frequency and amplitude before puberty
- For 2 years before puberty, rise in adrenal androgens
→ early pubic hair

Puberty – hormonal changes

- in young children, LH and FSH levels insufficient to initiate gonadal function
- between 9-12 yrs., blood levels of LH, FSH increase
- amplitude of pulses increases, especially during sleep
- high levels of LH, FSH initiate gonadal development
- GH (Growth hormone) secretion from pituitary increases
- TSH (thyroid stimulating hormone) secretion from pituitary increases in both sexes:
 - increases metabolic rate
 - promotes tissue growth

Puberty-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:
- androgen release by adrenal glands increases causing growth of pubic hair, lowering of voice, growth of bone, increased secretion from sebaceous glands

Puberty – Male hormonal changes

- LH and FSH release increases at about 10 years 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)
- androgens cause retention of minerals in body to support bone and muscle growth
- Sertoli cells also secrete some estrogens

Stages of pubertal development (Tanner Scale)

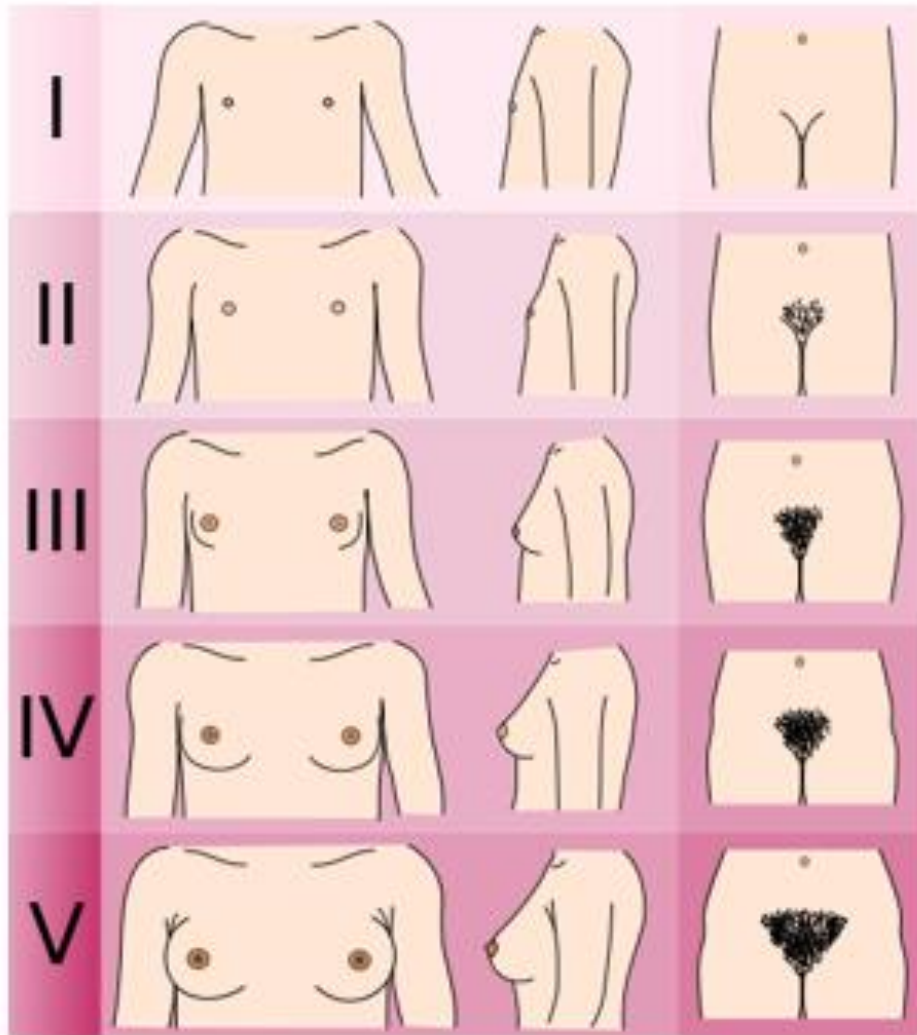
Pubertal development is classified according to the Tanner standard – 5 different stages

- Girls: *breast (B_{1-5}), pubic hair (Pu_{1-5}), axillary hair (A_{1-5}), *menarche**
- Boys: *testicular volume $> 4\text{ ml}$ (Te), penis enlargement (G_{1-5}), pubic hair (Pu_{1-5}), axillary hair (A_{1-5}), *spermarche**

Monitoring of the pubertal growth acceleration

- growth velocity is 2-3 times greater than prepubertal
- sexual dimorphism in pubertal growth

Pubertal Stages (Tanner Scale) in Female



- 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 dark curled pubic/axillary hair
- P4 Breast tissue and areolae protrude above breast level. Adult pubic hair but no spread to medial thighs.
- P5 Mature adult breast. Pubic hair extends to upper thigh

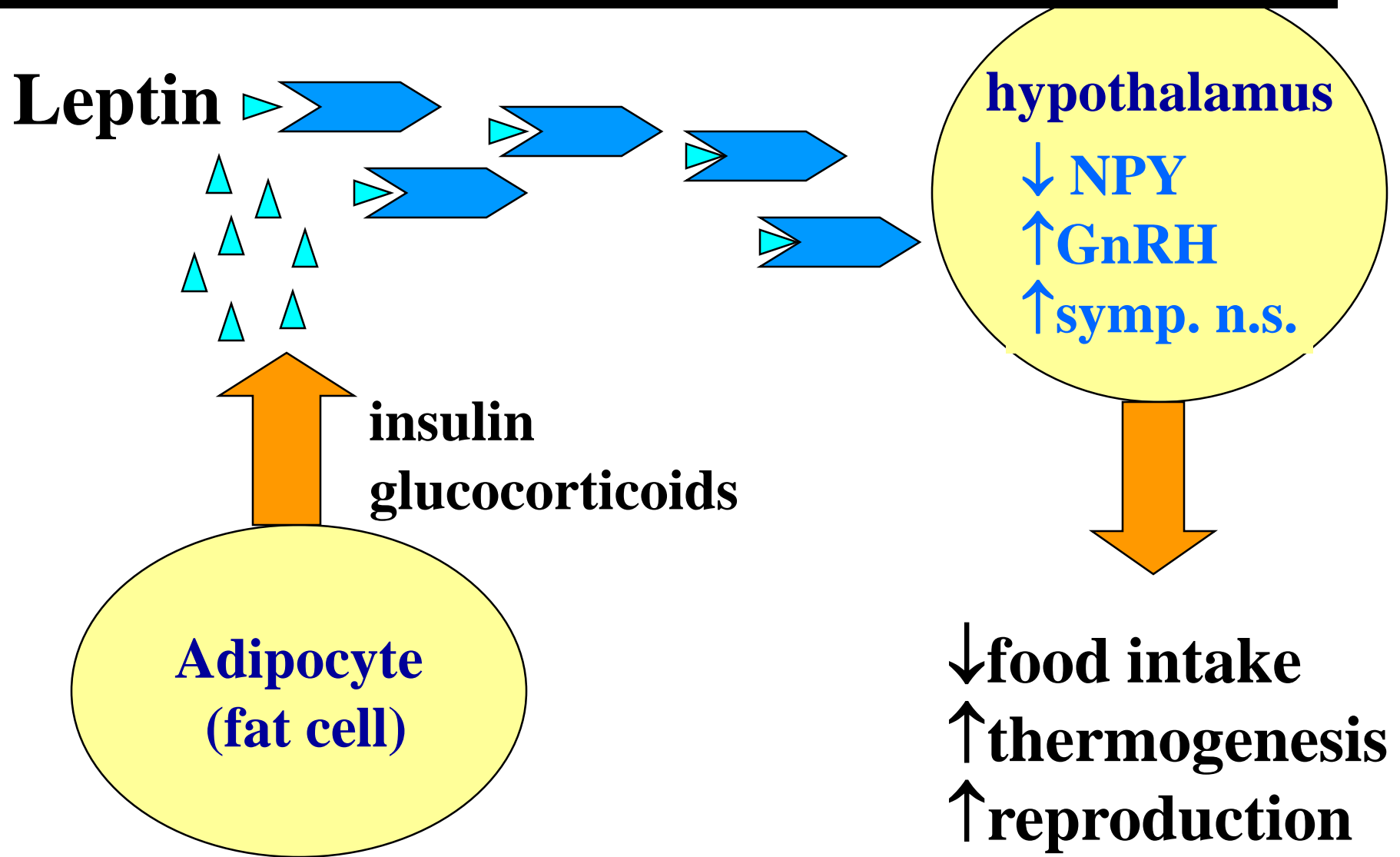
Menarche

- During puberty oestradiol levels fluctuate widely (reflecting successive waves of follicular development that fail to reach ovulatory stage)
- Endometrium affected by oestradiol. Undergoes cycles of proliferation and regression until point where withdrawal of oestrogen results in the first menstrual bleed (menarche)
- Increase of only 4% of final height after menarche

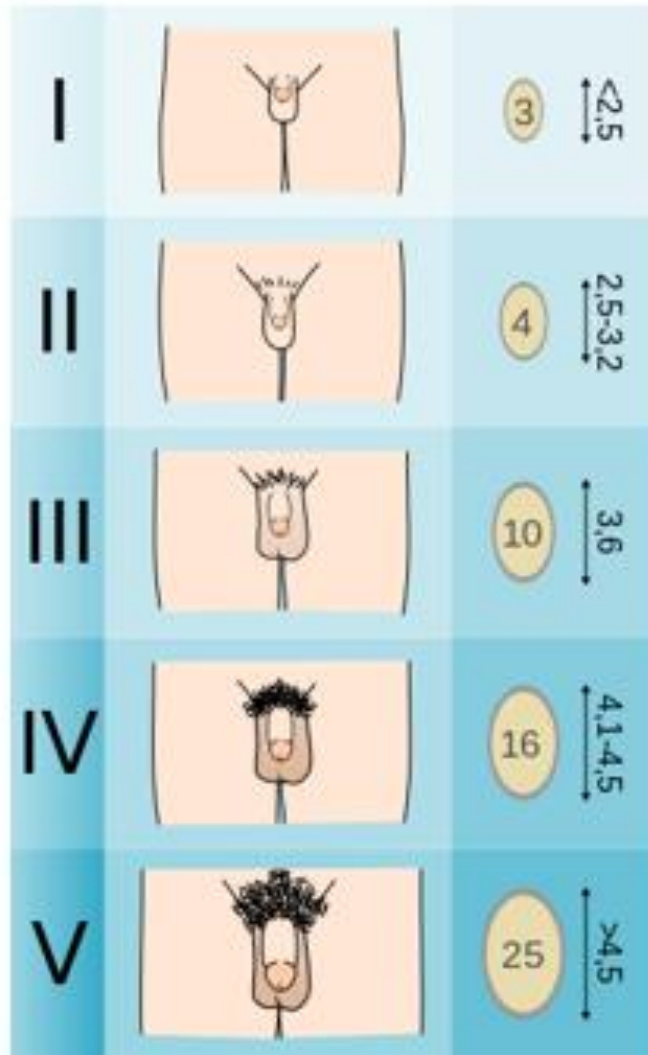
Role of Nutrition

- 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:



Puberty: Boys



- First signs often go unnoticed
- Testicular enlargement (12-13 years)
- Prepubertal testis – 2mls diameter
- Puberty begins when volume reaches 4mls
- Penile and scrotal enlargement occur approx. 1 year after testicular enlargement. Pubic hair appears at same time

Tanner Scale

- **Male external genitalia scale**
 - Stage 1: Testicular volume < 4 ml or long axis < 2.5 cm
 - Stage 2: 4 ml-8 ml (or 2.5-3.3 cm long), 1st pubertal sign in males
 - Stage 3: 9 ml-12 ml (or 3.4-4.0 cm long)
 - Stage 4: 15-20 ml (or 4.1-4.5 cm long)
 - Stage 5: > 20 ml (or > 4.5 cm long)
 - Note: Testicular length when measured along the long axis in cm.

Pubertal Stages (Tanner Scale) in Male

- P1 Prepubertal, testicular volume < 2mls
- P2 Enlargement of scrotum and penis. Scrotum slightly pigmented. Few long dark pubic hairs
- P3 Lengthening of penis. Further growth of testes and scrotum. Pubic hair darker, coarser and more curled
- P4 Penis increases in length and thickness. Increased pigmentation of scrotum. Adult pubic but no spread to medial thighs
- P5 Genitalia adult in size and shape. Pubic hair spread to thighs

Pubertal Growth Spurt: Boys

- Occurs later than in females
- Testosterone less of a stimulus to GH responsiveness than oestradiol
- Testosterone required in larger concentrations to produce same anabolic effect
- Greater and later growth spurt in boys

Pubertal disorders

A. Precocious puberty

B. Delayed puberty

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

Girls <8 years old

Boys <9 years old

1. Gonadotrophin-dependent (true / central)
2. Gonadotrophin-independent

Gonadotrophin-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 - definition

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 genital growth in boys is > 5 years

Causes of delayed puberty

- Gonadal failure (Hypergonadotrophic hypogonadism)
 - Turner's Syndrome
 - Post-malignancy chemo / radiotherapy / surgery
 - Polyglandular autoimmune syndromes
- Gonadal deficiency
 - Congenital hypogonadotrophic hypogonadism
 - Hypothalamic/pituitary lesions (tumours, post-radiotherapy)
 - Rare gene mutations inactivating FSH/LH or their receptors

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Study Questions

Short notes on:

1. Puberty in male
2. Puberty in female
3. Hormonal mechanisms in the initiation of puberty

Essay:

1. What is puberty? Discuss the onset and physiological changes during puberty.