SPR Teaching 8th June

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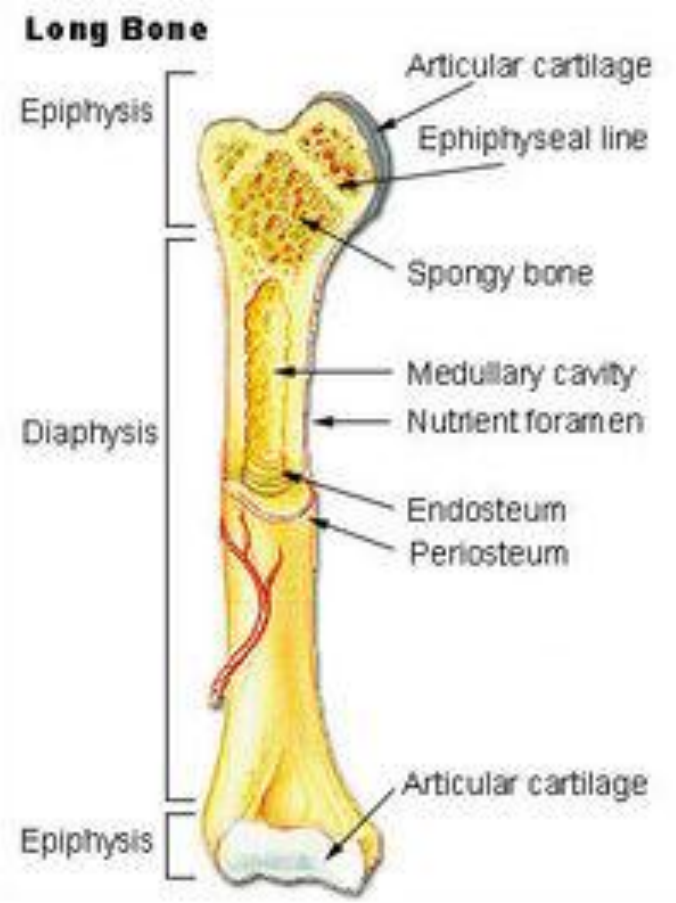
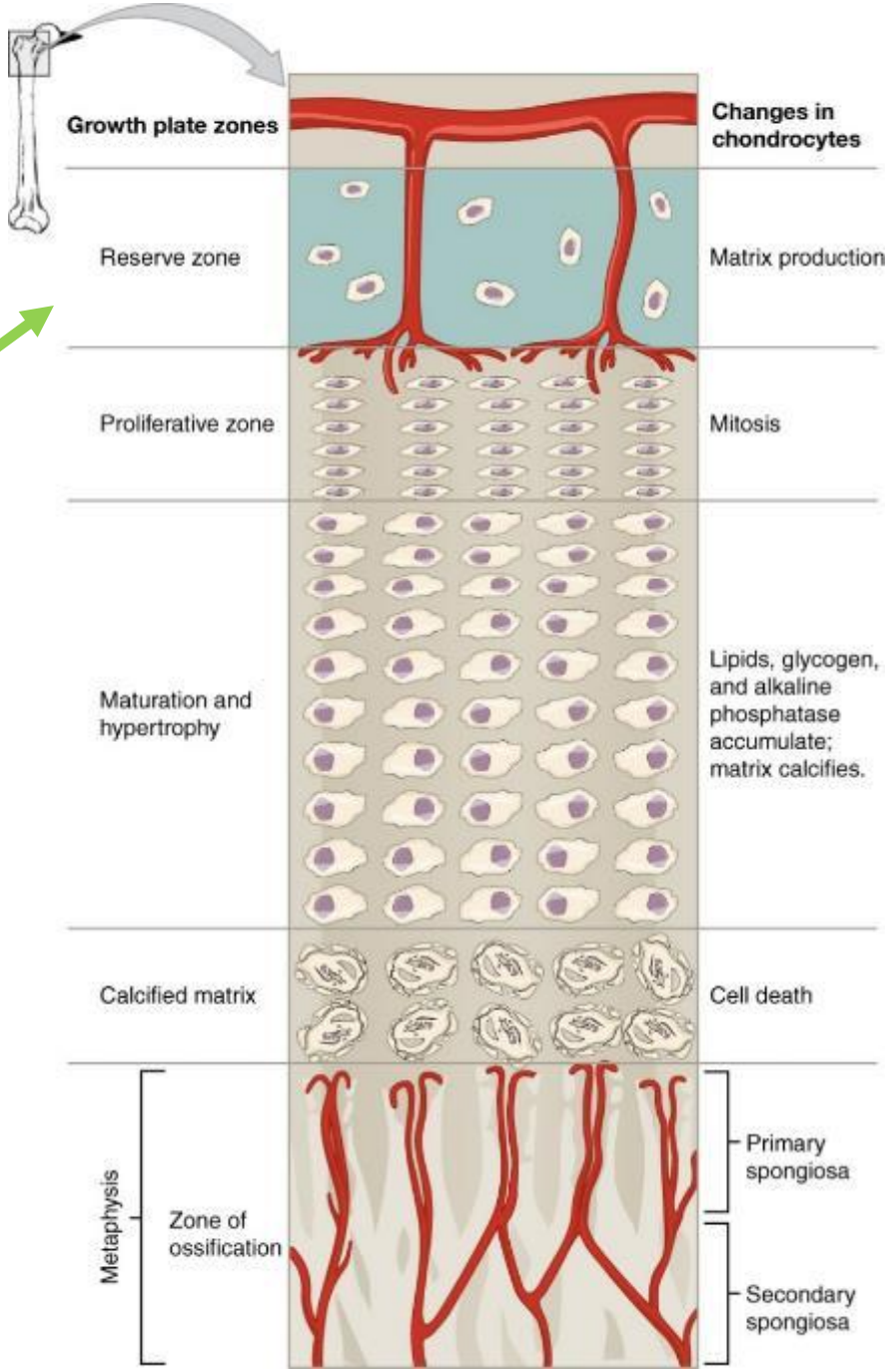
Longitudinal bone growth

- The epiphyseal growth plate is the main site of longitudinal growth of the long bones.



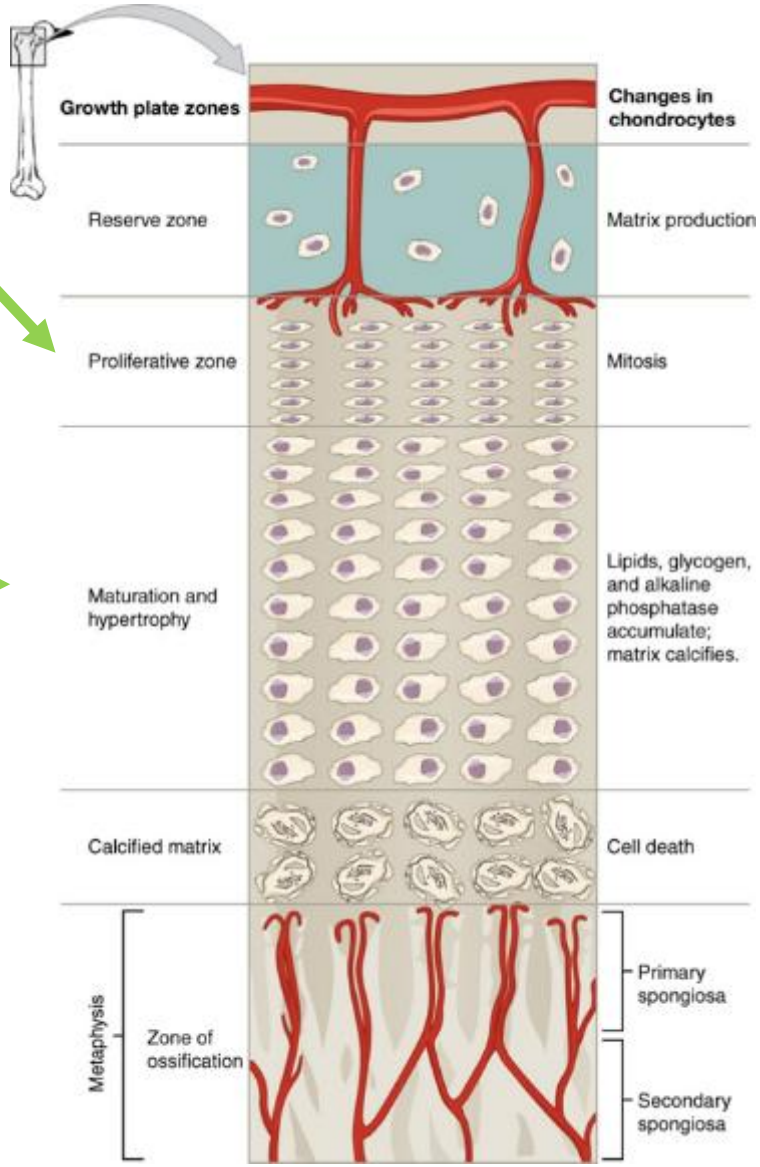
The epiphyseal plate is composed of four zones of cells and activity.

- The reserve zone, the region closest to the epiphyseal end of the plate, contains small chondrocytes within the matrix which secure the epiphyseal plate to the osseous tissue of the epiphysis.



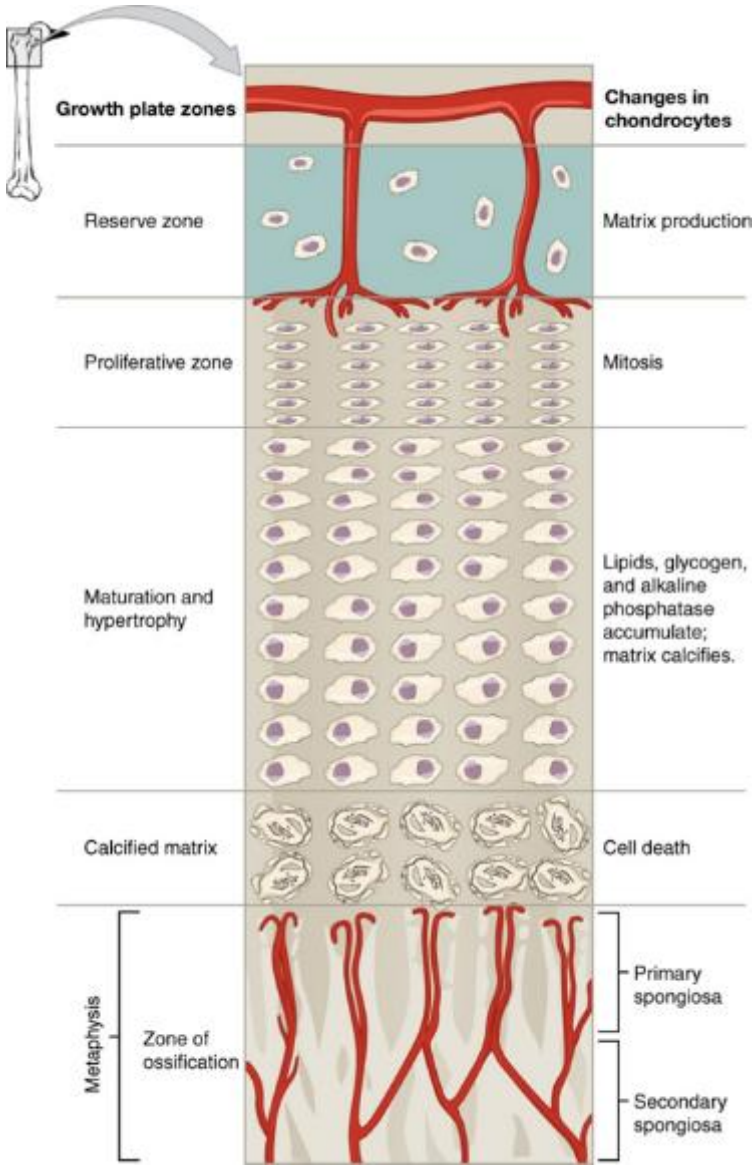
- The proliferative zone, the next layer toward the diaphysis, contains stacks of slightly-larger chondrocytes . It continually makes new chondrocytes via mitosis.

- The zone of maturation and hypertrophy contains chondrocytes that are older and larger than those in the proliferative zone . The more mature cells are situated closer to the diaphyseal end of the plate. In this zone, lipids, glycogen, and alkaline phosphatase accumulate, causing the cartilaginous matrix to calcify. The longitudinal growth of bone is a result of cellular division in the proliferative zone along with the maturation of cells in the zone of maturation and hypertrophy.



- After the zone of calcified matrix, there is the zone of ossification, which is actually part of the metaphysis . Arteries from the metaphysis branch through the newly-formed trabeculae in this zone.

- The zone is split into two zones – the newer bone being the primary spongiosa. The older bone at the bottom of the zone of ossification is the secondary spongiosa.



Source: Boundless. “Growth of Bone.” *Boundless Biology*. Boundless, 01 Jun. 2015. Retrieved 04 Jun. 2015 from https://www.boundless.com/biology/textbooks/boundless-biology-textbook/the-musculoskeletal-system-38/bone-216/growth-of-bone-818-12061/

Lower limb growth contribution:

- Prox femur 4mm/yr
- Distal femur 10mm/yr
- Prox tibia 6mm/yr
- Distal tibia 5mm/yr

Epiphyseal contribution of long bone growth

	Humerus	Radius	Ulna	Femur	Tibia	Fibula
Proximal	80%	25%	80%	30%	55%	60%
Distal	20%	75%	20%	70%	45%	40%

LLD

- 600 military recruits

  32% 0.5 – 1.5 cm

  4% > 1.5 cm

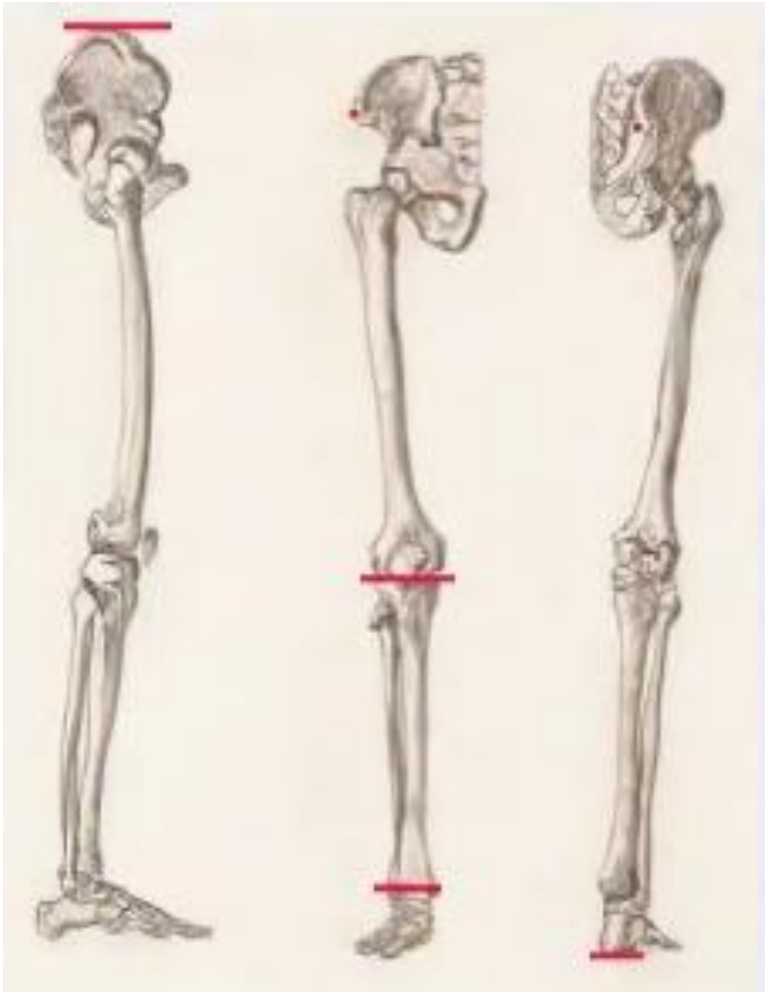
- Impact of LLD

- Scoliosis
- Low back pain poor evidence
- Hip / knee pain

- Gait asymmetry only when > 2 cm
- > 2-2.5cm at skeletal maturity – aim to equalise

Assessment of LLD

- Standing
  - Pelvic landmarks
    - PSIS, ASIS, Iliac crests
  - Knee Joint Line
  - Malleoli
  - Foot contour



LLD assessment

- Supine – Galeazzi or tape measure

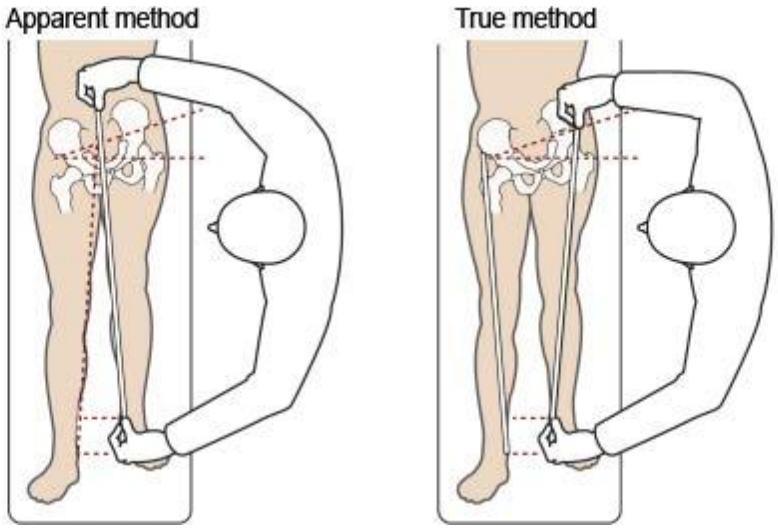
- Deformity – angulation/rotation
- Asymmetry - muscle girth, absent rays
- Neurology – check tone

Gait

- Gait – foot contact, knee position, trendelenberg etc
- Compensatory mechanisms
  - Circumduction or flexion of longer limb
  - Vaulting over longer limb
  - Toe-walking on shorter limb

Assessment of LLD

- Tape Measure
  - ASIS to medial malleolus
  - ASIS to sole (with foot component to LLD)
  - Belly button to medial malleolus



Tape cont..

- Debate surrounds the accuracy of tape measure methods
  - Always use the mean of at least 2 measures
  - If possible, compare measures between 2 or more clinicians
  - Iliac asymmetries may mask or accentuate a limb length inequality
  - Unilateral deviations in the long axis of the lower limb (eg. Genu varum,…) may mask or accentuate a limb length inequality
  - Asymmetrical position of the umbilicus
  - Joint contractures

Assessment of LLD

- Blocks
  - Place blocks under short limb.
  - Palpate bony landmarks – iliac crests and/or PSIS.

- What equalises leg length is not necessarily what feels comfortable/natural for the patient

Radiology

- The most accurate method to measure LLD
- Best way to differentiate an anatomical from a functional limb length inequality.
- A single exposure of the standing subject, imaging the entire lower extremity, using blocks to equalise limb length
- Limitations are an inherent inaccuracy in patients with hip or knee flexion contracture
- CT has no greater accuracy compared to the standard radiography for LLD

What is the impact of a LLD

Difference	Problem	Source
3mm	Running injury risk	Subotnik
5mm	Spinal compensaiont	Friberg
6mm	Running injury risk	Bordy
7mm	No problem <7mm	Corrigan, Maitland
9mm	Lumbar facet angle changes	Giles
10mm	Low back pain	Cyriax
15mm	Compensatory scoliosis	Gibson
20mm	Lower extremity compensation	Vogel
22mm	Scoliosis	Papaloannou
40mm	Surgical correction	Ingram

Structural/Functional LLD

- Structural (SLLD) or anatomical: Differences in leg length resulting from inequalities in bony structure.
- Functional (FLLD) or apparent: Unilateral asymmetry of the lower extremity without any bony shortening.

Common causes of LLD

Congenital defects:

- DDH
- Pseudarthrosis
- Proximal Femoral Focal Deficiency
- Fibular hemimelia, tibial hemimelia

Developmental – descrepancy evolves with growth

- CTEV
- Hereditary Multiple Exostoses
- Congenital pseudarthrosis tibia – neurofibromatosis
- Vasuclar eg klippel tranaunay syndrome

Acquired Structural

- Trauma
  - Malunion
  - Physeal trauma (including SUFE)
  - Over stimulation of fractured bone leading to overgrowth phenomenon
- Diseases:
  - Perthes
  - Osteomyelitis
  - Septic arthritis
  - Tuberculosis
  - Juvenile arthritis
  - Meningococcal Septicaemia
  - Polio

- Tumours
  - Neurofibromatosis:
  - Haemangioma

- Differences in growth:
  - Hemi hypertrophy (assoc with Proteus, Klippel-Trenanuny-Weber & Beckwith-Wiedemann)
  - Hemi-atrophy

- Neurogenic
  - Paralysis/Disuse

Functional LLD

- Functional:
  - Shortening of soft tissues
  - Joint contractures
  - Ligamentous laxity
  - Axial malalignments
  - Foot biomechanics (such as excessive ankle pronation)

Thomas test