Skeletal Considerations for Movement

Kinesiology
RHS 341
Lecture 2
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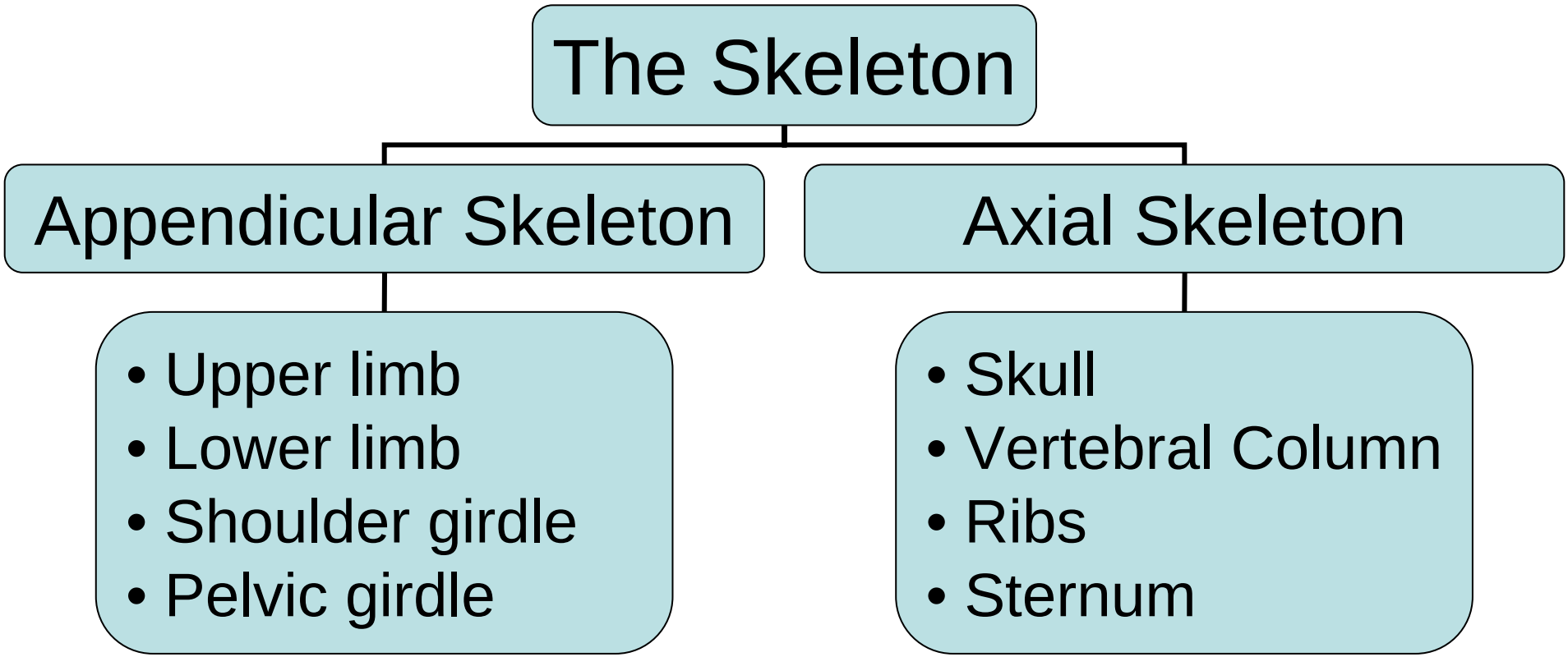
The Skeletal System

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


The Skeleton
Appendicular Skeleton
Axial Skeleton
• Upper limb
• Lower limb
• Shoulder girdle
• Pelvic girdle
• Skull
• Vertebral Column
• Ribs
• Sternum

Functions of the Skeletal System

- Leverage (attachment of muscles to produce movement)
- Support
- Protection (brain, spinal cord, internal organs)
- Mineral storage
- Blood cells formation in bone marrow

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.

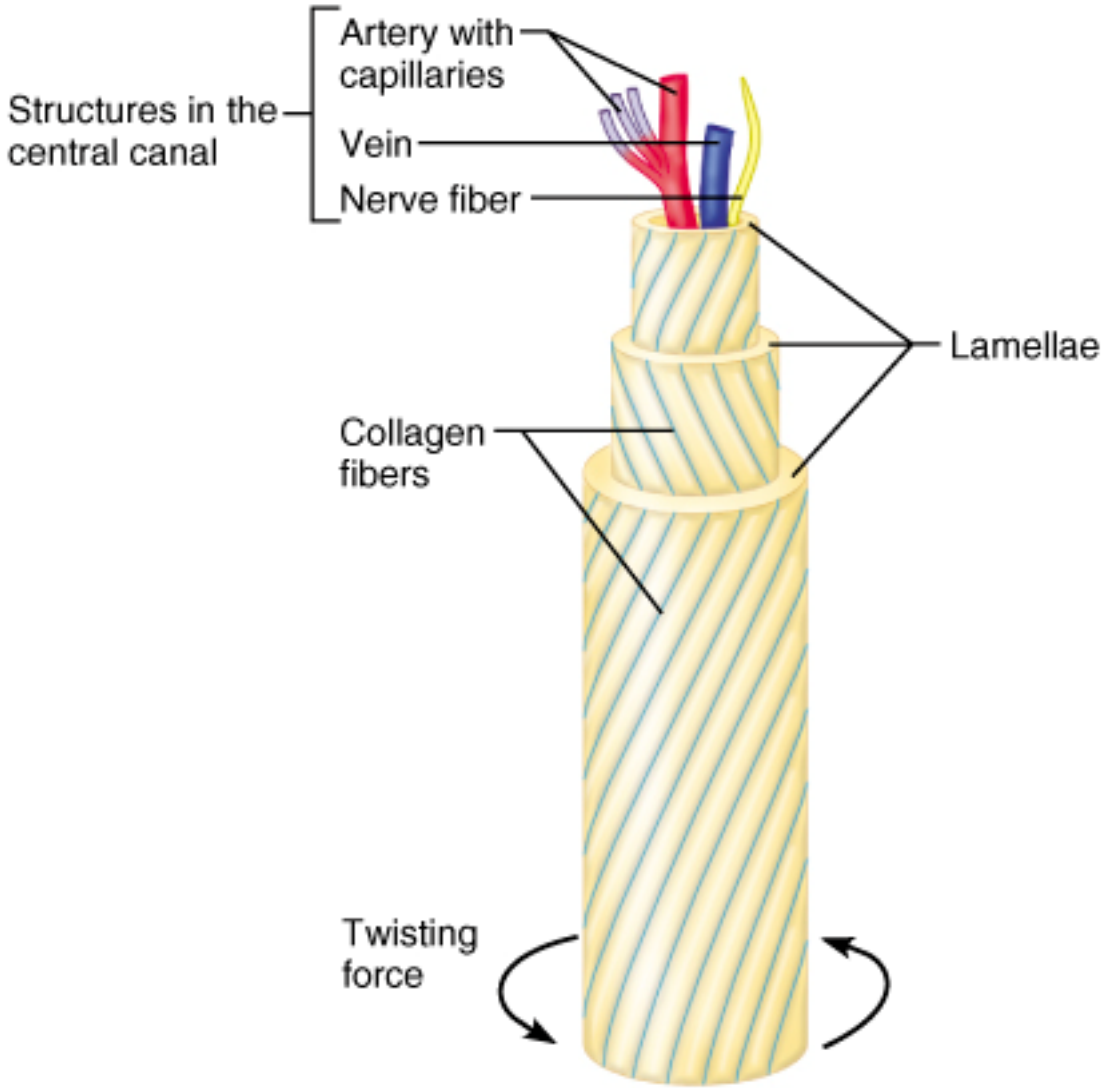
- **Morphology** = the shape & structural arrangement of the bones & articulations

  ⟶ determine movement

Architecture of bone (osseous tissue)

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** (weight-bearing pillars)
   - Provides strength for weight bearing & stiffness in response to muscle tension

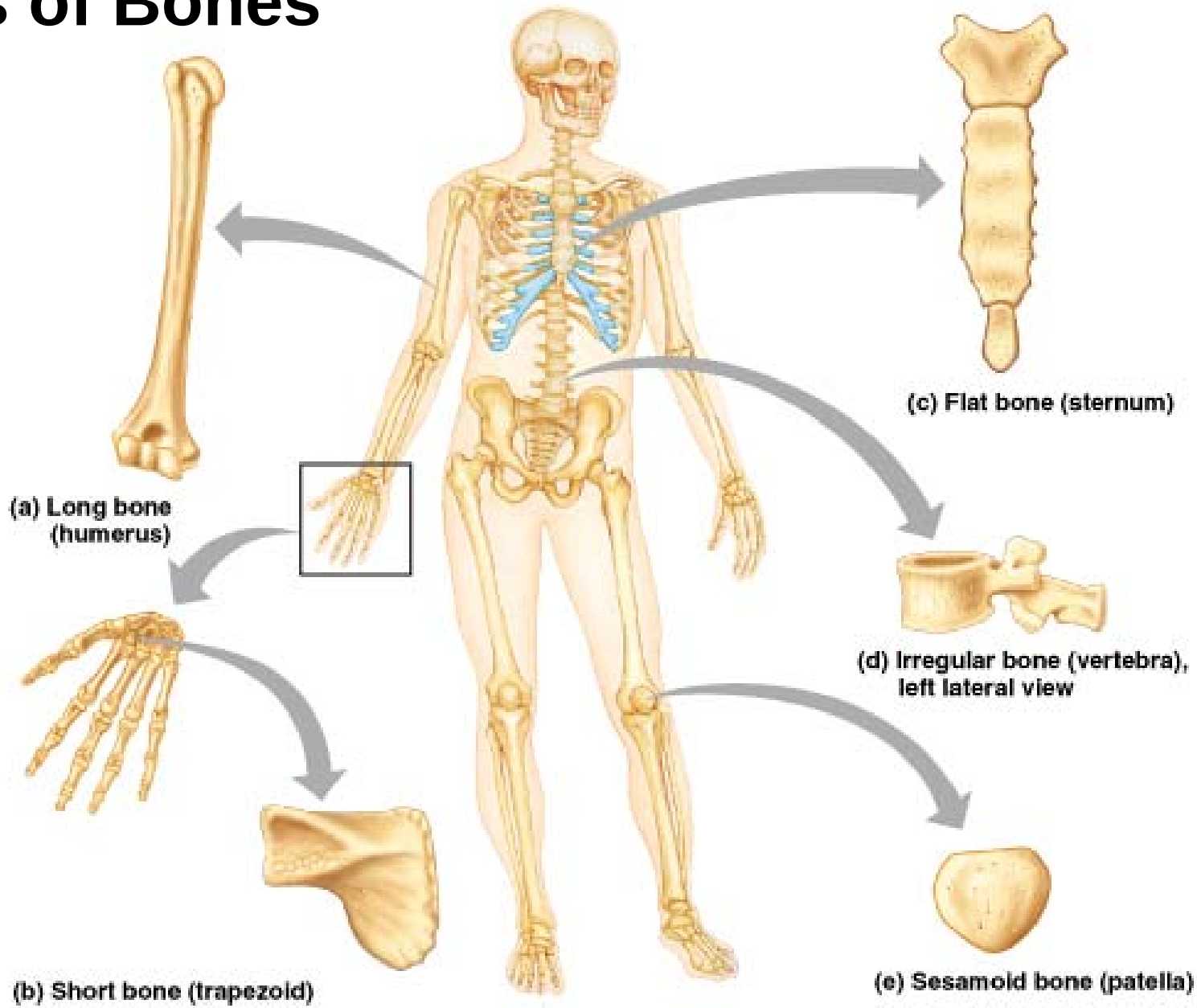
Osteon



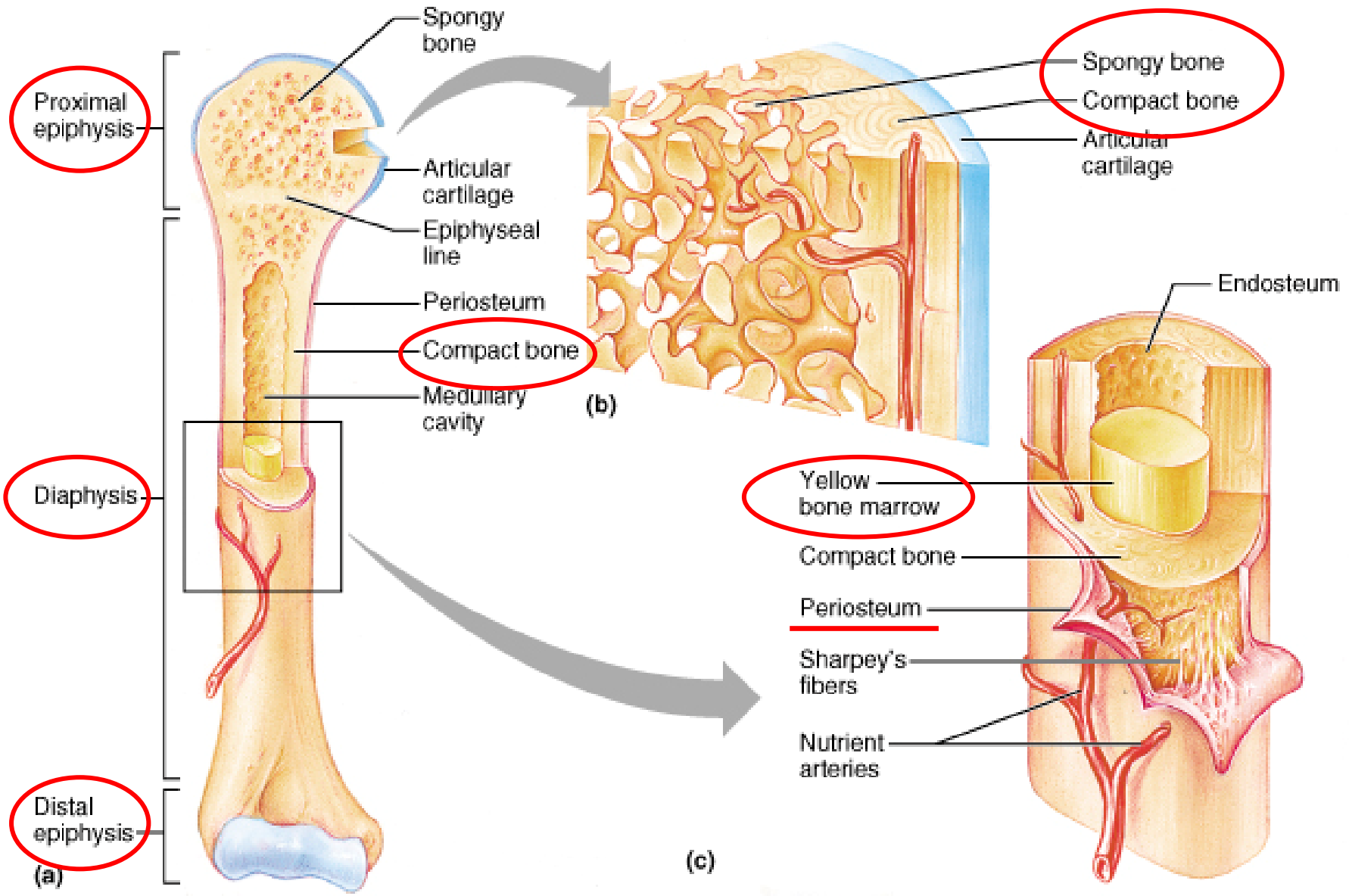
Architecture of bone (osseous tissue)

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)

Types of Bones



Long Bones



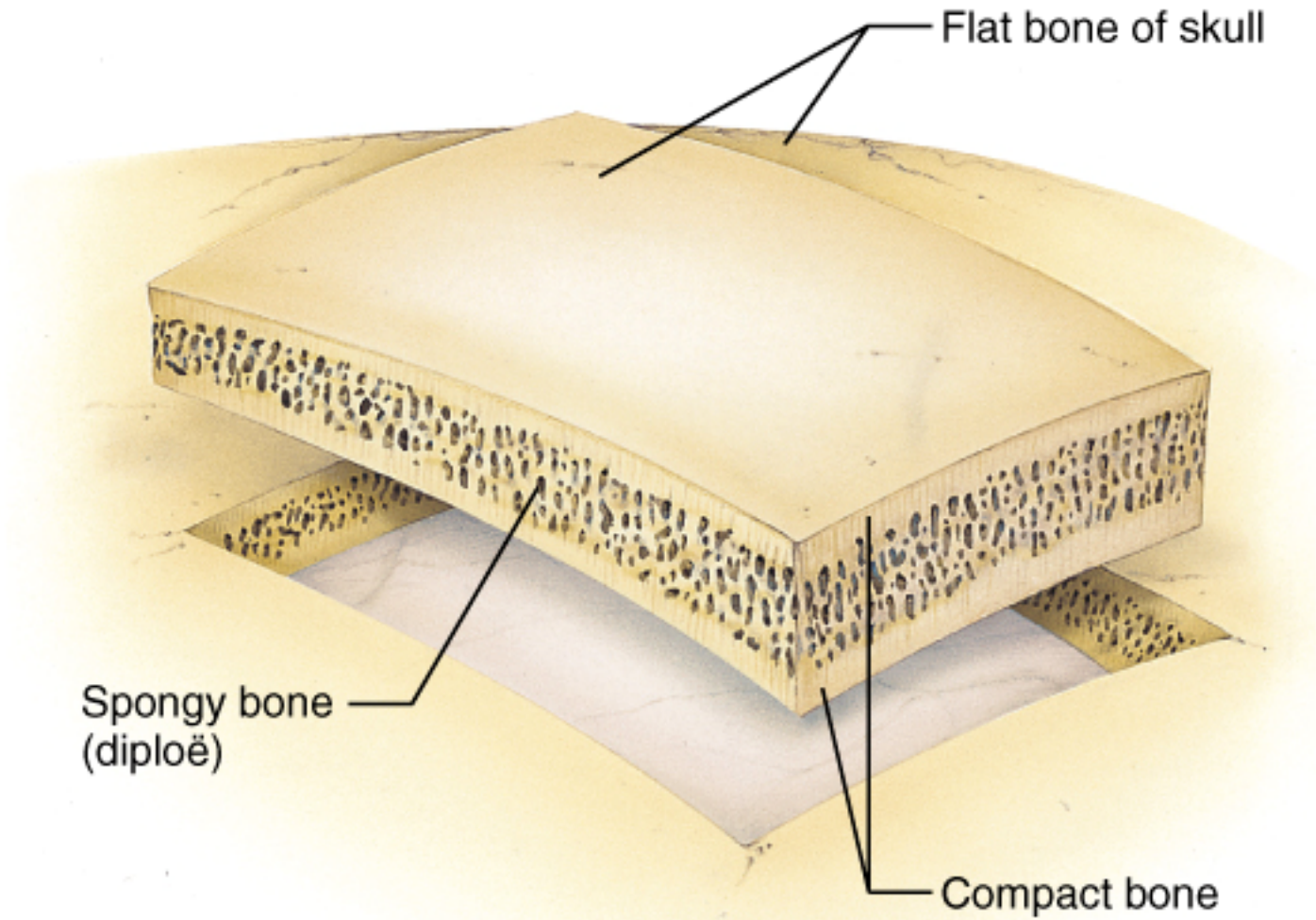
Long Bones

- 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)

- Offer support and leverage

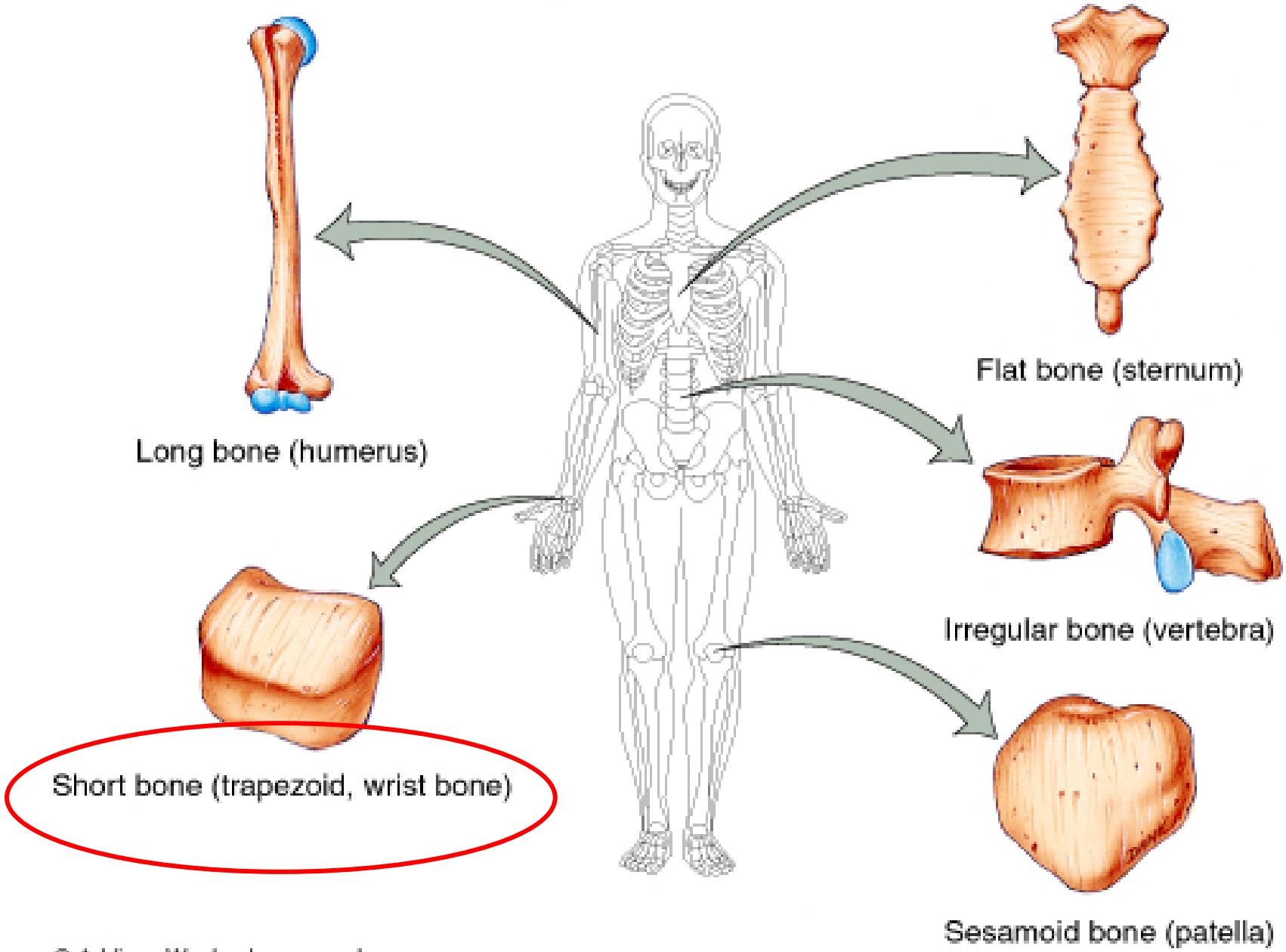
- Example: humerus, radius, ulna, femur, tibia, fibula, metacarpals, metatarsals

Flat Bones



Flat Bones

- Consist of two layers of compact bone with spongy bone in between
- Protect internal structures and offer broad surfaces for muscle attachments
- Example: ribs, illium, sternum, scapula



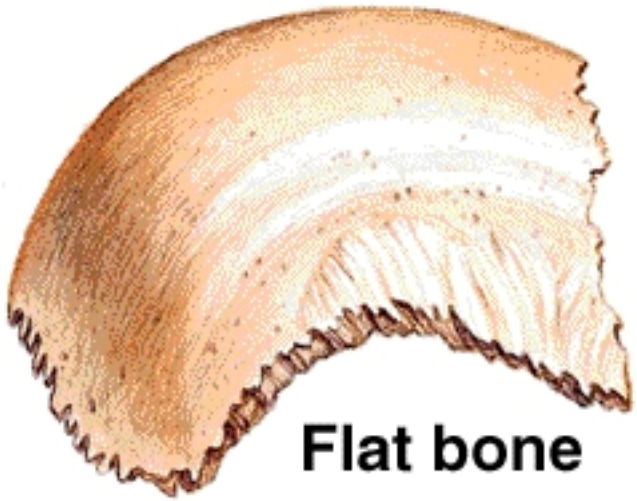
Short Bones

- 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

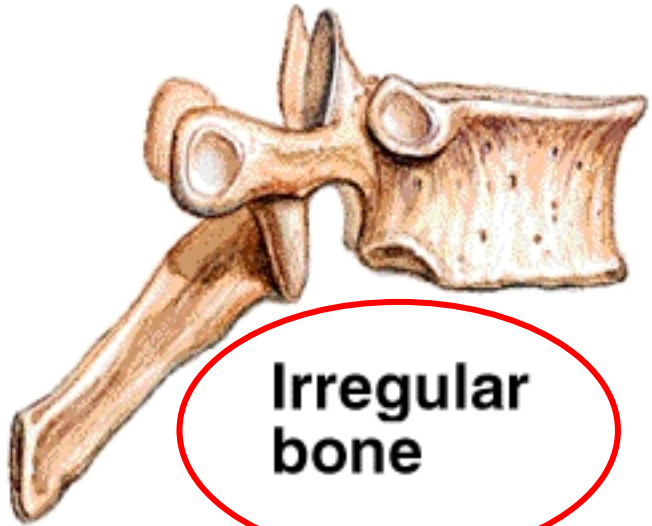
Bone Types

Long bone

Short bone



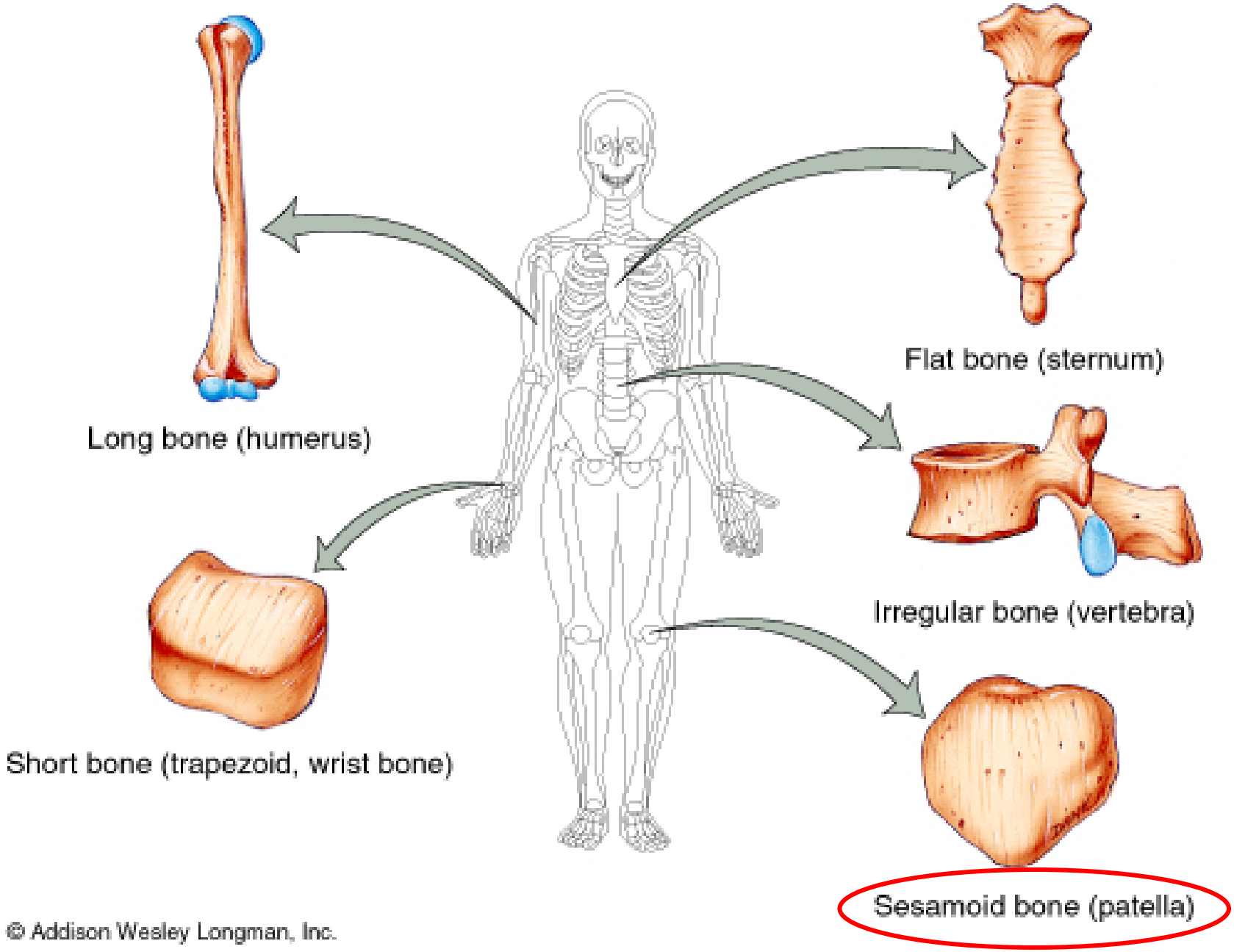
Flat bone



Irregular bone

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

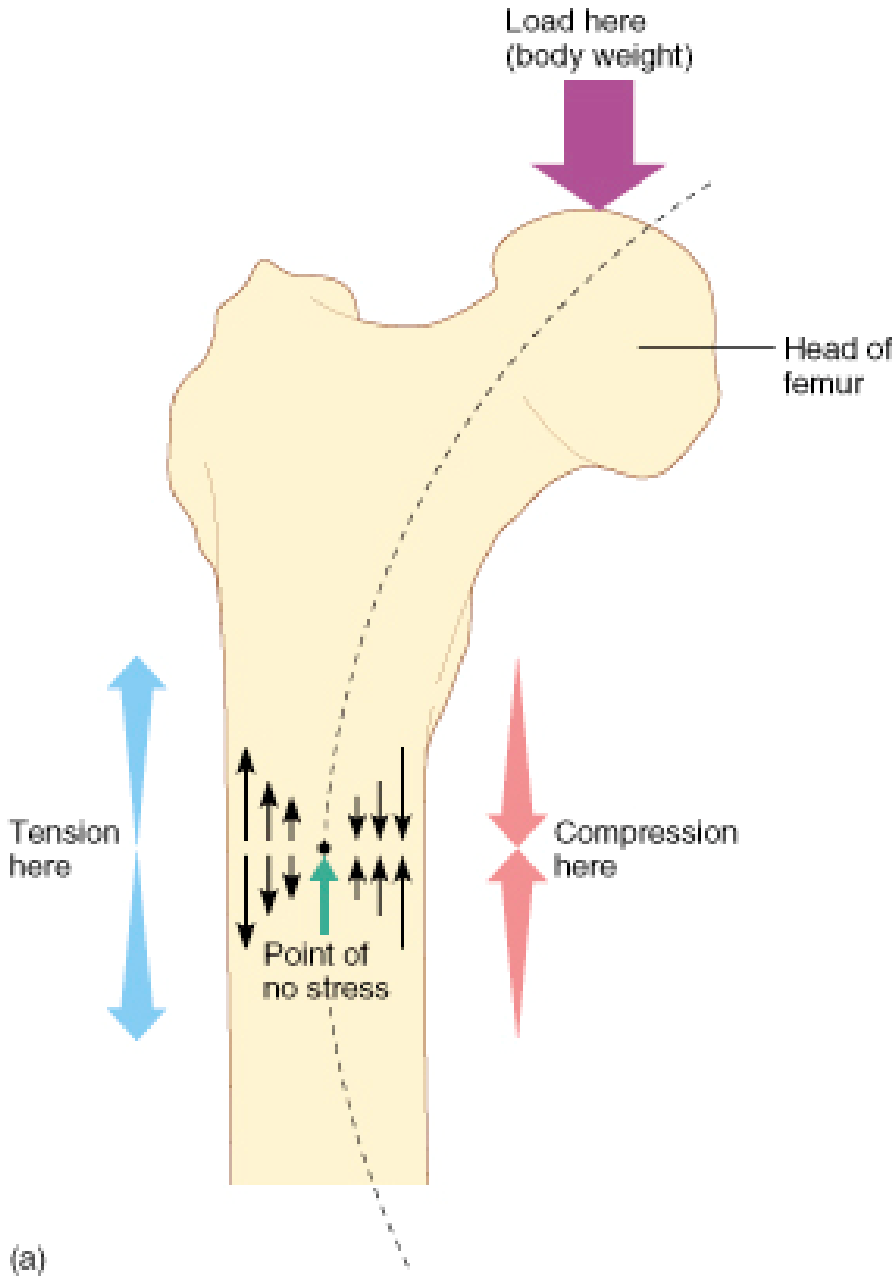


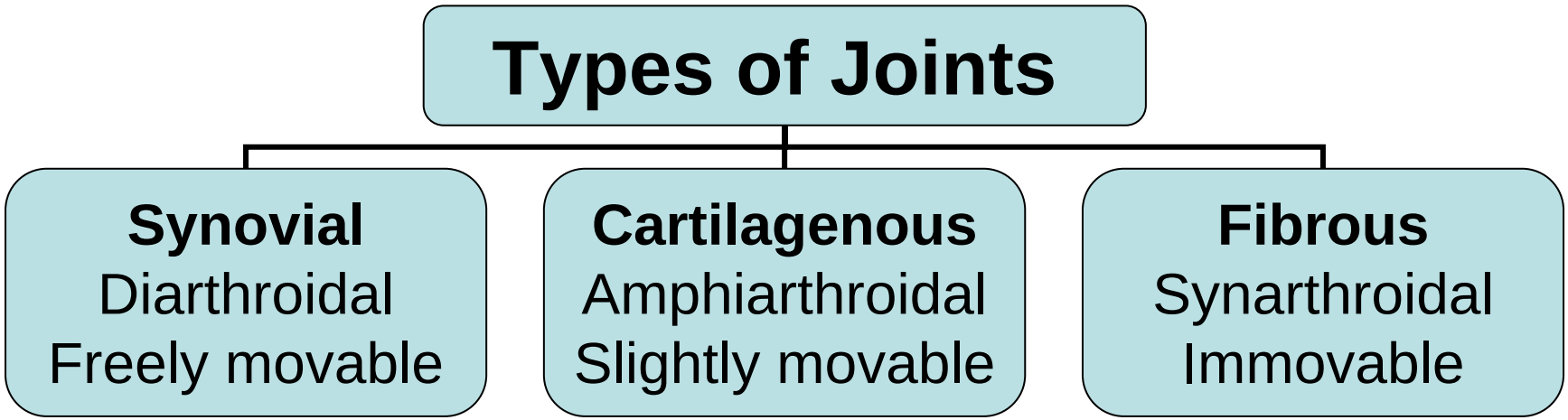
Sesamoid Bones

- Short type of bone embedded in a tendon or joint capsule
- Alter the angle of muscle insertion to increase its mechanical advantage
- Example: the patella embedded in the quadriceps tendon, sesamoid bones within the flexor tendons of the great toe & thumb

How does bone anatomy relate to stress?

- Bones are subjected to bending stresses (the load placed on most bones is off center)
- The strongest forces are at the periphery where they are resisted by the strongest compact bone
- Example: body weight is transmitted to the head of femur and threatens to bend the bone (compression on one side & tension on the other side).



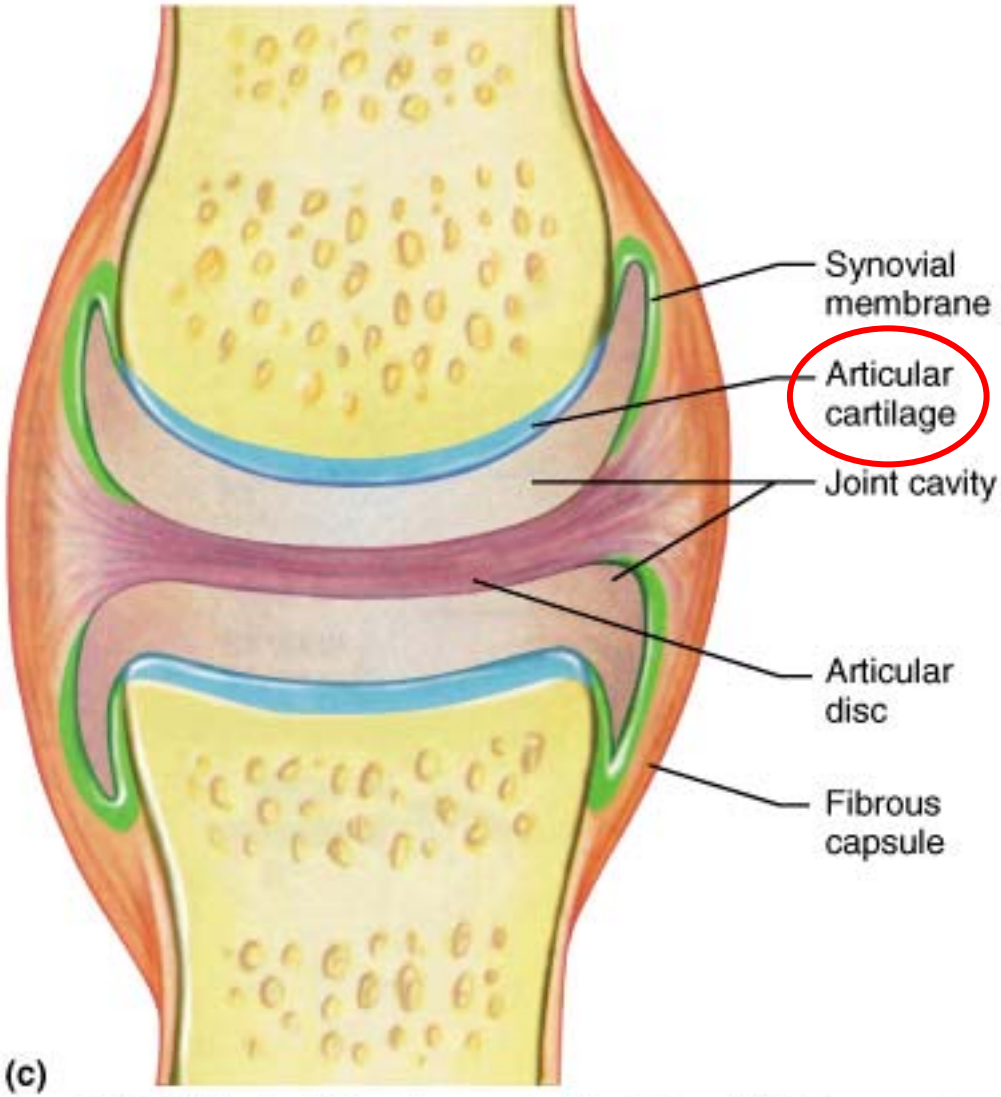

Types of Joints
Synovial
Diarthroidal
Freely movable
Cartilagenous
Amphiarthroidal
Slightly movable
Fibrous
Synarthroidal
Immovable

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



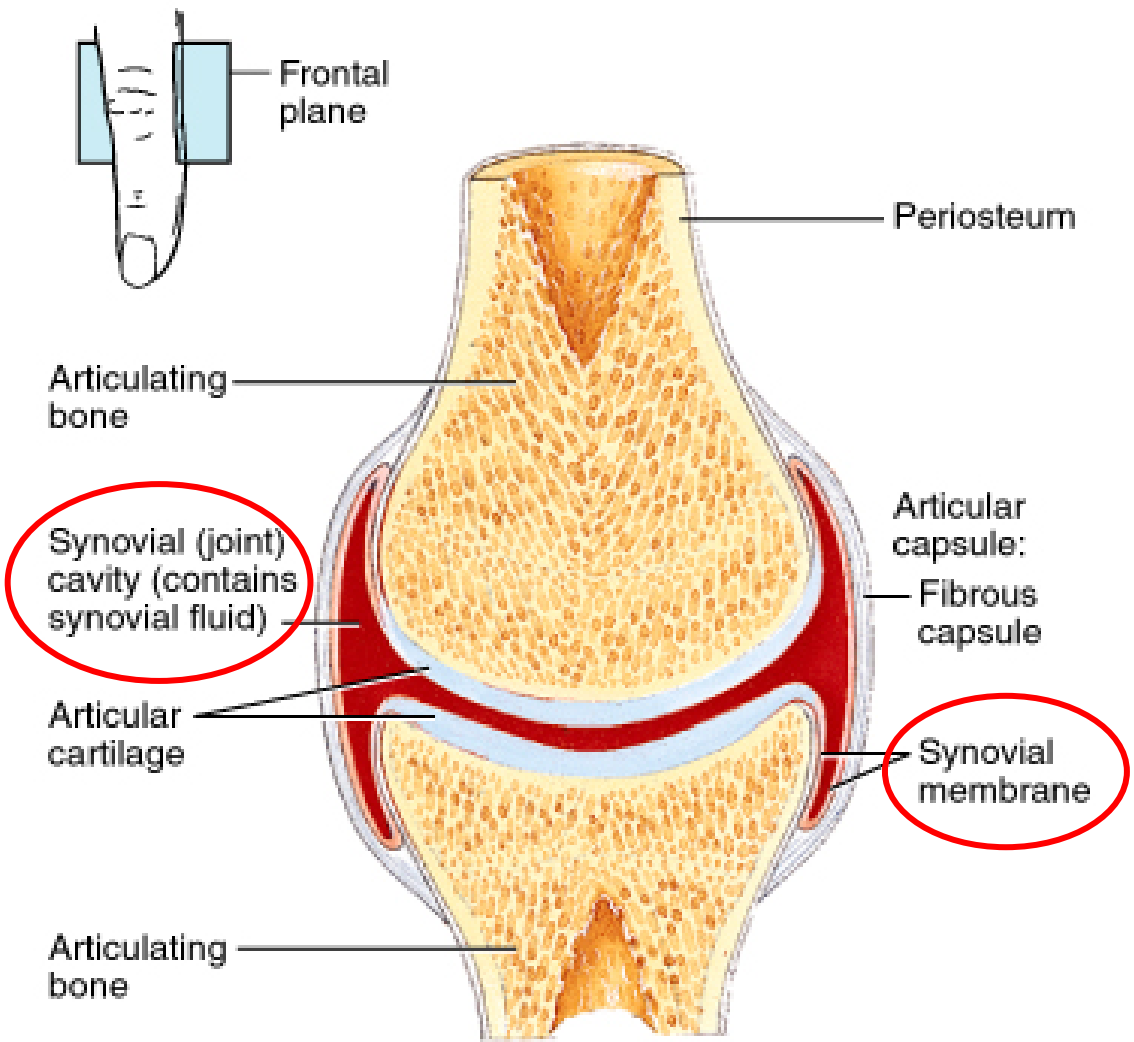
Characteristics of Synovial Joints

- **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

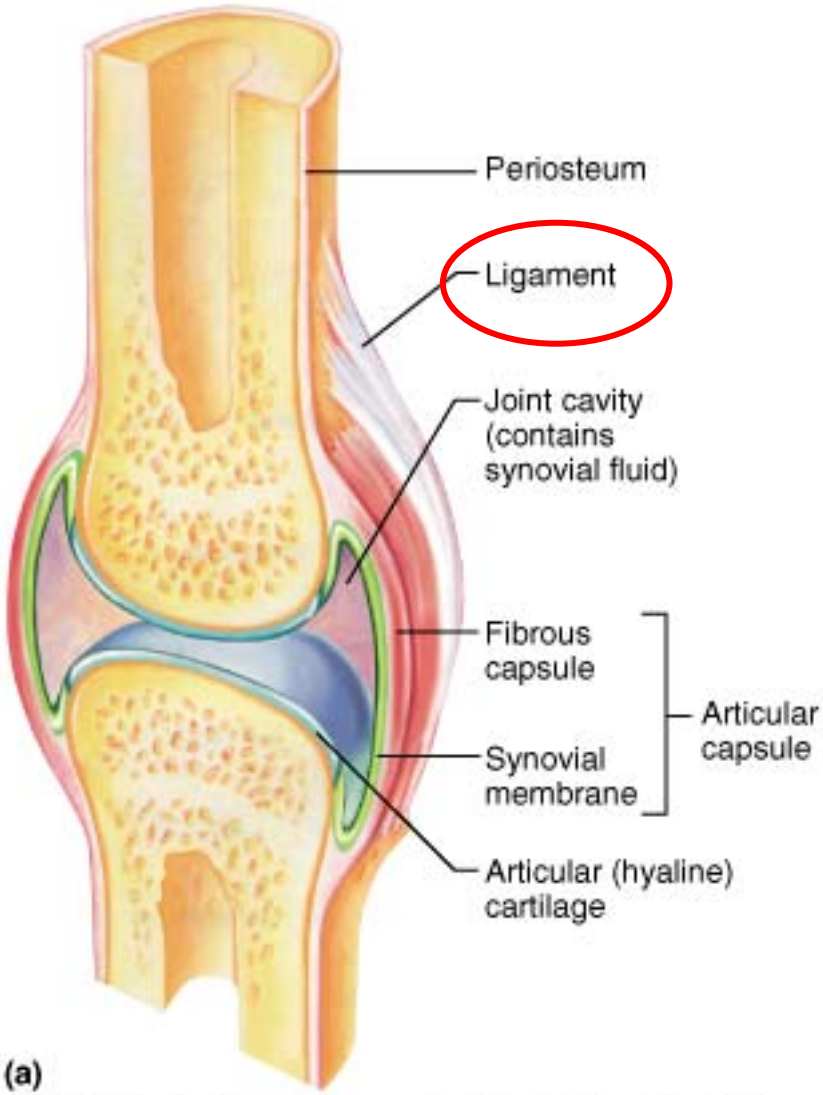


(a) Diagram of frontal section of a typical synovial joint

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.

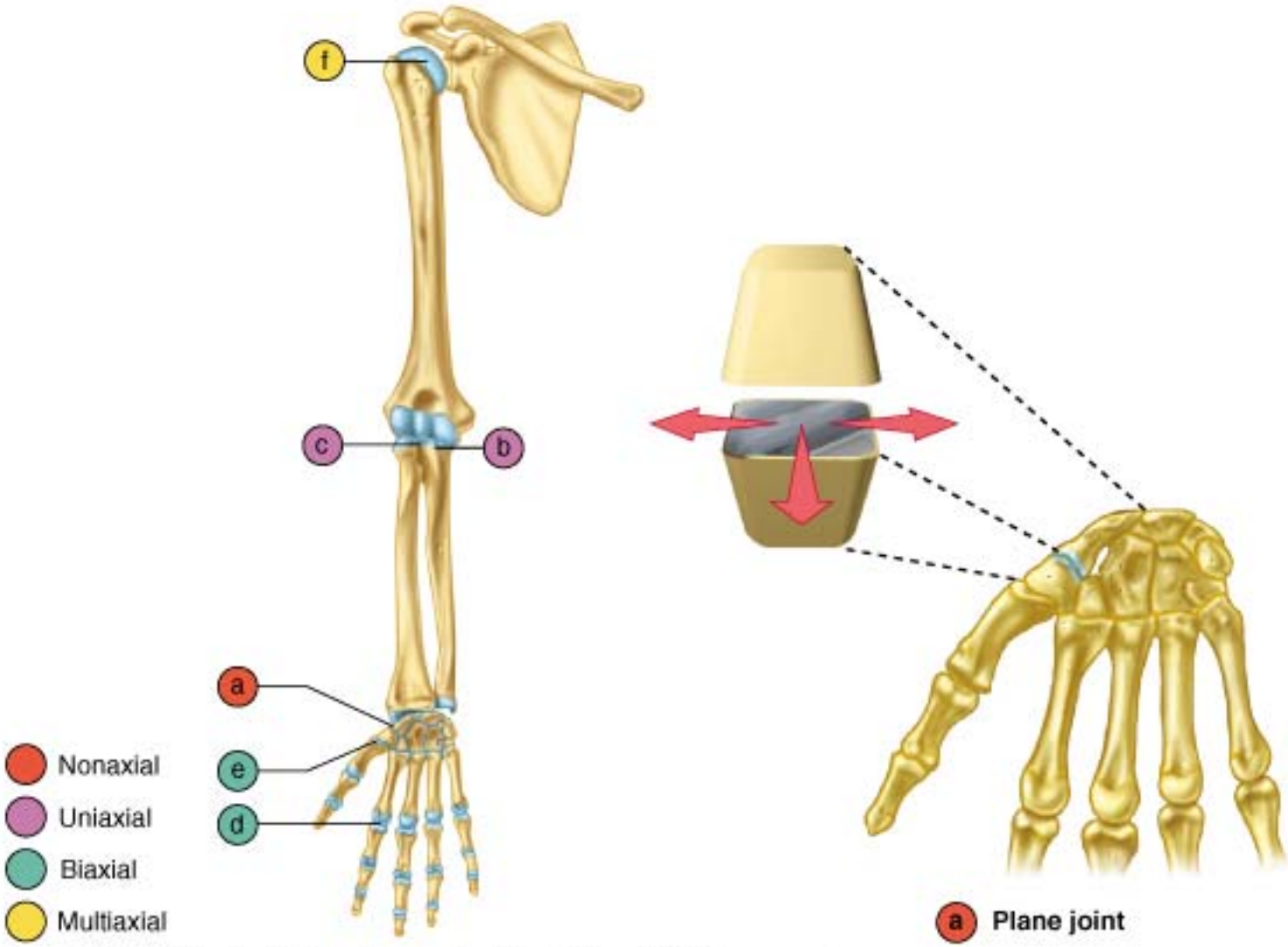


Types of synovial joints

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

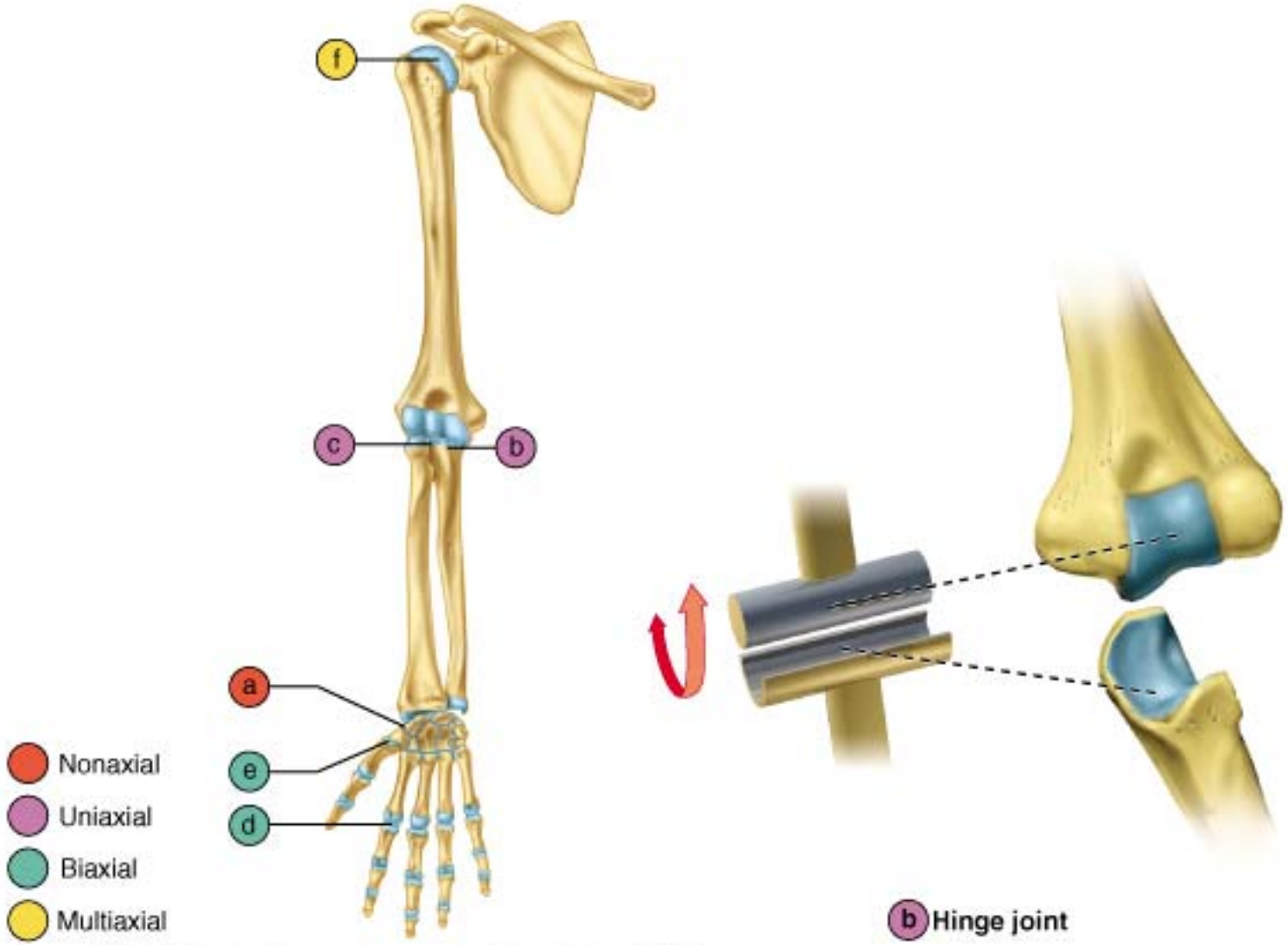


Types of synovial joints

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

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

Hinge Joint

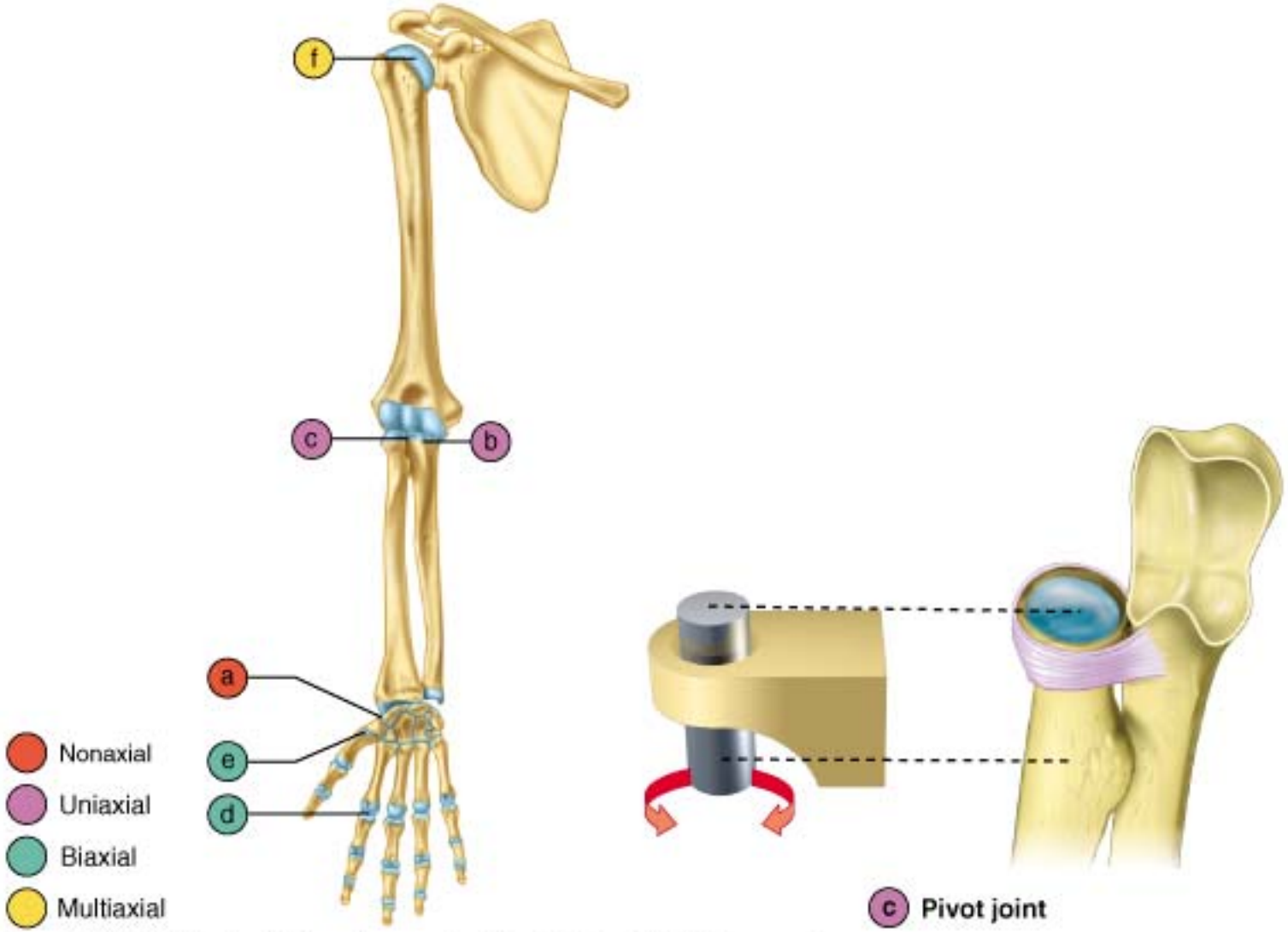


Types of synovial joints

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

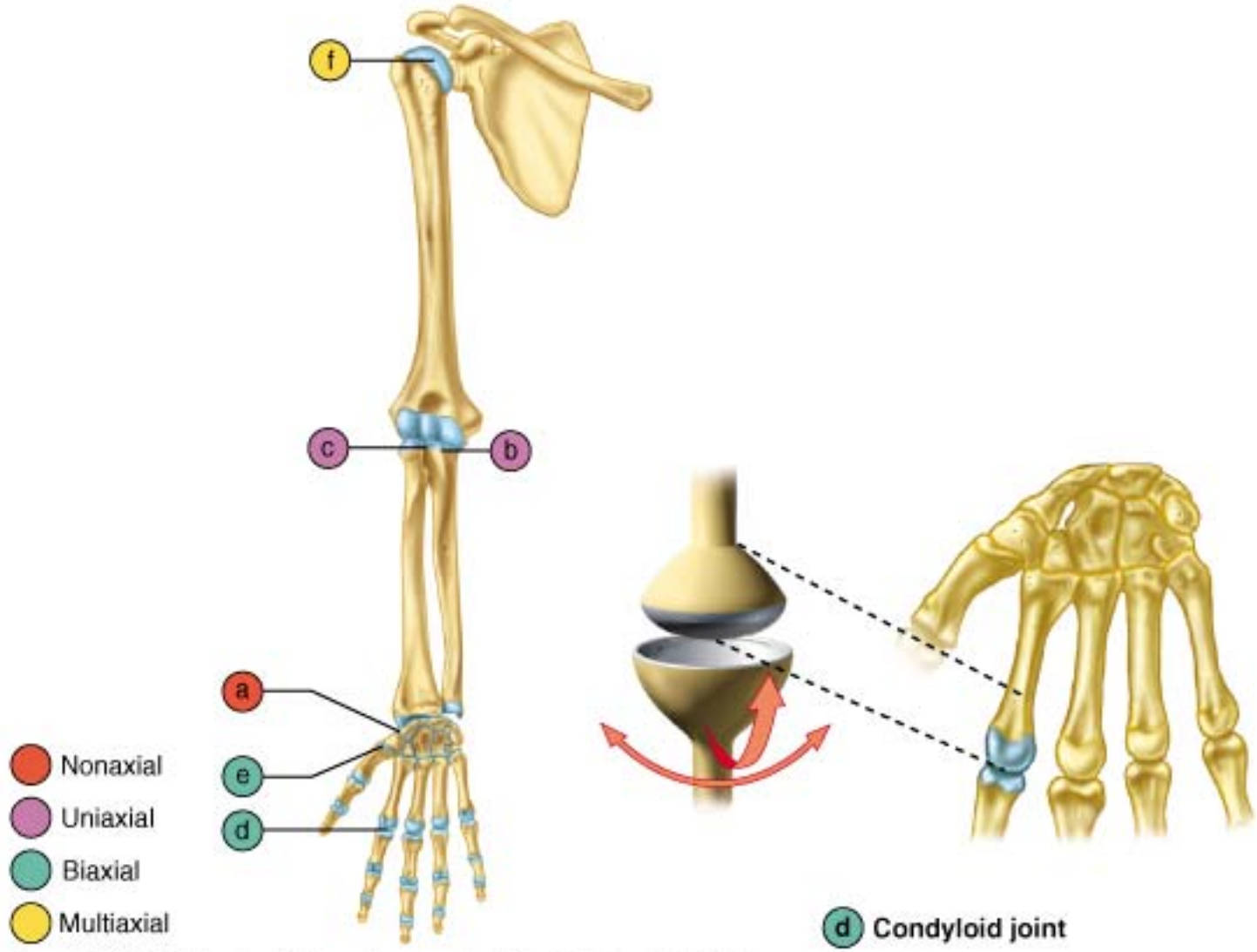


Types of synovial joints

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

Example: metacarpophalangeal joints,

Condyloid Joint

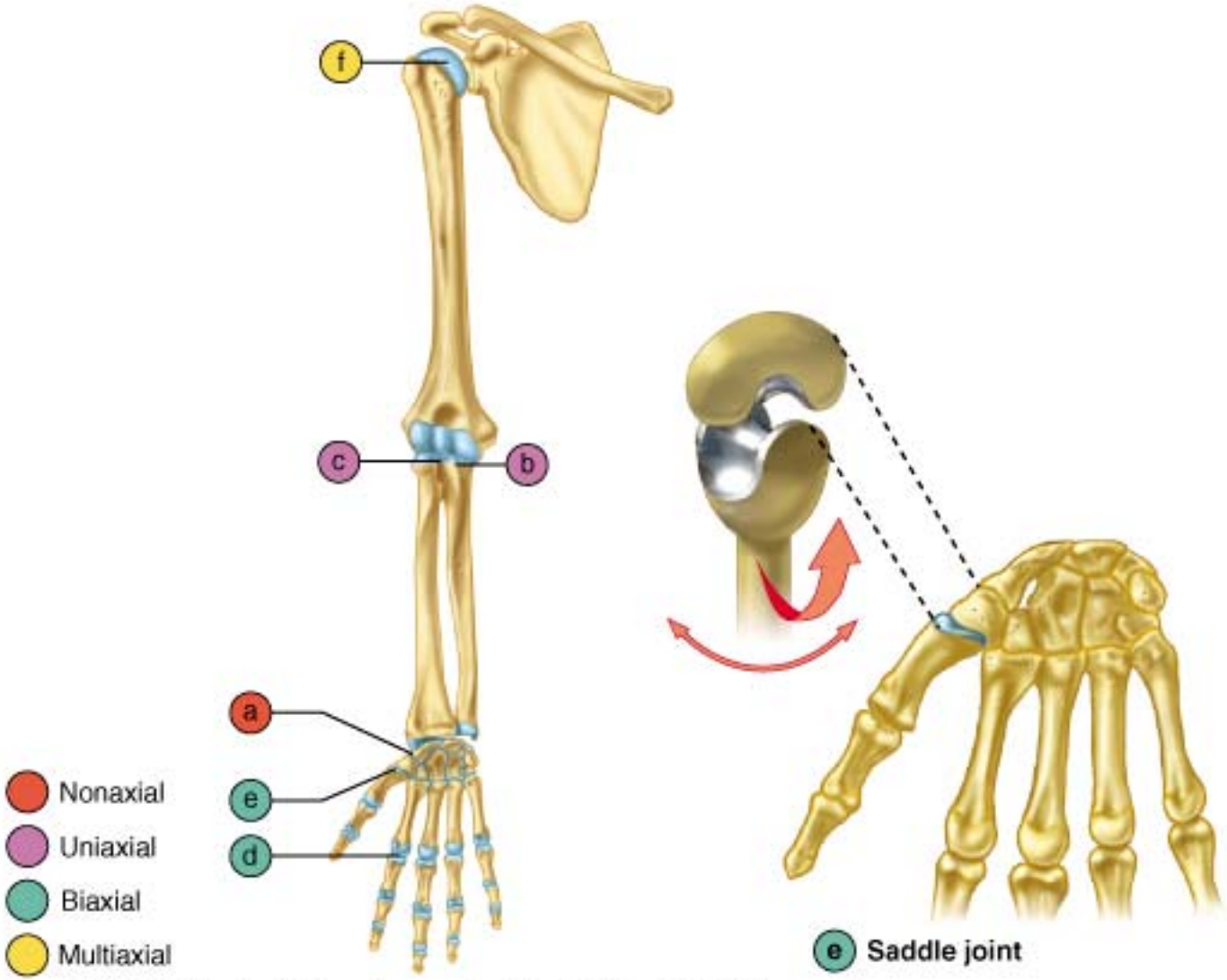


Types of synovial joints

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

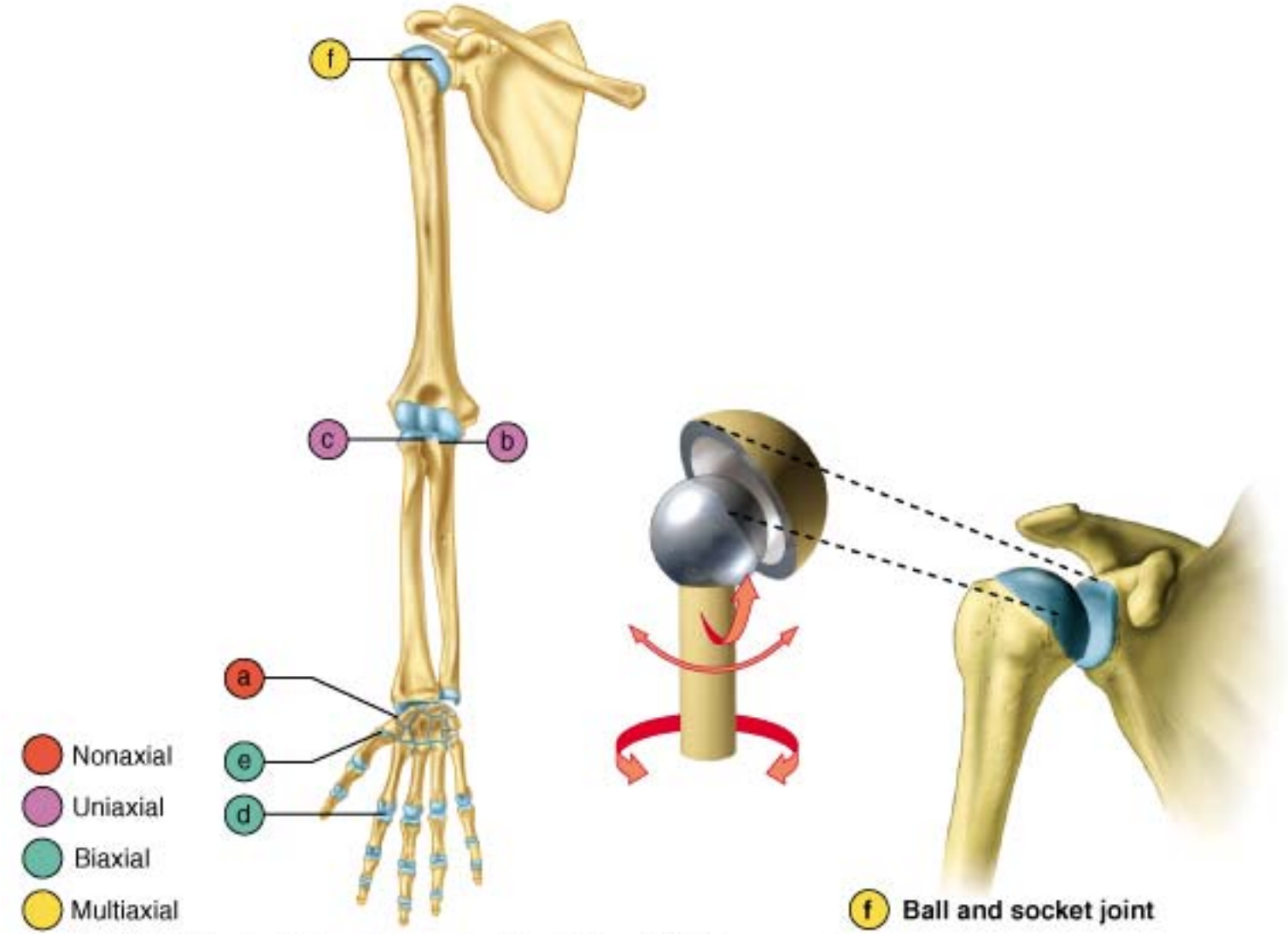


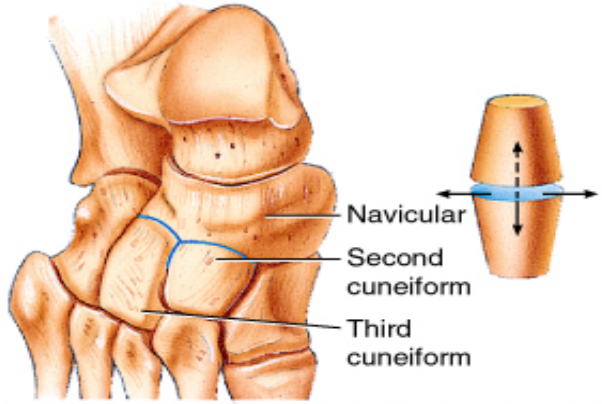
Types of synovial joints

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

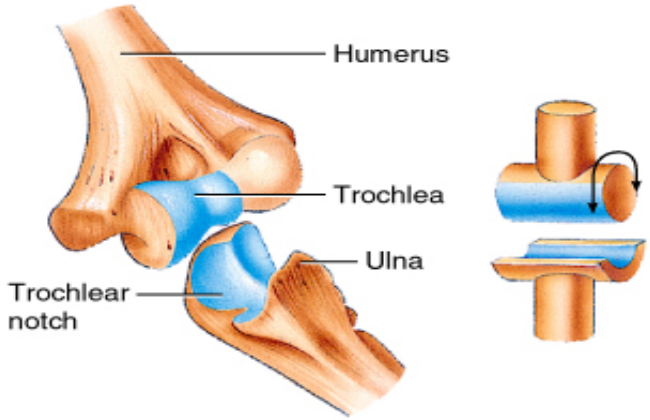
Example: the hip and shoulder joints.

Ball-and-socket Joint

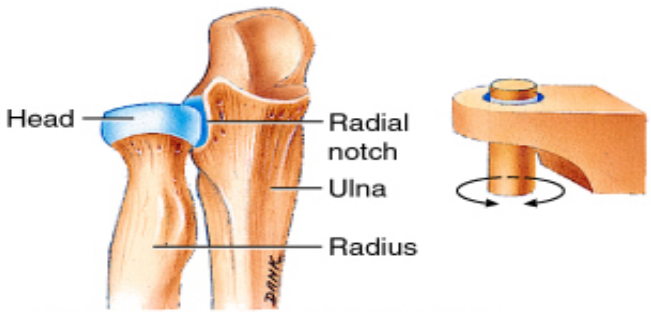




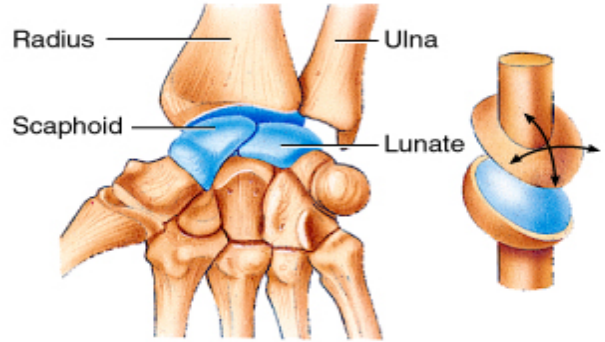
(a) Gliding joint between the navicular and second and third cuneiforms of the tarsus in the foot



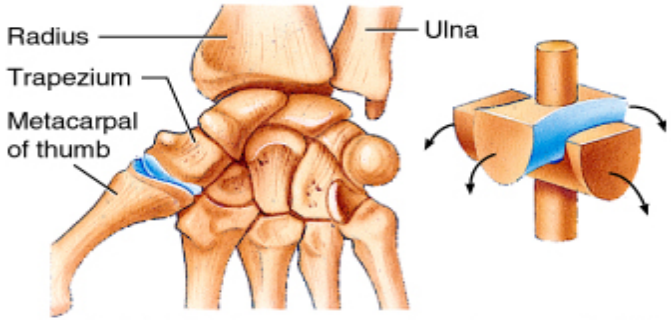
(b) Hinge joint between trochlea of humerus and trochlear notch of ulna at the elbow



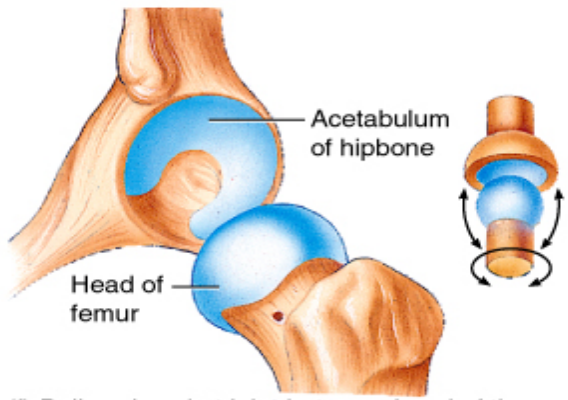
(c) Pivot joint between head of radius and radial notch of ulna



(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.