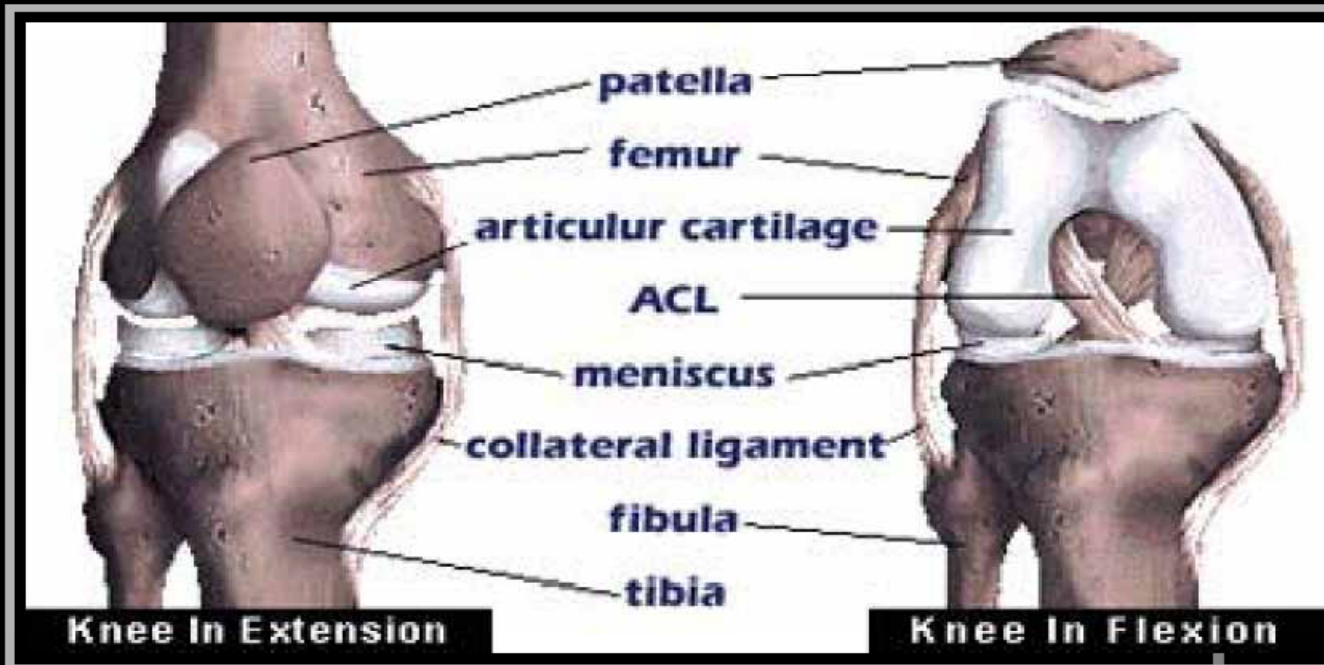


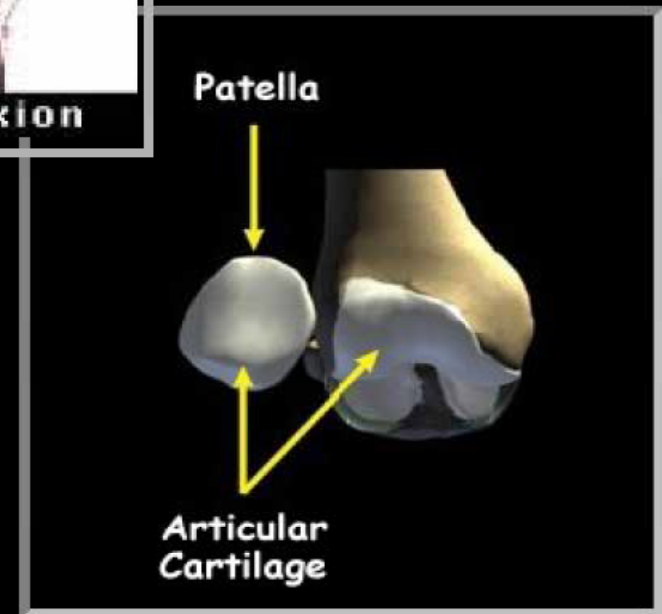
# Section 23: Articular Cartilage Structure and Function

# Articular Cartilage: Location



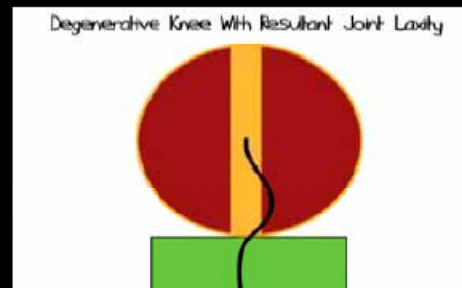
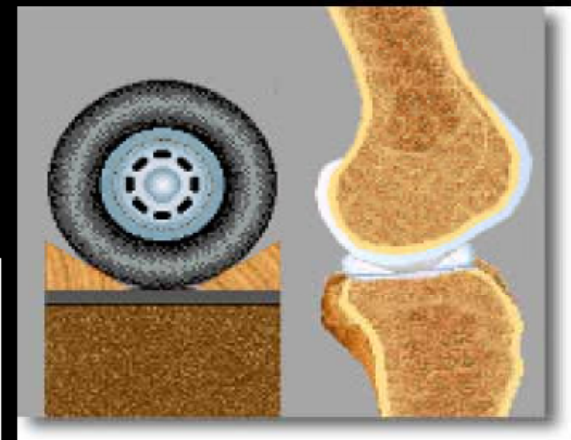
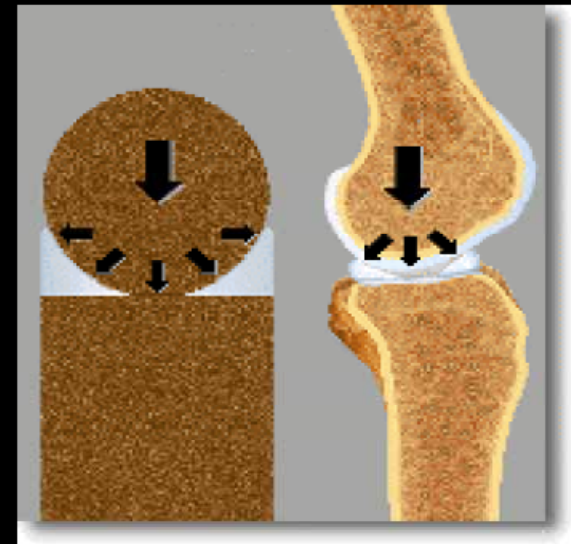
**Articular cartilage covers the joint surfaces:**

- Bottom of the femur
- Top of the tibia
- Back-side of the patella



# Articular Cartilage: Primary Functions

- Transmits applied loads across mobile surfaces
- Lines the ends of bones
- surfaces roll or slide during motion
  - Hyaline cartilage is fluid-filled wear-resistant surface
  - It reduces friction coefficient to 0.0025.



# Cartilage Types

- Distinguished by composition, microstructure, and mechanical properties
- Hyaline cartilage
  - Glassy-smooth and bluish-white
  - e.g. articular cartilage, and growth plate
- Elastic cartilage
  - Yellowish and opaque, more flexible than hyaline
  - e.g. epiglottis, external auditory canal
- Fibrocartilage
  - e.g. annulus fibrosus, meniscus

# Understanding cartilage tissue mechanics requires knowledge of

- Mechanical properties of normal cartilage
- Relationship between biochemical and structural factors in cartilage and its material properties
- How changes in composition and structure (with arthritis) affect mechanical properties of cartilage

# Structural Considerations

- Before we consider tissue mechanics, we must understand certain concepts of structural mechanics
- Cartilage tissue will be overloaded because of excessive loading through
  - High contact stresses
  - Excessive frictional forces

# Diarthrodial (articulating) joints

- Enclosed in strong fibrous capsule
- Inner surfaces of joint capsules are lined with synovium
  - Secretes synovial fluid – a lubricant
  - Provides nutrition
- Articular cartilage at the ends of bone on articulating surfaces

# Structure diarthrodial joints

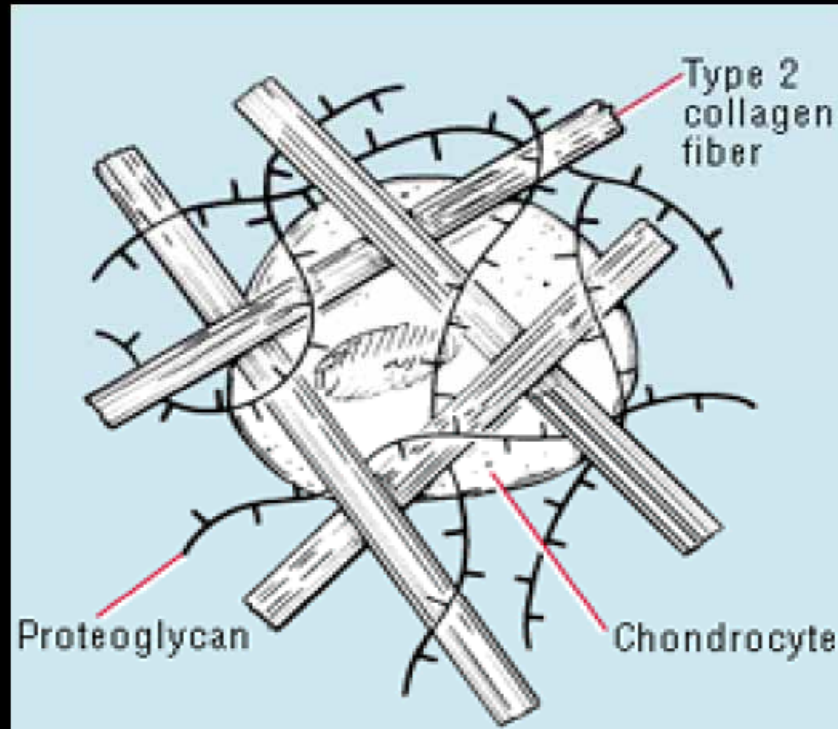
- Enclosed in fibrous capsule
- Lined with synovium (secretes fluid / provides nutrients)
- Articular cartilage lines each end of articulating bone
- Joint cavity formed from synovium and articular cartilage



# Composition

- Fluid phase: water and electrolytes
- Solid phase: chondrocytes (cells), collagen fibers (type I and II), proteoglycans & other glycoproteins
  - Collagen: key structure within connective tissue, hair-like, helical molecule
  - Proteoglycan: protein with 1 or more glycosaminoglycan (GAG) chains attached by covalent bonds

# Articular Cartilage: Composition

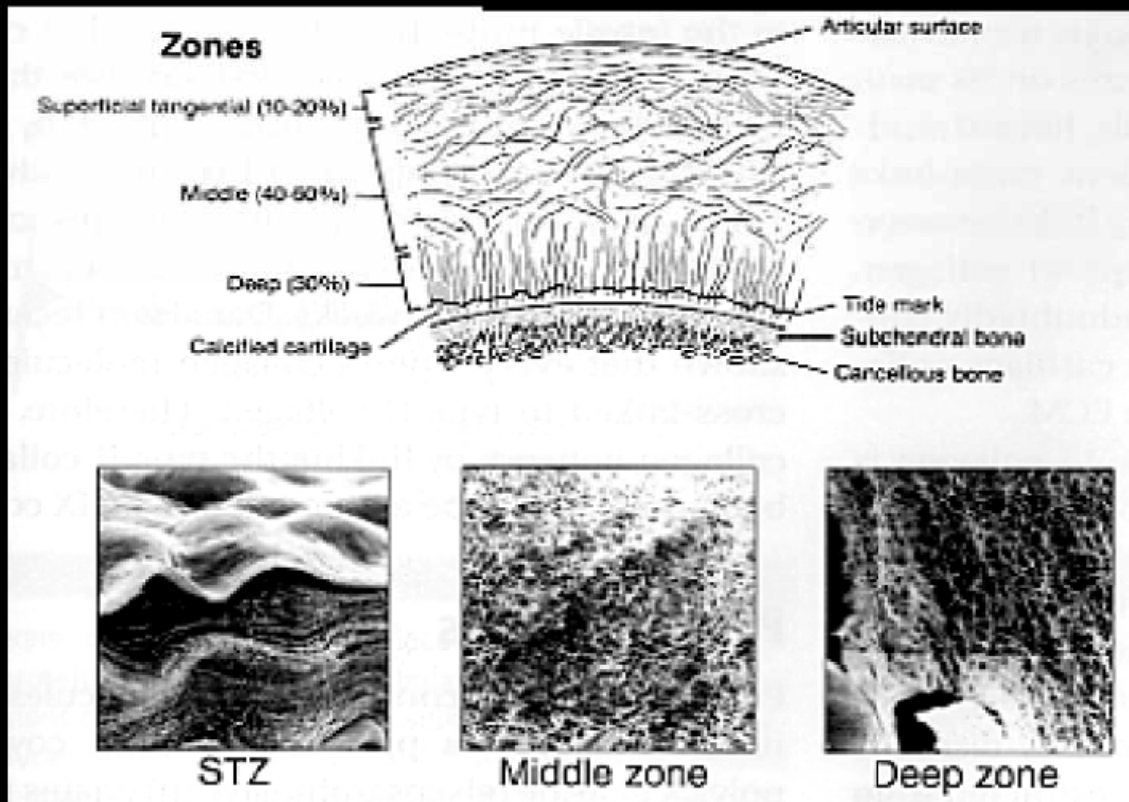


Components are arranged in a way that is maximally adapted for biomechanical functions

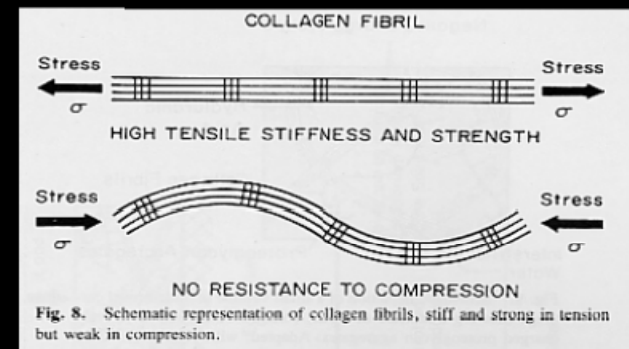
- Chondrocytes (~ 1%)
- Collagen (15%) (Type II in articular cartilage)
- Proteoglycans (15%)
- Water (70 %)

# Collagen (15%)

Creates a framework that houses the other components of cartilage



- Majority is Type II collagen
  - Provides cartilage with its tensile strength
- Look at Ligament & Tendon notes for structure of collagen fibers



# Collagen



Alpha chain



Triple helix



Tropocollagen molecule



Collagen fibril with quarter stagger array



Fibril with repeated banding pattern seen under electron microscope

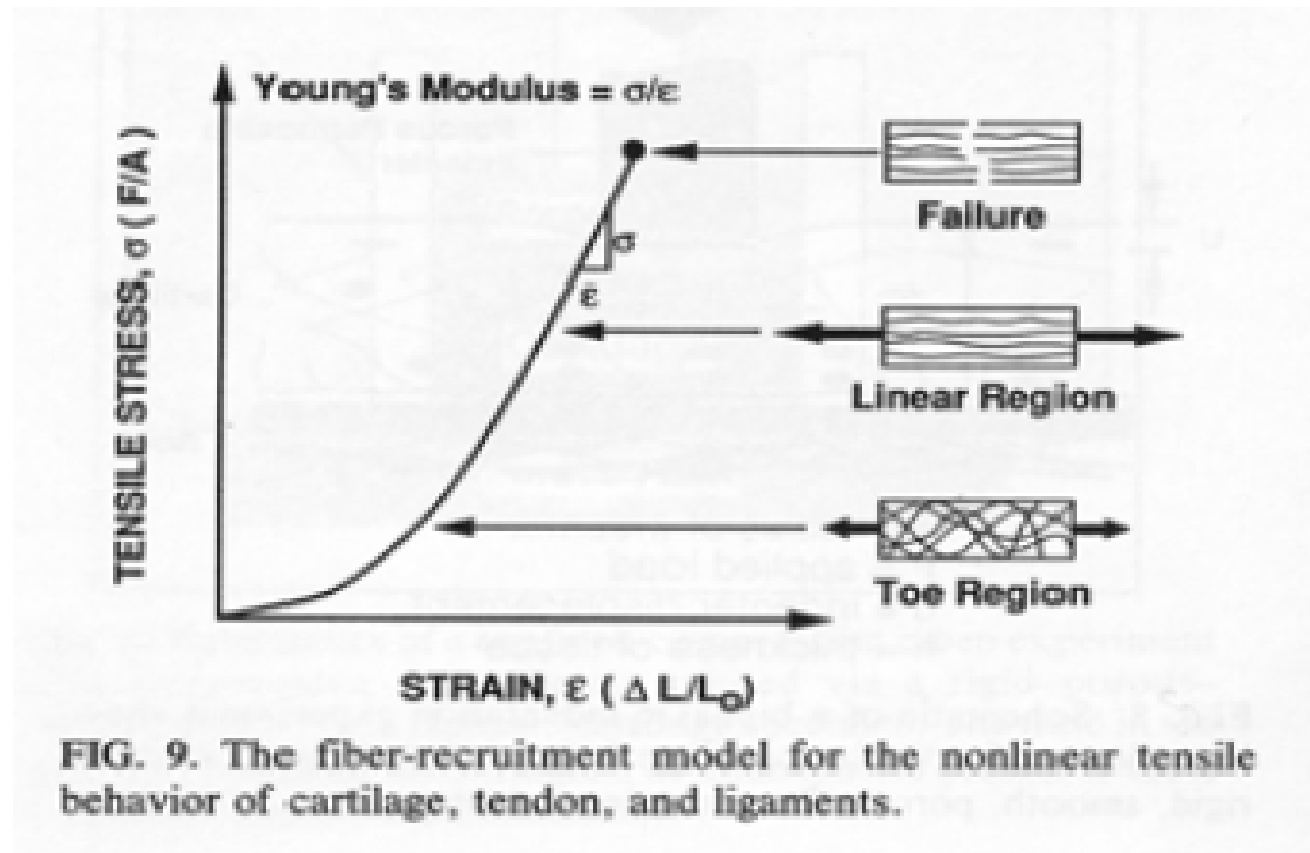
alpha chains are the building blocks.

What is the mechanical role of collagen?

Iatridis

ME208

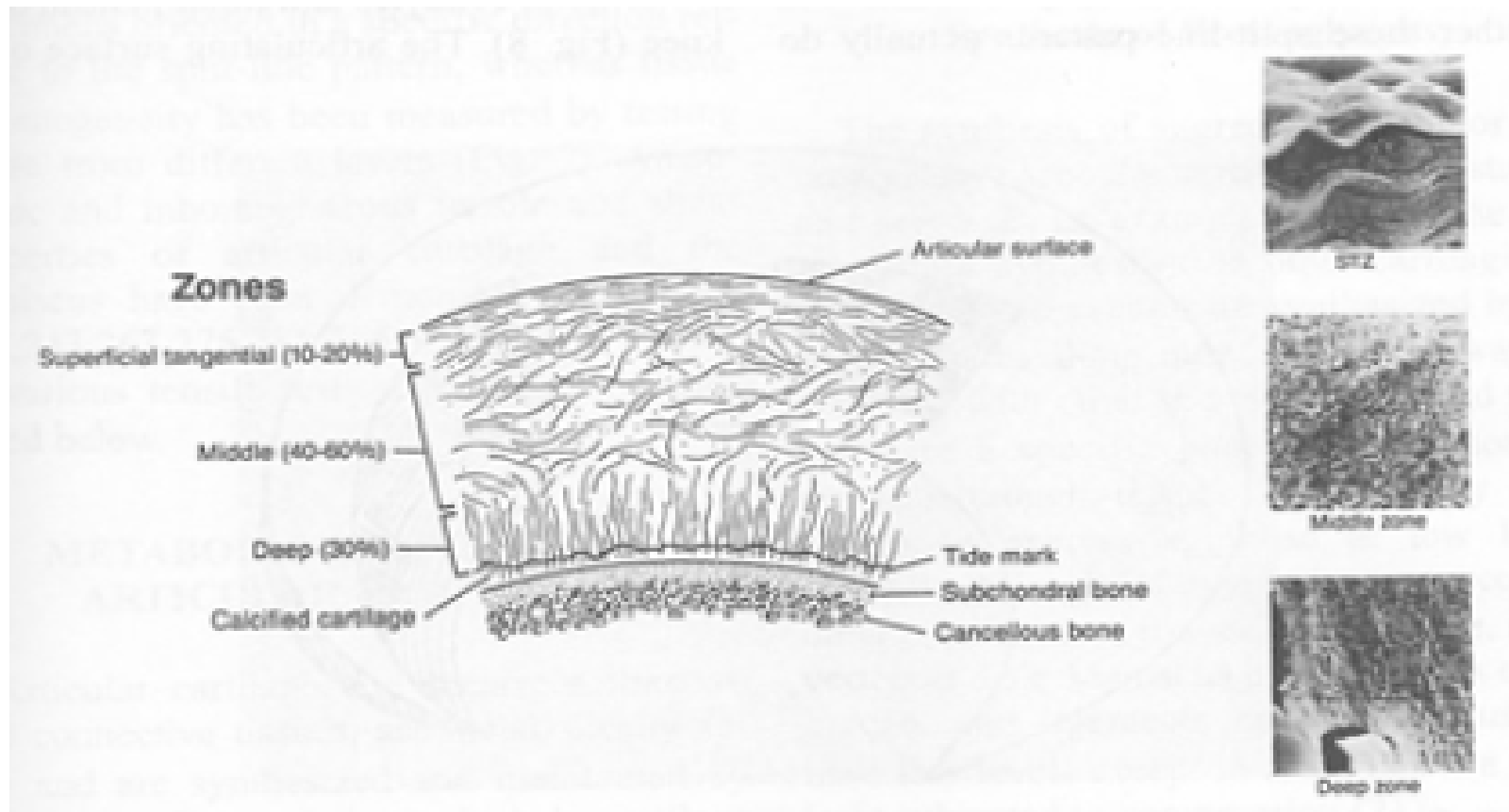
The mechanical role of collagen is to support tension in the extracellular matrix



# Articular cartilage structure

- Collagen
  - Dense at surface, parallel to surface
  - Fine fibers at surface, larger below
  - Middle zone random
  - Calcified cartilage
  - Perpendicular, thick fibers at calcified cartilage

# Extracellular matrix structure



Iatridis

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