Introduction to Bone Classification: Brian K. Hall

1. **Bone is**: A vertebrate tissue/organ/organ system(s) [Cartilage is found in inverts]
    (a) Cellular in tetrapods and many teleosts
    (a) Acellular as pathology in tetrapods, normal in 'higher teleosts'

2. **Bone develops from**: Neural crest and mesoderm in origin [evol. independent for 475+ My]
    (a) Only cranial NC? — skull, jaws, gills, cardiac
    (b) axial mesoderm (sclerotome) — vertebrae/ribs
    (c) appendicular mesoderm (sclerotome) — fins, limbs
    (d) Cranial (craniofacial) mesoderm — skull, jaws, gills
    (e) connective tissue, ligaments, tendons [extraskeletal]
    (f) cartilage [chondroid bone, by metaplasia]

3. **Location**:
    (a) exoskeletal — dermal [neural crest]
    (b) endoskeletal — mostly 'endochondral' and mostly mesodermal
    (c) extraskeletal — intratendinous, intra-ligamentous, sesamoids, [metaplasia]
    (d) Functional units — pharyngeal arch; shoulder girdle

4. **Formation**

    (a) **Direct** — membranous — from condensation of mesenchyme

    (b) **Indirect**
        (i) from dense connective tissue; Indirect because by metaplasia (or from 'stem cells'
        (ii) on surface of cartilage —perichondral
        (iii) by replacing eroded cartilage — endochondral
        (iv) as chondroid bone as primary tissue or by metaplasia from, cartilage
        (iv) by replacing marrow
        (v) in ligament — intra-ligamentous [metaplasia?]
        (vi) in tendon — intratendinous [metaplasia?]
        (vii) in perichondral extensions — direct (if perichondrium —> periosteum)

— indirect if by metaplasia

5. Fate:

(a) persists, remodeled, resorbed

(b) woven, trabecular, fibrolamellar, etc

6. Cells:

(a) preosteoblast, osteoblast, osteocyte

(b) prechondroblast, chondroblast, chondrocyte, hypertrophic chondrocyte

7. Genes:

(a) expression in whole mounts

(b) expression in particular cell types

(c) levels – RT-PCR