**Puberty**

* **Definitions**
	+ Central puberty
		- Transition from the sexually immature to the sexually mature stage
		- Associated with secondary sexual characteristics and growth spurt
		- Due to activation of the hypothalamic-pituitary-gonadal axis (HPG) axis
	+ Adrenarche/pubarche
		- Increased adrenal androgen (DHEAS) production, often before gonadarche
		- Signs of increased androgens: pubic/axillary hair development, apocrine gland maturation (adult body odor), acne
	+ Thelarche
		- Onset of breast development
	+ Menarche
		- First menstrual period
* **Normal Physiology**:
	+ Continuous GnRH inhibits puberty
	+ Puberty starts with pulsatile secretion of GnRH

* **Evaluation:**
	+ History
		- Growth patterns since birth
		- Age of onset and progression of physical puberty changes
		- Past medical history, social, psychological history
		- Exposure to exogenous hormones (medications, lavender, tea tree oils)
		- Signs of CNS abnormalities (headache, vomiting, vision changes)
	+ Exam Findings:
		- Progression of physical changes in puberty
			* Girls – Breast development 🡪 growth spurt (10 cm/yr) 🡪 menarche (~2 yrs after thelarche)
			* Boys – Testicular growth 🡪 penile/scrotal enlargement 🡪 growth spurt (12cm/yr)
		- Tanner Staging System - \*Start of puberty indicated by Tanner Stage 2 breasts or testicles

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| Stage | Breasts | Testicles | Pubic Hair |
| 1 | Prepubertal, papilla elevation | Testicles 1-3mL, prepubertal genitals | No pigmented hair |
| 2 | *Breast budding, larger areola, palpable and visible elevated contour\** | *Testicles 4-6mL, early testicular, penile, and scrotal growth\** | Minimal pigmented hair, mainly labial in girls, at base of penis in boys |
| 3 | Enlargement of the breast and areola | Testicles 8-12mL, increased penile length and width, scrotal growth | Dark, coarser hair, spread over mons in girls, and extending midline above penis in boys |
| 4 | Second mound of areola and papilla | Testicles >12mL, increased penis side including breadth, pigmented scrotum | Adult type hair, less than adult distribution |
| 5 | Mature breast | Testicles >15mL, adult size and shape genitalia | Adult distribution, spread to medial thighs |

* Bone age
	+ - Key component in evaluation of normal vs. abnormal puberty
		- Sex steroids cause accelerated skeletal maturity
		- Puberty typically occurs when skeletal age reaches the average age of puberty for that gender – approximately 10.5 years in girls, 12.5 years in boys
	+ Determining puberty with laboratory data
		- Single random sample of LH >0.3 U/L using ultrasensitive gonadotropin assay
			* 3rd generation, or “pediatric” immunoassays are best
			* Consider early morning sample, because puberty initially starts with GnRH release at night
		- Historic gold standard is LH obtained 60 minutes after GnRH stimulation
* **Abnormal puberty:**
	+ Precocious puberty
		- Definition – Secondary sexual characteristics in Girls<8 yo (<7 yo in minority girls), Boys <9 yo
			* NOTE: Boys with sexual precocity require careful evaluation because many have underlying disorders.

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| *Gonadotropin dependent (central)* | *Gonadotropin independent (peripheral)* |
| Tumors (hamartomas/gliomas) | Exogenous exposure |
| Congenital (hydrocephalus) | Adrenal tumor |
| Acquired (irradiation, surgery, infection) | Ovarian/testicular tumor |
| Idiopathic | CAH |
|  | Hypothyroidism |
|  | McCune-Albright |

* + Delayed puberty
		- Definition – Girls >13yo, Boys >14 yo who are still Tanner Stage 1
		- Types:
			* Constitutional delay: normal variation of the timing and tempo of maturation, delayed bone age
			* Hypogonadotropic hypogonadism: hypothalamic/pituitary disease, Kallman syndrome, chronic illness, malnutrition, exercise, tumors (craniopharyngioma), suppression (hyperthyroidism, hyperprolactinemia, Cushing Syndrome, CAH), panhypopituitarism
			* Gonadal dysgenesis or failure
* **Normal pubertal variation**
	+ Premature thelarche – Isolated breast development without growth acceleration or other pubertal findings
	+ Premature adrenarche – Sexual hair (pubic/axillary) without growth acceleration or other pubertal changes
* **References:**
1. Sperling, Mark A. Pediatric Endocrinology 4th Edition.
2. Pediatric Endocrinology, Fifth Edition Volume 2. Lifshitz.