

Skeletal Consideration for Movement

Kinesiology

RHS 341

Lecture 2

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The Skeletal System

Objectives

- List and describe the two major divisions of the skeletal system.
- List and describe the major functions of the skeletal system.
- Describe the types of various bone tissues, their locations, and functions.
- List, describe and give specific examples of the types of bones.

Objectives

- List and describe different types of joints and their functions.
- Degrees of freedom (joint motion).
- Close-packed versus Loose-packed position.
- List and describe various disorders and diseases of the skeletal system.

Skeletal System

- Bones, cartilage, ligaments, & joints
- Consists of approximately 20% of total body weight
- Bone constitutes the majority of structures in the skeletal system (206 bones)



Divisions of the Skeleton

- The Skeleton is divided into two major regions:

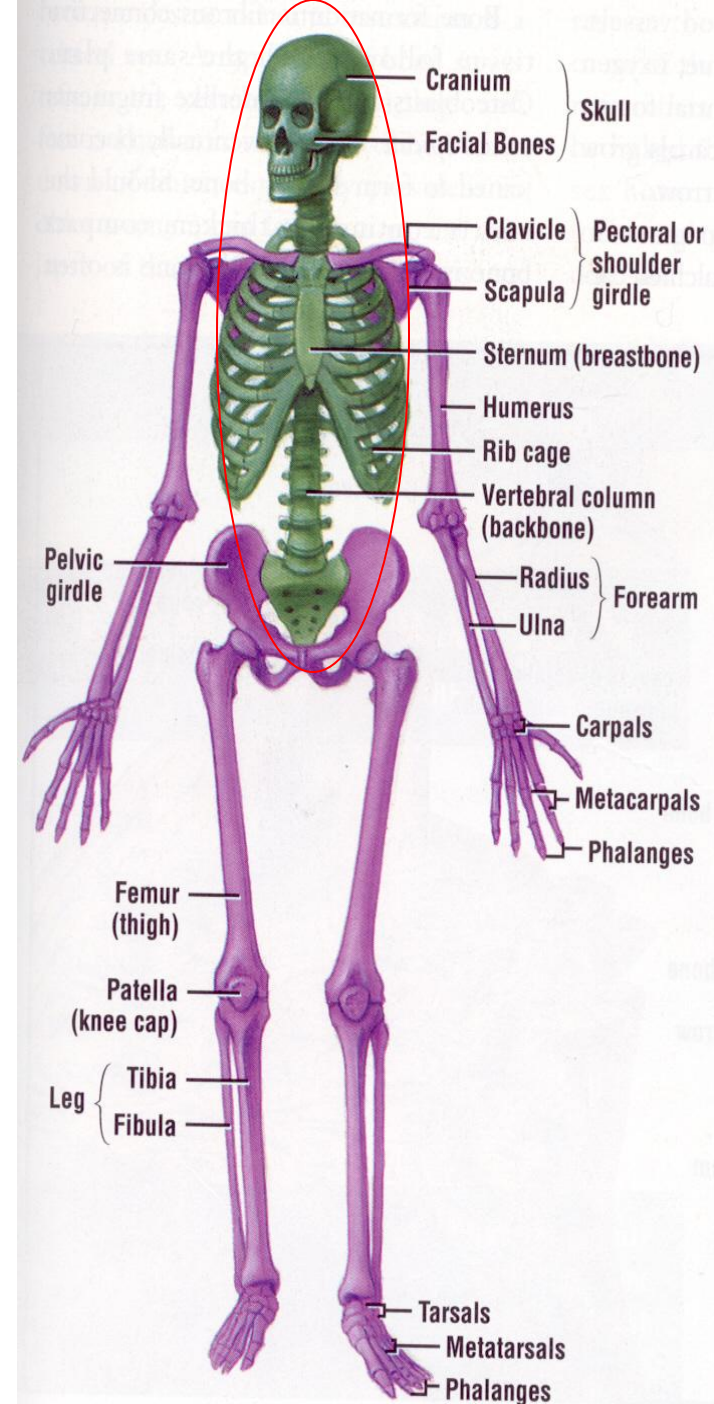
a. Axial Skeleton

b. Appendicular Skeleton

- **The Axial Skeleton** forms the longitudinal part of the body
 - ✓ 80 bones (head (29), thorax (51))

- Divided into three parts

- Skull
- Vertebral column
- Bony thorax

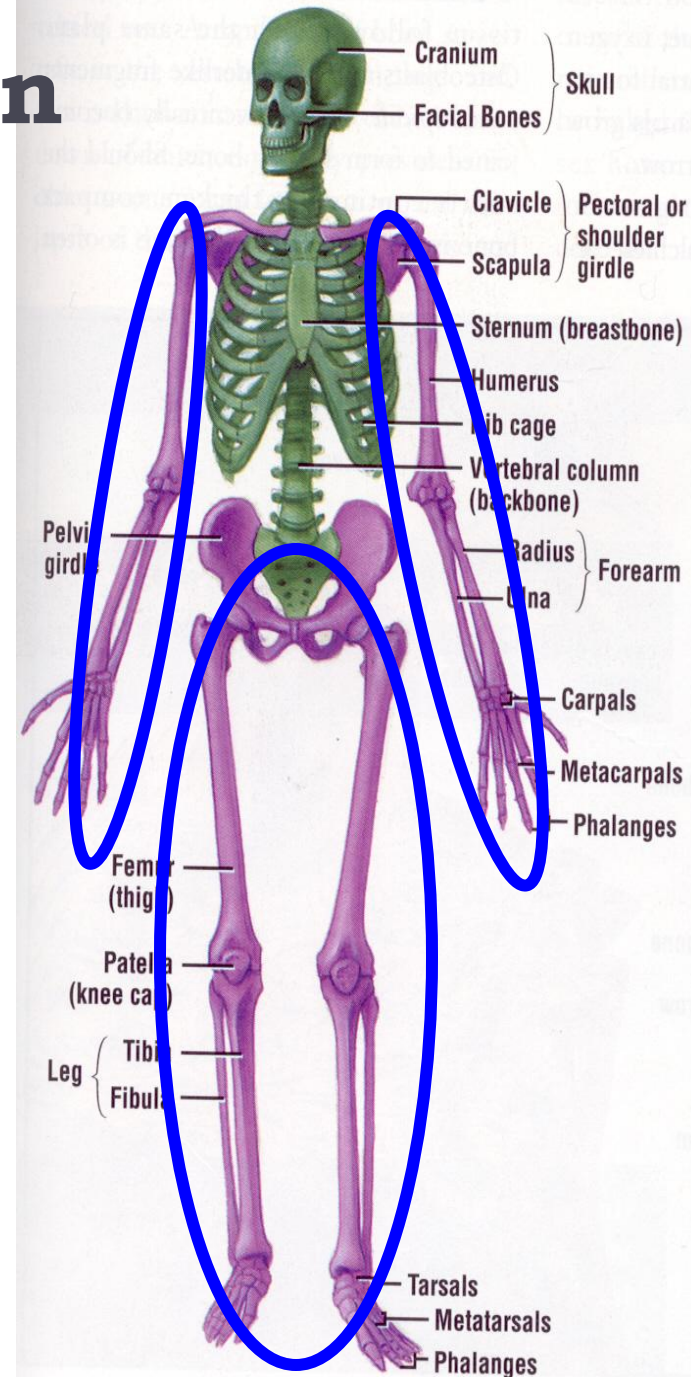


Divisions of the Skeleton

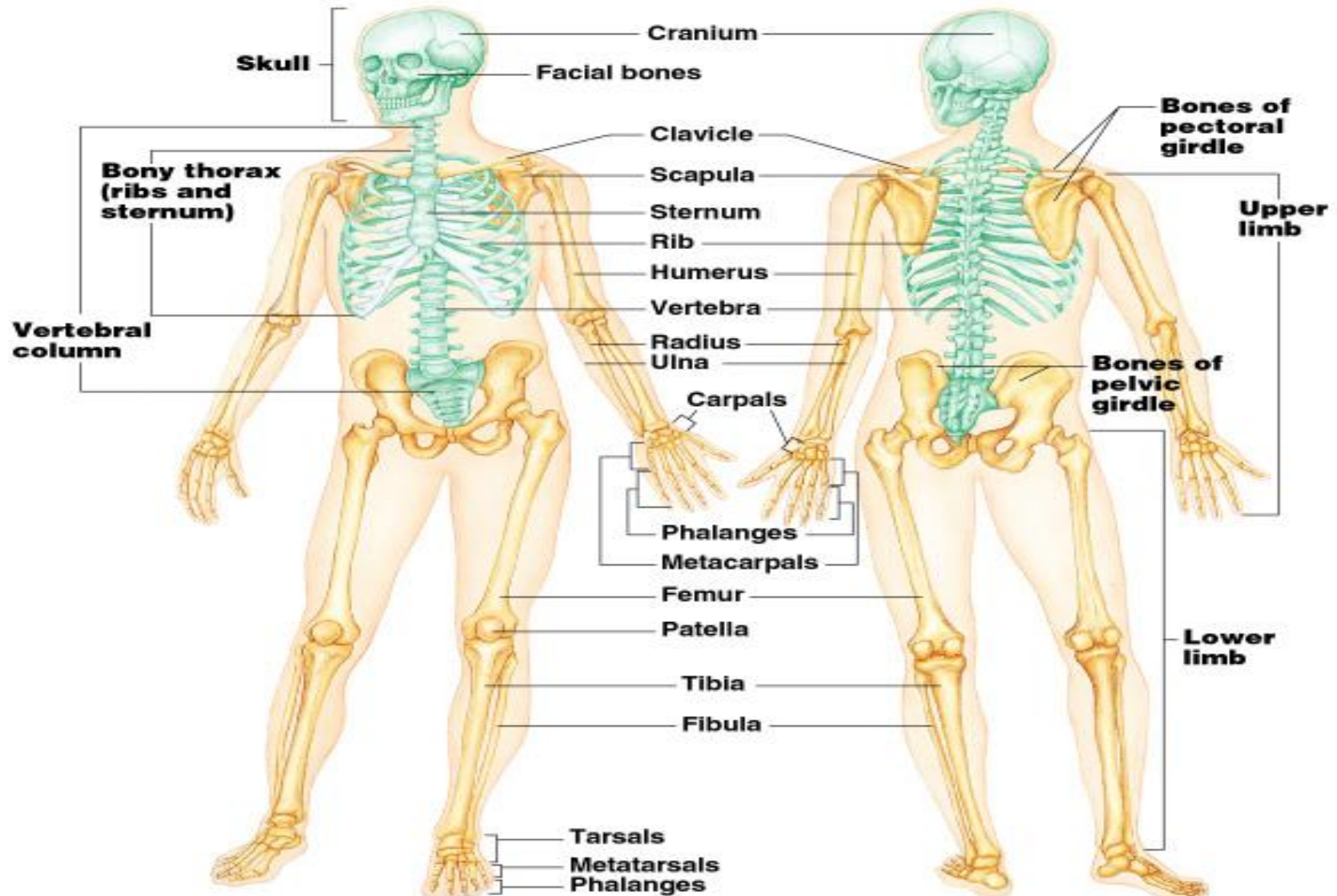
- **The Appendicular skeleton** is composed of the appendages and the joints which attach them to the axial skeleton

- ✓ 126 bones
- ✓ upper (32)
- ✓ lower (31)
- ✓ Girdles

- **Upper & Lower Limbs** (appendages)
- **Shoulder girdle** (shoulder, scapula, and clavicle)
- **Pelvic girdle** (pelvis)



Divisions of the Skeleton



(a) Anterior view

(b) Posterior view

Functions of Skeletal System

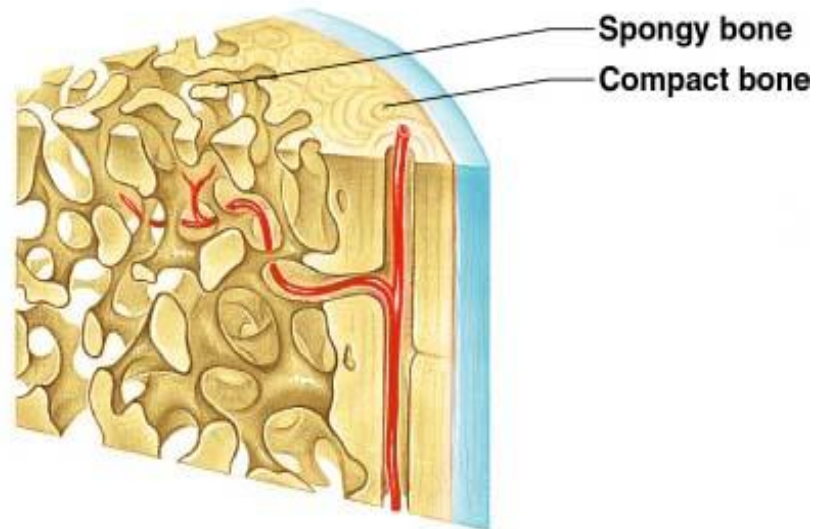
- **SUPPORT:** Hard framework that supports and anchors the soft organs of the body.
- **PROTECTION:** Surrounds organs such as the brain and spinal cord.
- **LEVERAGE :** attachment for muscles to produce movement.
- **STORAGE:** Minerals and lipids are stored within bone material.
- **BLOOD CELL FORMATION:** The bone marrow is responsible for blood cell production.

Leverage

- Lever = a simple machine that magnifies the force and/or speed of movement
- The long bones act as the levers about which the muscular system generates the movements.
- **Morphology** = the shape & structural arrangement of the bones & articulations
—————→ determine movement

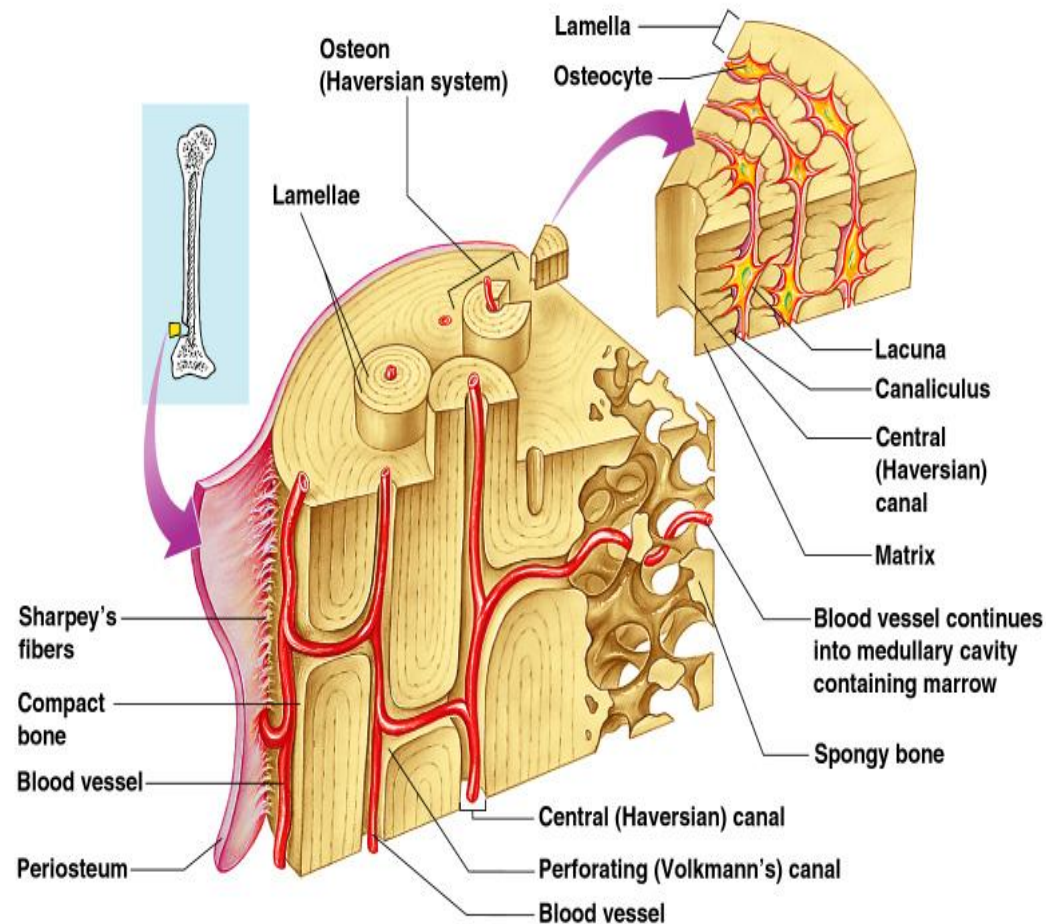
Architecture of bone (osseous tissue)

- **Two basic types of bone tissue**
 - 1) Compact bone
 - 2) Cancellous (spongy) bone



1. Cortical (compact) bone

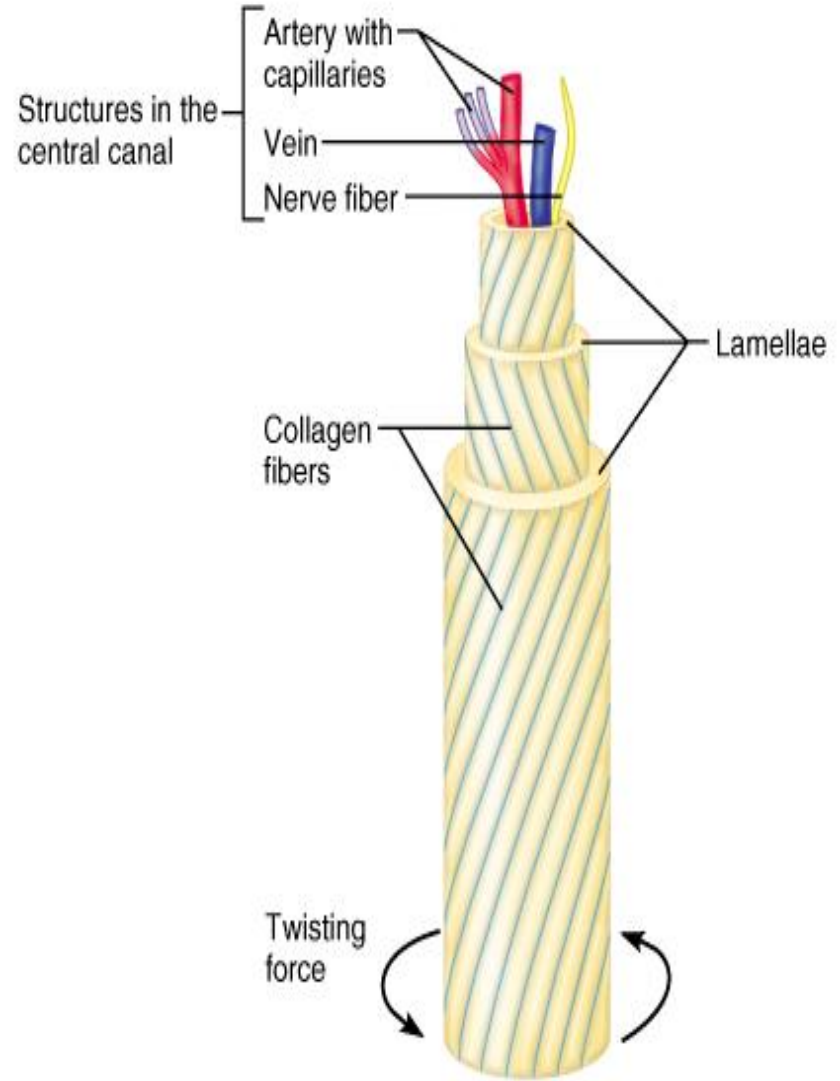
- The exterior dense layer of the bone
- Consists of hollow tubes called **lamellae** (collagen fibers that are arranged in layers and run in different directions)
- A series of lamellae form an **osteon or haversian system**



□ Osteon or Haversian

System: A unit of bone
(weight-bearing pillars)

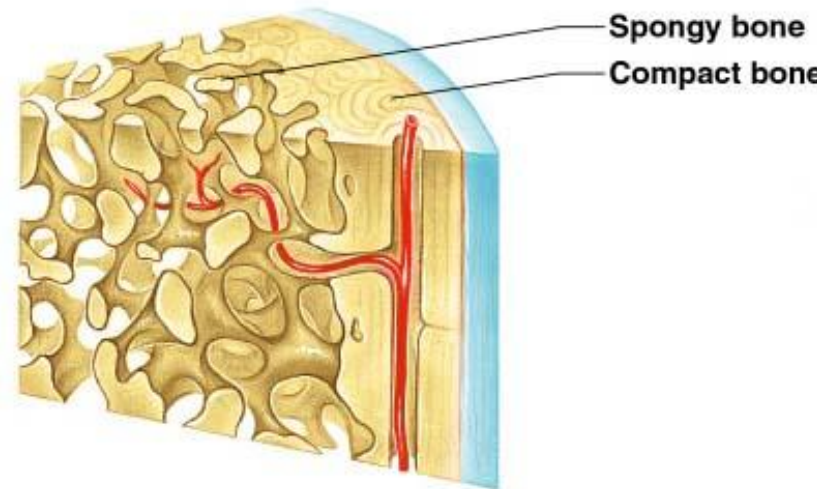
- Provides strength for weight bearing & stiffness in response to muscle tension
- **Central (Haversian) canal**
 - Opening in the center of an osteon
 - Carries blood vessels and nerves



Architecture of bone (osseous tissue)

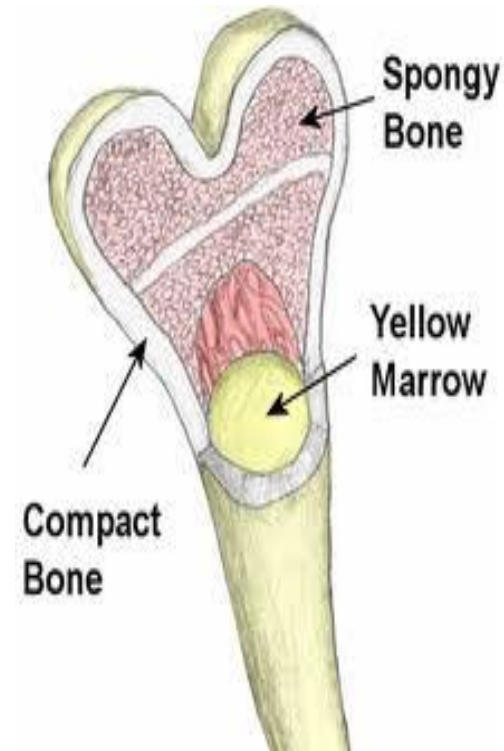
2. Cancellous (spongy) bone :

- interior to cortical bone
- consists of flat pieces of bone called **trabeculae** (collagen runs along the axis of the trabeculae)
- Provides energy absorption & stress distribution in response to loads
- Not as strong as cortical bone (risk of fracture in the elderly)



Bone Structure

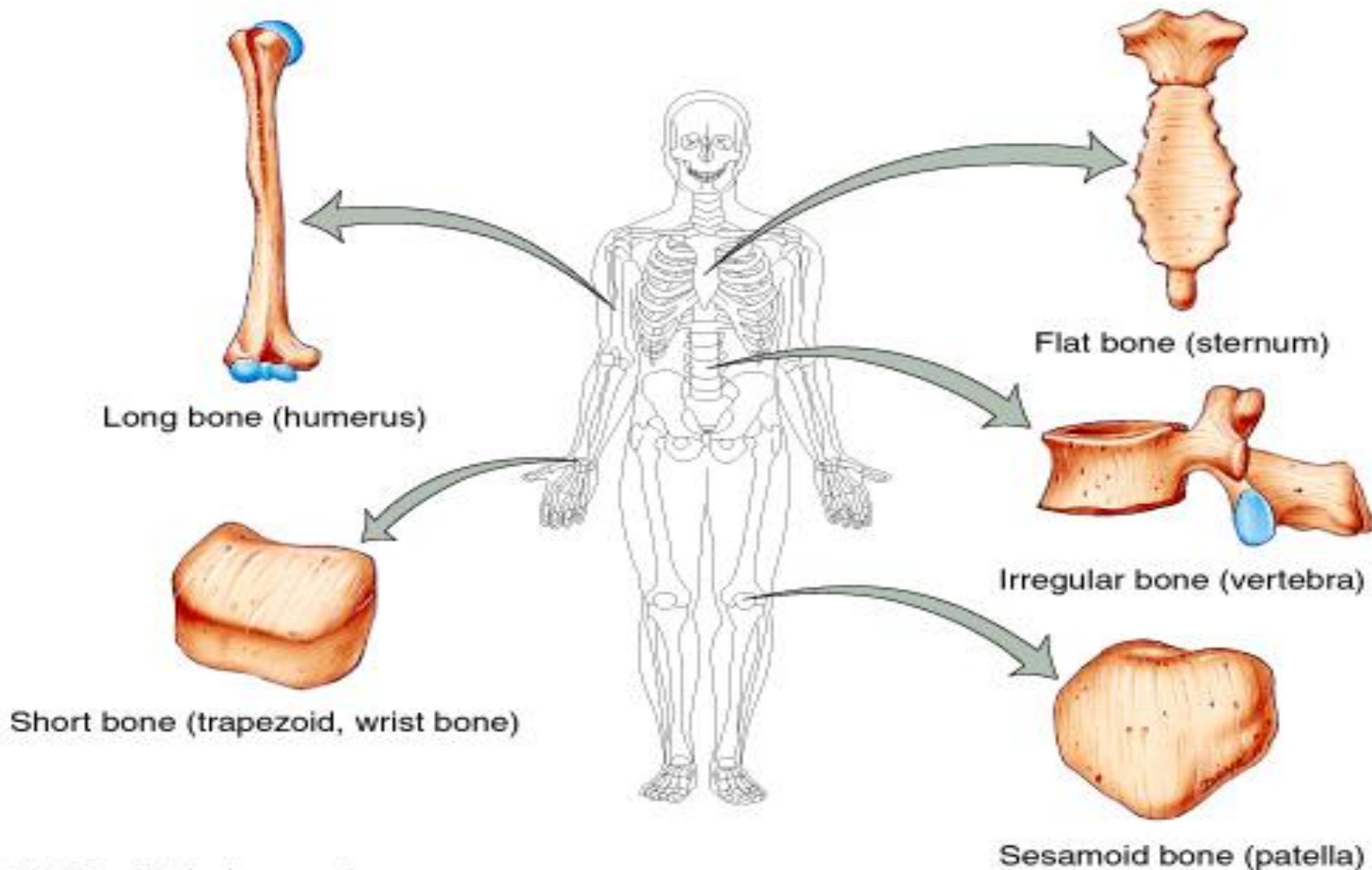
- **Periosteum** – hard outer covering
 - Cells for growth and repair
- **Compact bone** – hard strong layer
 - Bone cells, blood vessels, protein with Ca and P
- **Spongy bone** – at ends of long bones
 - Has small open spaces to lighten weight
- **Marrow cavity** – hollow in middle of long bones



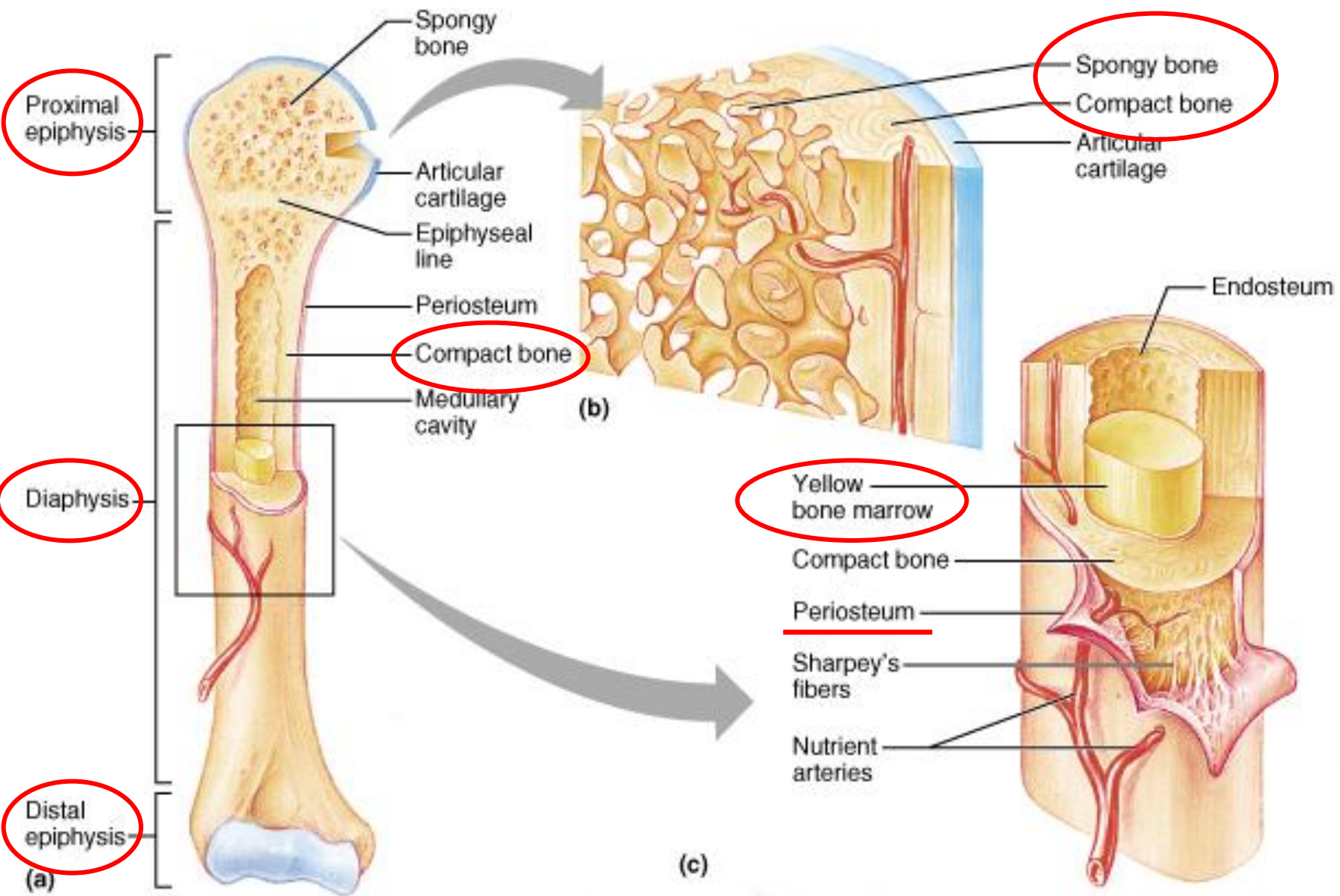
Bone Marrow

- Red marrow – produces blood cells and clotting factors
 - Found in humerus, femur, sternum, ribs, vertebrae, pelvis
 - Produces RBC 2 million per second
- Yellow marrow – stores fat
 - Found in many bones

Classification of Bones by Shape



Types of Bones: 1) Long Bones



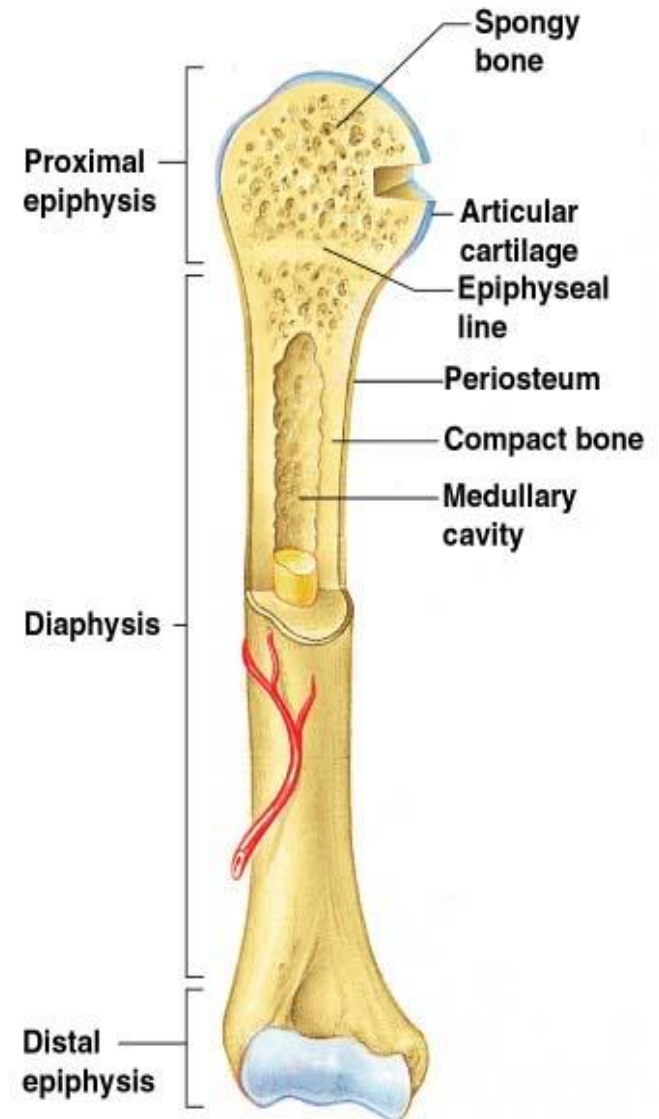
Long Bones

- **Consist of:**
 - a shaft called **diaphysis** (made of compact bone),
 - Which broadens out into the **epiphysis** (made up of spongy bone inside a thin layer of compact bone)
- **Function:** support and leverage
- **Example:** humerus, radius, ulna, femur, tibia, fibula, metacarpals, metatarsals



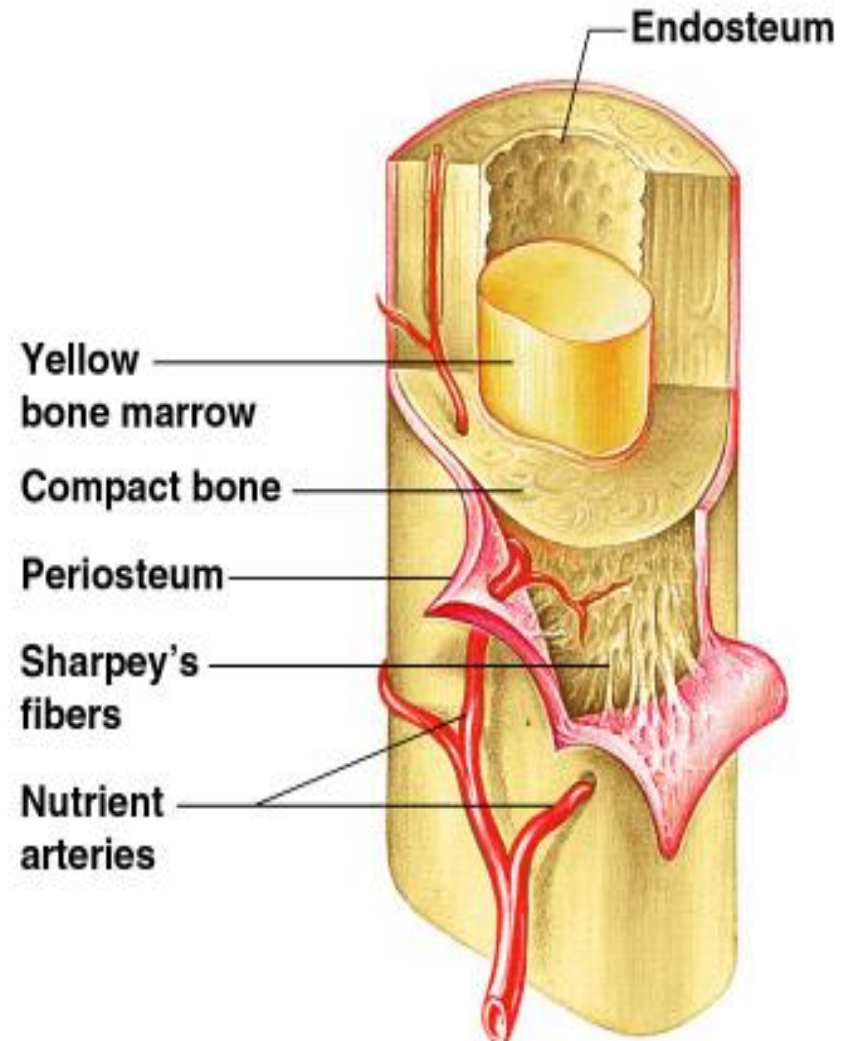
Gross Anatomy of a Long Bone

- **Diaphysis**
 - Shaft
 - Composed of compact bone
- **Epiphysis**
 - Ends of the bone
 - Composed mostly of spongy bone
- **Medullary cavity**
 - Cavity of the shaft
 - Contains yellow marrow (mostly fat) in adults
 - Contains red marrow (for blood cell formation) in infants
- **Articular cartilage**
 - Covers the external surface of the epiphyses
 - Made of hyaline cartilage
 - Decreases friction at joint surfaces

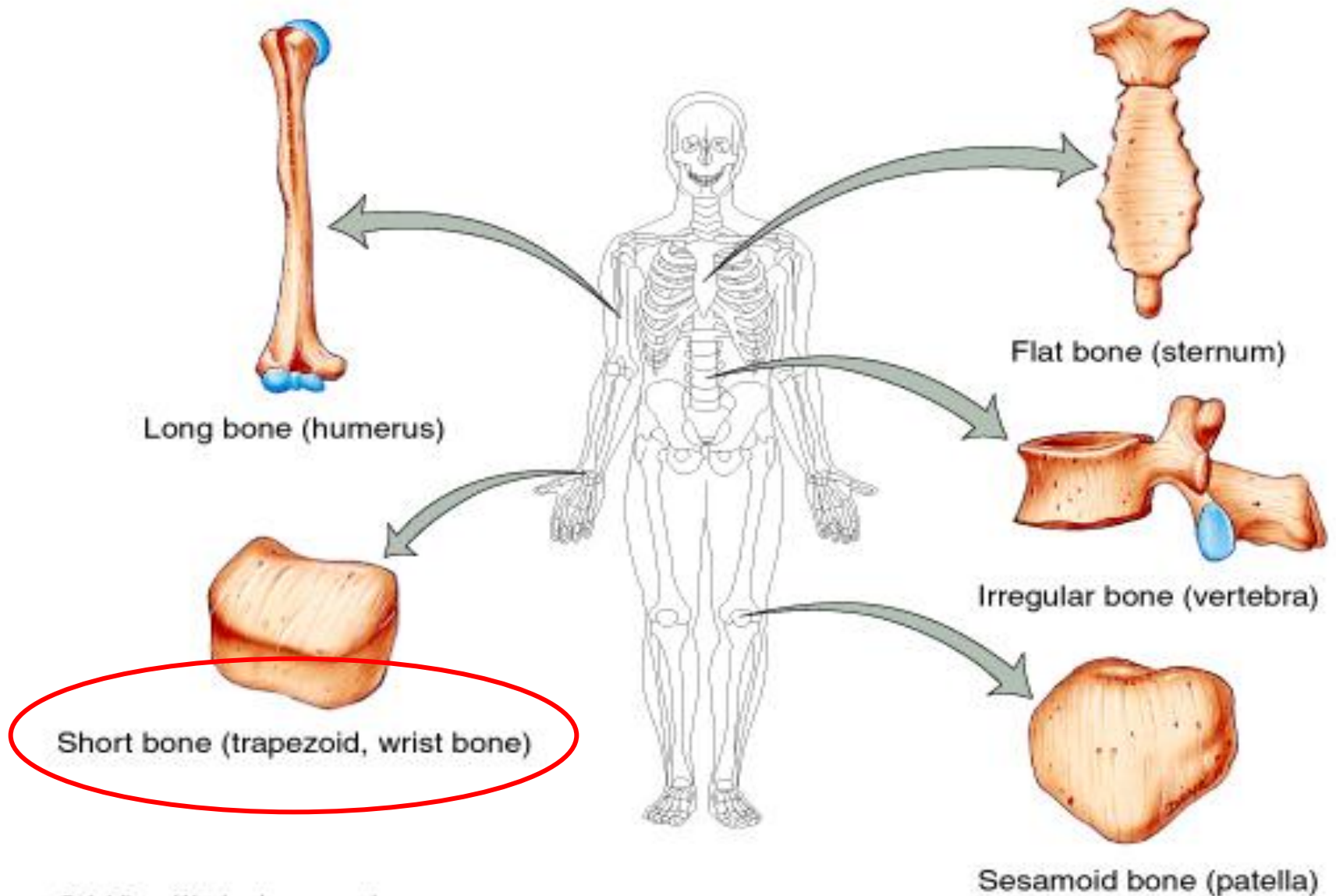


Gross Anatomy of a Long Bone

- **Periosteum**
 - Outside covering of the diaphysis

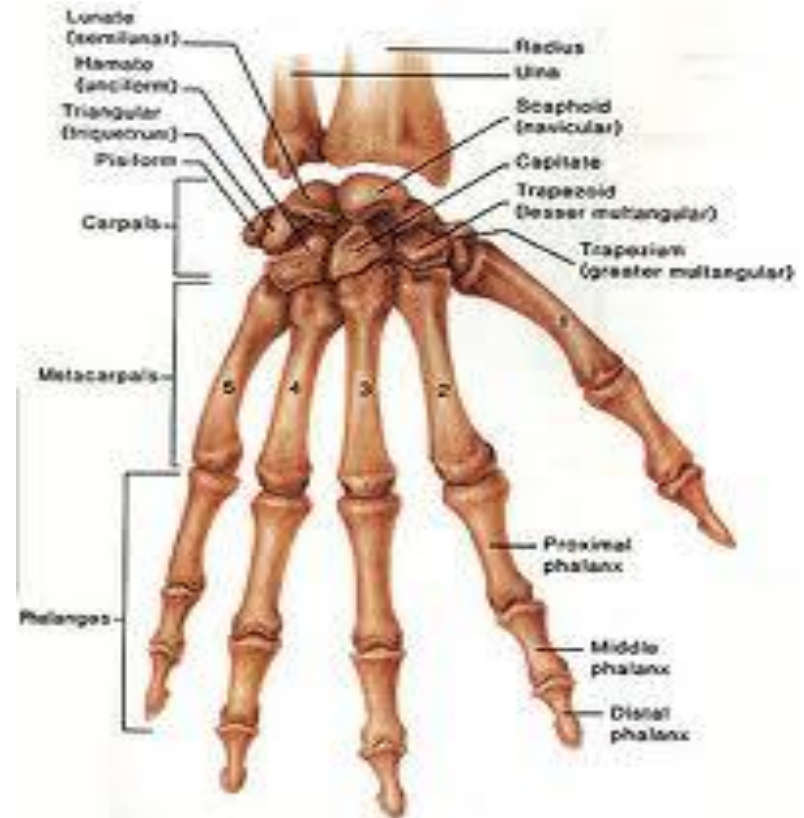


Types of Bone



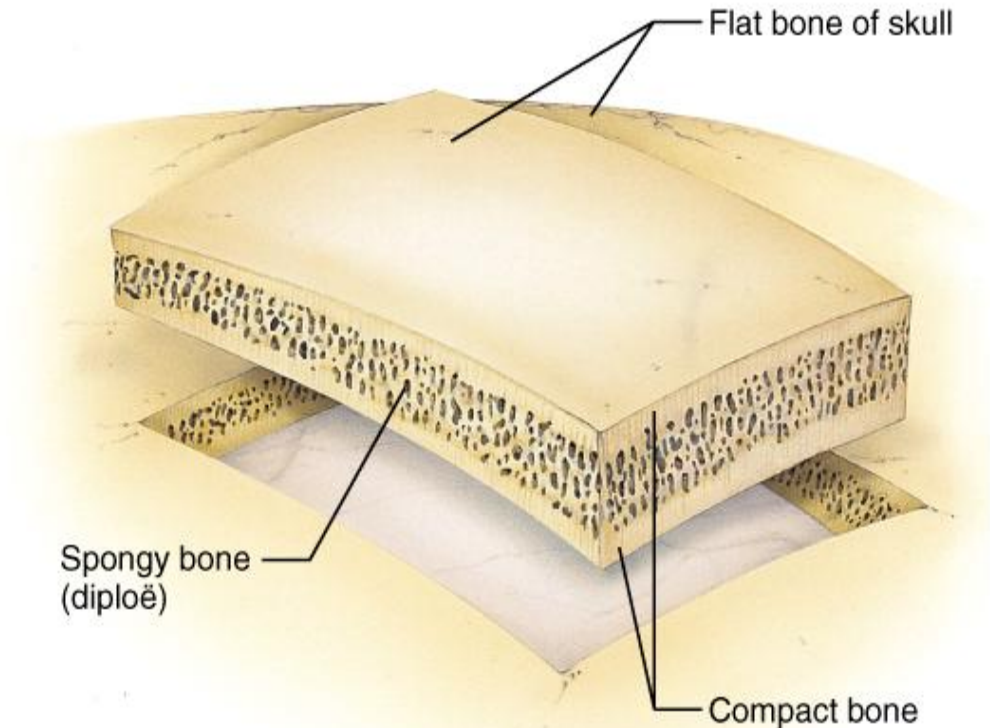
Types of Bone

- **2- Short bones**
- Consist of spongy bone covered with a thin layer of compact bone
- Play an important role in shock absorption and transmission of forces
- Example: carpals of the hand and the tarsals of the foot



Types of Bone

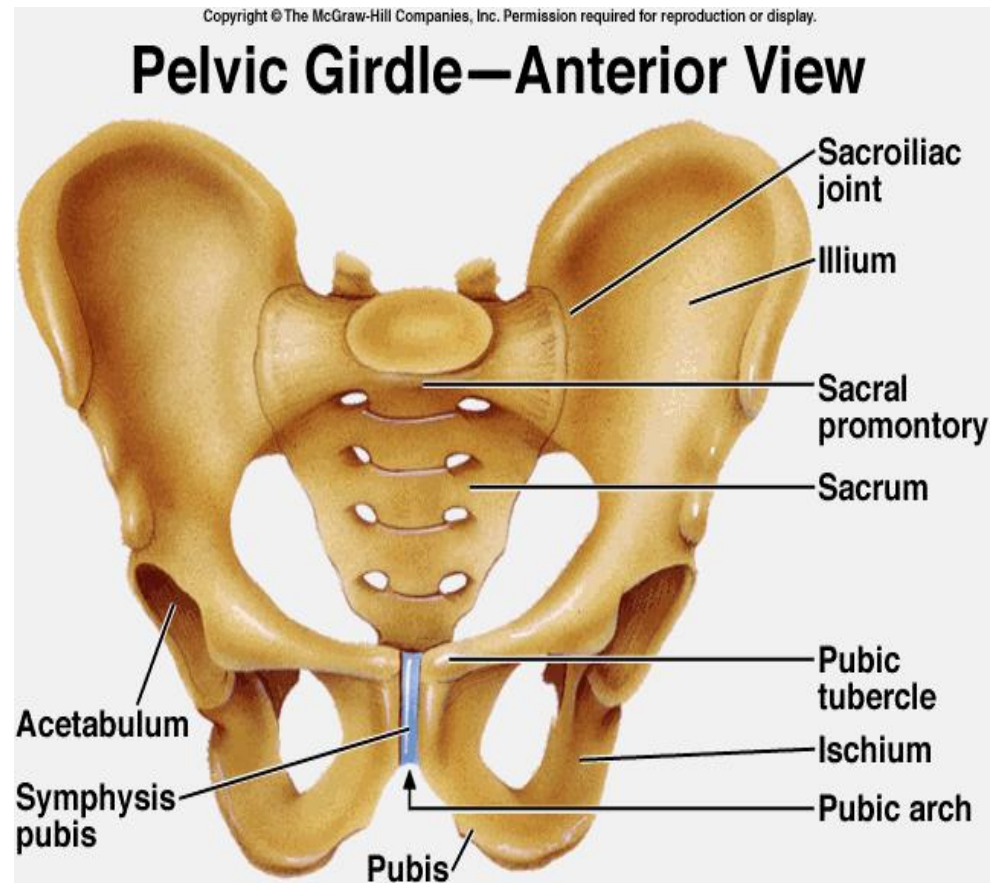
- **3- Flat bones**
- Flat , plate-like bones.
- **Consist of:** two layers of compact bone with spongy bone in between.



Types of Bone

3- Flat bones

- **Function:** protect internal structures and offer broad surfaces for muscle attachments
- **Example:** ribs, illium, sternum, scapula



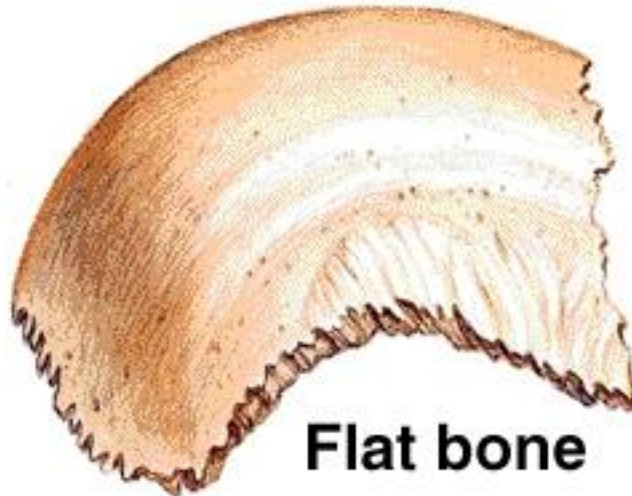
Bone Types



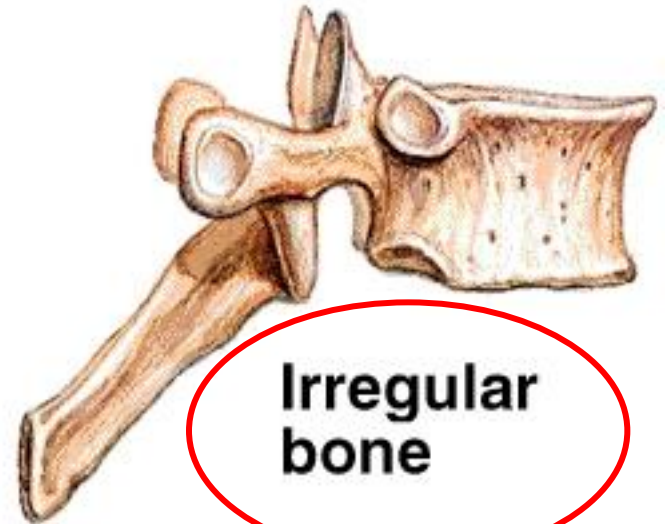
Long bone



Short bone



Flat bone



**Irregular
bone**

Types of Bone

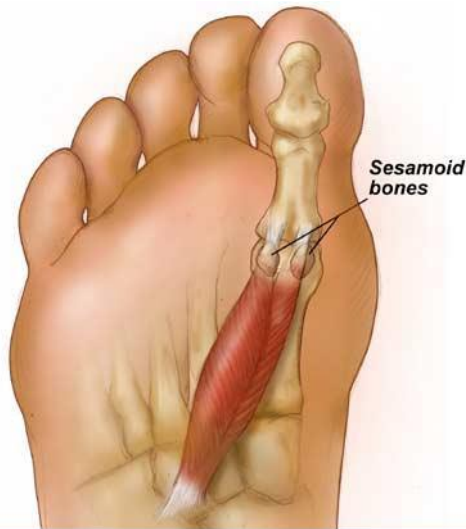
4- Irregular bones

- **Consist of:** spongy bone and thin exterior layer of compact bone
- **Specialized functions** such as: supporting the weight, protecting the spinal cord, dissipating loads
- Example: vertebrae, ischium, pubis

Types of Bone

5- Sesamoid bones

- Short type of bone embedded in a tendon or joint capsule



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e.g.: sesamoid bones within the flexor tendons of the great toe & thumb



e.g.: the patella embedded in the quadriceps tendon,

Types of Bone

5- Sesamoid bones

Function:

- **Increase the tendon's mechanical effect**
 - The presence of the sesamoid bone holds the tendon slightly farther away from the center of the joint and thus increases its moment arm.
- **Protect the tendon**
 - prevent the tendon from flattening into the joint as tension increases



Articulations: Joints

- **A joint** is a location where two or more bones meet.
- **Functions of joints**
 - Hold bones together
 - Allow for mobility
- **Joints can be classified**
 - Functionally
 - Structurally



Types of Joints

Structural → **Synovial**

Functional → **Diarthroidal**
Freely movable
e.g.: hip joint

Cartilagenous

Amphiarthroidal
Slightly movable
e.g.: intervertebral
discs

Fibrous

Synarthroidal
Immovable
e.g.: Sutures of
the skull

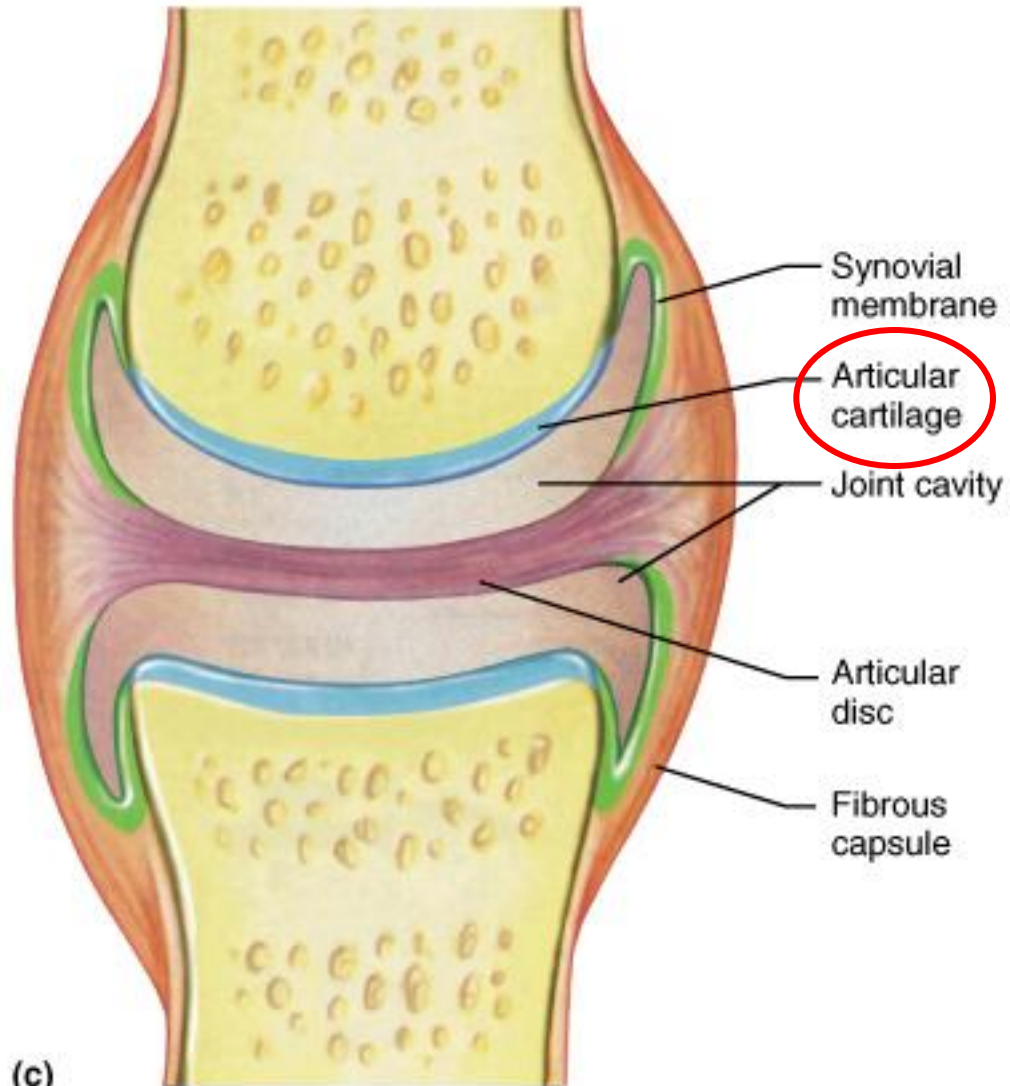
Characteristics of Synovial Joints

- **Articular end plate** = a thin layer of compact bone over the spongy bone (covering the ends of the bones)



Covered by:

- **Articular (hyaline) cartilage** for shock absorption, stability, improved fit for the surfaces, lubrication



(c)

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Characteristics of Synovial Joints

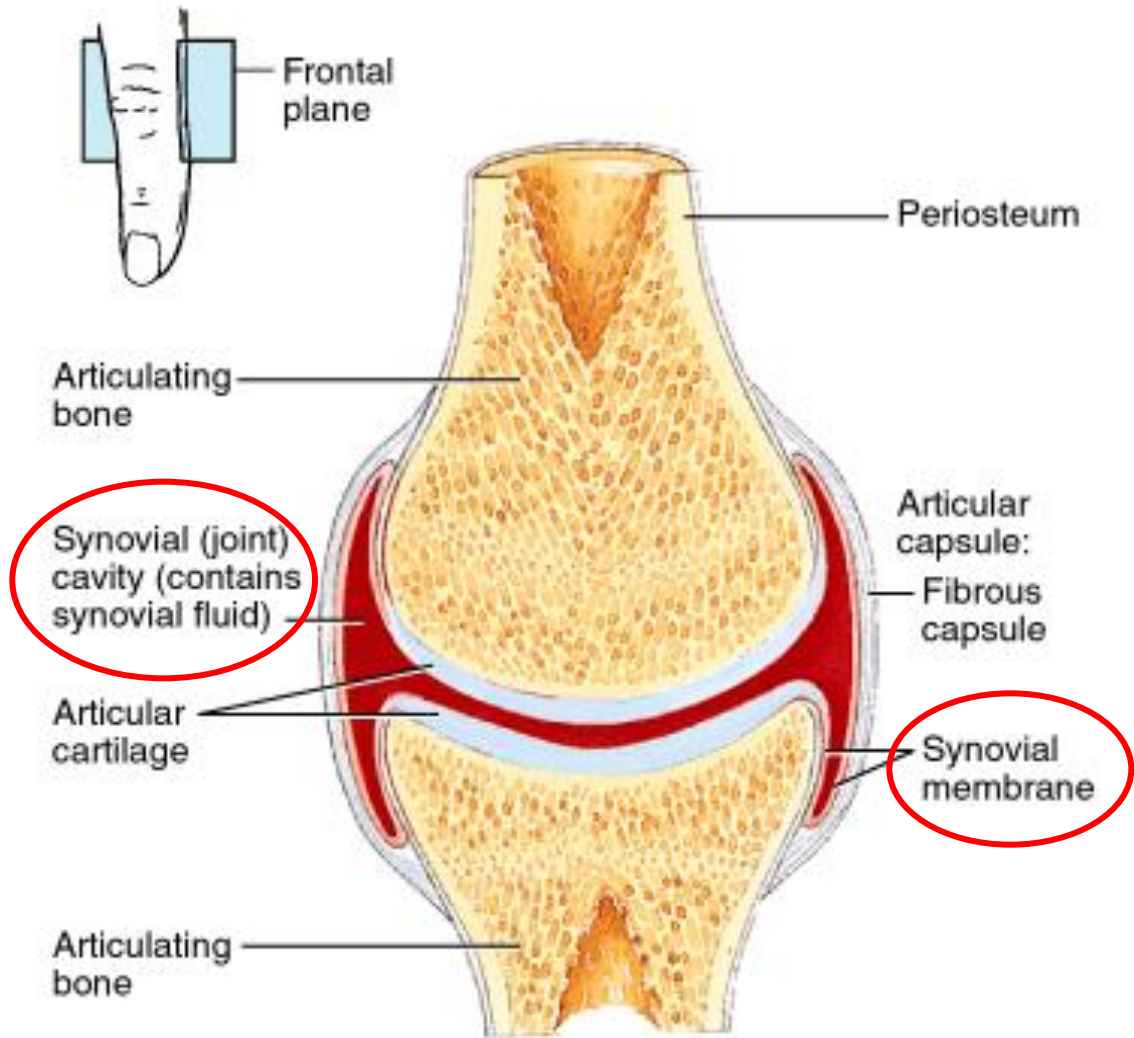
- **Joint capsule** = a fibrous connective tissue that surround the bony ends forming the joint



Lined with:

- **Synovial membrane** = loose, vascularized connective tissue that secretes **synovial fluid** into the joint cavity for lubrication

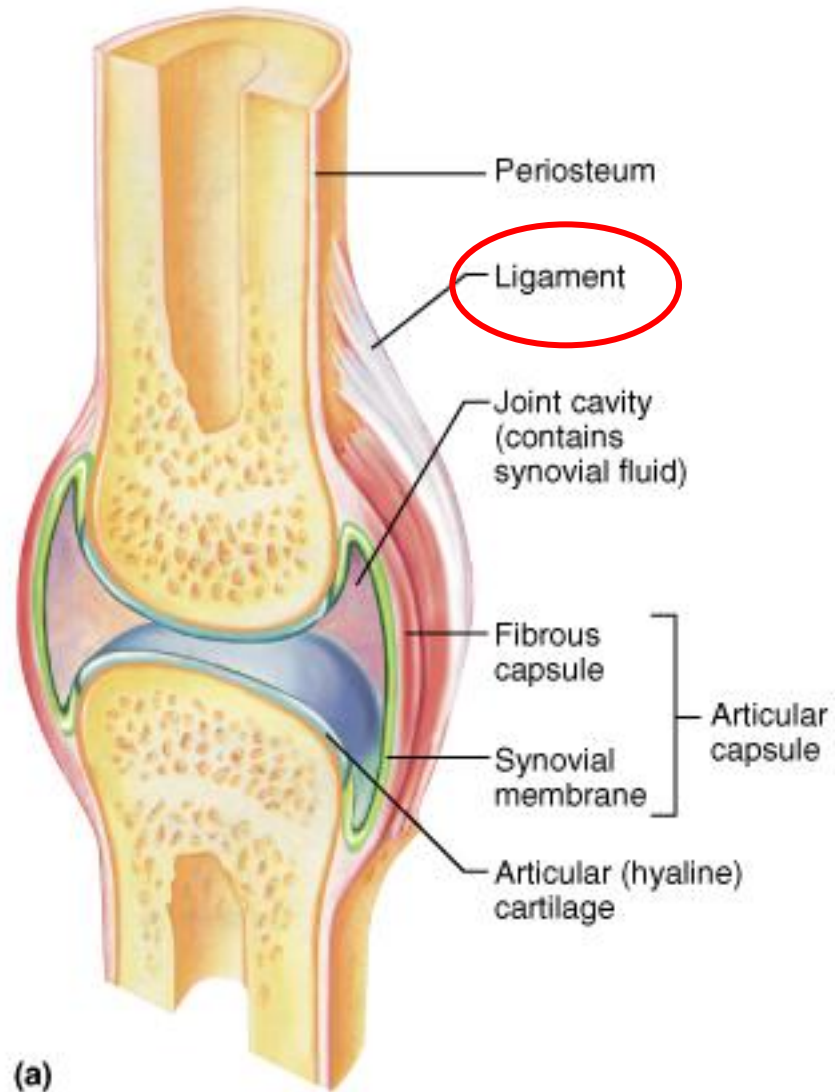
Synovial joint



(a) Diagram of frontal section of a typical synovial joint

Characteristics of Synovial Joints

- Where additional support is needed, the joint capsule is thickened to form tough, non-elastic **ligaments** to provide additional support.
- **Stability** of a synovial joint is provided by: the capsule, ligaments, muscles & tendons spanning the joint, and the congruency of the bone surfaces.



(a)

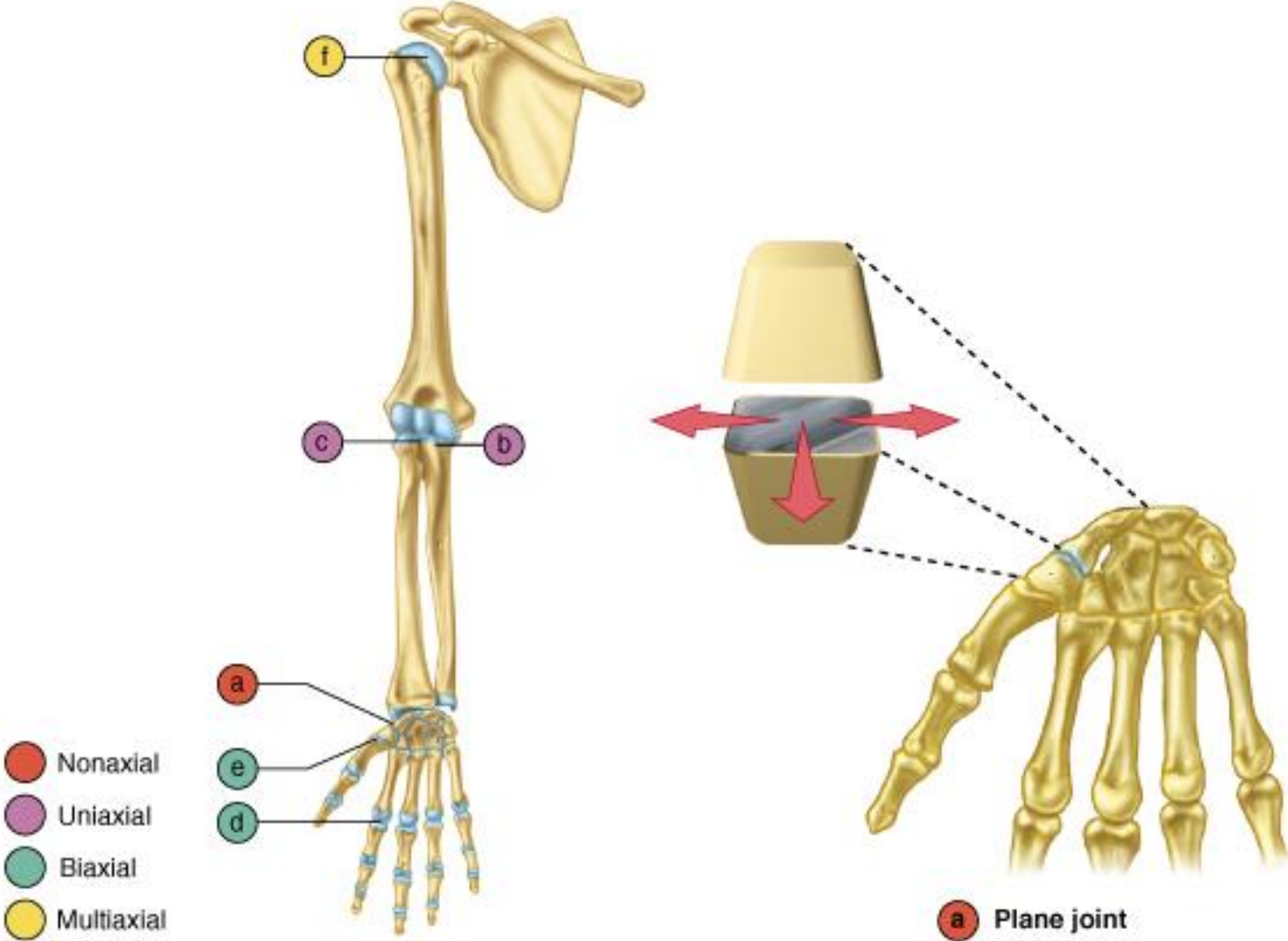
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Types of synovial joints

1) Plane (gliding) joint: consists of two flat surfaces that glide over each other rather than around an axis (nonaxial)

Example: carpals & tarsals (radial & ulnar deviation, foot pronation & supination)

Plane (gliding) Joint



- Nonaxial
- Uniaxial
- Biaxial
- Multiaxial

a Plane joint



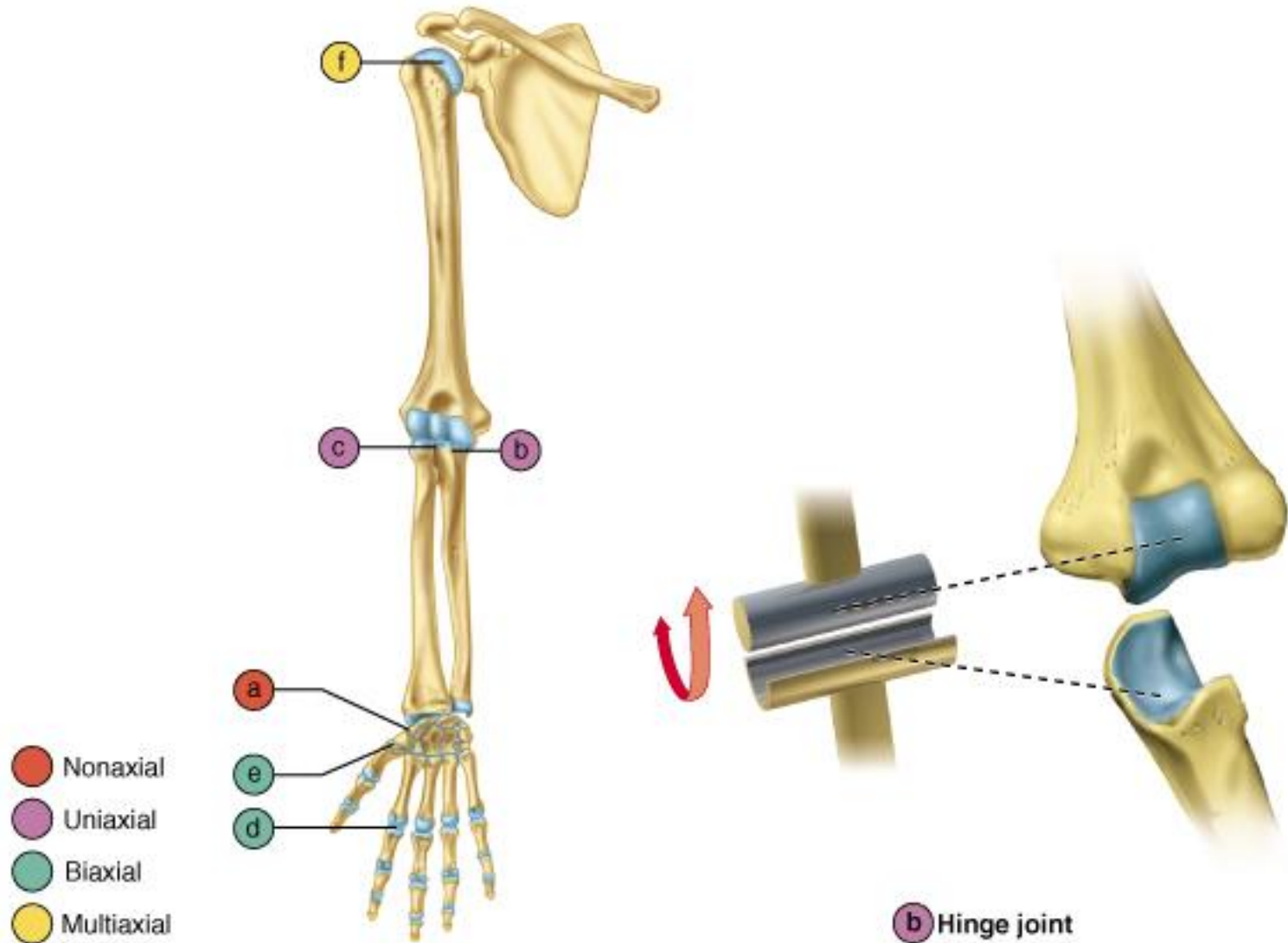
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Types of synovial joints

2) Hinge joint: allow movement in one plane (flexion / extension) around a single axis (uniaxial)

Example: interphalangeal joints (hand),
ulnohumeral joint (elbow)

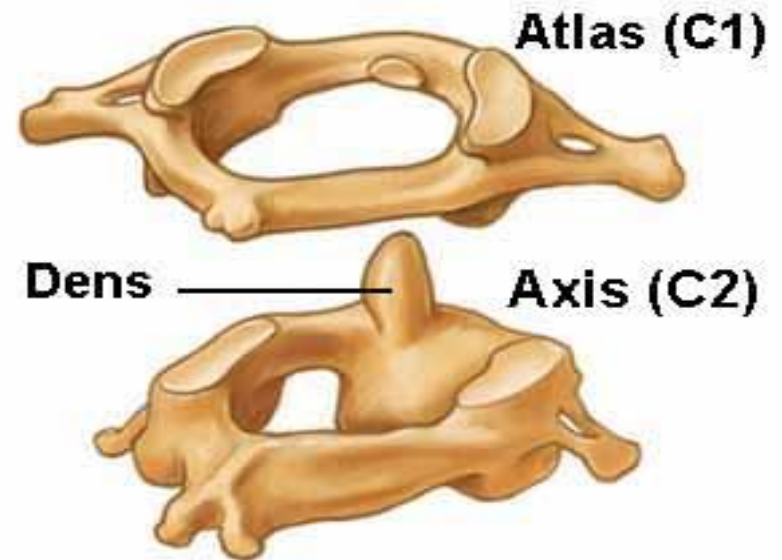
Hinge Joint



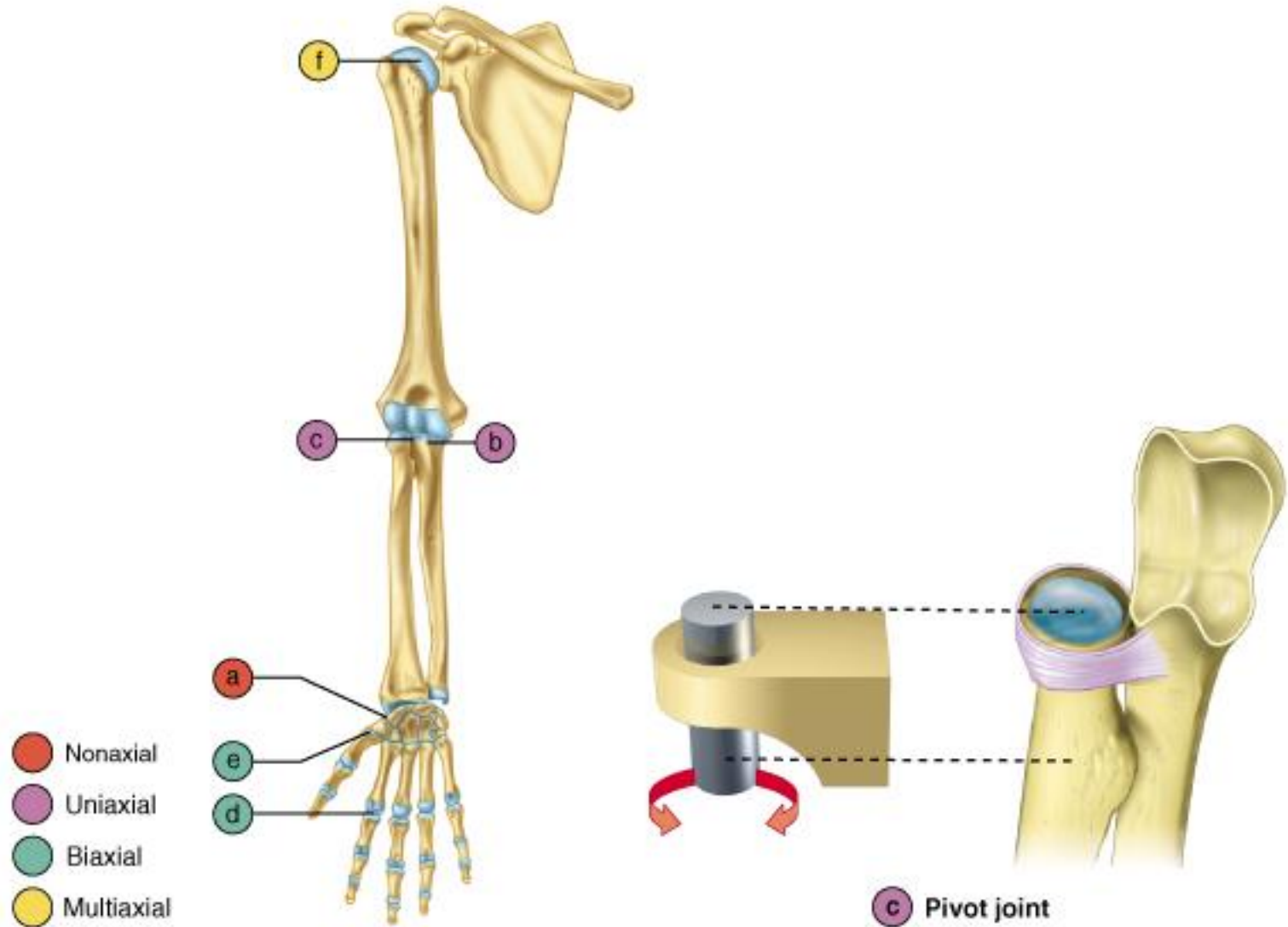
Types of synovial joints

3) Pivot Joint: allows a rotational movement around a long axis (movement in one plane, uniaxial)

Example: superior & inferior radioulnar joint
(pronation / supination),
atlantoaxial joint at the
base of the skull (rotation)



Pivot Joint

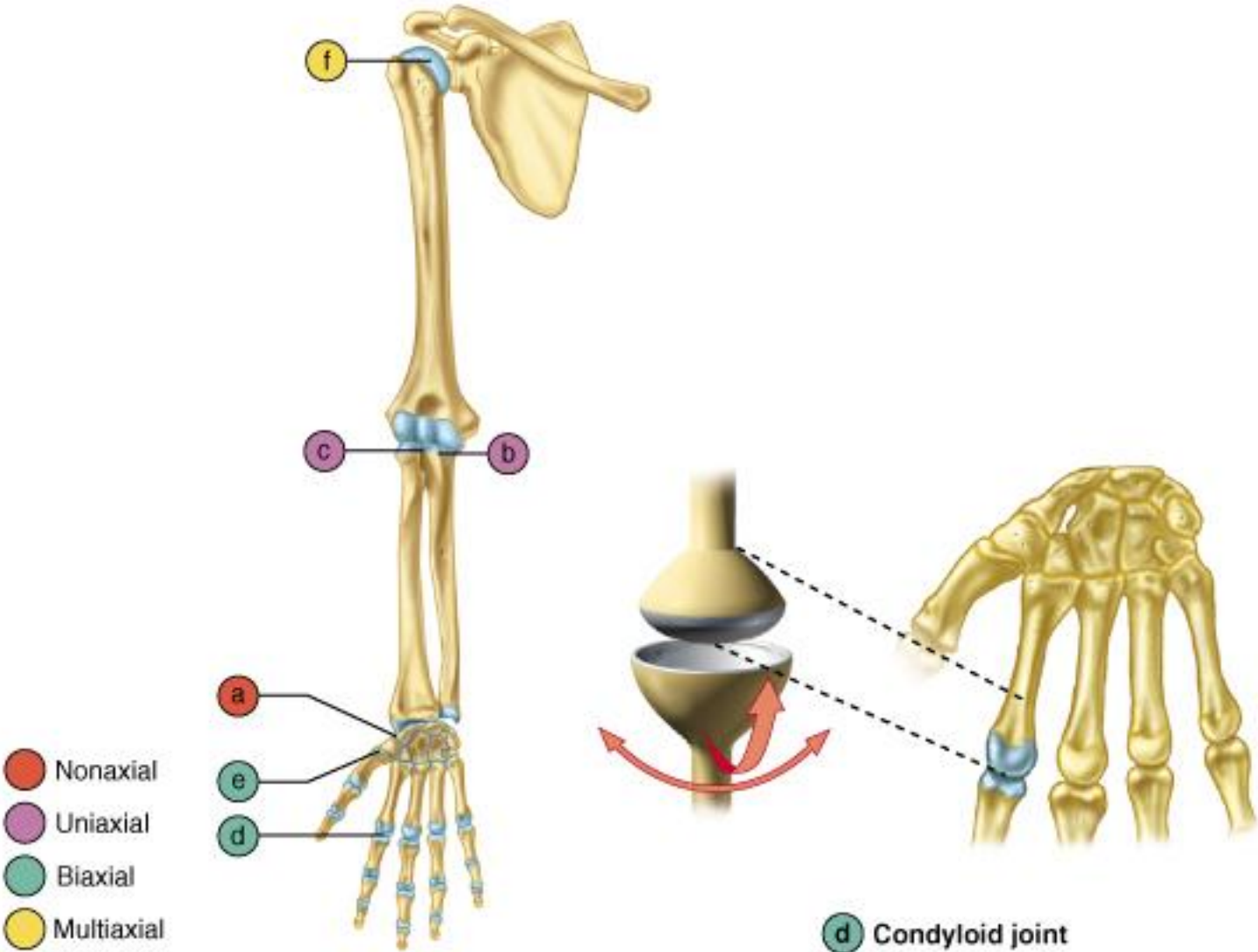


Types of synovial joints

4) Condyloid joint: allows movement in two planes (flexion / extension and abduction /adduction) without rotation (biaxial).

Example: metacarpophalangeal joints

Condylloid Joint

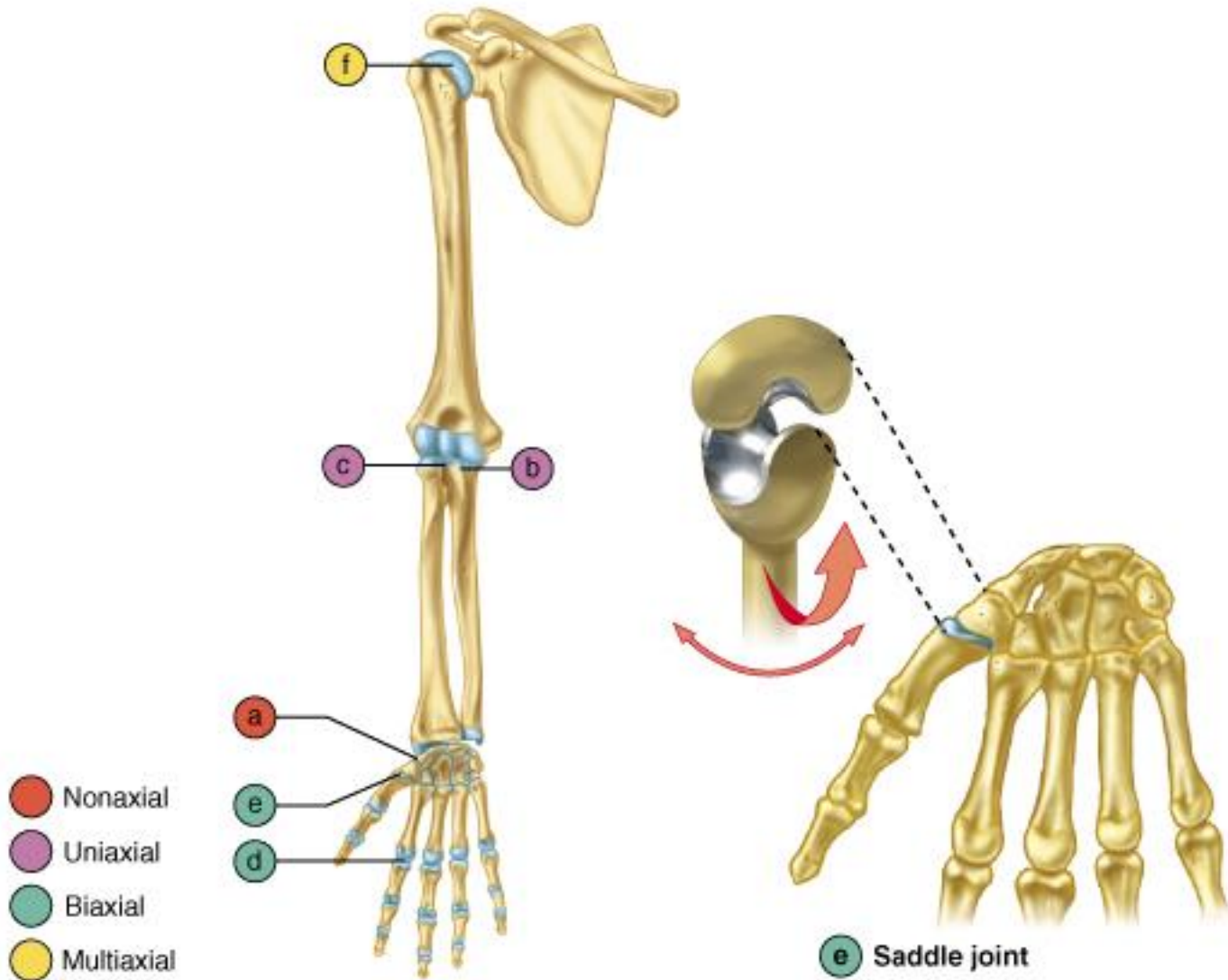


Types of synovial joints

5) Saddle joint: allows two planes of movement (flexion / extension, abduction / adduction) which makes it biaxial.

Example: only found at the carpometacarpal joint of the thumb.

Saddle Joint



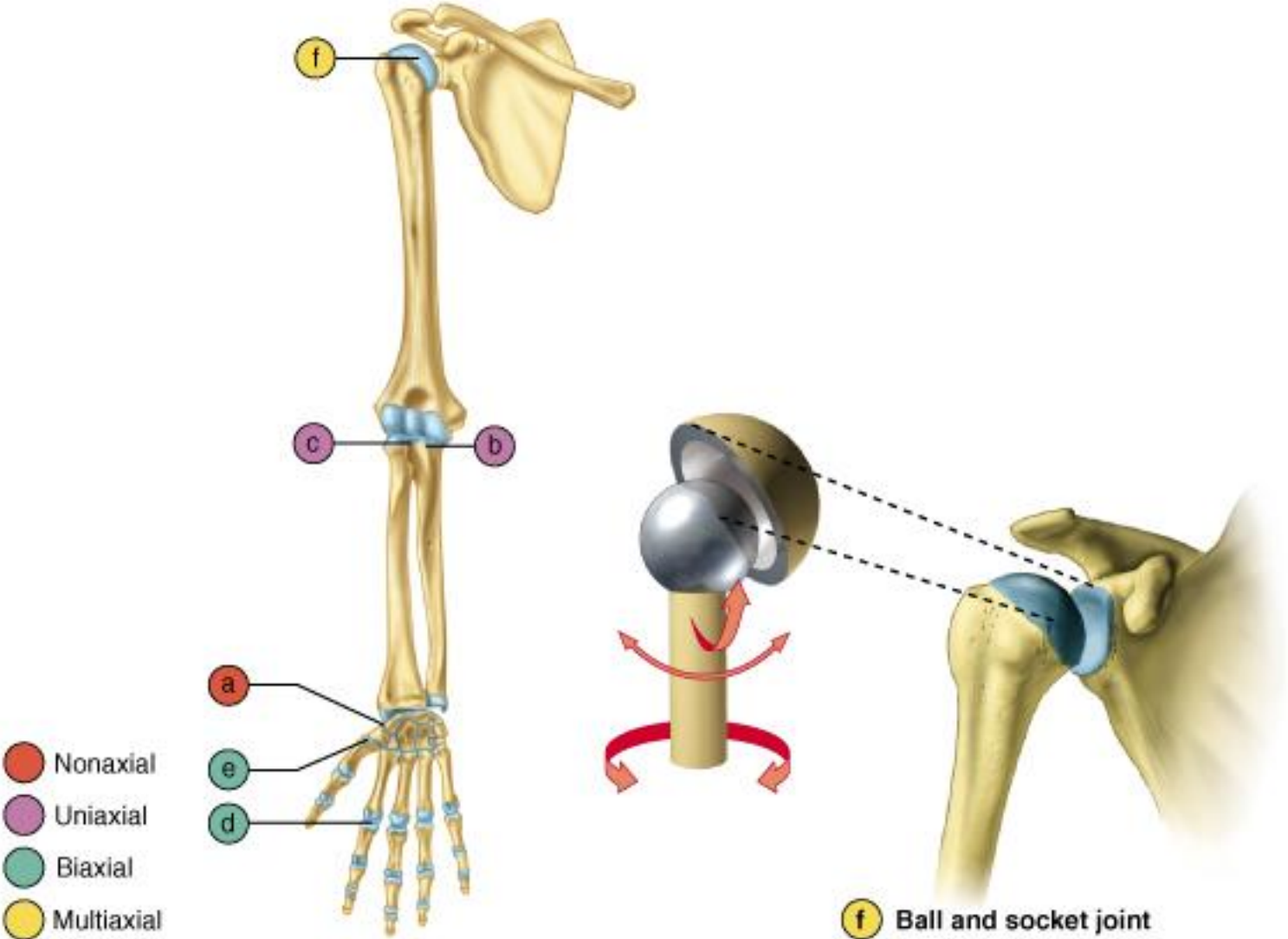
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Types of synovial joints

6) Ball-and-socket joint: allows movement in all three planes (multiaxial: flexion/extension, abduction/adduction, & rotation)

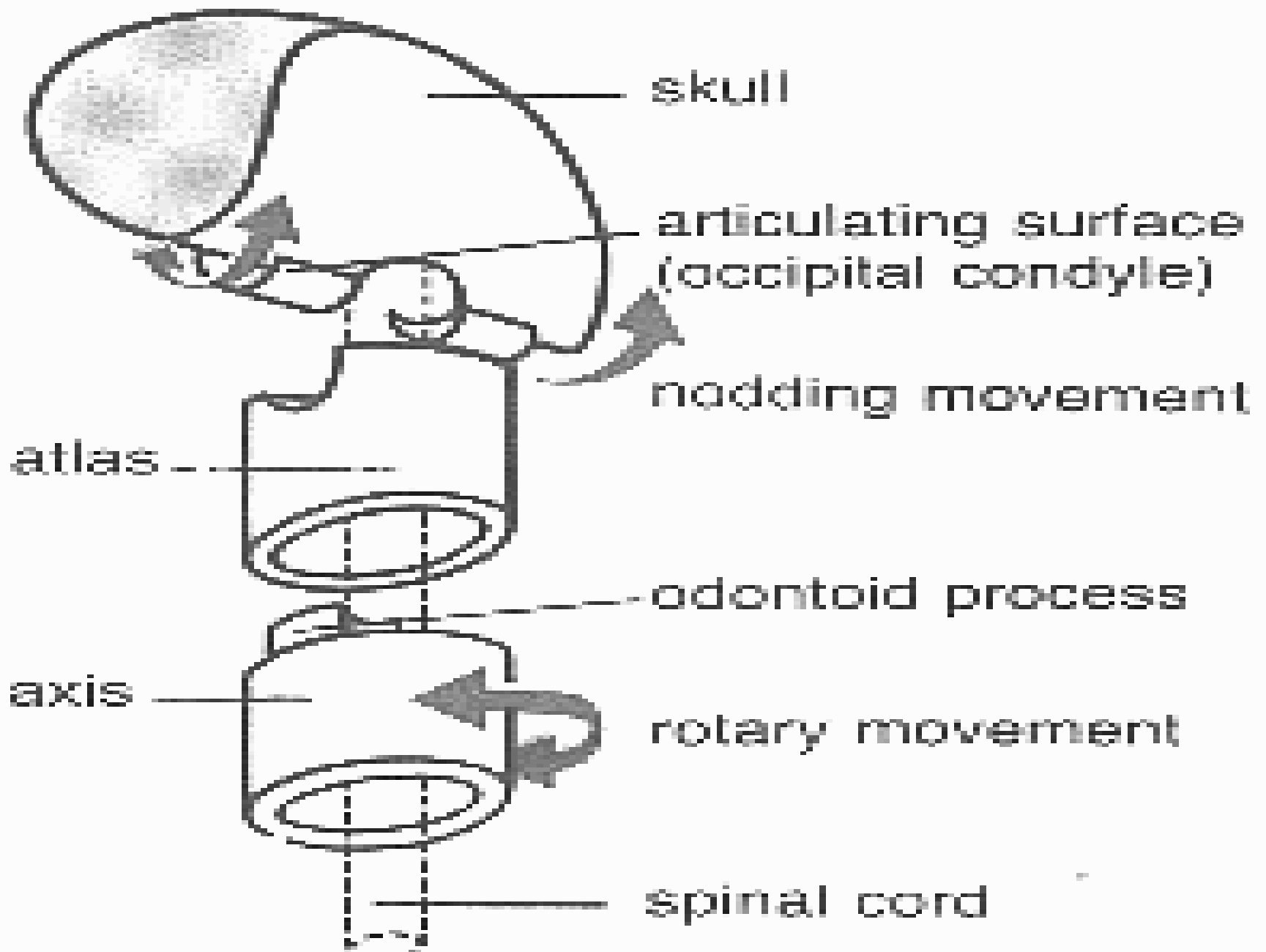
Example: the hip and shoulder joints.

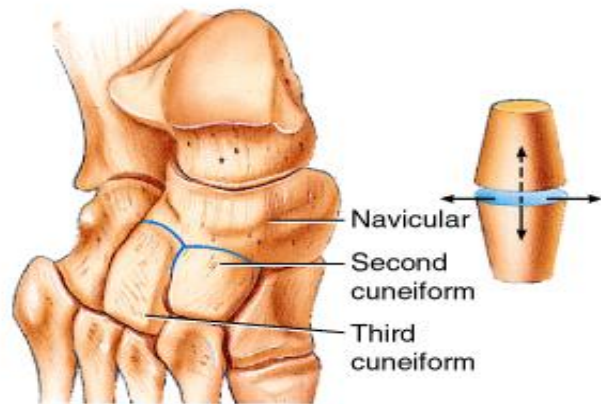
Ball-and-socket Joint



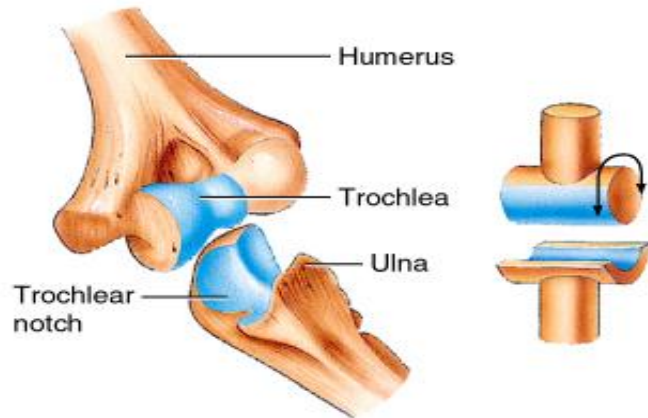
- **Compound Joints:** made up of several joints between a number of different bones.
- The bones articulate with one another in different ways, allowing for a **variety of movements** such as the set of joints which operate the **movement of the skull** on the vertebral column.
- The **condyles** at the base of the skull fit into the facets of the **atlas**, allowing for the **nodding movement** of the head.

- While one moves one's head, the atlas is able to **rotate** around the **odontoid process of the axis**, allowing the head to turn from side to side. There are also other articulating surfaces, where the atlas and axis meet.
- All these joints together make a **compound joint** with its many **possible movements** in the neck region.

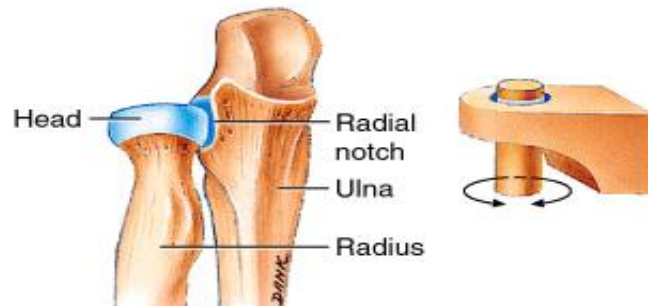




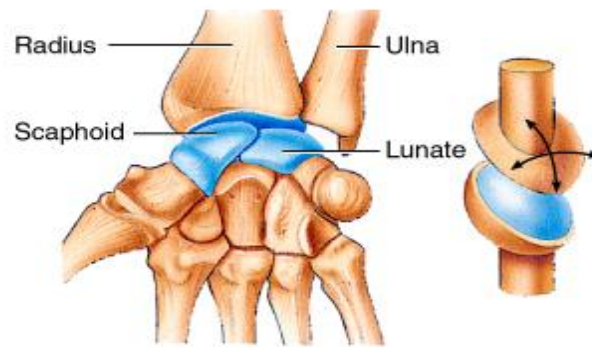
(a) Gliding joint between the navicular and second and third cuneiforms of the tarsus in the foot



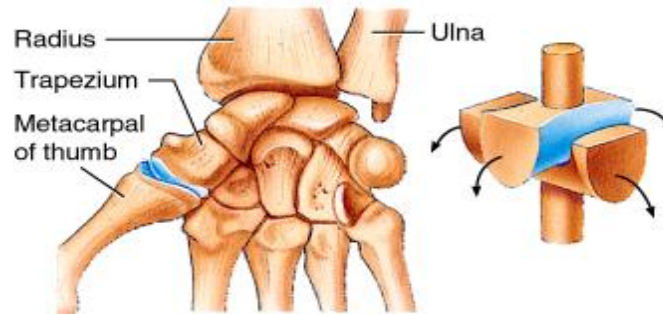
(b) Hinge joint between trochlea of humerus and trochlear notch of ulna at the elbow



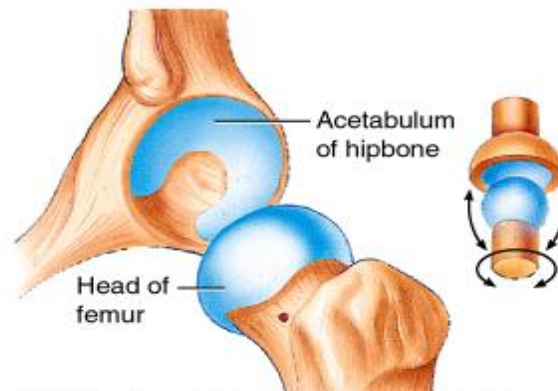
(c) Pivot joint between head of radius and radial notch of ulna



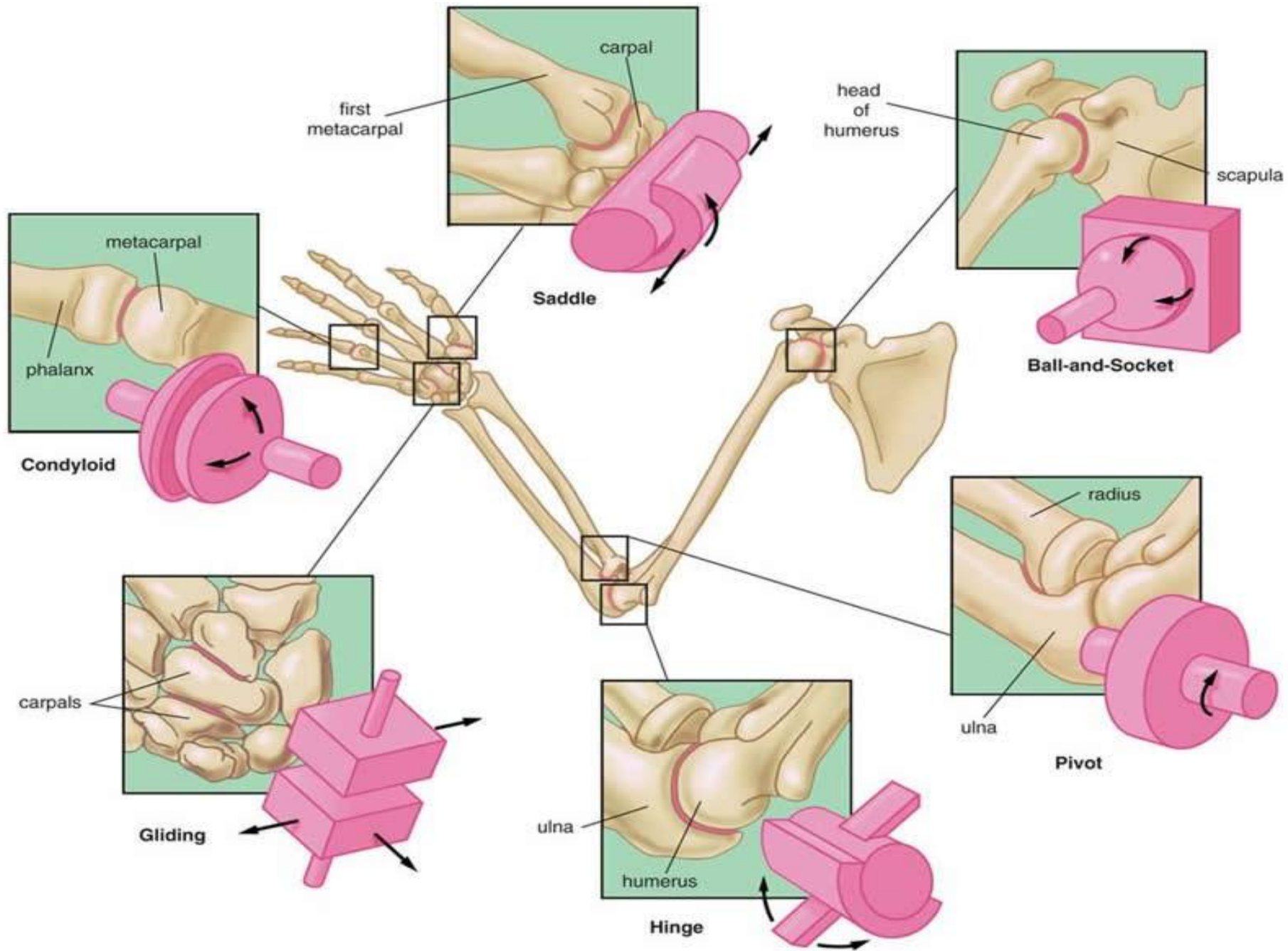
(d) Condyloid joint between radius and scaphoid and lunate bones of the carpus (wrist)



(e) Saddle joint between trapezium of carpus (wrist) and metacarpal of thumb



(f) Ball-and-socket joint between head of the femur and acetabulum of the hipbone



Degrees of freedom

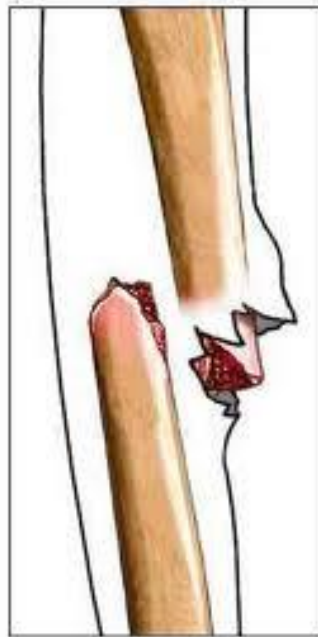
- Movement in a plane can be described as a **single degree of freedom**.
- **Degree of freedom** = the terminology used to describe the amount of movement structurally allowed by the joint
- Example: a uniaxial joint has one degree of freedom, ball and socket joints have 3 degrees of freedom

Joint Position

- **Loose packed** (resting) position = the position at which the joint is under the least amount of stress (capsule, ligaments, bone contact).
- **Close packed position** = the position in which the majority of joint structures are under maximum tension.

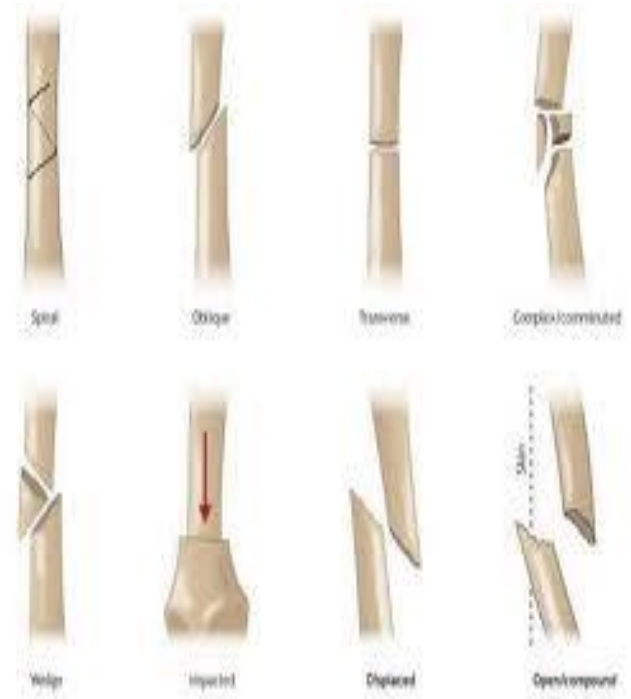
Diseases and Disorders of the Skeletal System

- A fracture is a break in a bone



Diseases and Disorders of the Skeletal System

- Types of bone fractures
 - Closed (simple) fracture – break that does not penetrate the skin
 - Open (compound) fracture – broken bone penetrates through the skin
- Bone fractures are treated by reduction and immobilization
 - Realignment of the bone



Diseases and Disorders of the Skeletal System: Fractures

**Simple
Greenstick
radius**



**Simple
Complete
fibula**



**Compound
Fracture
tibia and
fibula**

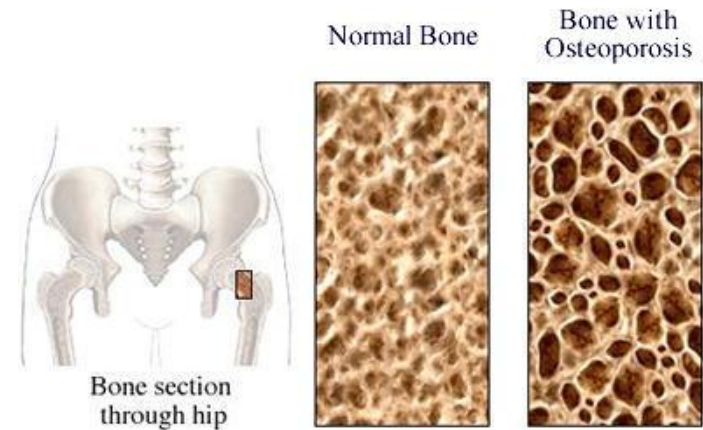


**Comminuted
Fracture
radius**



Diseases and Disorders of the Skeletal System

- **Osteoporosis:**
 - affect both men and women but it is most common in post menopausal women.
 - The bone tissue becomes brittle and breaks easily with little applied stress; due to loss of calcium from the bone matrix.



Diseases and Disorders of the Skeletal System

- **Arthritis** – inflammatory or degenerative diseases of joints
 - Over 100 different types

➤ **Osteoarthritis**

- Most common chronic arthritis
- Probably related to normal aging processes
- Cartilage wears out and deteriorates between the bones at synovial joints. Bones rub together produce stiffness and severe pain



Diseases and Disorders of the Skeletal System

➤ Rheumatoid arthritis

- An autoimmune disease
 - the immune system attacks the joints
- Symptoms begin with bilateral inflammation of certain joints
- Often leads to deformities
- Can appear at any age

