**Short Stature**

**Normal Physiology of Growth:**

* dynamic process influenced by many intrinsic and extrinsic factors
* linear rate of growth and regulation of growth vary with age
* Growth hormone (GH) synthesis and secretion occurs in the anterior pituitary (adenohypophysis) which originates from the floor of the primitive pharyngeal epithelium known as Rathke’s pouch
* GH is produced in the somatotropes

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| **Growth hormone stimulants** | **Growth hormone inhibitors** |
| GHRH (growth hormone releasing hormone) from hypothalamus | somatostatin |
| hypoglycemia | IGF-1 |
| exercise, stress, ghrelin | hypothyroidism, chronic steroids |
| agents such as arginine, clonidine, L-dopa (used in stimulation testing) |  |
| sex steroids (puberty!) |  |

* Growth occurs in 4 phases: prenatal, infancy, childhood and adolescence
  + Prenatal:
    - Complex interactions between mother, placenta and fetus
    - GH has minimal effect on prenatal growth
  + Infancy: Nutrition dependent
    - Hormonal Control: GH
    - Growth velocity:
      * 0-12 months: 25 cm/year
      * 12-24 months: 10 cm/year
      * 24-36 months: 7 cm/year
  + Childhood:
    - Hormonal Control: GH
    - Growth Velocity: 5 cm/year
  + Adolescents:
    - Hormonal Control: abrupt increase in sex hormones + increased GH secretion
    - Growth Velocity: 13 cm/year
* **Evaluation of Short Stature:**
  + Three main questions to ask:
    - Is the patient short compared to the population?
    - Is the patient short for her/his mid-parental height?
    - Is the growth velocity abnormal?
  + Definition of short stature:
    - Height less than 2 SD below the mean for age or below the 3rd percentile for age
    - Height more than 2 SD below mid-parental height
      * Mid-parental height:
        + For boys: Mother’s height + 5 inches ( 12.7 cm) averaged with father’s height
        + For girls: Father’s height – 5 inches (12.7 cm) averaged with mother’s height
  + Pertinent History and Exam Findings:
    - History:
      * Chronic illness, history of serious illness, steroid, or medication exposure
      * IUGR or SGA without catch up growth by 2 years of age
      * Decreasing growth velocity (crossing percentiles after age of 3)
    - Exam:
      * General: syndromic features
      * HEENT: any midline defects, thyromegaly, lymph node enlargement
      * CV: murmur
      * GU: micropenis (indicates pan-hypopituitarism), pubertal staging
      * MSK: deformities, scoliosis, Madelung, short 4th metacarpal, ossifications
  + Work Up:
    - Free T4 and TSH, Comprehensive metabolic panel, Complete blood count, ESR or CRP, IGF-1 and IGFBP-3, Tissue transglutaminase IgA and total serum IgA
    - Consider chromosome analysis in female patients, whether or not features of Turner’s syndrome are present
    - Bone age x-ray of left hand and wrist
    - Do not get random growth hormone level!
  + Differential Diagnosis:

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| Constitutional delay: “late bloomer”, normal growth velocity for pubertal stage (not falling further from the curve)  Familial: short parents or grandparents  Genetic causes   * Turner syndrome * SHOX deficiency * Noonan syndrome * Trisomy 21 * Russell-Silver Syndrome * Prader-Willi Syndrome * DiGeorge Syndrome   Systemic causes   * GI disease: celiac, IBD * Pulmonary disease: asthma, cystic fibrosis * Cardiac disease * Renal disease * Poorly controlled diabetes mellitus * Medications: glucocorticoids, ADHD stimulant medications | Endocrine causes   * Growth hormone deficiency or insensitivity * Hypothyroidism * Cushing’s syndrome   Musculoskeletal issues   * scoliosis * skeletal dysplasia   Psychosocial issues   * Psychosocial dwarfism * Fetal alcohol syndrome   Other   * SGA without catch up growth * Idiopathic short stature |

* **Available Resources:**
* Braun LR, Marino R. Disorders of Growth and Stature. Pediatr Rev2017; 38:293-304
* Cohen P, Rogol AD, Deal CL, Saenger P, Reiter EO, Ross JL, Chernausek SD, Savage MO, Wit JM, participants ISSCW. Consensus statement on the diagnosis and treatment of children with idiopathic short stature: a summary of the Growth Hormone Research Society, the Lawson Wilkins Pediatric Endocrine Society, and the European Society for Paediatric Endocrinology Workshop. J Clin Endocrinol Metab2008; 93:4210-4217