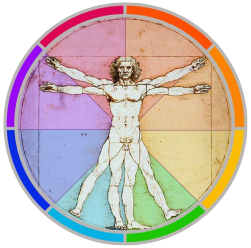
HUBS191 Lecture Material

This pre-lecture material is to help you prepare for the lecture and to assist your note-taking within the lecture, it is NOT a substitute for the lecture !



Please note that although every effort is made to ensure this pre-lecture material corresponds to the live-lecture there may be differences / additions.

HUBS191

Lecture 5:
Bone growth
Joints: tissues and structures

Dr Rebecca Bird

Department of Anatomy

Lecture objectives

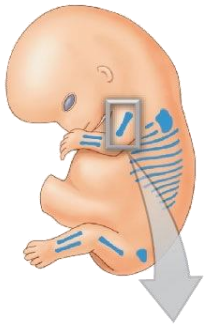
- Describe the general principles of bone growth
- Describe the microanatomy of tissues in the joints, and explain how their structure reflects function
- Describe fibrous and cartilaginous joints

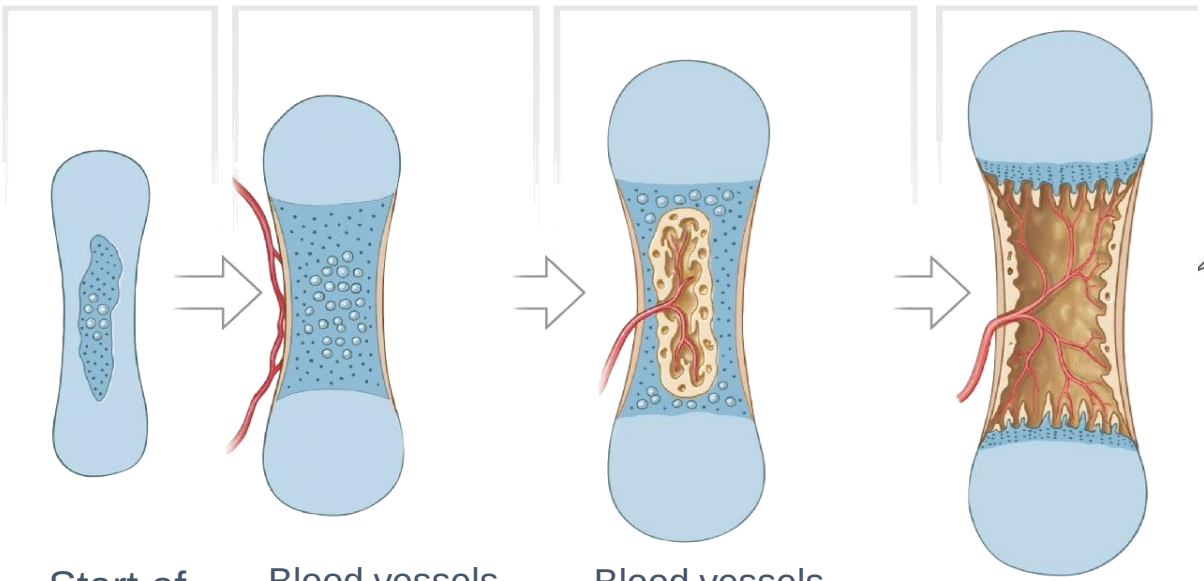
The story so far...

- We know:
  - Basic tissues
  - Bone tissue
  - Bones form the skeleton
- We need to know:
  - How bones grow (shape and size)
  - How bones fit together (joints)
  - How bones are held together (soft tissues)

Bone growth

- Start with cartilage model
  - ~6 weeks after fertilisation
- Endochondral ossification
  - Process of turning cartilage into bone



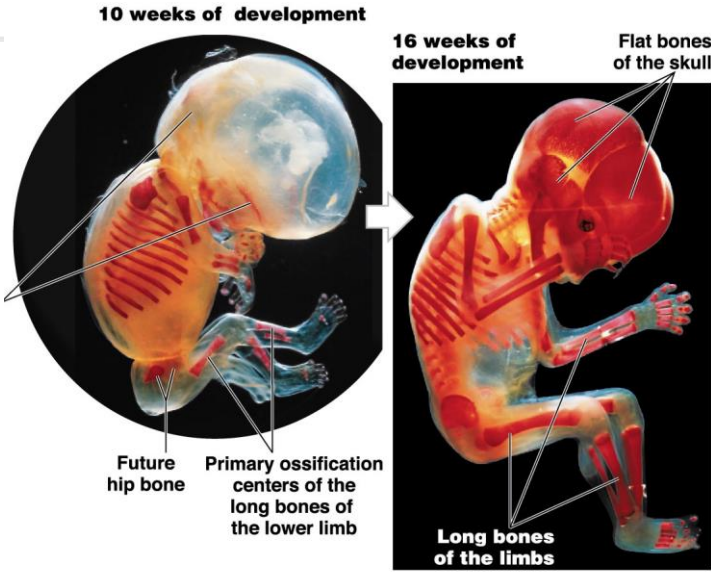


Start of calcification

Blood vessels and osteoblasts external

Blood vessels (and osteoblasts) internal

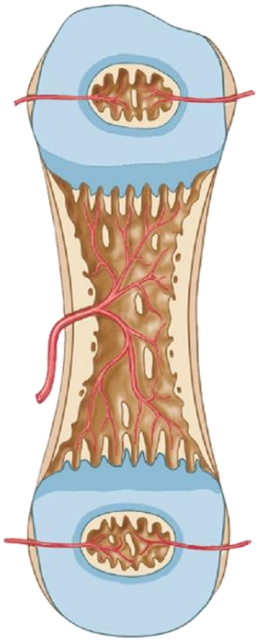
Primary ossification centre developed



Martini *et al*, *Visual Anatomy & Physiology*, 3rd Edn, 2018, p.264 & 267

Primary ossification centres

- Diaphysis (shaft) is primary ossification centre
- Epiphyses remain cartilage



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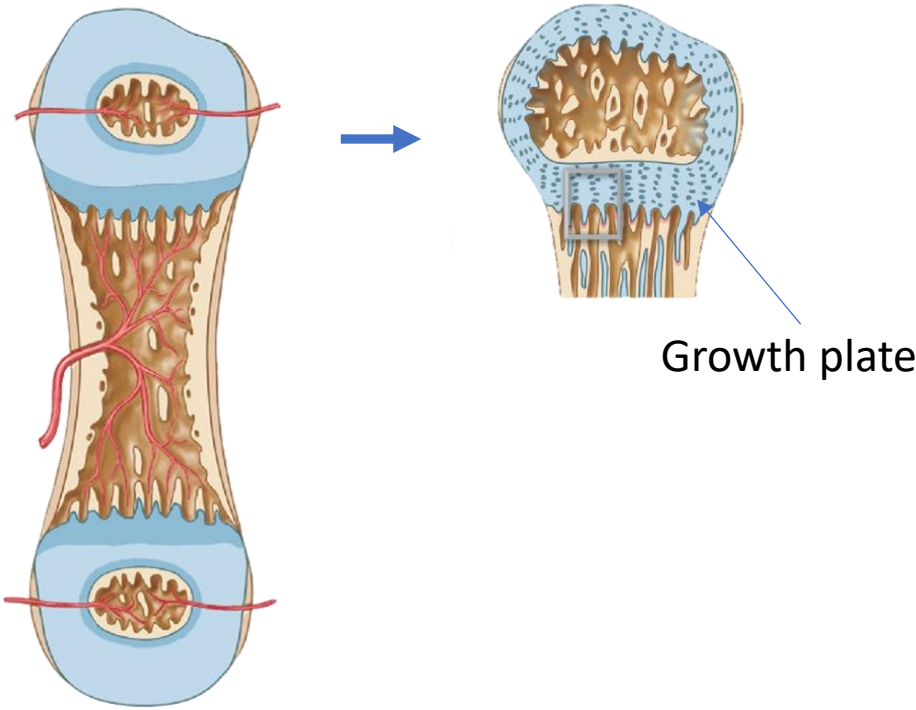
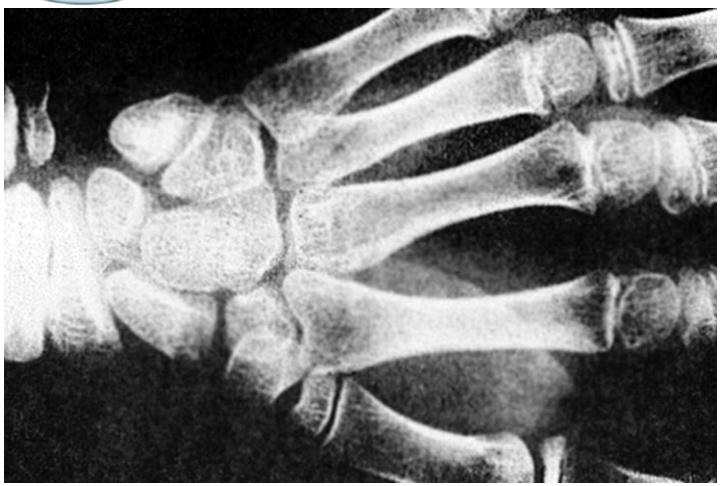
Martini *et al*, *Visual Anatomy & Physiology*, 3rd Edn, 2018, p.264 & 267

Secondary ossification centres

- Epiphyses
  - same ossification process as primary centres
- Separated from diaphysis by epiphyseal plate/growth plate





Martini *et al*, *Visual Anatomy & Physiology*, 3rd Edn, 2018, p.264 & 267

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Bone growth

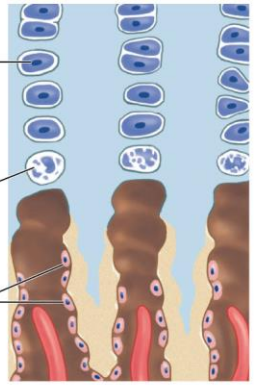
- **In length:**
- Enabled by epiphyseal plates
  - aka ‘growth plates’
  - formed of cartilage
- Starting from puberty, epiphyses start to fuse with diaphyses

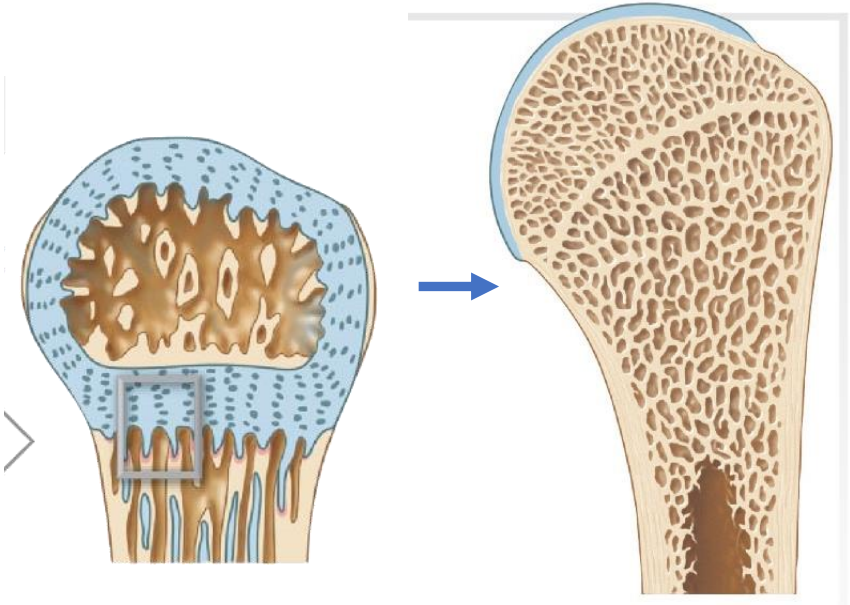
For interest only:

Chondrocytes at the epiphyseal side of the cartilage continue to divide and enlarge.

Chondrocytes degenerate at the diaphyseal side.

Osteoblasts migrate upward from the diaphysis, and cartilage is gradually replaced by bone.





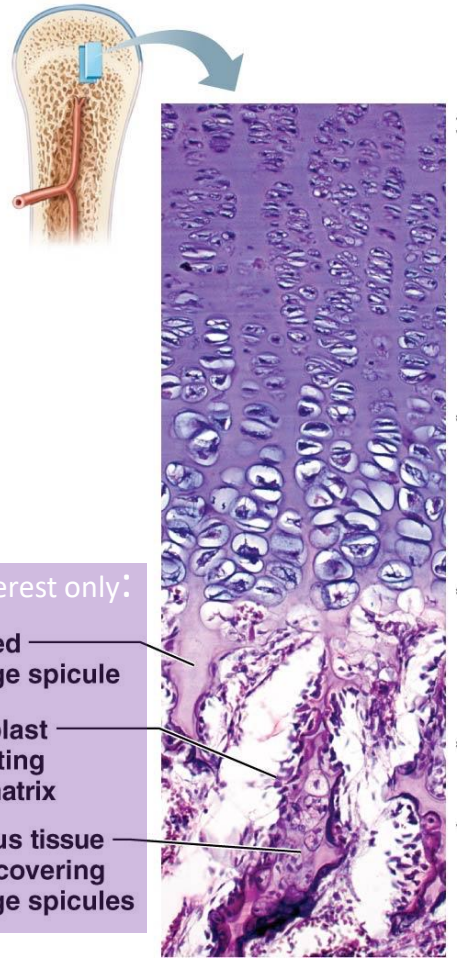
Martini *et al*, *Visual Anatomy & Physiology*, 3rd Edn, 2018, p.267

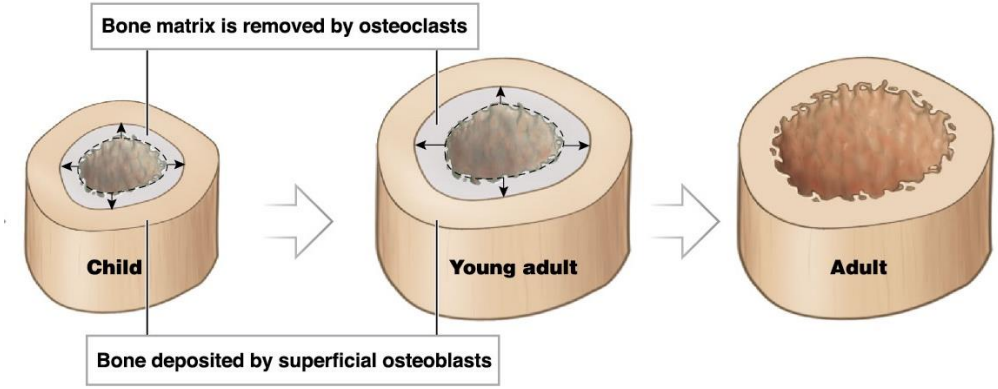
Child vs Adult

https://radiopaedia.org/

Bone growth

- **In width:**
- Appositional growth
- Osteoblast activity produces circumferential lamellae
- Osteoclasts mould bone shape and form medullary cavity





Martini *et al*, *Visual Anatomy & Physiology*, 3rd Edn, 2018, p.262

Marieb & Hoehn, *Human Anatomy & Physiology*, 10th Edn, 2018

How does our skeleton move?

- Bones articulate at **joints**
- **A joint:**
  - holds bones together
  - involves bone ends
  - involves soft tissues
  - allows control of movement

Key soft tissues

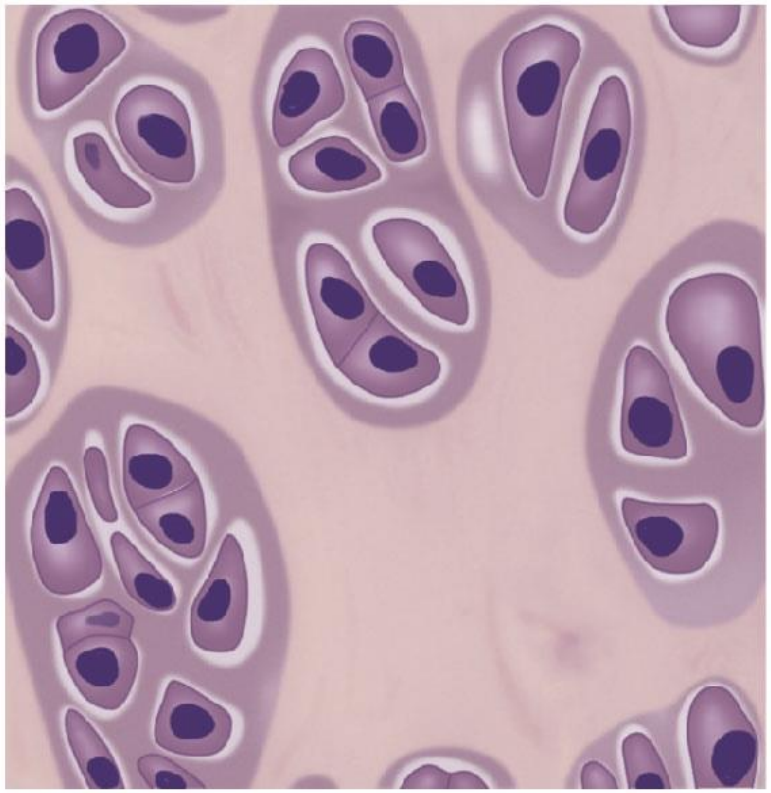
- Cartilage
  - Hyaline (articular)
  - Fibrocartilage
- DFCT
  - Ligaments
  - Tendons
  - Joint capsules

Cartilage

- Chondrocytes
  - in lacuna
- Collagen fibres embedded in ground substance
- Avascular
  - No blood vessels
  - nutrients diffused through matrix by joint loading
- Two key types in joints:
  - Hyaline (articular)
  - Fibrocartilage

Hyaline (articular) cartilage

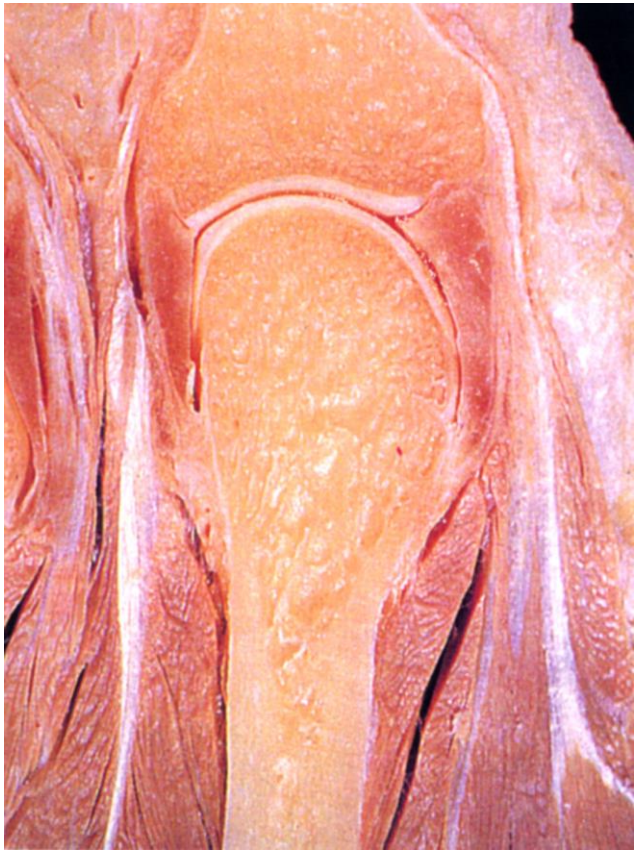
- Function = resist compression
- High water content in matrix
- Sparse collagen fibres



Martini *et al*, *Visual Anatomy & Physiology*, 3rd Edn, 2018, p.206

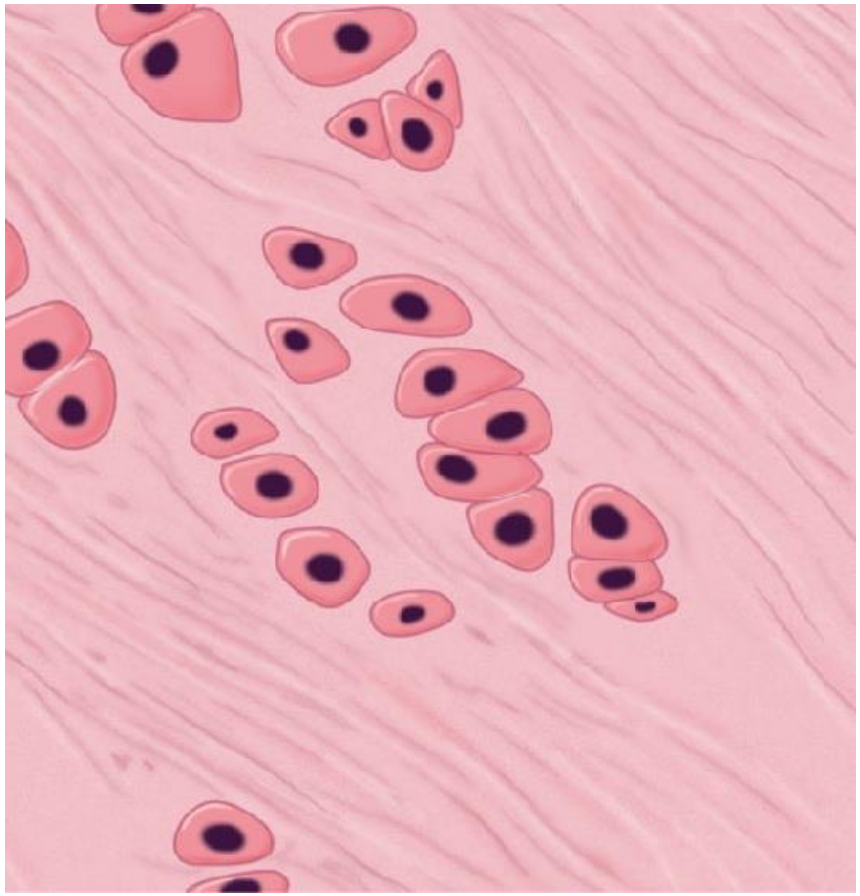
Hyaline (articular) cartilage

- Moulds to surfaces of bones where they articulate
- Creates smooth surface = frictionless movement
- Found on articulating surfaces of bones
- Degrades with age



Fibrocartilage

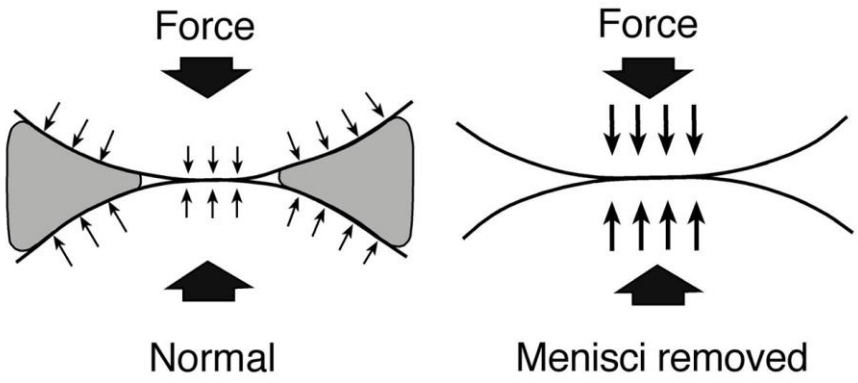
- Function = resist compression AND tension
- Many collagen fibres in bundles
- Orientation of fibres aligns with stresses



Martini *et al*, *Visual Anatomy & Physiology*, 3rd Edn, 2018, p.206

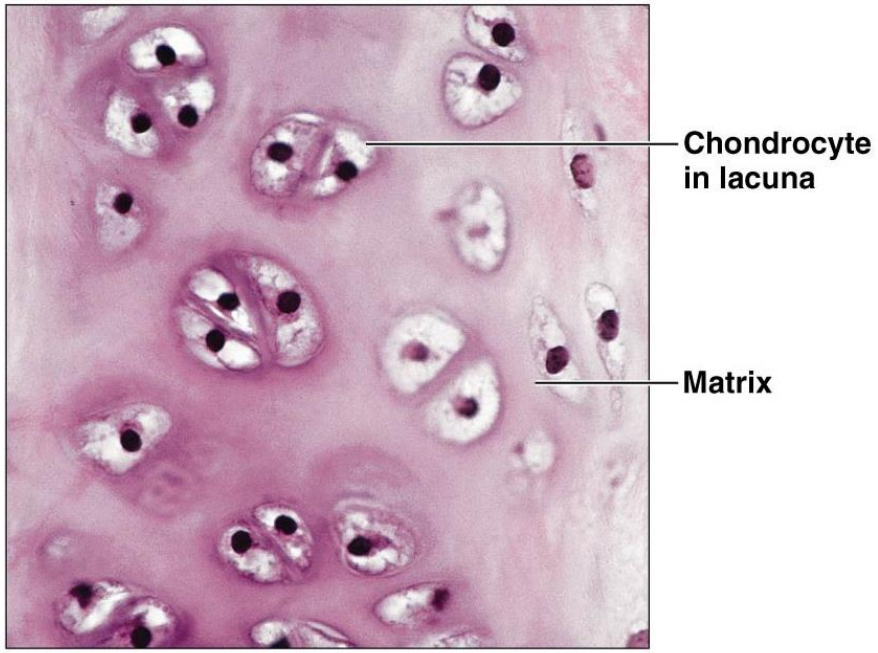
Fibrocartilage

- Useful at joints that experience both compression and tension
- Acts as buffer/shock absorber
  - distribute force over wider area
- Deepens articular surfaces

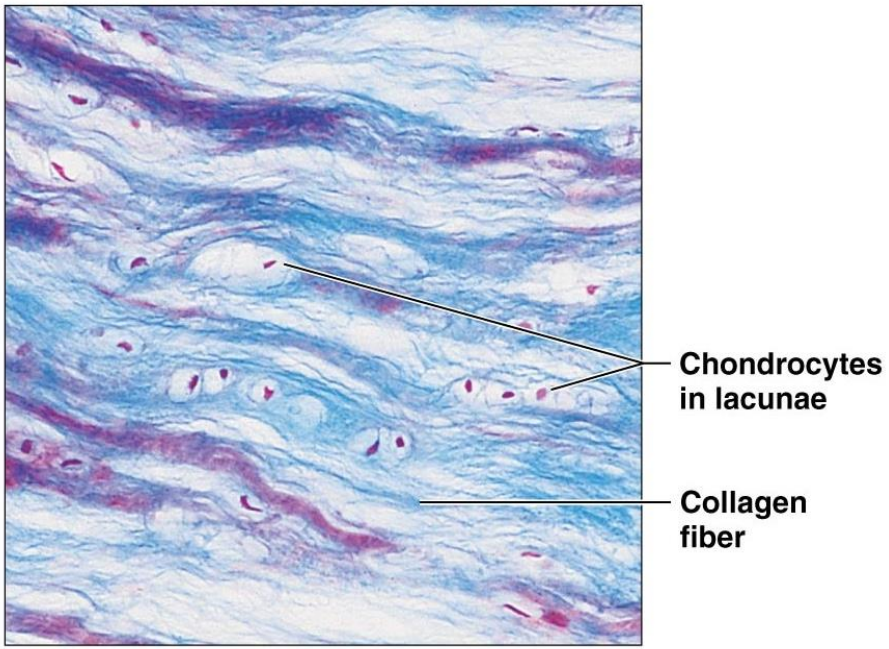


Hyaline vs Fibrocartilage

Hyaline cartilage



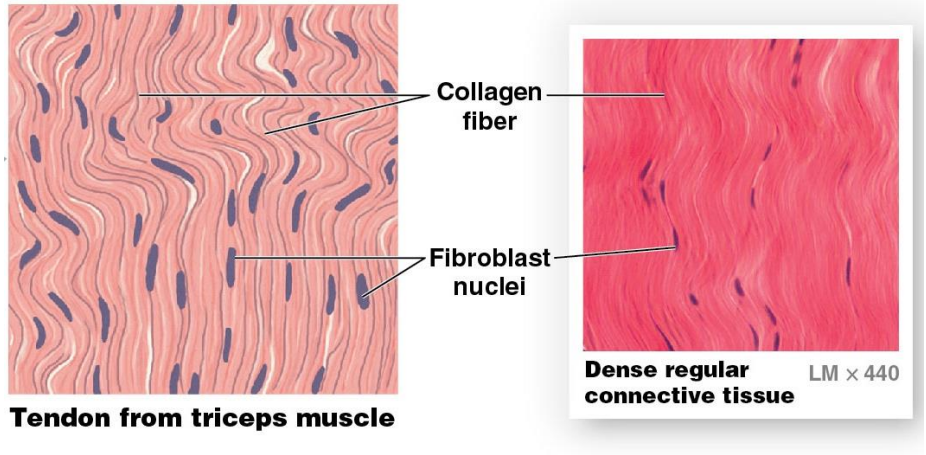
Fibrocartilage



Marieb & Hoehn, *Human Anatomy & Physiology*, 10th Edn, 2018

DFCT

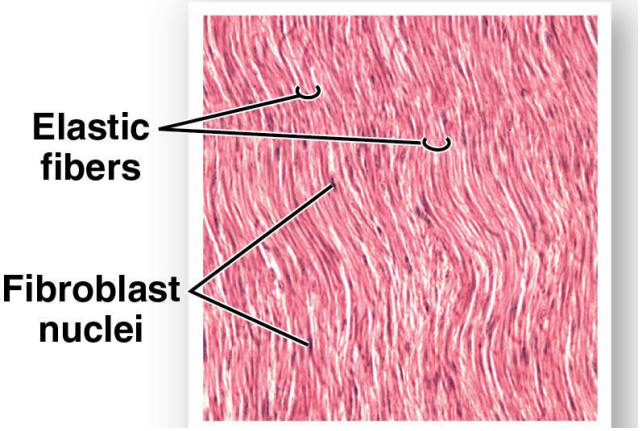
- Fibroblasts
- Collagen fibres
- (Some) elastin fibres
- Tightly packed
- Function = resist tension
- Little vascularity
- Slow to heal

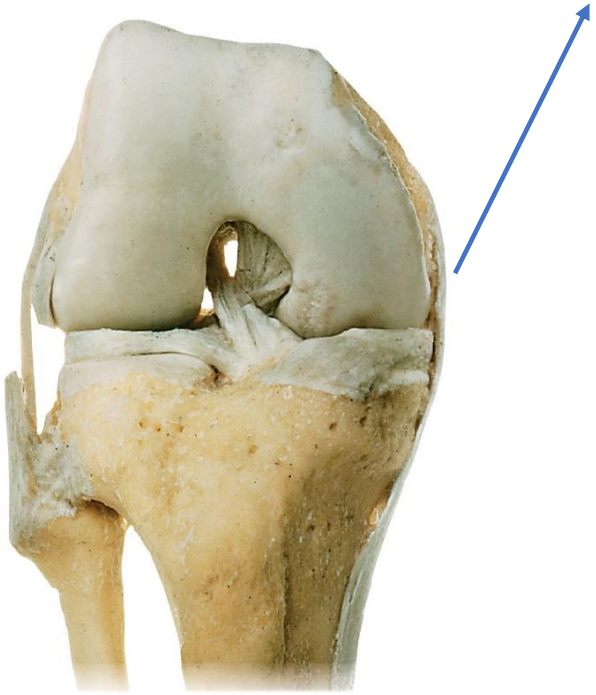


Martini *et al*, *Visual Anatomy & Physiology*, 3rd Edn, 2018, p.204

Ligaments

- Connect bone to bone
- Collagen and elastin
  - resist tension
  - allow a little stretch and recoil
- Restrict movement (away from themselves)





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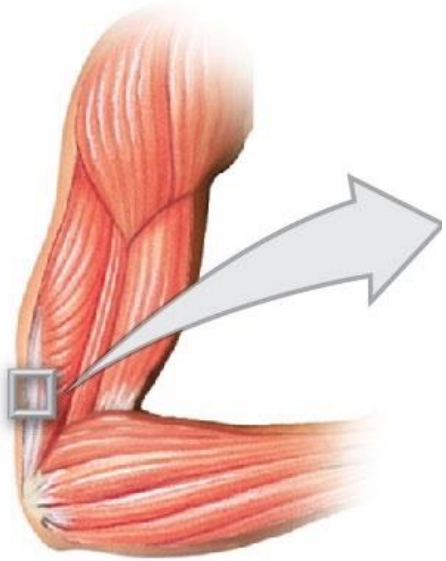
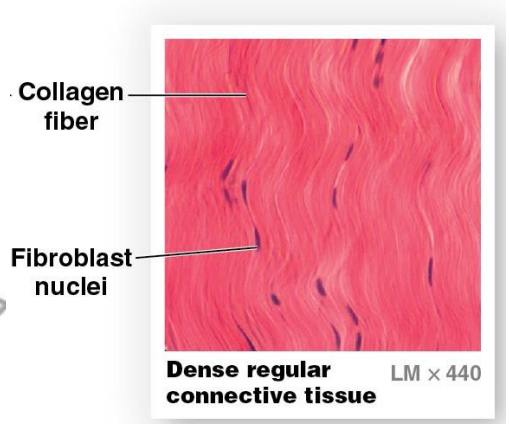
Tendons

- Connect muscle to bone
- Less elastin than ligaments
- Facilitates and controls movement
- Contraction of muscles transmitted to bone

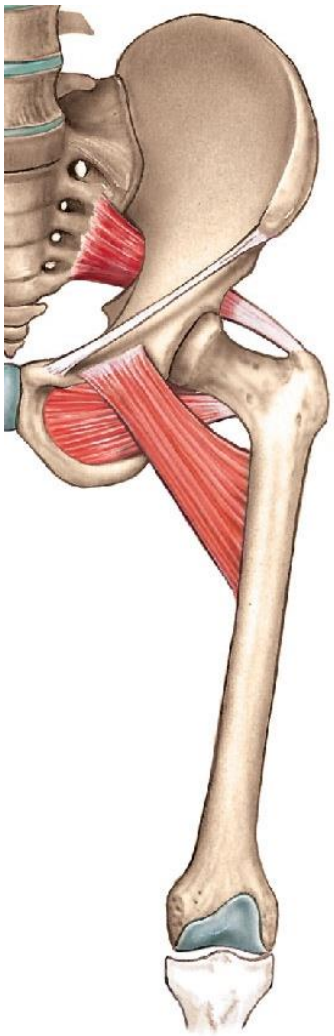




Martini *et al*, *Visual Anatomy & Physiology*, 3rd Edn, 2018, p.204

Bony congruence

- Sum of bone surfaces that form an articulation
- Less congruence = more soft tissue support needed



True or False?

- Tendons connect bone to bone
- The primary centre of ossification is the epiphysis
- Hyaline cartilage has a high water content

Joint Classifications

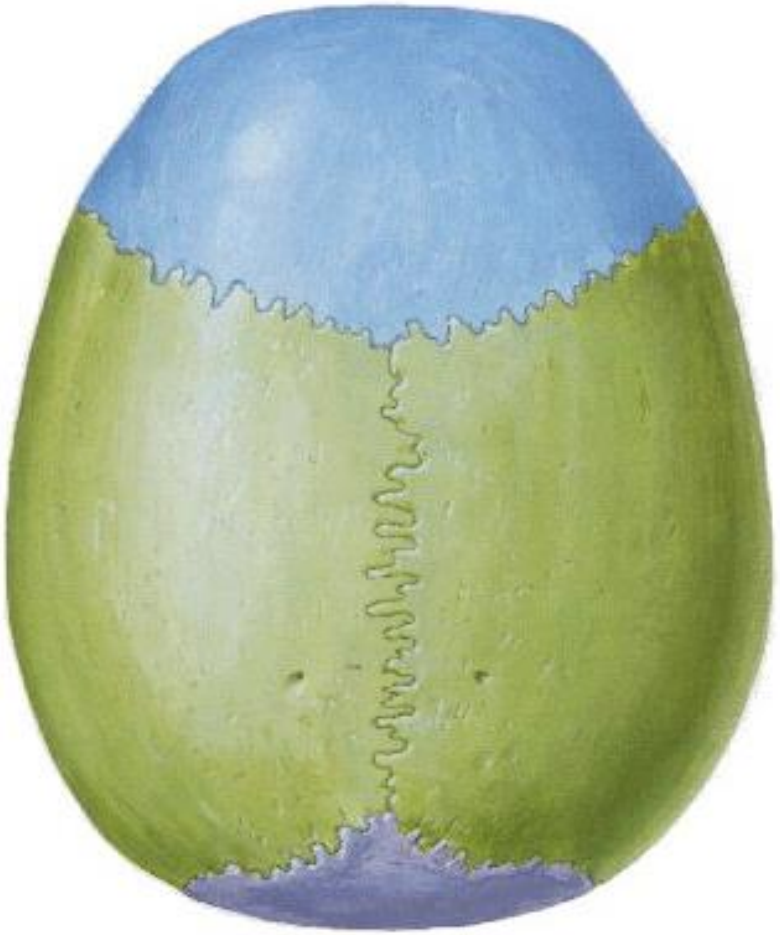
- Fibrous = least amount of movement
- Cartilaginous
- Synovial = most amount of movement

Some terminology:

- Tissue
  - cells grouped together in a highly organized manner according to specific structure and function
  - e.g. DFCT
- Structure
  - something formed of a tissue
  - e.g. ligament

Fibrous joints

- Tissue = DFCT
- Structure = ligament
- Function =
  - limit movement
  - provide stability
- E.g. cranial sutures
  - stability for skull
  - Protects brain



Netter, *Atlas of Human Anatomy*, 2004

Fibrous joints

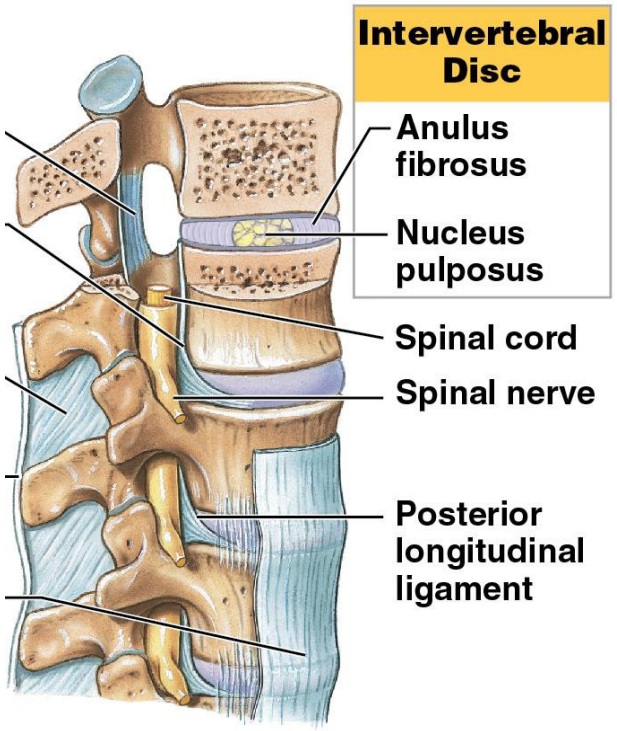
- Tissue = DFCT
- Structure = ligament
- Function =
  - limit movement
  - provide stability
- E.g. distal tibiofibular joint
  - stability for ankle
  - Prevents rotational movements at ankle joint

Cartilaginous joints

- Tissue = fibrocartilage
- Structure = varies
- Function = some movement

- Bones connected entirely by fibrocartilage

- E.g. Intervertebral disc



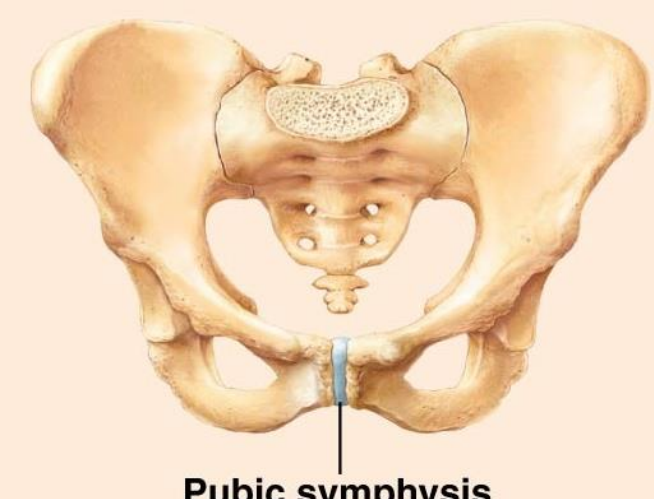
Martini *et al*, *Visual Anatomy & Physiology*, 3rd Edn, 2018, p.267

Cartilaginous joints

- Tissue = fibrocartilage
- Structure = varies
- Function = some movement

- Bones connected entirely by fibrocartilage

- E.g. pubic symphysis



Synovial joints

- Tissues = many
- Structures = many
- Function = allow lots of movement

- E.g. most joints in appendicular skeleton

- Details next lecture

Practice questions

1. Which of the following tissues/structures resists both compression and tension?

A. Ligament

B. Tendon

C. Hyaline cartilage

D. Fibrocartilage

2. _____ allow bones to grow in length while growth in width occurs via _____.

A. primary ossification centres; secondary ossification centres

B. growth plates; appositional growth

C. appositional growth; epiphyseal plates

D. osteoclasts; osteoblasts

Mini-Essay Practice

- Compare the structure and function of the three classes of joints. Include a description of the tissues involved, and a specific example of each class of joint.

- Brainstorm what you know so far (2 out of 3 joints) & we'll look at an answer tomorrow!

Lecture summary

- Bone begins as cartilage, then undergoes ossification
  - primary and secondary ossification centres
  - Bone growth requires growth/epiphyseal plates, and appositional growth
- Joints require connective tissues
  - Cartilage
  - DFCT
- The three classes of joint are defined by the amount of movement they have

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