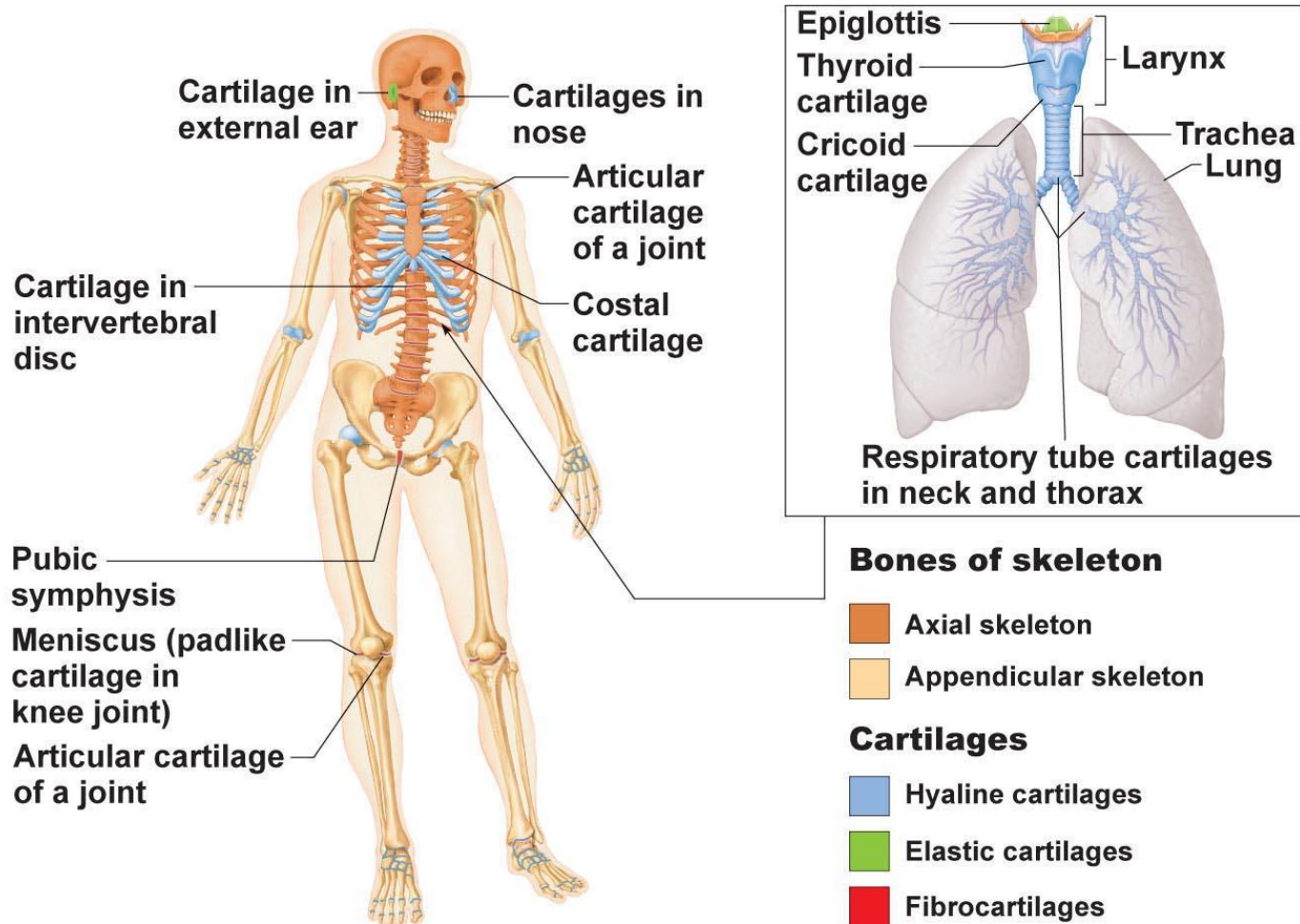


# Skeletal System

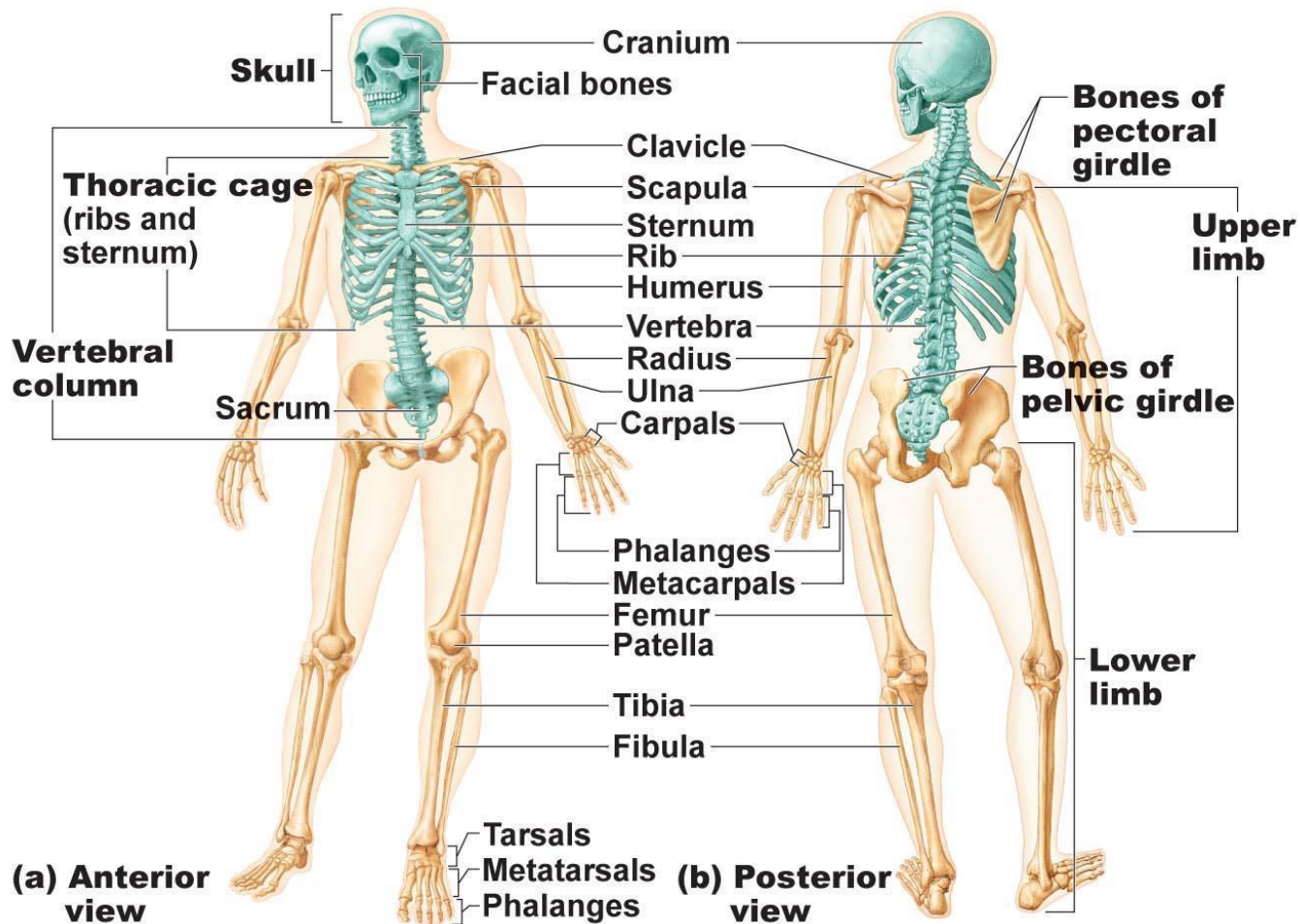
Chapters 6 & 7

A decorative graphic consisting of several horizontal lines of varying lengths and colors (teal, light blue, white) extending from the right side of the slide.

# Skeletal System = bones, joints, cartilages, ligaments



- **Axial skeleton**: long axis (skull, vertebral column, rib cage)
- **Appendicular skeleton**: limbs and girdles



## Axial Skeleton

- Cranium (skull)
- Mandible (jaw)
- Vertebral column (spine)
  - Cervical vertebrae
  - Thoracic vertebrae
  - Lumbar vertebrae
  - Sacrum
  - Coccyx
- Sternum (breastbone)
- Ribs

## Appendicular Skeleton

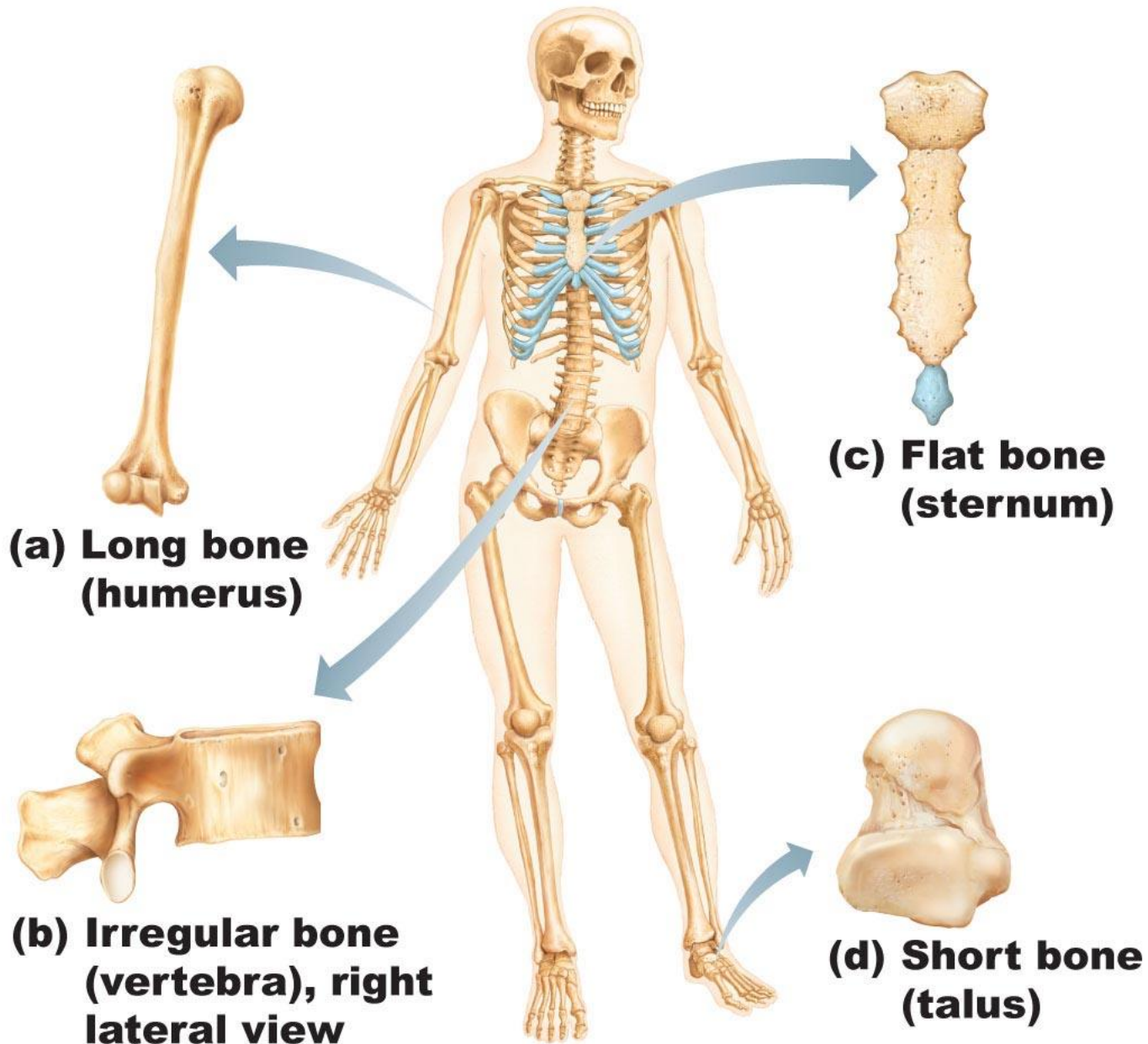
- Clavicle (collarbone)
- Scapula (shoulder blade)
- Coxal (pelvic girdle)
- Humerus (arm)
- Radius, ulna (forearm)
- Carpals (wrist)
- Metacarpals (hand)
- Phalanges (fingers, toes)
- Femur (thigh)
- Tibia, fibula (leg)
- Tarsal, metatarsals (foot)
- Calcaneus (heel)
- Patella (knee)

# Functions of the Bones

- **Support** body and cradle soft organs
- **Protect** vital organs
- **Movement**: muscles move bones
- **Storage** of minerals (calcium, phosphorus) & growth factors
- **Blood cell formation** in bone marrow
- **Triglyceride (fat) storage**

# Classification of Bones

1. Long bones
  - Longer than they are wide (eg. femur, metacarpels)
2. Short bones
  - Cube-shaped bones (eg. wrist and ankle)
  - Sesamoid bones (within tendons – eg. patella)
3. Flat bones
  - Thin, flat, slightly curved (eg. sternum, skull)
4. Irregular bones
  - Complicated shapes (eg. vertebrae, hips)



**(a) Long bone  
(humerus)**

**(b) Irregular bone  
(vertebra), right  
lateral view**

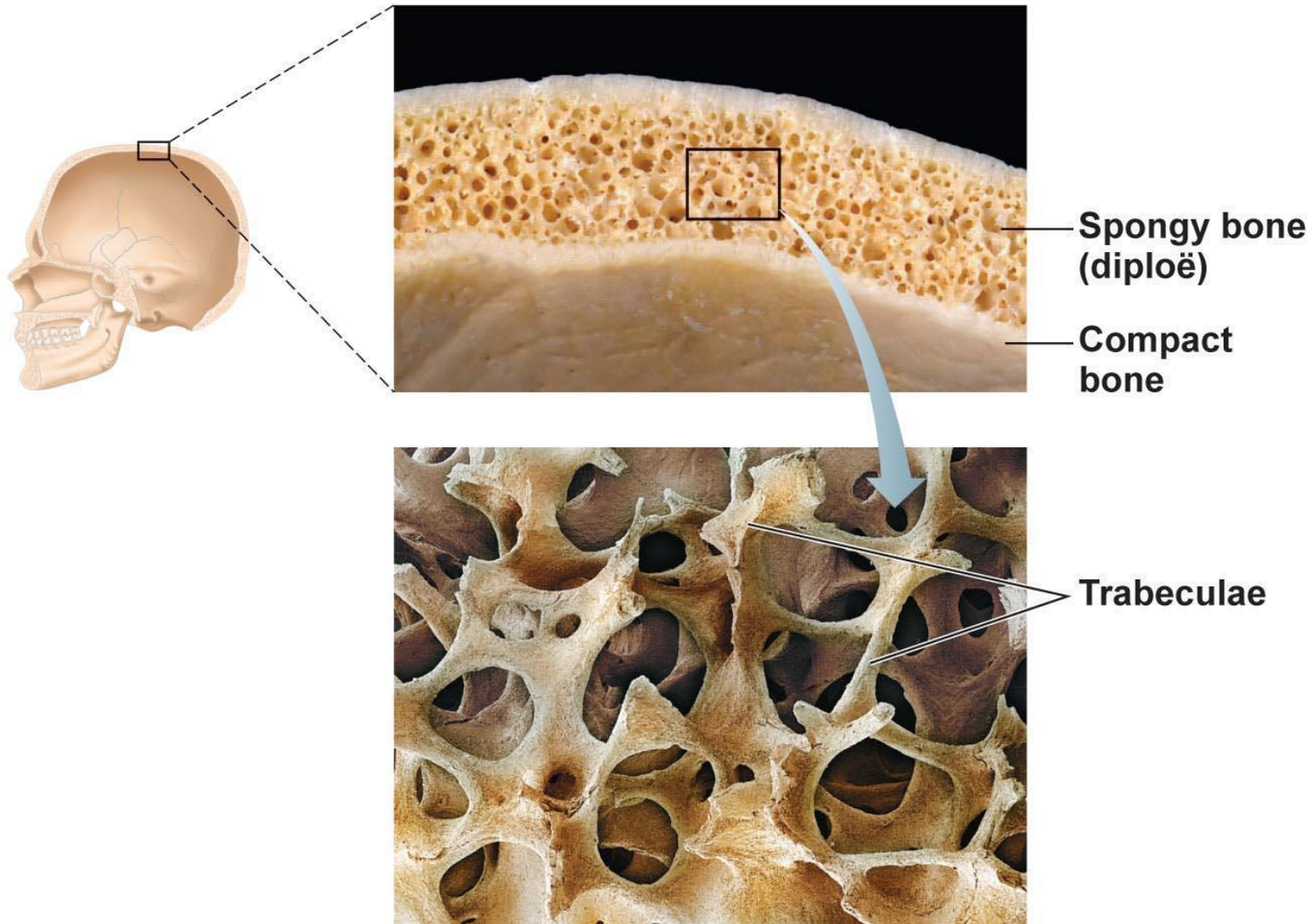
**(c) Flat bone  
(sternum)**

**(d) Short bone  
(talus)**

- Adult = 206 bones
- Types of bone tissue:
  - Compact bone: outer layer – dense & solid
  - Spongy bone: inner layer - open spaces, marrow
- Features:
  - Very hard (calcium salts)
  - Light weight
  - Ability to resist tension and forces (collagen fibers)



# Spongy vs. Compact Bone



# Bone Development

- Osteogenesis (ossification): bone tissue formation

## Stages:

- Begins at 8 weeks gestation
  - Start as **cartilage** → replaced by **bone**
- Post-natal bone growth → early adulthood
  - Epiphyseal plates: (growth plates) regions where long bones lengthen
  - Appositional growth: bones increase in thickness
- Bone modeling and repair – lifelong

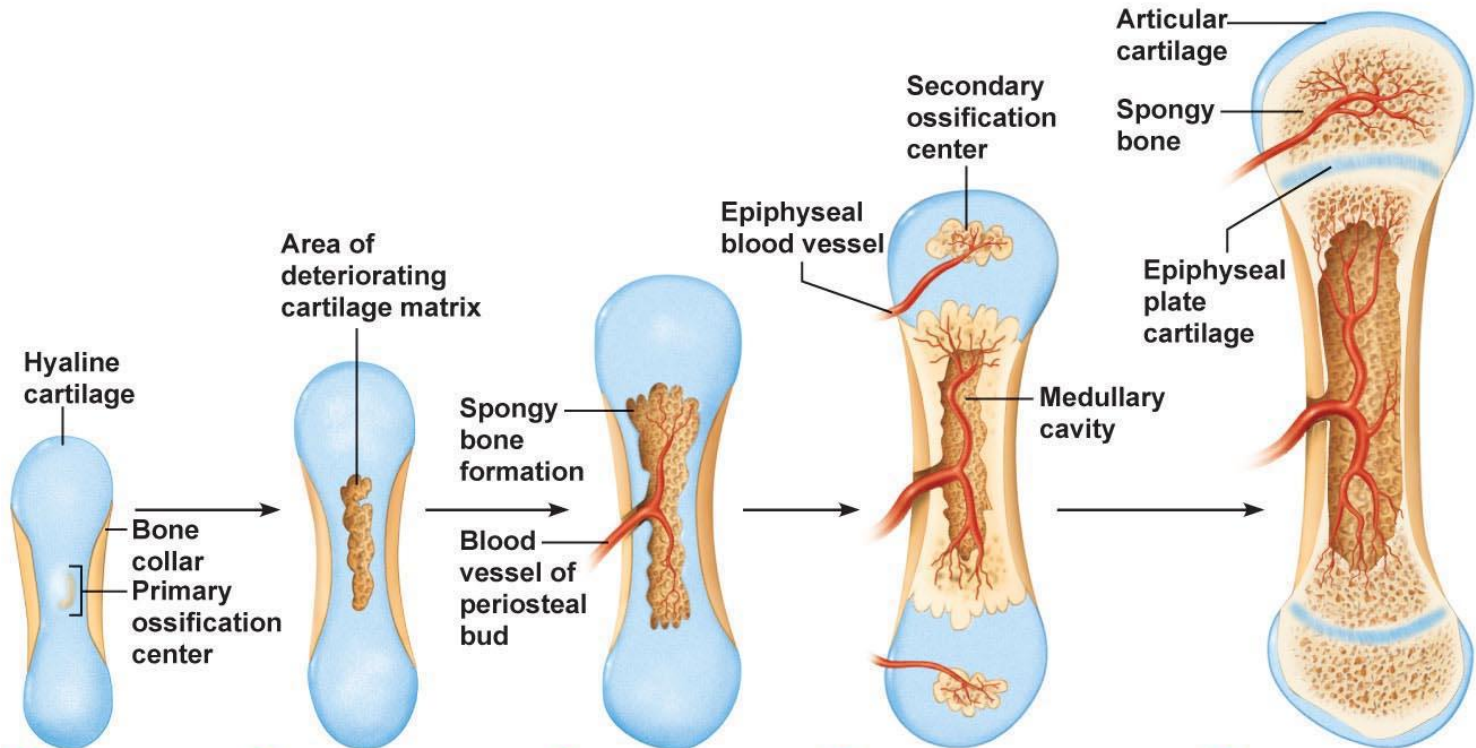
# Formation of bony skeleton

Week 9

Month 3

Birth

Childhood to adolescence



① Bone collar forms around hyaline cartilage model.

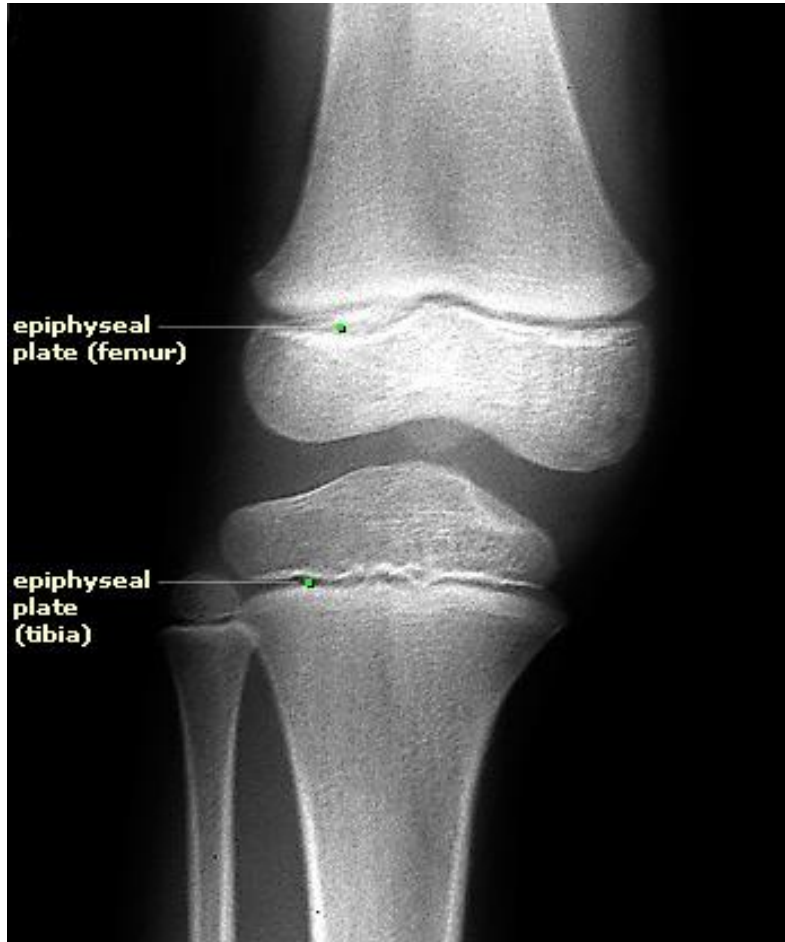
② Cartilage in the center of the diaphysis calcifies and then develops cavities.

③ The periosteal bud invades the internal cavities and spongy bone begins to form.

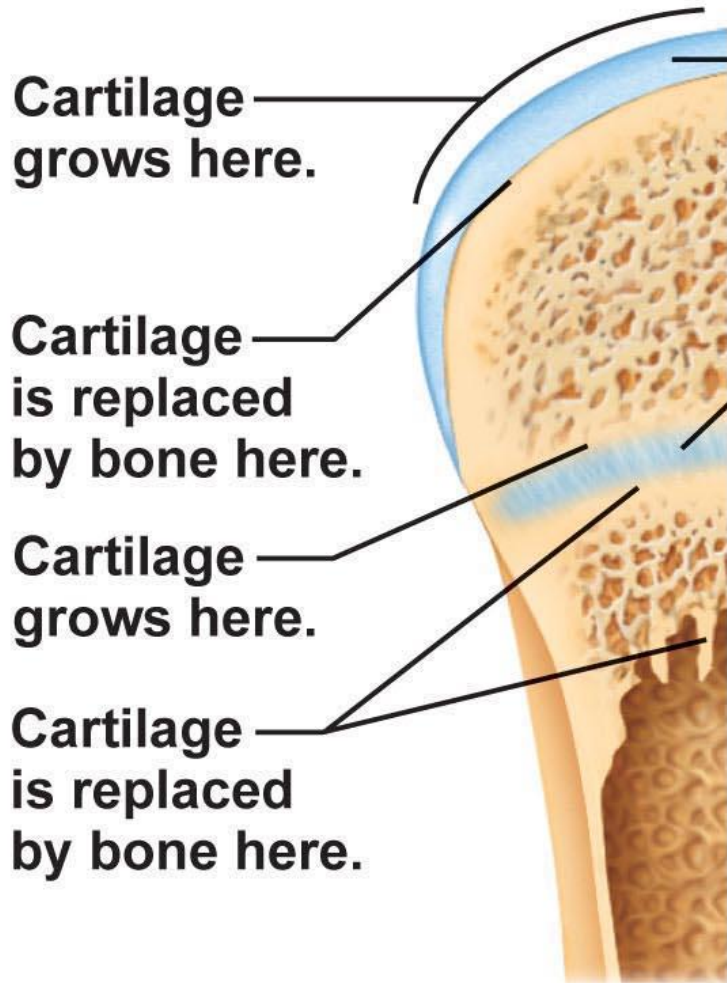
④ The diaphysis elongates and a medullary cavity forms as ossification continues. Secondary ossification centers appear in the epiphyses in preparation for stage 5.

⑤ The epiphyses ossify. When completed, hyaline cartilage remains only in the epiphyseal plates and articular cartilages.

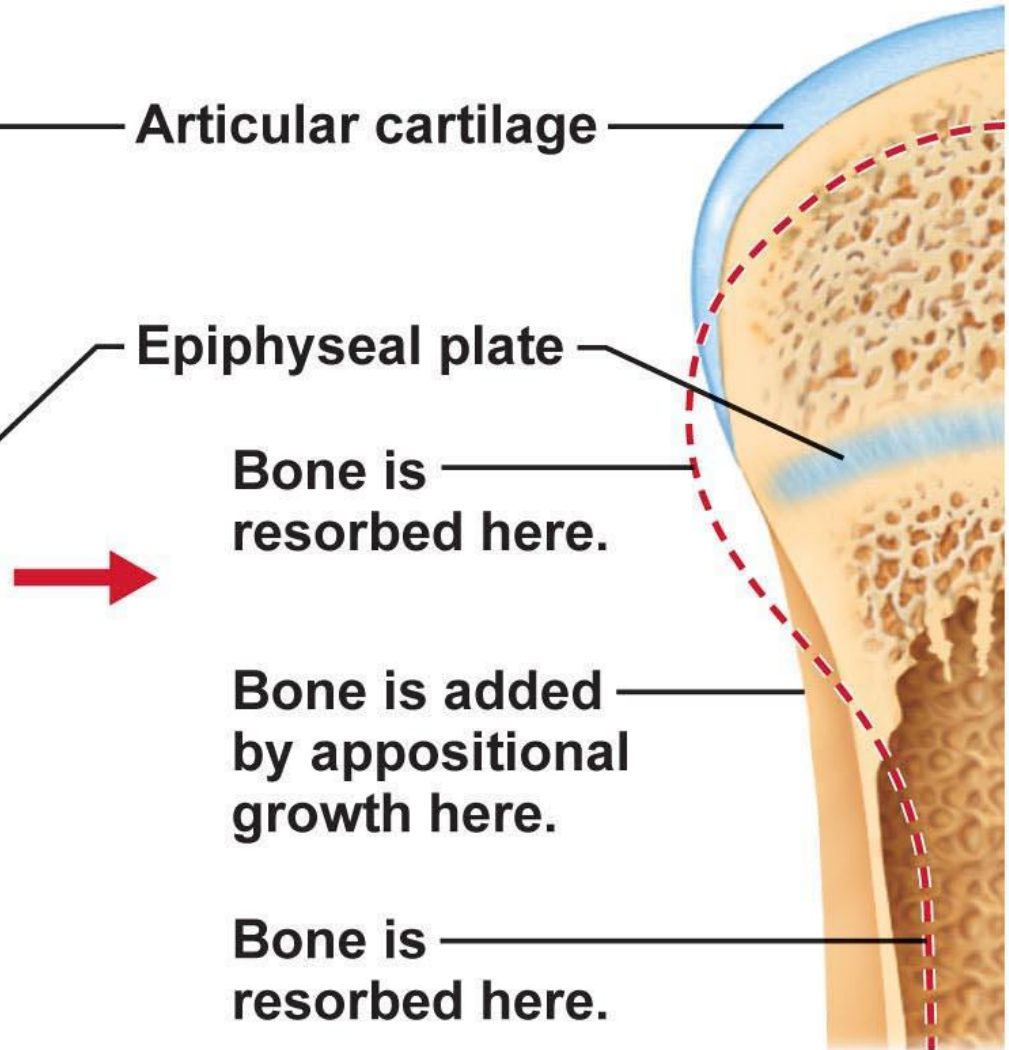
# Epiphyseal plates



# Bone growth



# Bone remodeling



# Epiphyseal plates

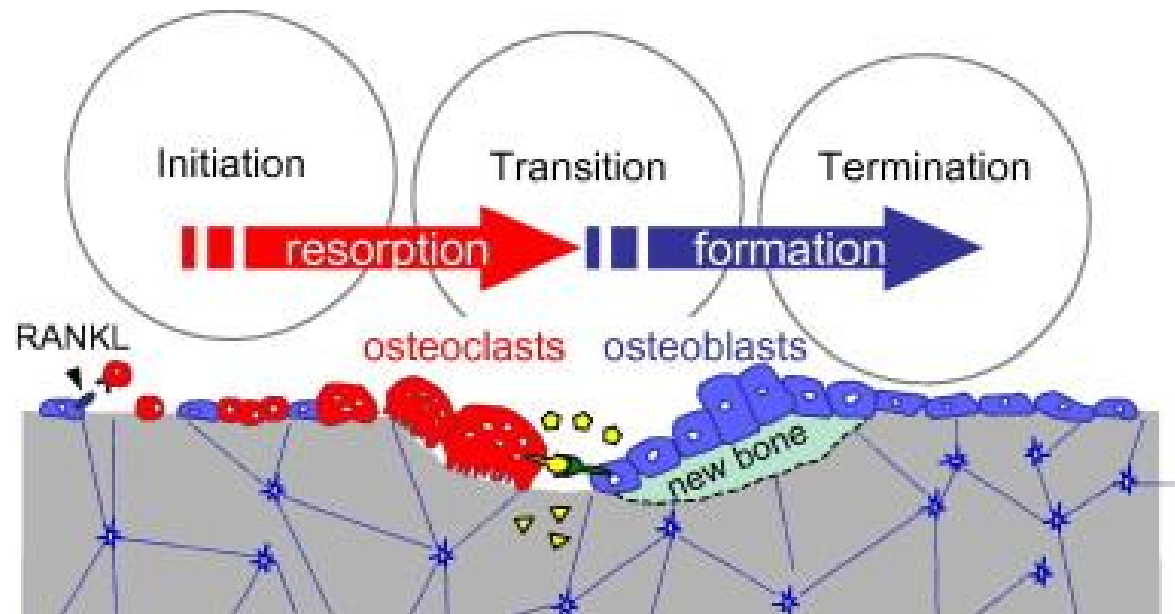


# Hormonal Control

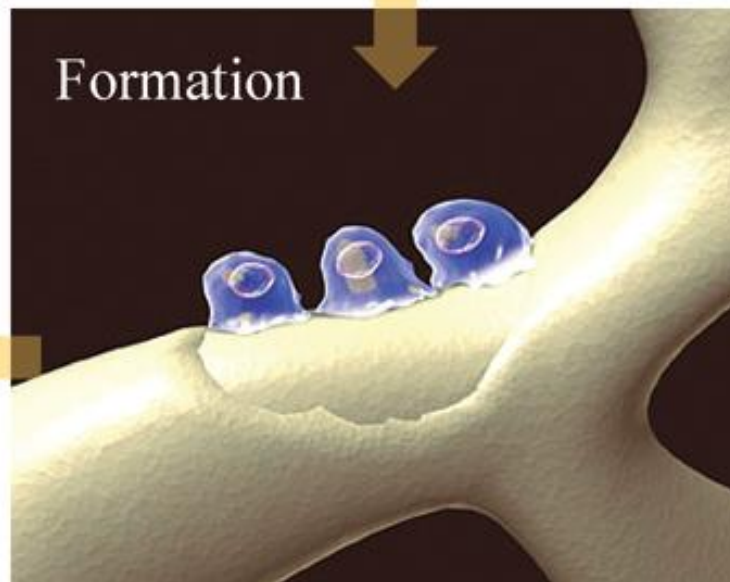
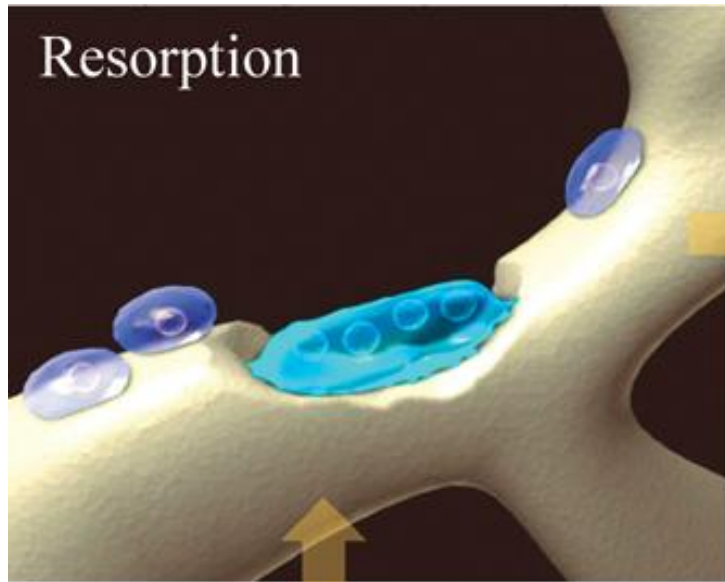
- Growth hormones: stimulate longitudinal bone growth
- Thyroid hormone: control activity of growth hormone
- Testosterone & estrogens (at puberty):
  - Adolescent growth spurt
  - Close epiphyseal plates → end growth

# Bone Cells

- Osteoblasts: bone-forming cells
- Osteocytes: mature bone cell (doesn't divide)
- Osteoclasts: dissolve/break down bone (*bone resorption*)







# Fractures (Breaks)

## **Classified by:**

1. Position of bone – nondisplaced (normal) or displaced (bone out of alignment)
2. Completeness of break – complete (broken through) or incomplete
3. Orientation to long axis of bone – linear (parallel to bone) or transverse (perpendicular to bone)
4. If bone penetrates skin – open (compound) fracture or closed (simple) fracture

**TABLE 6.2****Common Types of Fractures****FRACTURE TYPE****DESCRIPTION AND COMMENTS****FRACTURE TYPE****DESCRIPTION AND COMMENTS****Comminuted**

Bone fragments into three or more pieces.  
Particularly common in the aged, whose bones are more brittle

**Compression**

Bone is crushed.  
Common in porous bones (i.e., osteoporotic bones) subjected to extreme trauma, as in a fall



Crushed vertebra

**TABLE 6.2****Common Types of Fractures****FRACTURE TYPE****DESCRIPTION AND COMMENTS****FRACTURE TYPE****DESCRIPTION AND COMMENTS****Spiral**

Ragged break occurs when excessive twisting forces are applied to a bone.

Common sports fracture

**Epiphyseal**

Epiphysis separates from the diaphysis along the epiphyseal plate.

Tends to occur where cartilage cells are dying and calcification of the matrix is occurring



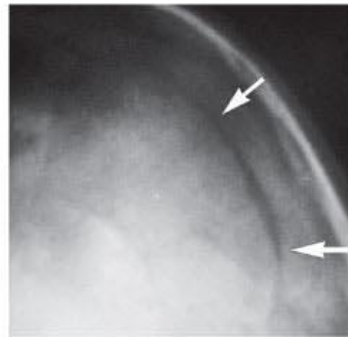
**TABLE 6.2****Common Types of Fractures**

FRACTURE TYPE	DESCRIPTION AND COMMENTS	FRACTURE TYPE	DESCRIPTION AND COMMENTS
---------------	--------------------------	---------------	--------------------------

**Depressed**

Broken bone portion is pressed inward.

Typical of skull fracture

**Greenstick**

Bone breaks incompletely, much in the way a green twig breaks. Only one side of the shaft breaks; the other side bends.

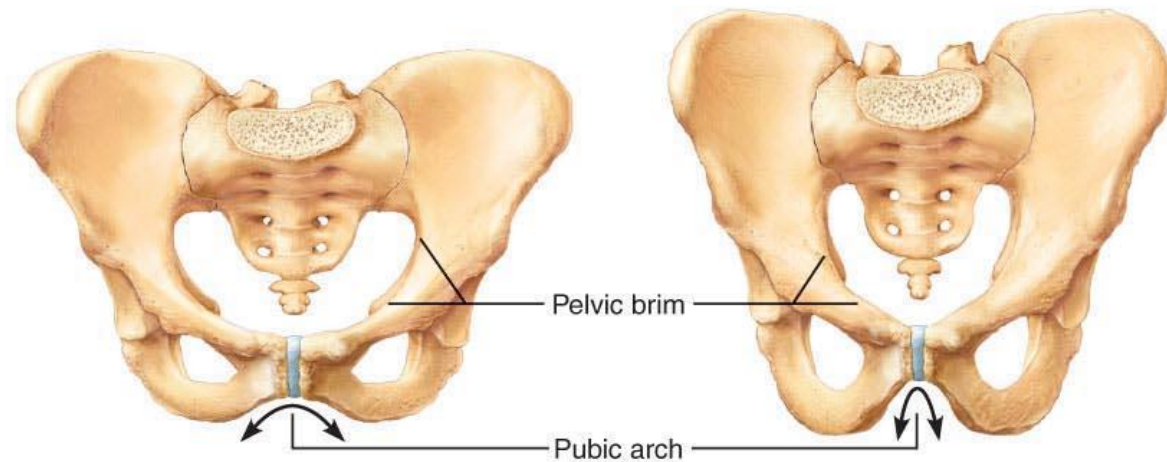
Common in children, whose bones have relatively more organic matrix and are more flexible than those of adults



# Male vs. Female Bone Structure

**TABLE 7.4** Comparison of the Male and Female Pelves

CHARACTERISTIC	FEMALE	MALE
General structure and functional modifications	Tilted forward; adapted for childbearing; true pelvis defines the birth canal; cavity of the true pelvis is broad, shallow, and has a greater capacity	Tilted less far forward; adapted for support of a male's heavier build and stronger muscles; cavity of the true pelvis is narrow and deep
Bone thickness	Less; bones lighter, thinner, and smoother	Greater; bones heavier and thicker, and markings are more prominent
Acetabula	Smaller; farther apart	Larger; closer
Pubic angle/arch	Broader (80° to 90°); more rounded	Angle is more acute (50° to 60°)
Anterior view		



# Male vs. Female Bone Structure

**TABLE 7.4**

**Comparison of the Male and Female Pelves** *(continued)*

**CHARACTERISTIC**

**FEMALE**

**MALE**

Sacrum

Wider; shorter; sacral curvature is accentuated

Narrow; longer; sacral promontory more ventral

Coccyx

More movable; straighter

Less movable; curves ventrally

Greater sciatic notch

Wide and shallow

Narrow and deep

Left lateral view



# Male vs. Female Bone Structure

**TABLE 7.4**

**Comparison of the Male and Female Pelves** *(continued)*

**CHARACTERISTIC**

**FEMALE**

**MALE**

Pelvic inlet (brim)

Wider; oval from side to side

Narrow; basically heart shaped

Pelvic outlet

Wider; ischial tuberosities shorter, farther apart and everted

Narrower; ischial tuberosities longer, sharper, and point more medially

Posteroinferior view





# Bone Structure: *Gender Differences*

- **Male Skull**

- Larger and heavier
- Forehead shorter
- Face less round
- Jaw larger
- Mastoid processes more prominent

- **Male pelvic bones**

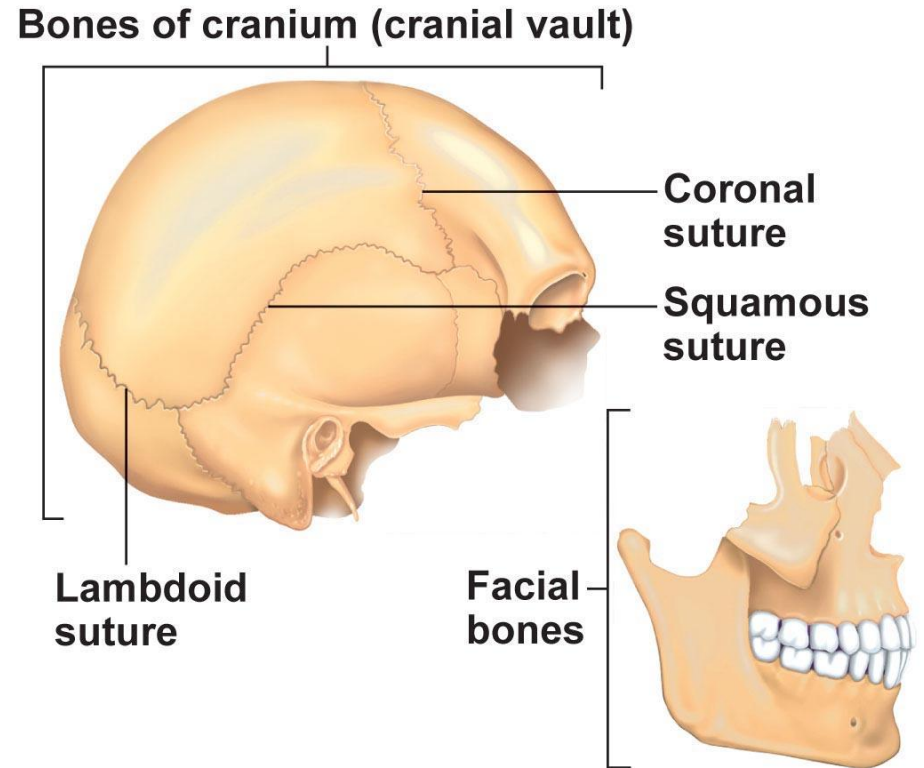
- Heavier and thicker
- Obturator foramen and acetabula are larger and closer together

# Bone Structure: *Gender Differences*

- **Male pelvic cavity**
  - Narrower and longer
  - Less roomy and more funnel shaped
- **Male sacrum**
  - Narrower
  - Sacral promontory projects forward
  - Sacral curvature is less sharp posteriorly
- **Male coccyx**
  - Less movable

# The Skull

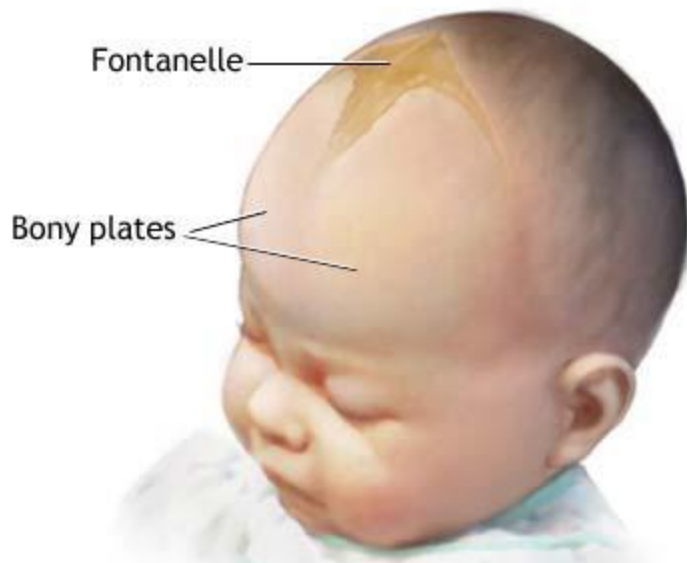
- **2 bone types:**
  - **Cranial** – form the top, sides, and back of the skull
  - **Facial** – form the face



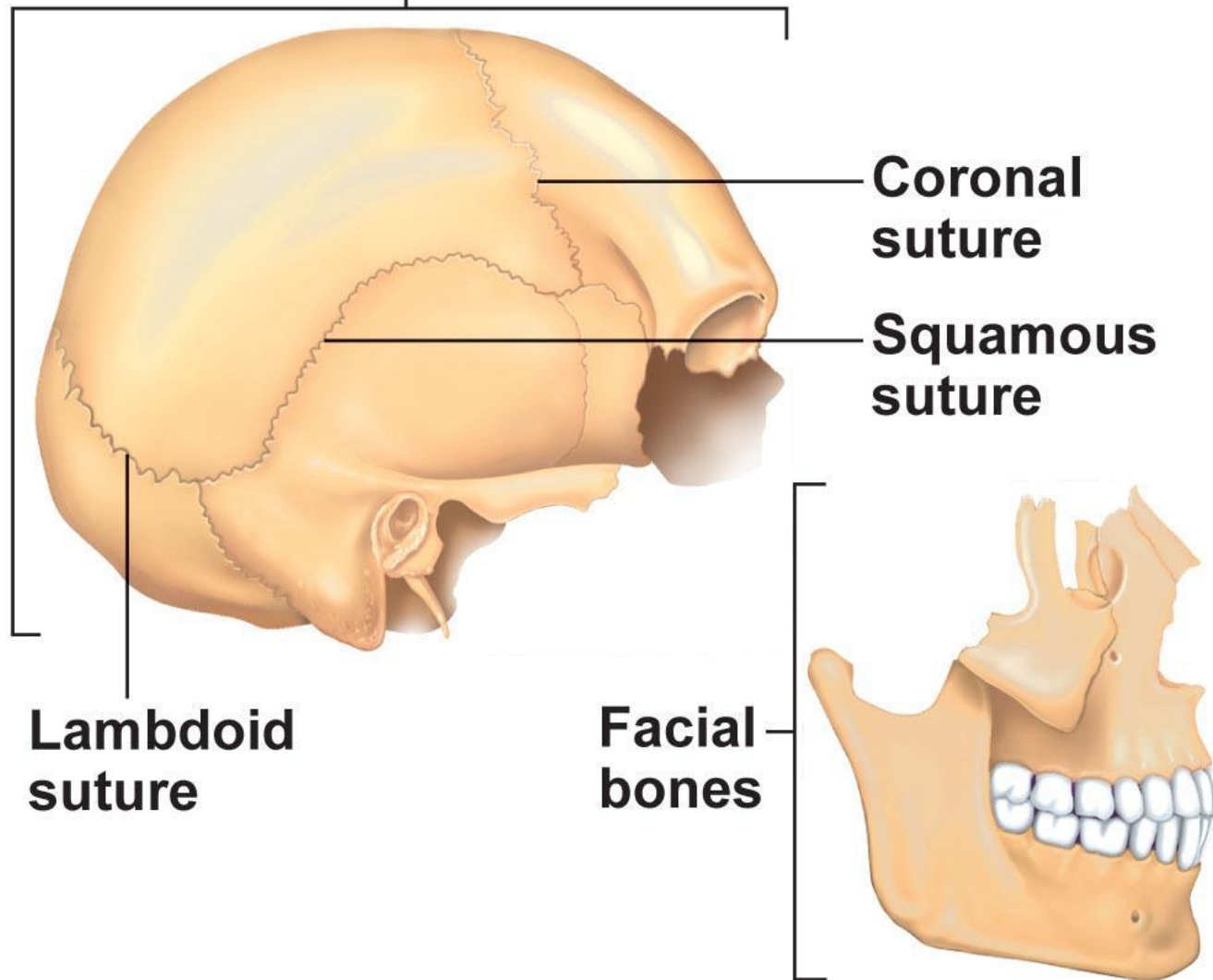
**(a) Cranial and facial divisions of the skull**

“Soft spots” felt on an infant's skull are actually *fontanelles*

- Fibrous connective tissue that connect the incompletely developed flat bones



## Bones of cranium (cranial vault)



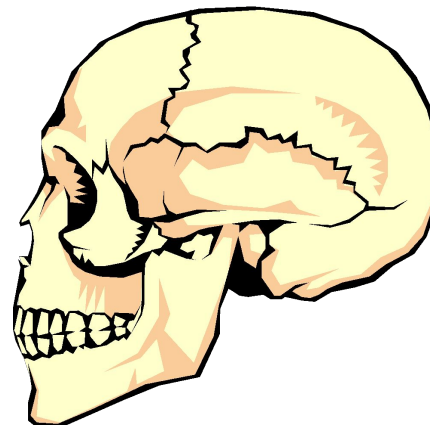
**(a) Cranial and facial divisions of the skull**

# The Skull: *Cranial Bones*

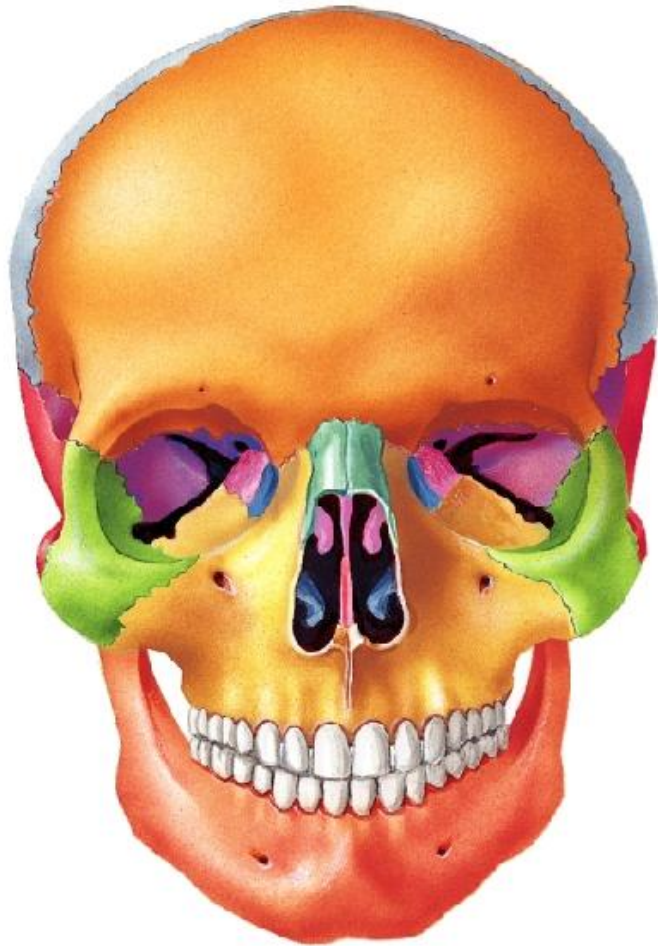
- Frontal – anterior
- Parietal – top and most of the sides
- Occipital – back
- Temporal – form the lower sides of the skull
- Sphenoid and ethmoid bones – floor
- Ear ossicles are the smallest bones of the body
  - Malleus
  - Incus
  - Stapes

# The Skull (cont.)

- Mandible – forms the lower jaw bone
- Maxillae – form the upper jawbone
- Zygomatic – form the prominence of the cheeks
- Nasal bones – fuse together to form the bridge of the nose
- Palatine – form the anterior portion of the palate
- Vomer – a thin bone that divides the nasal cavity



# The Skull (cont.)





# The Spinal Column

- 7 Cervical vertebrae
- 12 Thoracic vertebrae
- 5 Lumbar vertebrae
- Sacrum
- Coccyx

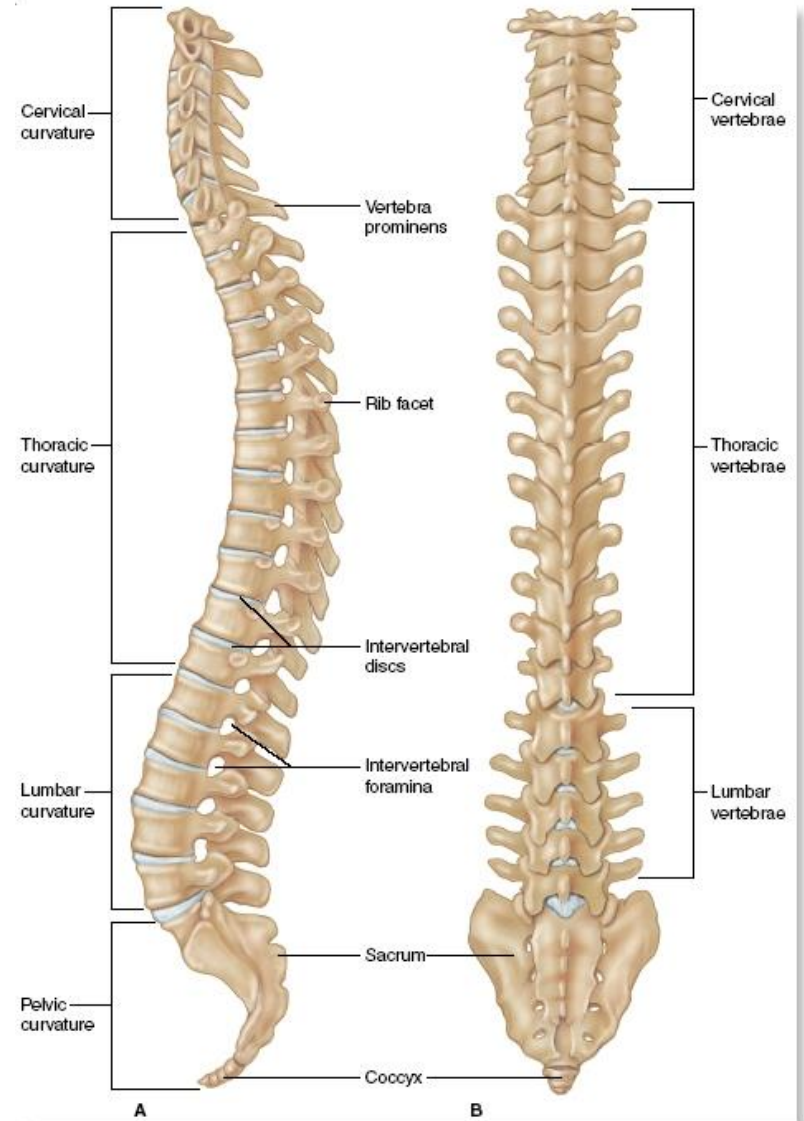


Figure 25-7. Vertebral column: (a) lateral view and (b) posterior view.

# The Spinal Column (cont.)

- **Cervical vertebrae**

- Smallest and lightest
- Located in the neck region
- C1 = **Atlas**
- C2 = **Axis**



- **Thoracic vertebrae**

- Join the 12 pairs of ribs

- **Lumbar vertebrae**

- Have very sturdy structures
- Weight-bearing

# The Spinal Column (cont.)

- **Sacrum**

- Triangular-shaped bone → 5 fused vertebrae

- **Coccyx**

- Small, triangular bone → 3-5 fused vertebrae

- Considered unnecessary

- Also called the **tailbone**

# The Rib Cage

- ***Sternum***
  - Breastplate
  - Forms the front middle portion of the rib cage
  - Joins with the clavicles and most ribs
- ***Xyphoid process***
  - Cartilage tip in youth
  - Ossified by age 40

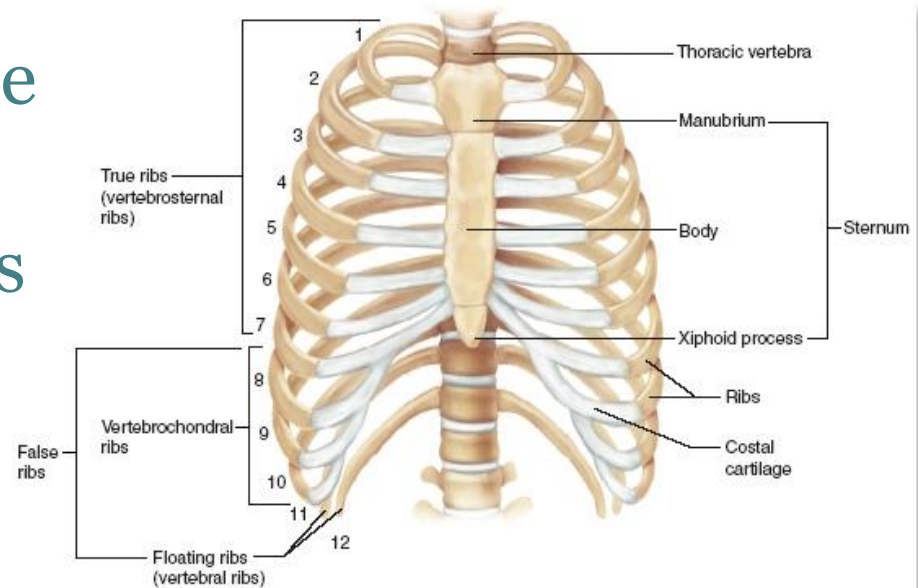


Figure 25-8. Rib cage.

# The Rib Cage (cont.)

- **12 pairs of ribs**
  - All are attached posteriorly to thoracic vertebrae
- **True**
  - First 7 pairs of ribs
  - Attach to sternum by **costal** cartilage
- **False**
  - Rib pairs 8-10
  - Attach to the costal cartilage of rib pair 7
- **Floating**
  - Rib pairs 11-12
  - Do not attach anteriorly to any structure

# Common Diseases and Disorders

- *Arthritis* – general term meaning joint inflammation
- *Osteoarthritis* – degenerative joint disease, primarily of weight-bearing joints
- *Rheumatoid Arthritis* – chronic systemic inflammatory disease of smaller joints and surrounding tissues

# Common Diseases and Disorders

- ***Bursitis*** – inflammation of a bursa (fluid-filled sac that cushions tendons)
- ***Carpal Tunnel Syndrome*** – overuse of wrist; the median nerve in the wrist becomes compressed
- ***Ewing's Family of Tumors (EFT)*** – a group of tumors that affect different tissue types; primarily bone
- ***Gout*** – a type of arthritis; deposits of uric acid crystals in the joints

# Common Diseases and Disorders

- *Kyphosis* – abnormal curvature of the spine (humpback)
- *Lordosis* – exaggerated inward curvature of the lumbar spine (swayback)
- *Osteogenesis imperfecta* – brittle-bone disease
- *Osteoporosis* – a condition in which bones thin (become porous) over time



# Common Diseases and Disorders

- ***Osteosarcoma*** – a type of bone cancer that originates from osteoblasts, the cells that make bony tissue
- ***Paget's disease*** – causes bones to enlarge and become deformed and weak
- ***Scoliosis*** – an abnormal S-shaped curvature of the spine



# JOINTS

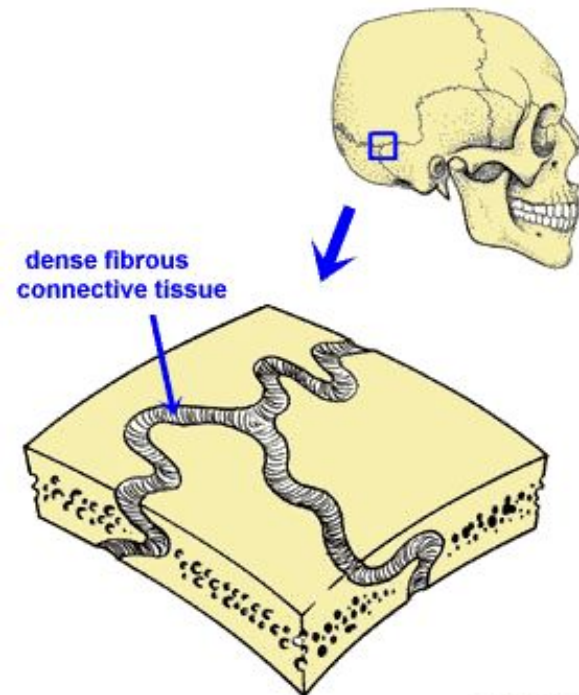
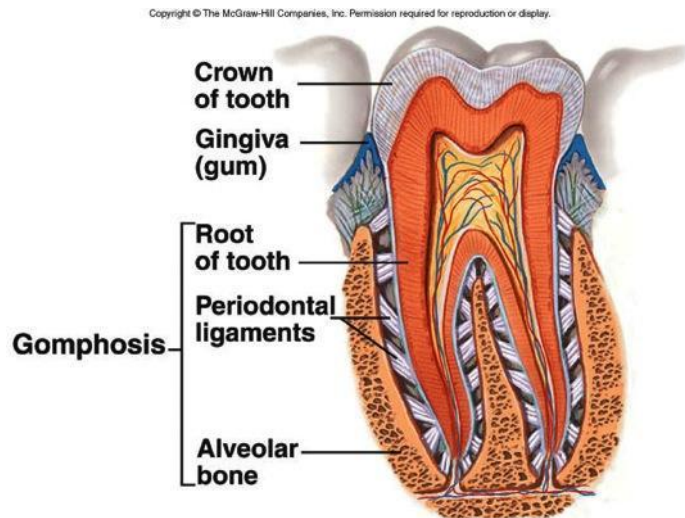
Chapter 8

# Joints (or articulations)

- Where two or more bones meet
- Functions: movement, hold skeleton together
- Classified by **structure** (or **function**):
  1. **Fibrous** (**synarthroses**): immovable joint
  2. **Cartilaginous** (**amphiarthroses**): slightly movable
  3. **Synovial** (**diarthroses**): freely movable

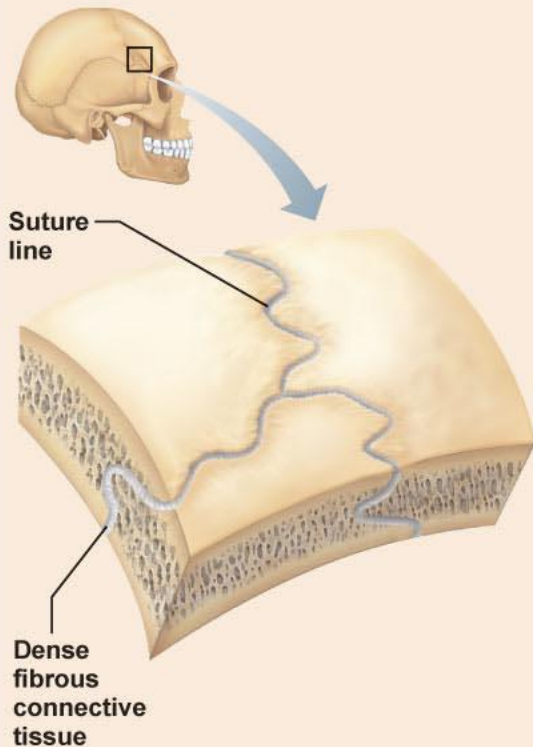
# Fibrous Joints

- No movement
- Located:
  - **Sutures**: bones of skull held together by connective tissue fibers
  - Between teeth & jaws



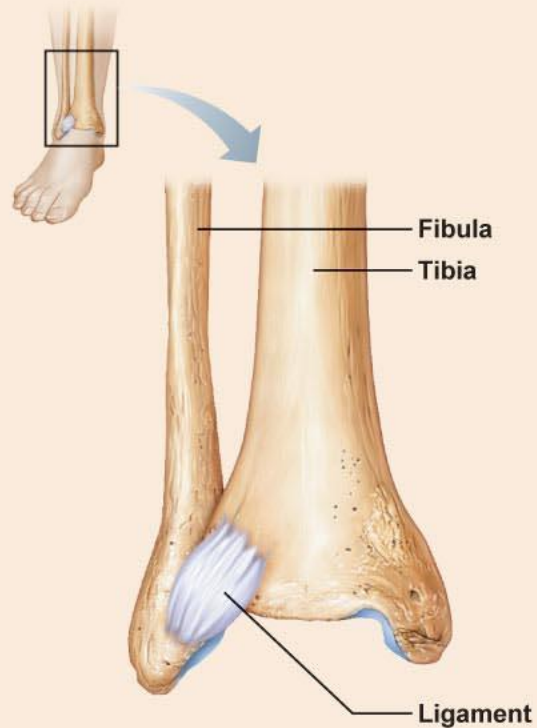
### (a) Suture

Joint held together with very short, interconnecting fibers, and bone edges interlock. Found only in the skull.



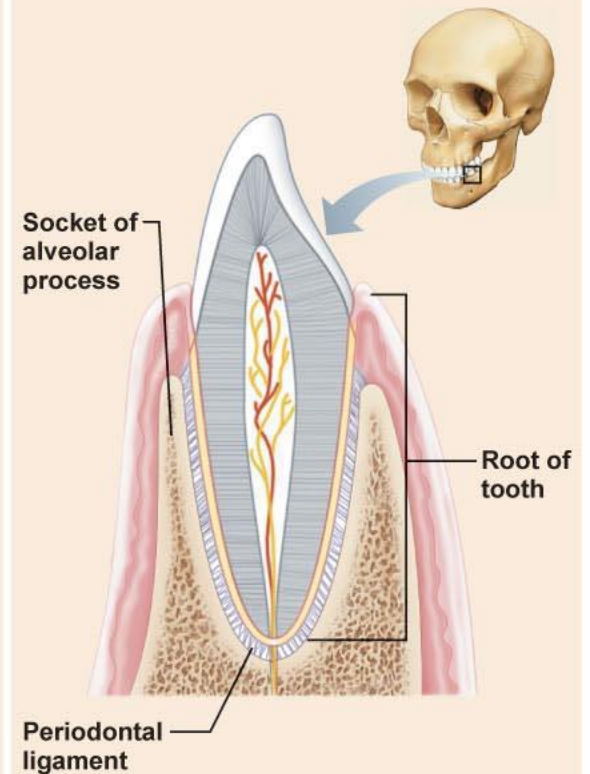
### (b) Syndesmosis

Joint held together by a ligament. Fibrous tissue can vary in length, but is longer than in sutures.



### (c) Gomphosis

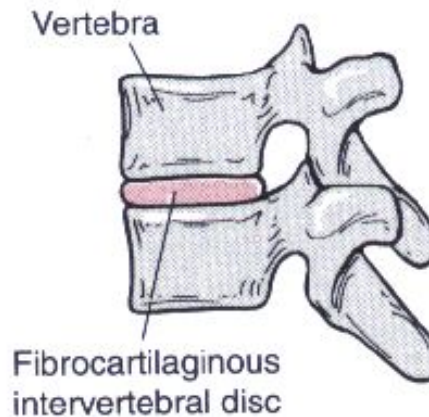
“Peg in socket” fibrous joint. Periodontal ligament holds tooth in socket.



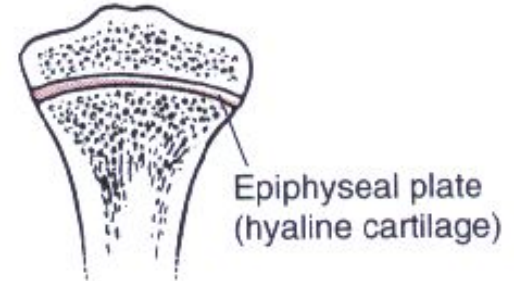
# Cartilaginous Joints

- Bones united by cartilage
- Located:
  - Epiphyseal plates
  - Rib & sternum
  - Pubic symphysis

B. Amphiarthrodial



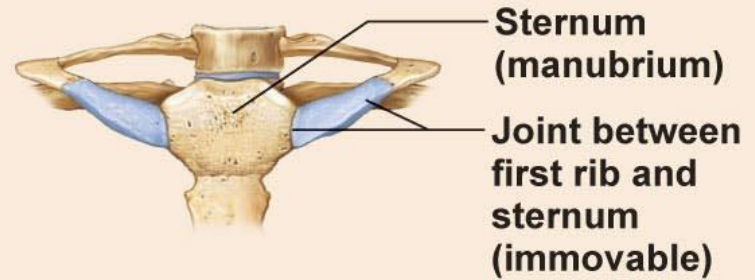
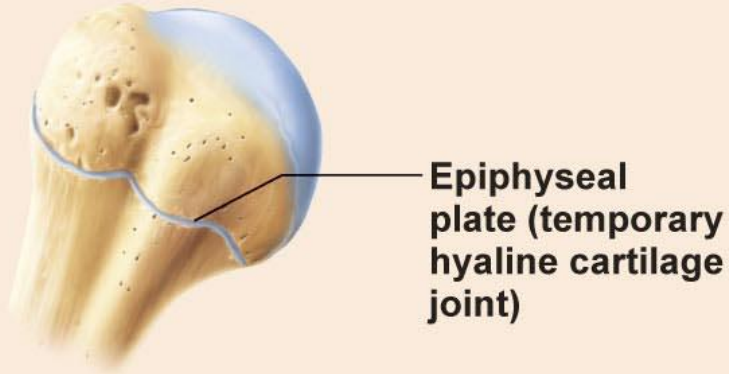
Intervertebral Disc



Epiphysis

## (a) Synchondroses

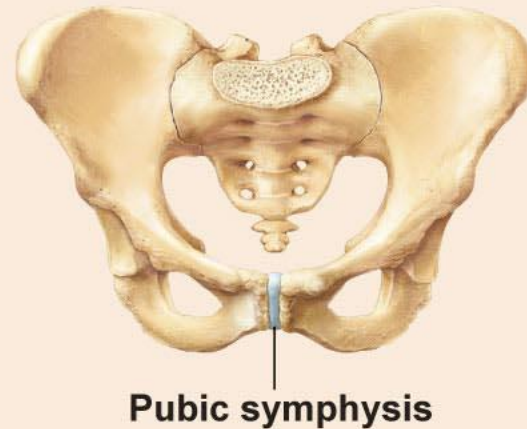
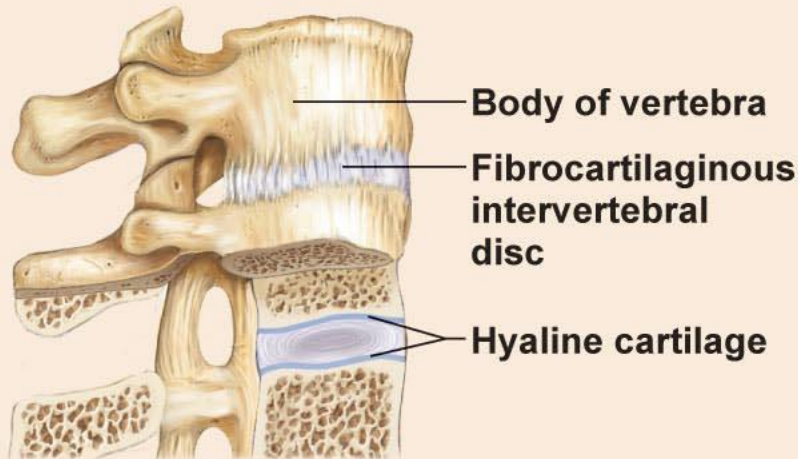
Bones united by hyaline cartilage



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## (b) Symphyses

Bones united by fibrocartilage



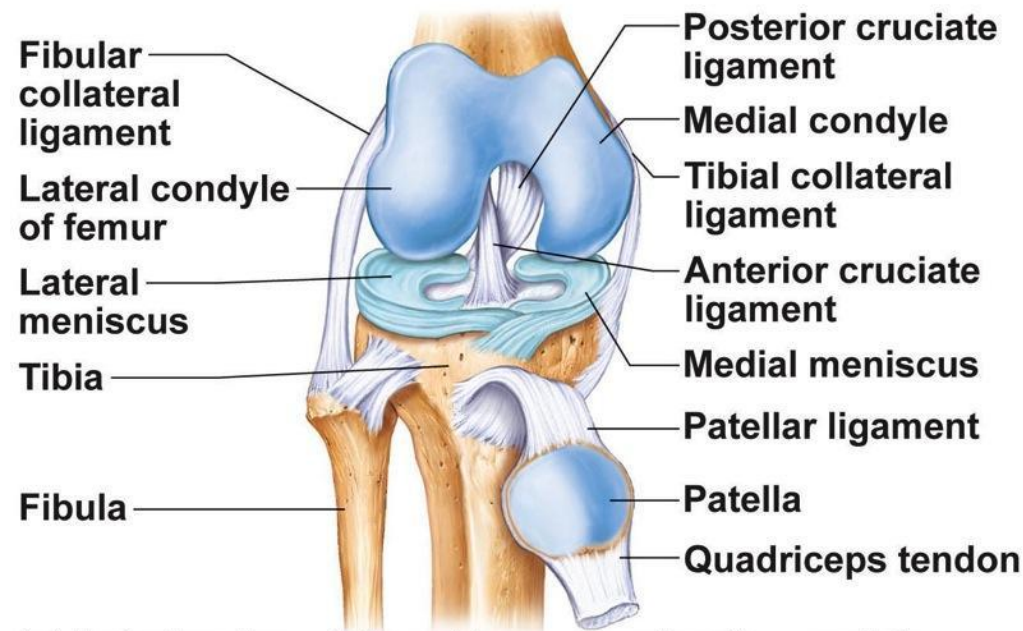
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# Synovial Joints

- Bones separated by fluid-containing joint cavity
- **Synovial fluid** reduces friction between cartilages
- **Menisci**: fibrocartilage that partially divides a joint cavity at knee, reduces friction
- **Bursa**: flattened sacs containing synovial fluid, occur where bones, ligaments, tendons, muscles, skin rub together



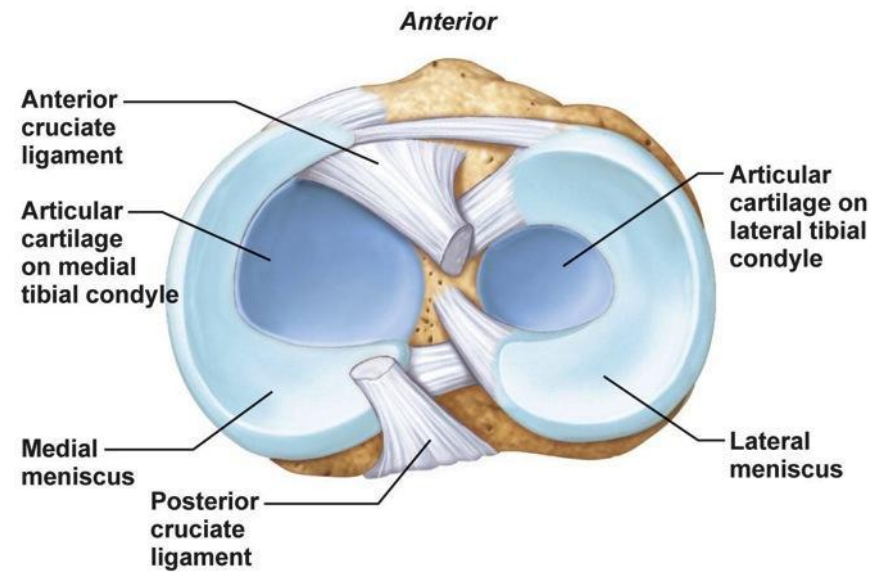
# Lateral & Medial Meniscus



- Fibular collateral ligament
- Lateral condyle of femur
- Lateral meniscus
- Tibia
- Fibula
- Posterior cruciate ligament
- Medial condyle
- Tibial collateral ligament
- Anterior cruciate ligament
- Medial meniscus
- Patellar ligament
- Patella
- Quadriceps tendon

**(e) Anterior view of flexed knee, showing the cruciate ligaments (articular capsule removed, and quadriceps tendon cut and reflected distally)**

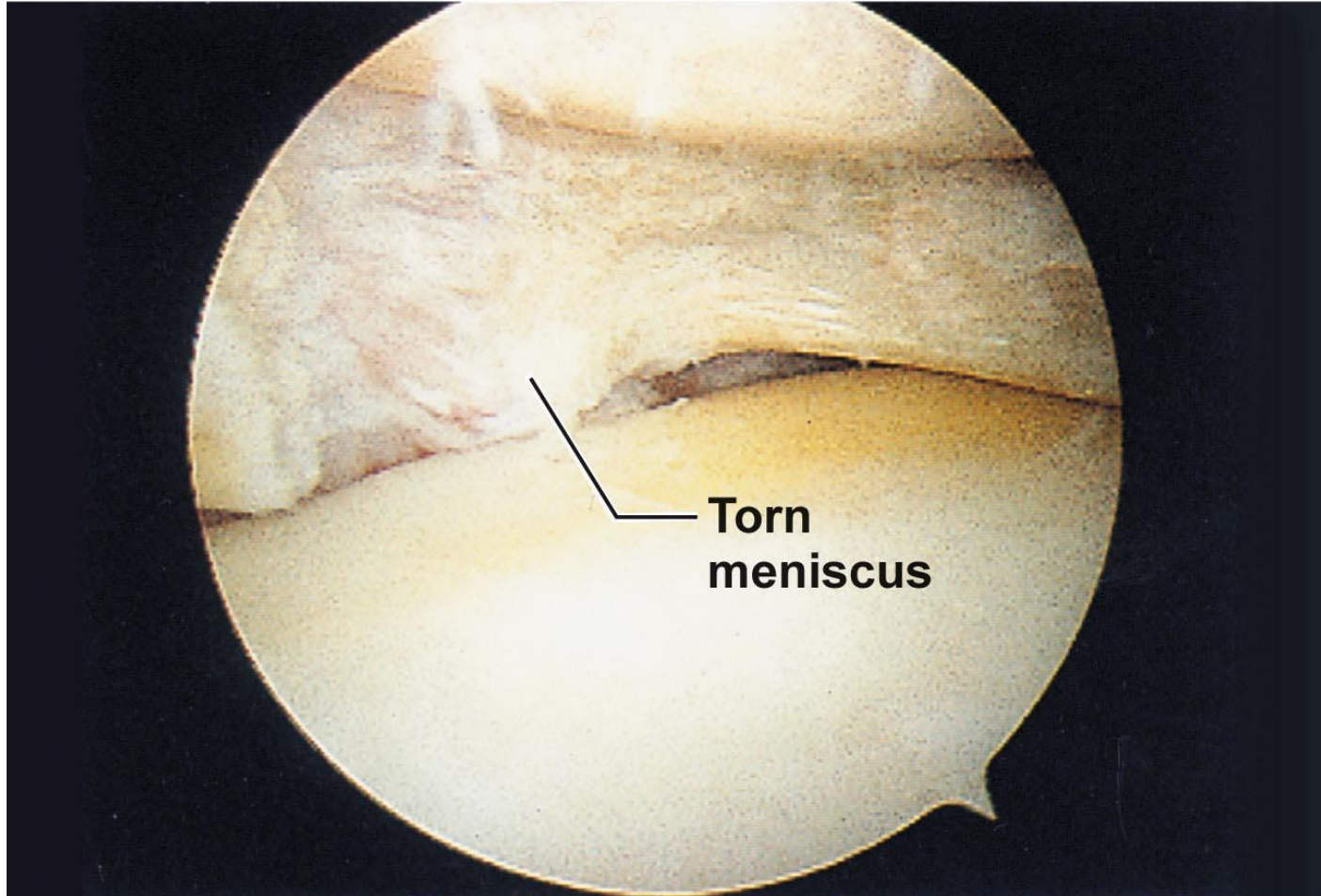
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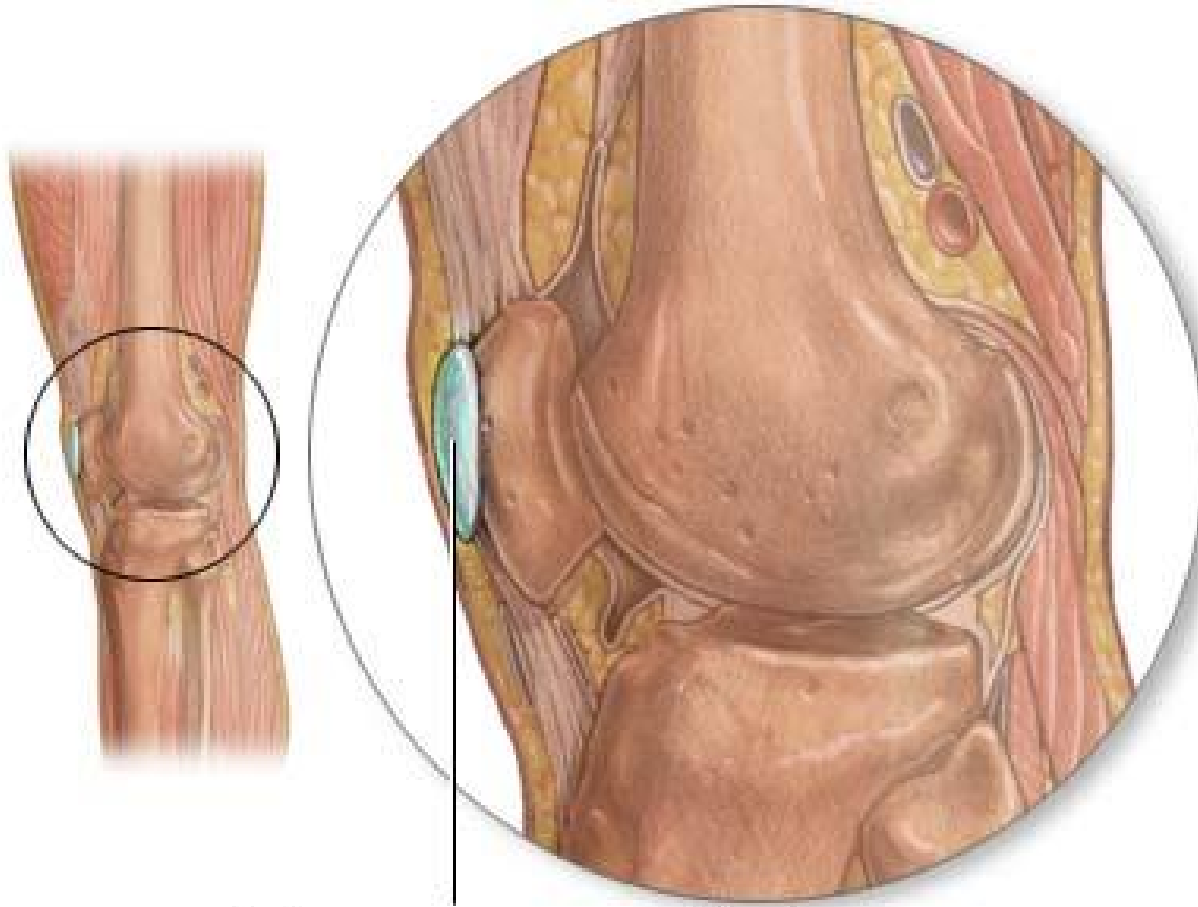
**(b) Superior view of the right tibia in the knee joint, showing the menisci and cruciate ligaments**

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# Torn medial meniscus



**Bursa** (fluid-filled sac that cushions between bones & tendons/muscles



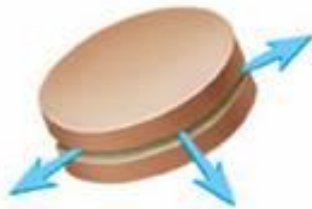
Subcutaneous prepatellar bursa

# Types of Synovial Joints

1. **Plane** – wrist
2. **Hinge** – elbow, ankle, fingers
3. **Pivot** – ulna/radius
4. **Condylloid** (ellipsoidal) – wrist, knuckle
5. **Saddle** – thumb
6. **Ball-and-socket** – shoulder, hip

# Types of Synovial Joints

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**Plane Joint**



**Saddle Joint**



**Hinge Joint**



**Pivot Joint**

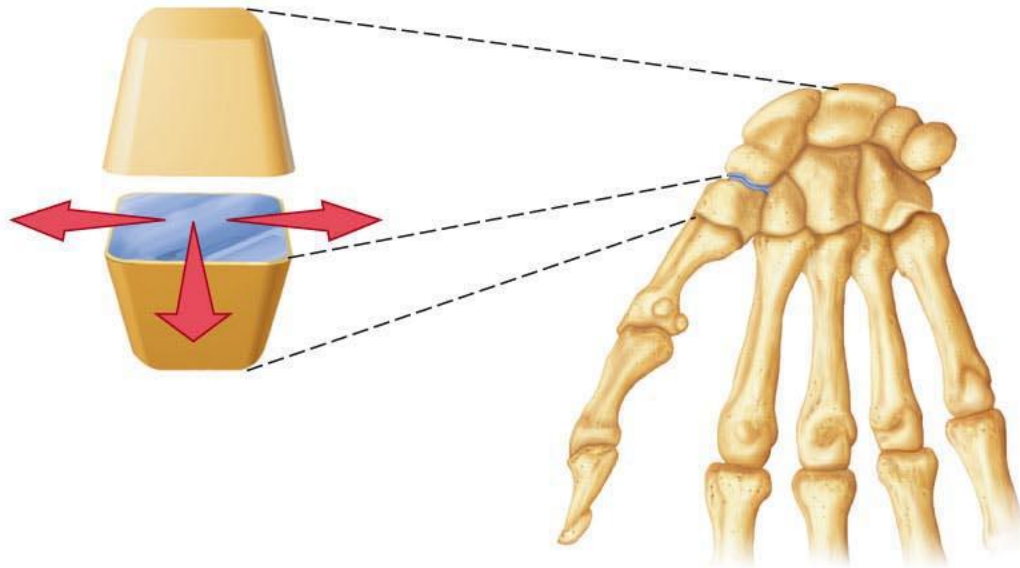


**Ball-and-Socket Joint**

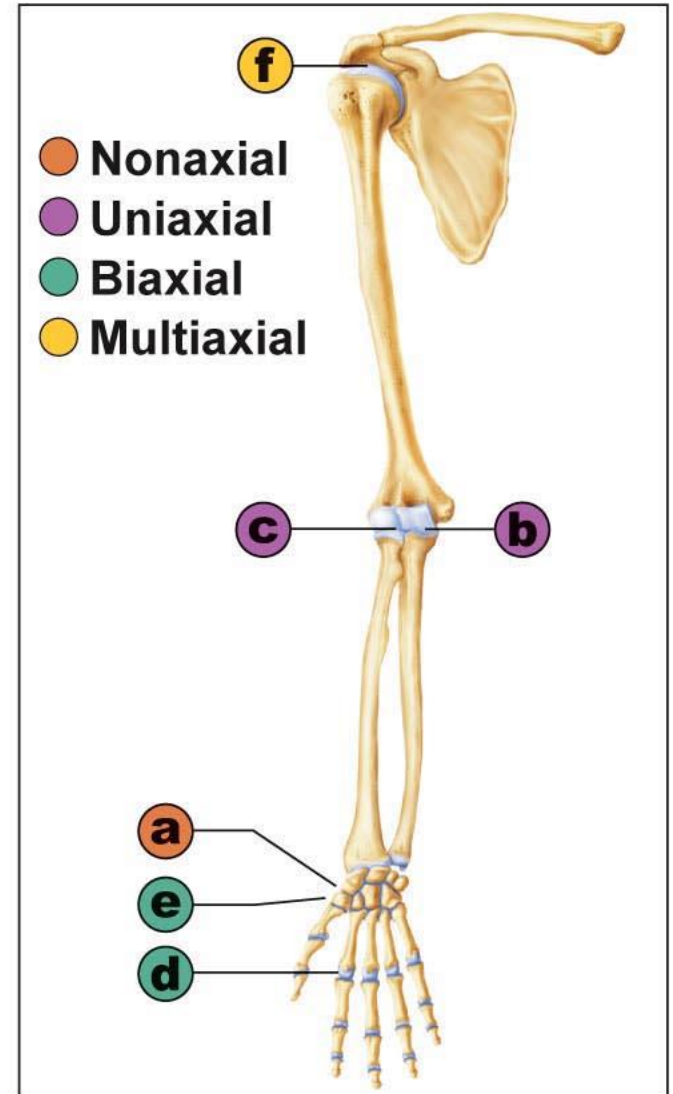


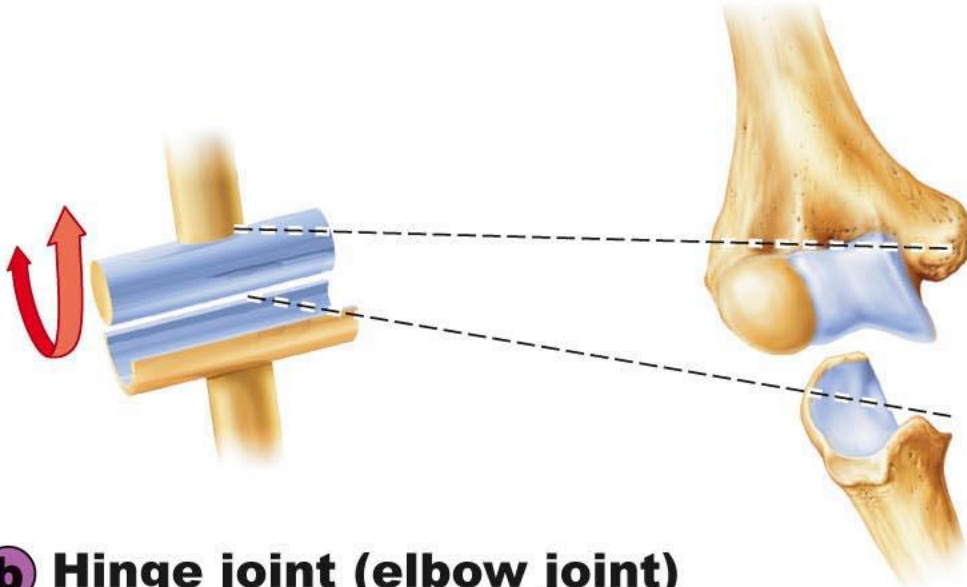
**Ellipsoid Joint**



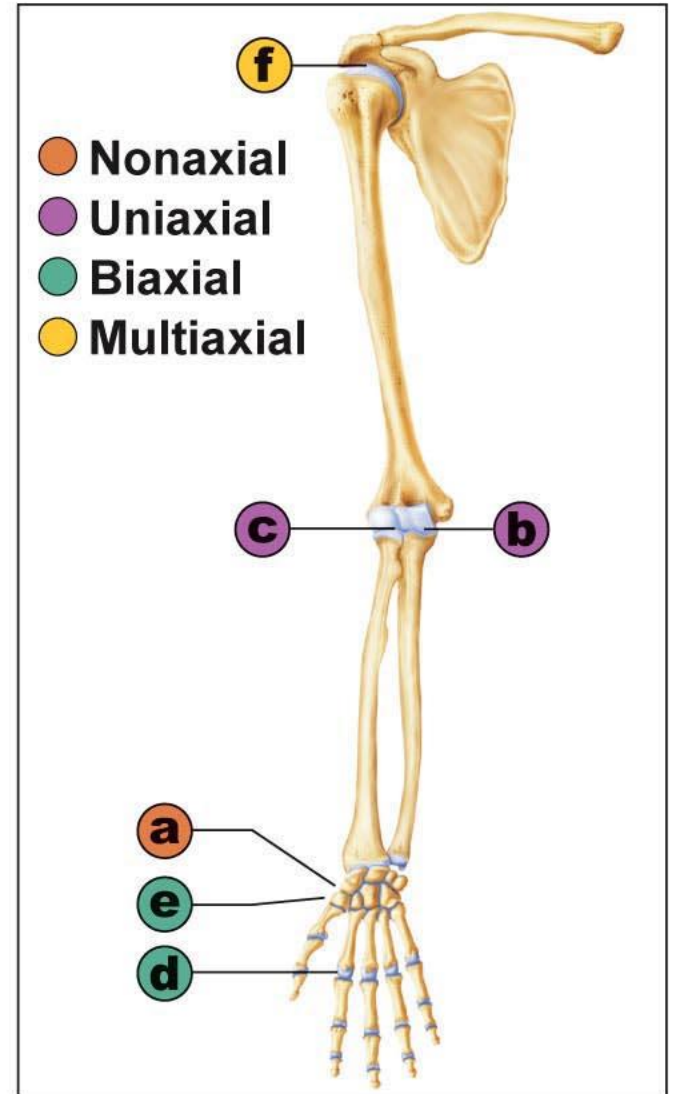


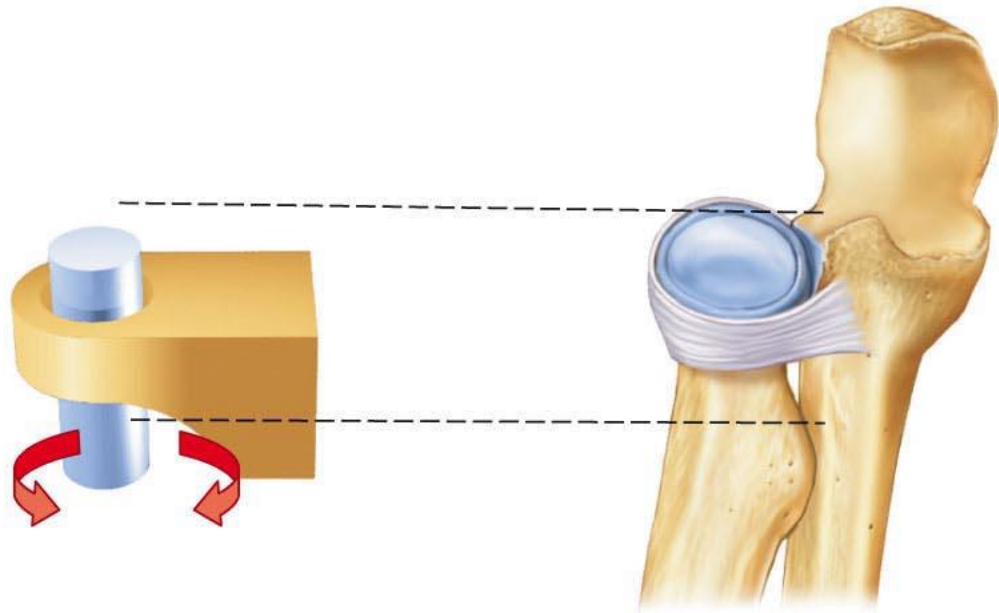
**a** Plane joint (intercarpal joint)



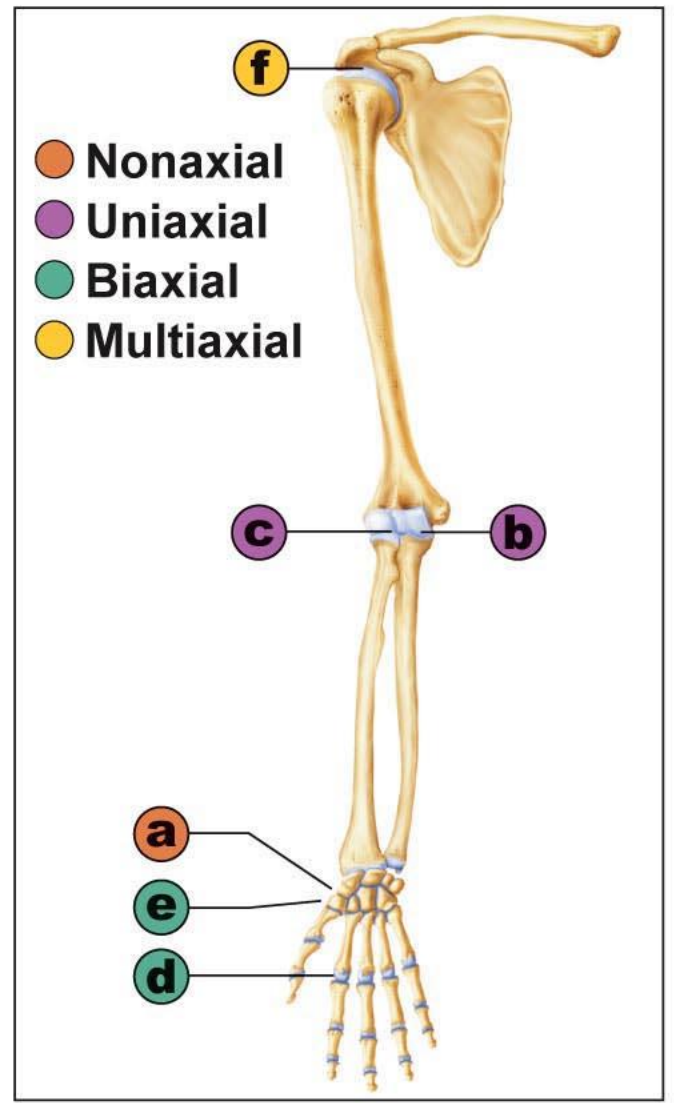


**b Hinge joint (elbow joint)**

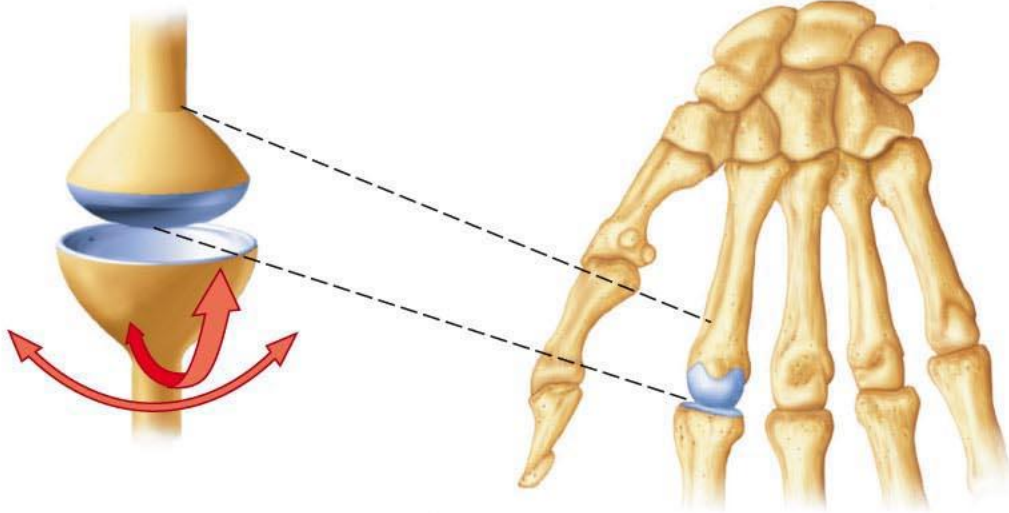




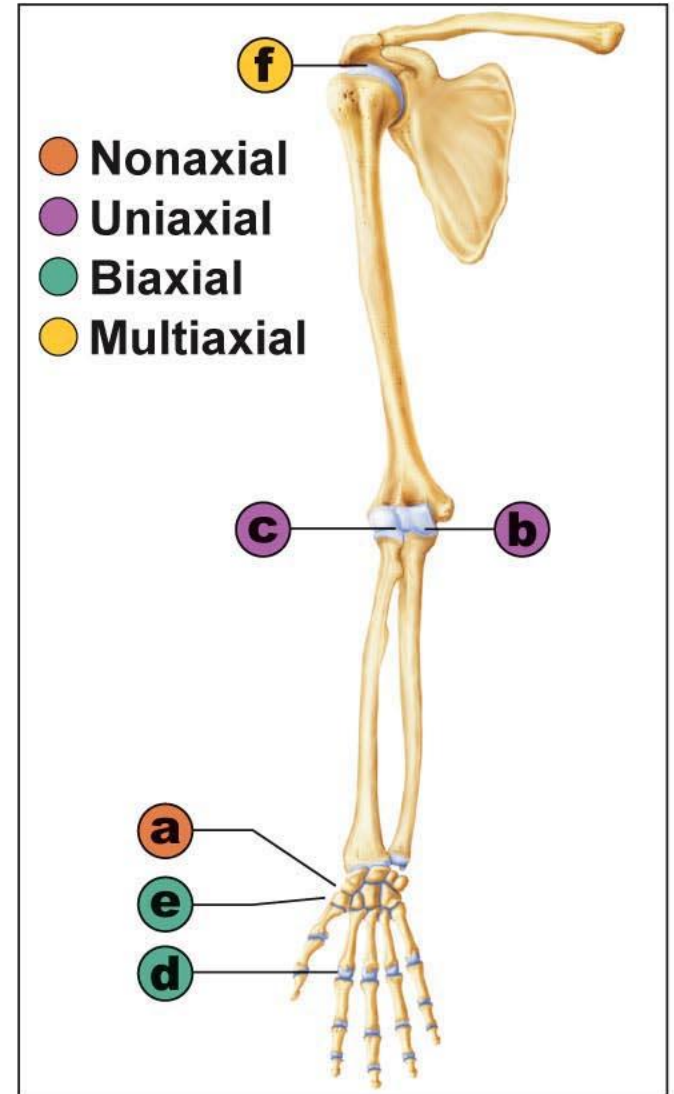
**c Pivot joint (proximal radioulnar joint)**

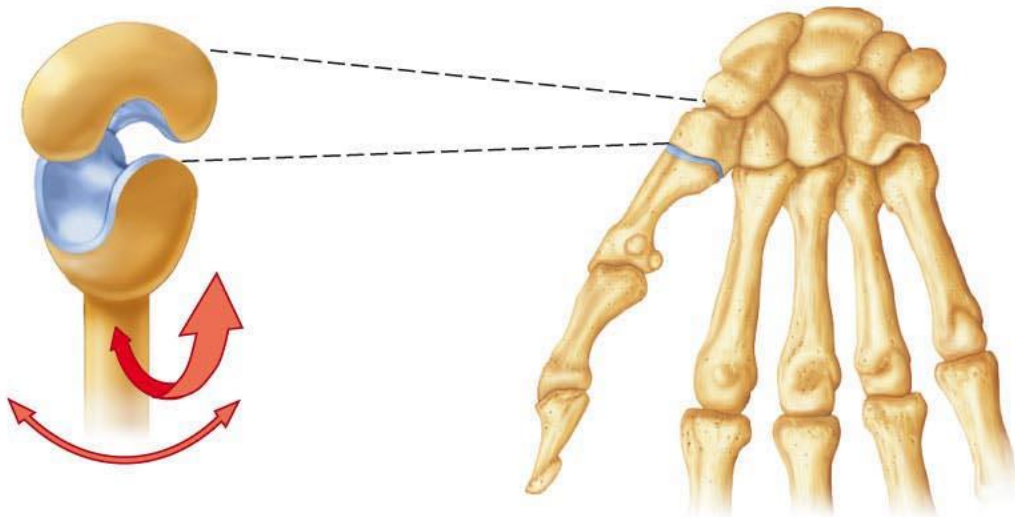




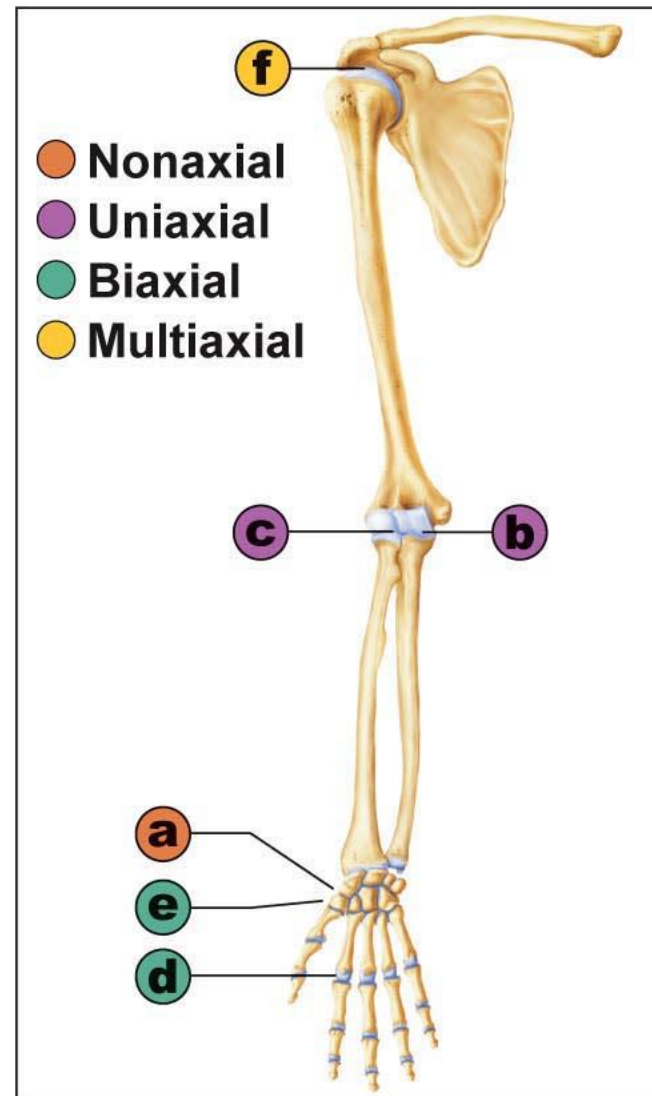


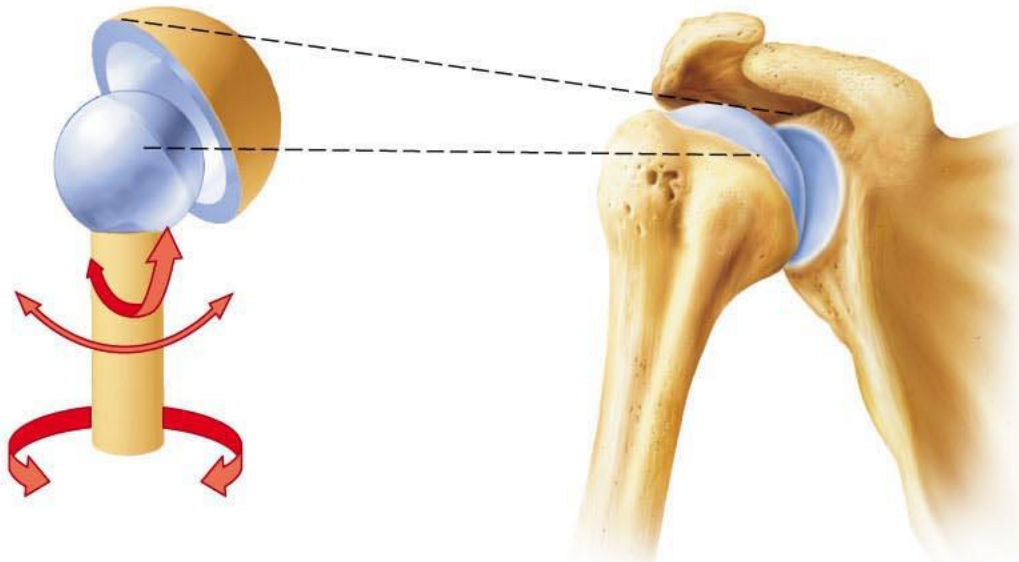
**d** Condyloid joint  
(metacarpophalangeal joint)



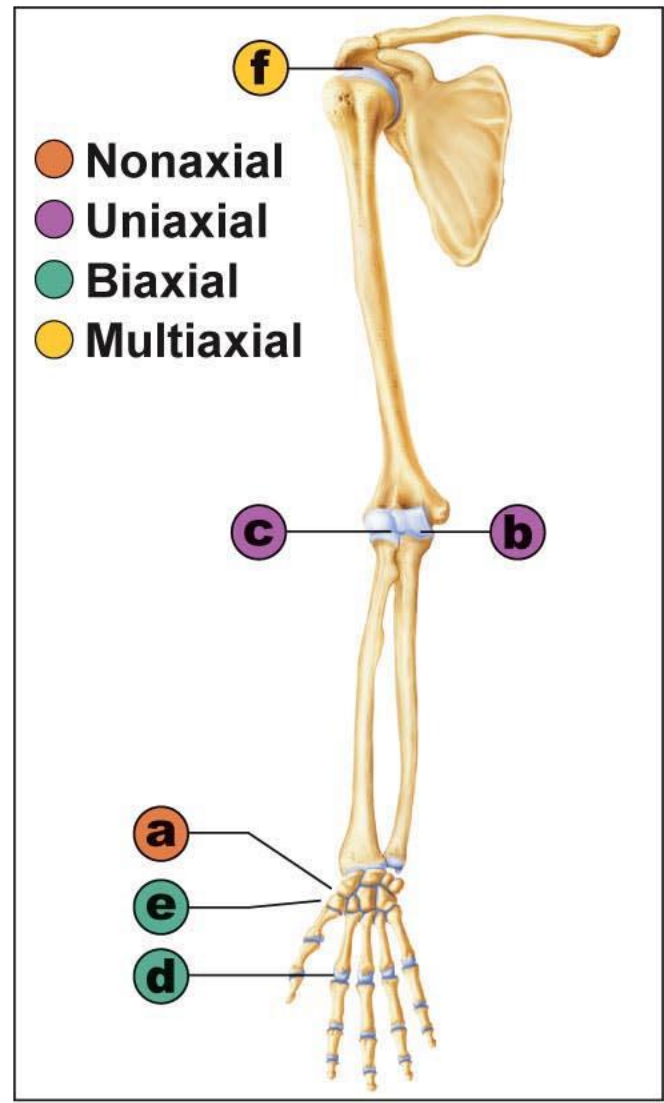


**e Saddle joint (carpometacarpal joint of thumb)**





**f** Ball-and-socket joint (shoulder joint)

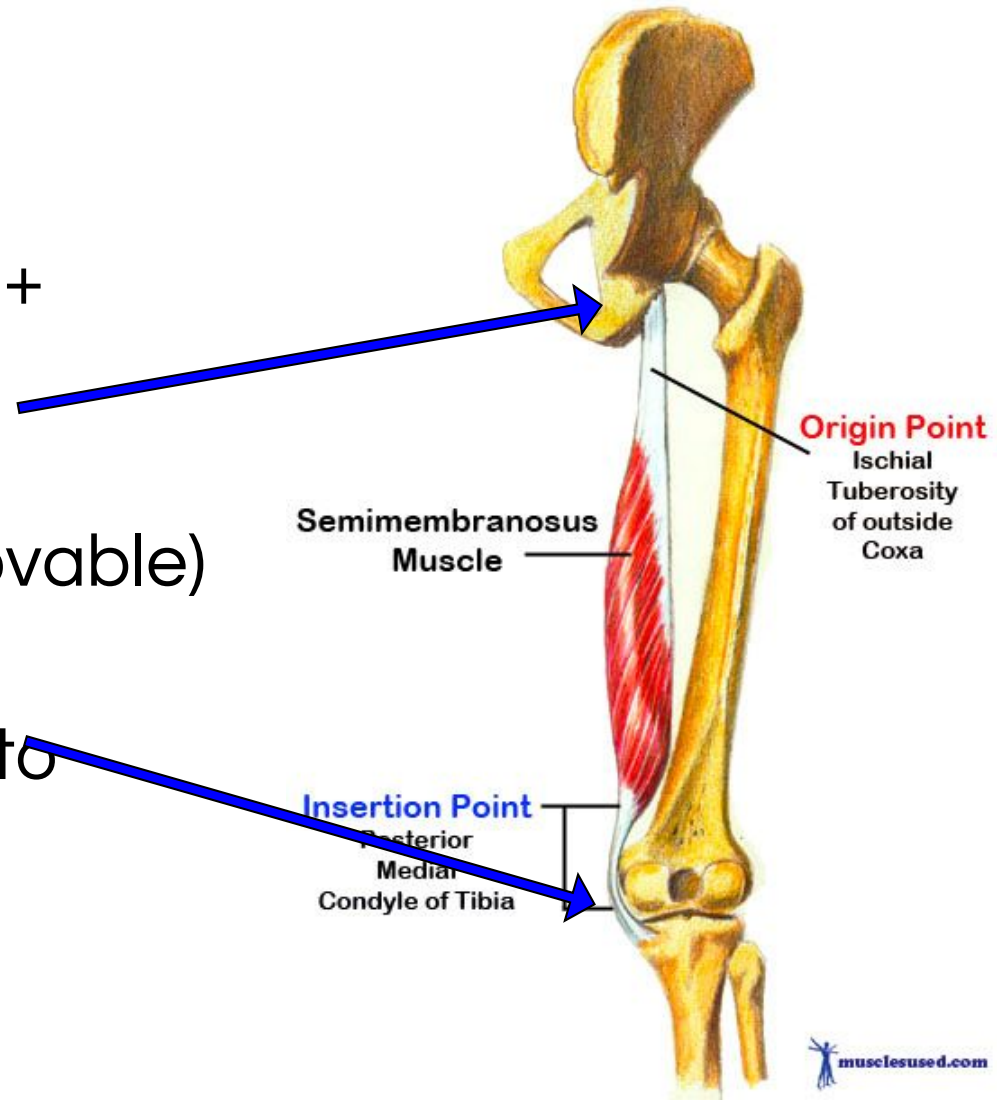


# Types of Synovial Joints

## Types of Synovial Joints

# Joint Movement

- Every skeletal muscle attached to bone or connective tissue at 2+ points
  - **Origin**: attached to immovable (less movable) bone
  - **Insertion**: attached to movable bone

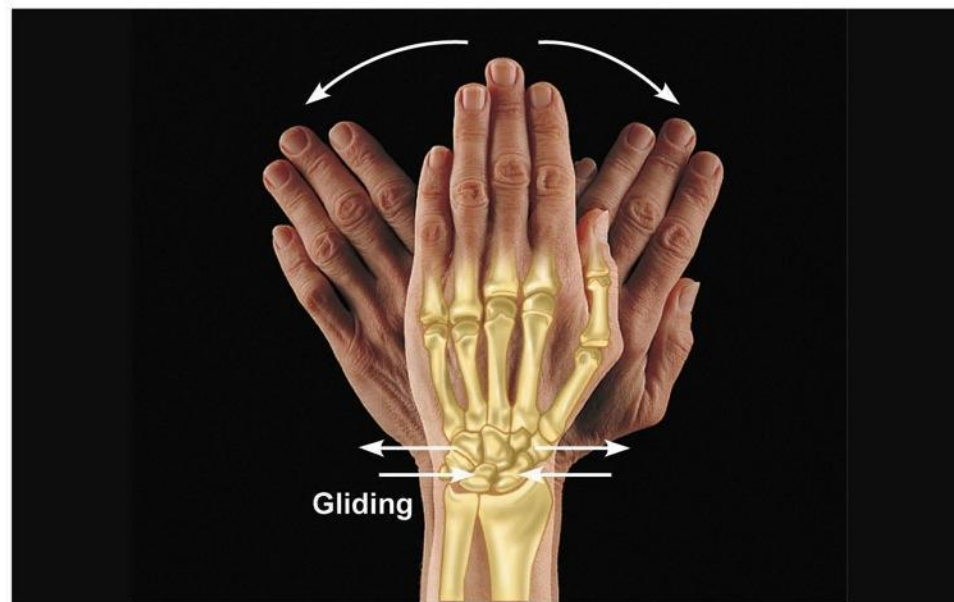


# Types of Synovial Joint Movement

1. Gliding
2. Angular movements
3. Rotation

# 1. Gliding

- Flat bone slips over another
- Back-forth, side to side
- Eg. Between vertebrae, wrist, ankle



**(a) Gliding movements at the wrist**

# 2. Angular Movement

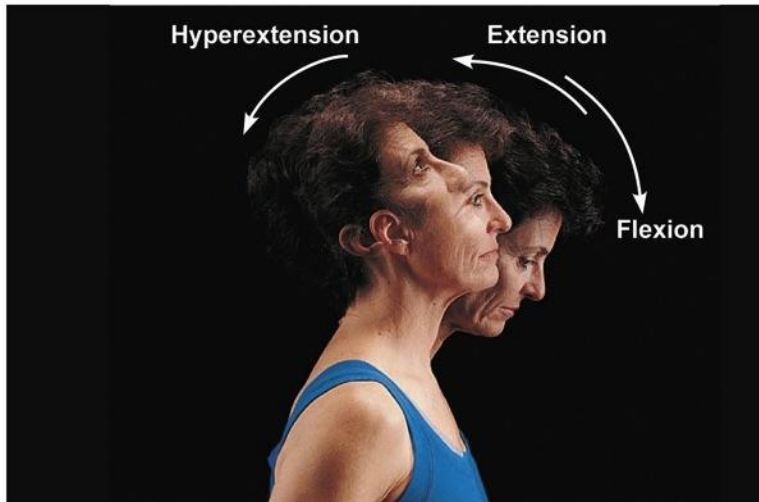
- Increase or decrease angle between bones

Types:

- A. **Flexion**: ↓ angle between bones (bend knee)
- B. **Extension**: ↑ angle along **sagittal plane**, straighten limbs, (unbend knee)
- C. **Abduction**: “moving away” from midline along **frontal plane** (spread apart fingers)
- D. **Adduction**: “move toward” midline (arm moving in)
- E. **Circumduction**: make “cone” in space (pitcher

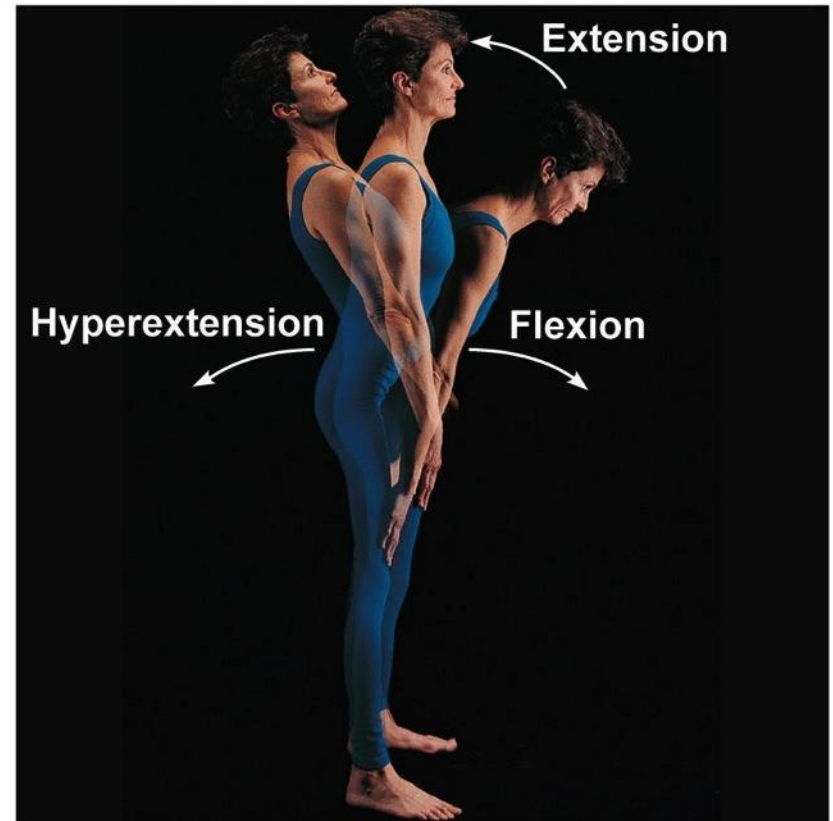


**Flexion**: ↓ angle between bones



**(b) Angular movements: flexion, extension, and hyperextension of the neck**

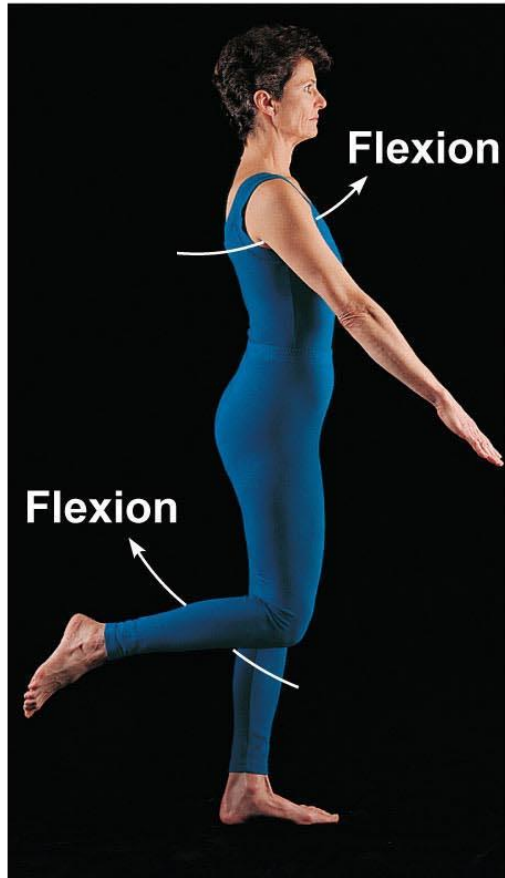
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**(c) Angular movements: flexion, extension, and hyperextension of the vertebral column**

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**Extension**: ↑ angle along sagittal plane,  
straighten limbs



**(d) Angular movements: flexion and extension at the shoulder and knee**

# Hyperextension

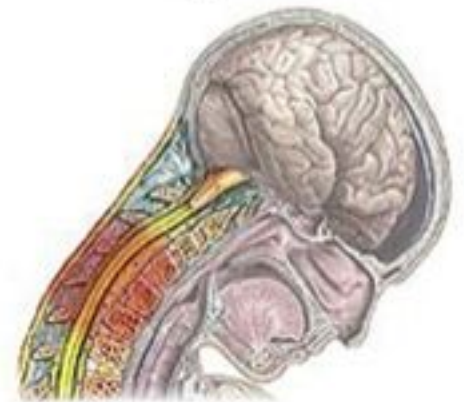


Hyperextension



Sprain or strain of cervical tissues

Hyperflexion



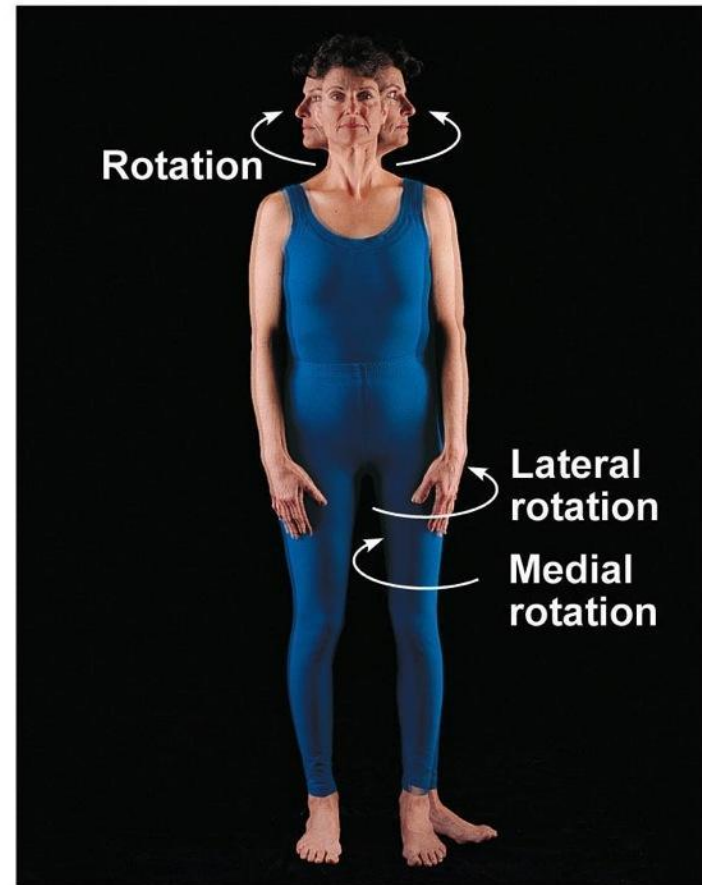
# Abduction – Adduction - Circumduction



**(e) Angular movements: abduction, adduction, and circumduction of the upper limb at the shoulder**

# 3. Rotation

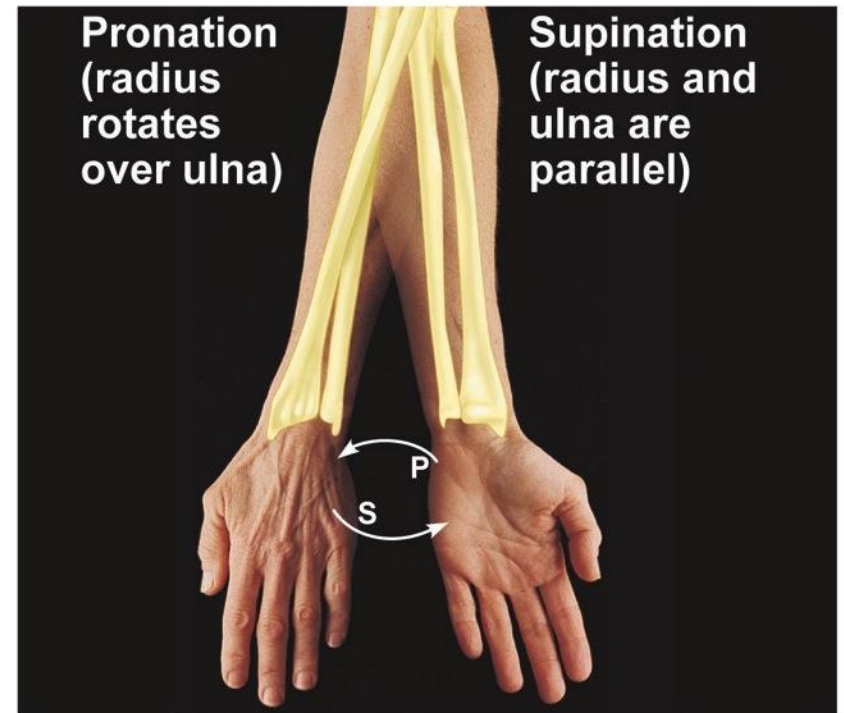
- Turn bone along long axis
- Eg. Hip, shoulder, swivel head (C1/C2)



**(f) Rotation of the head, neck, and lower limb**

# Special Movements

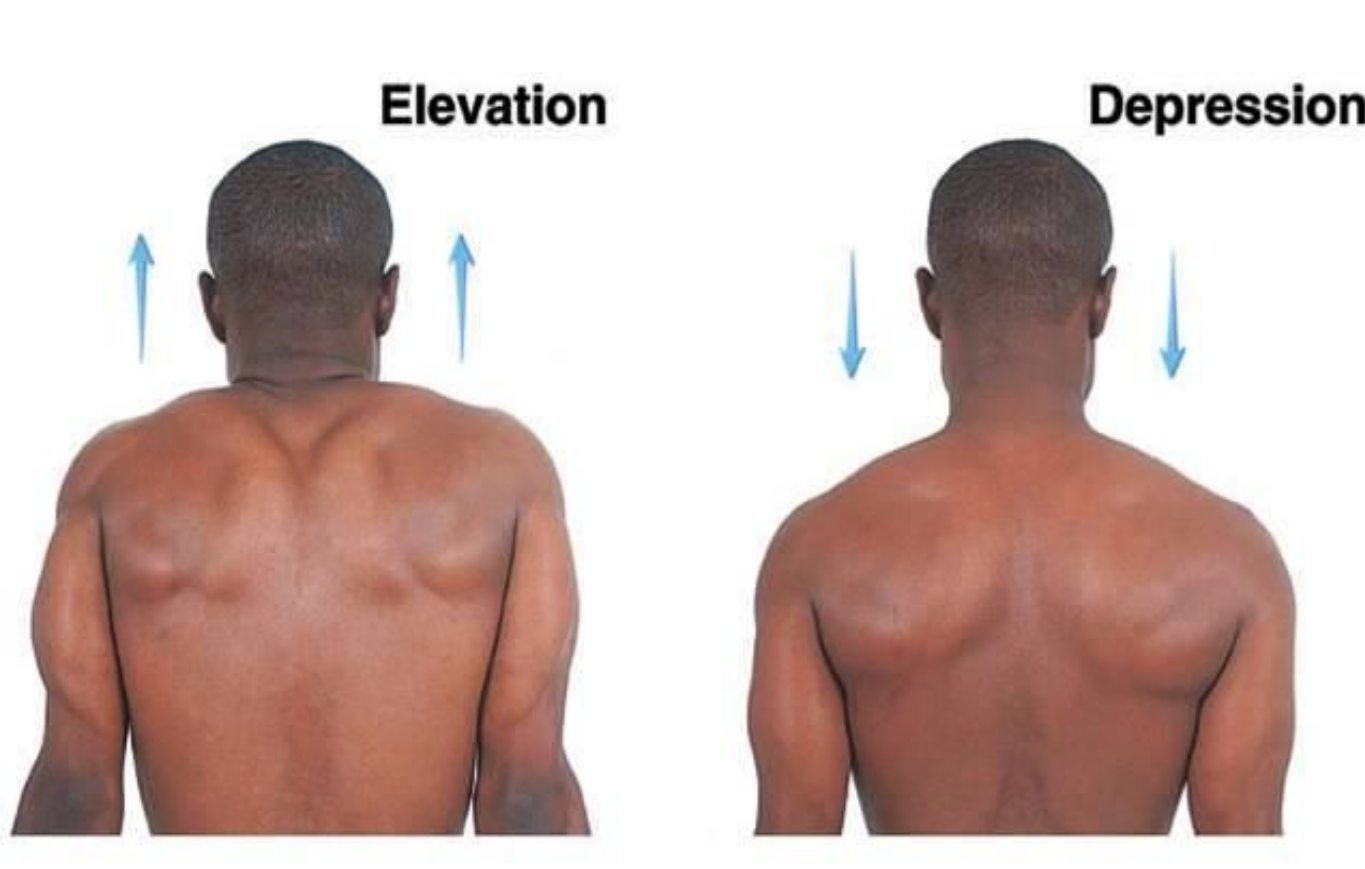
- **Radius & Ulna:**
  - **Supination:** bones are parallel, anatomical position
    - Sup- = “soup bowl”
  - **Pronation:** bones form an X, relaxed position
    - Pro- = pro-basketball player dribbles



**(a) Pronation (P) and supination (S)**

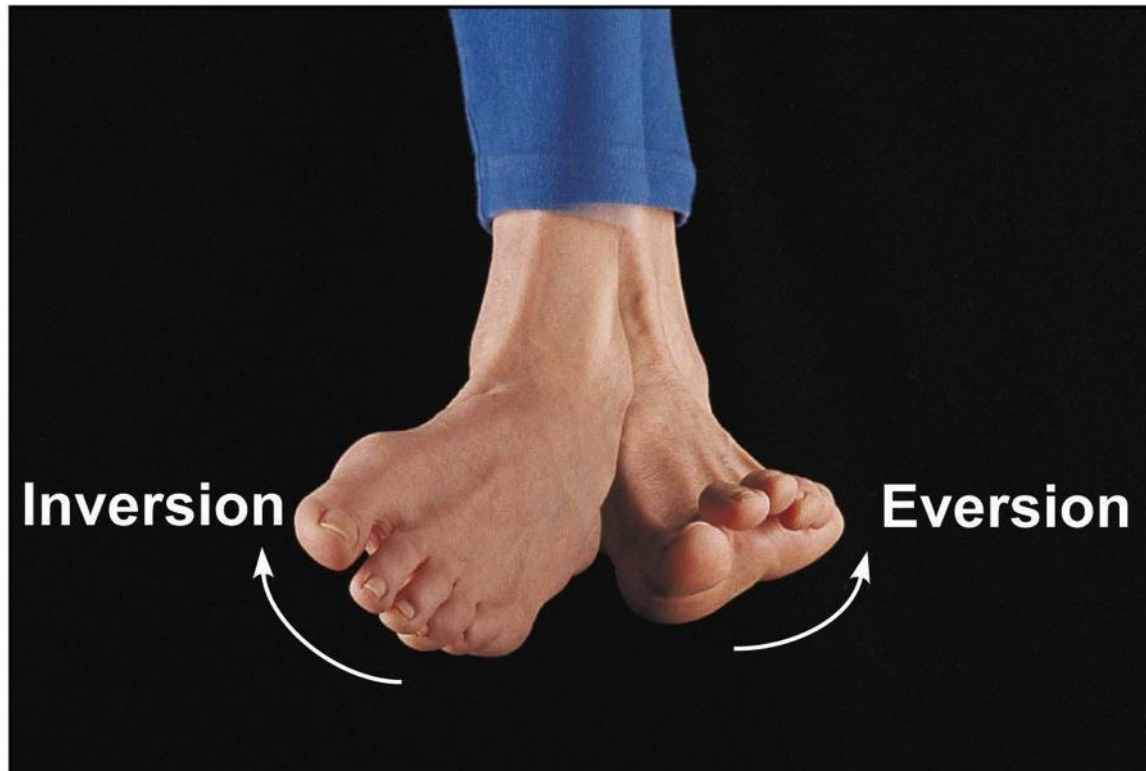
# Special Movements

- **Elevation/Depression**: ↑ and ↓ (shrug, chewing)



# Special Movements

- **Foot:** inversion (medially)/eversion (laterally)

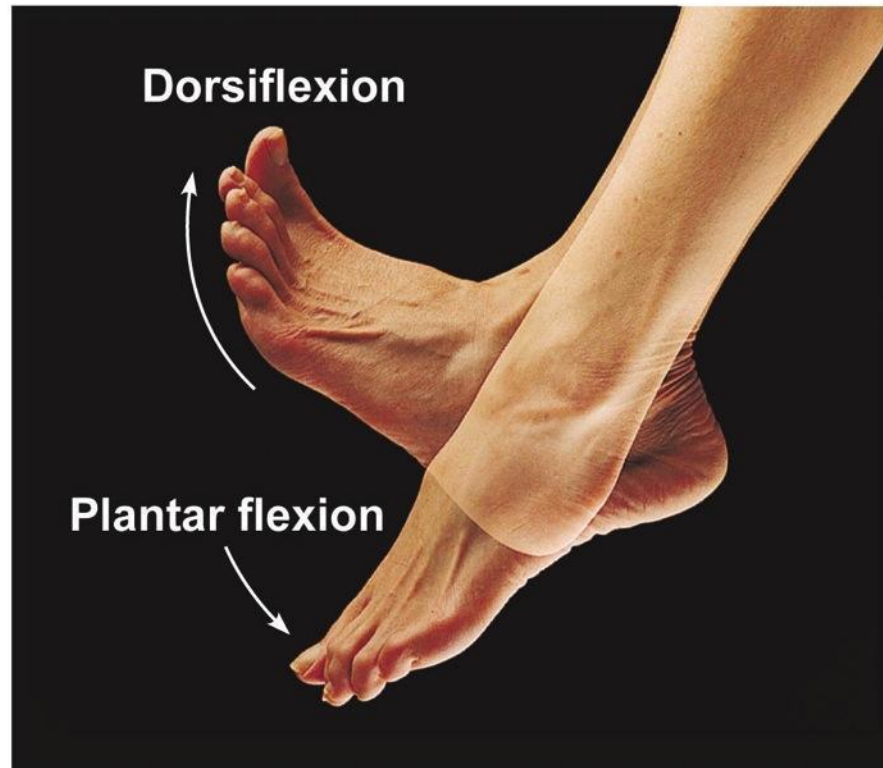


**(c) Inversion and eversion**



# Special Movements

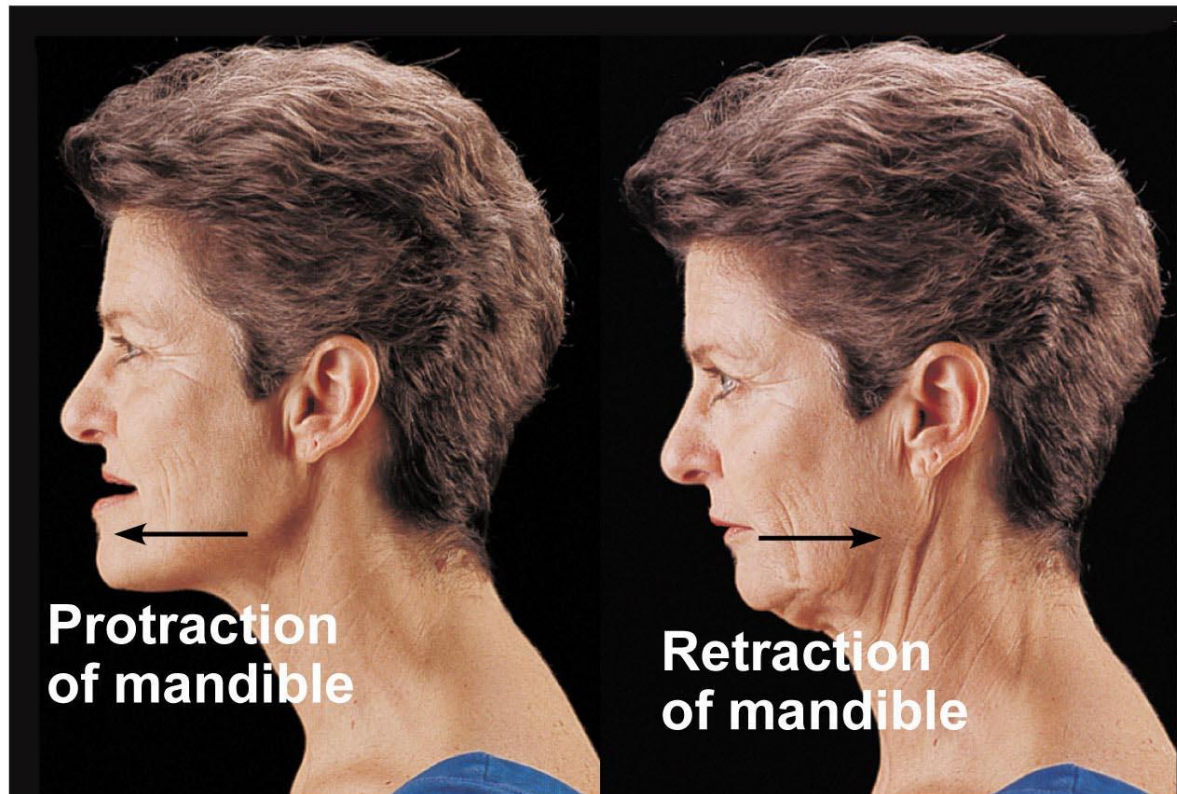
- **Ankle:** dorsiflexion (toes point up)/plantar flexion (toes point down)



**(b) Dorsiflexion and plantar flexion**

# Special Movements

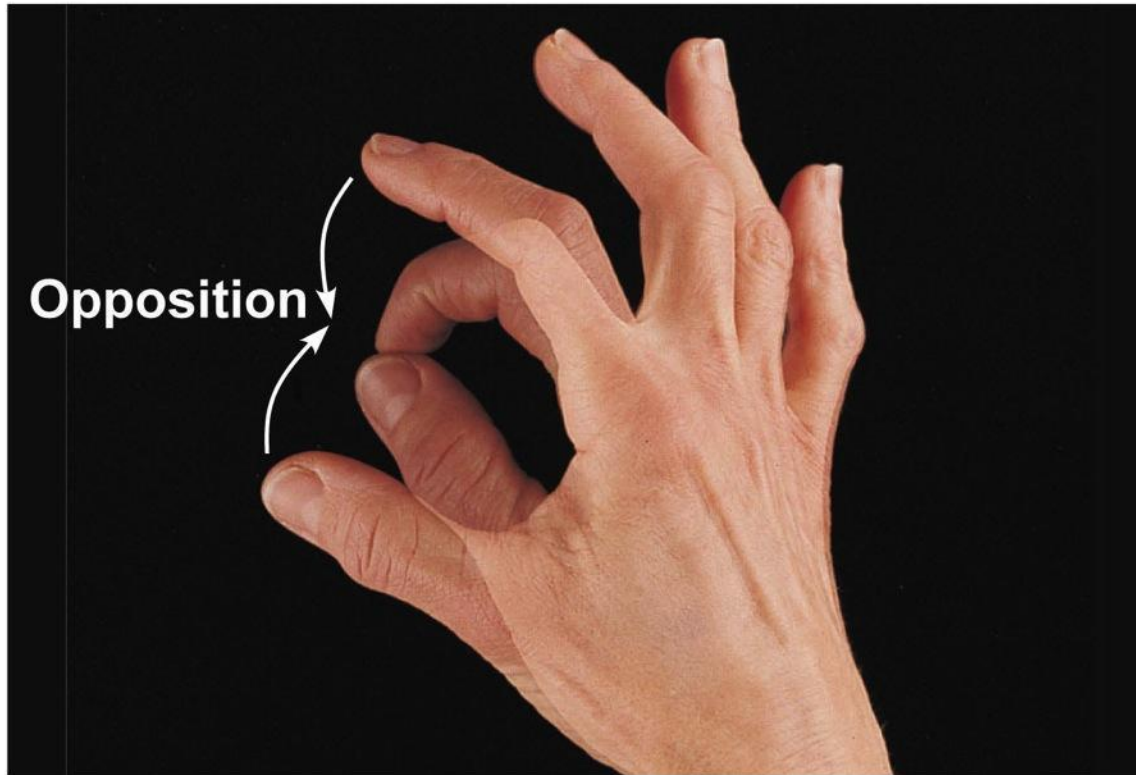
- **Jaw:** protraction (jut out)/retraction (bring back in)



**(d) Protraction and retraction**

# Special Movements

- **Thumb:** opposition (touch to other fingers on hand)



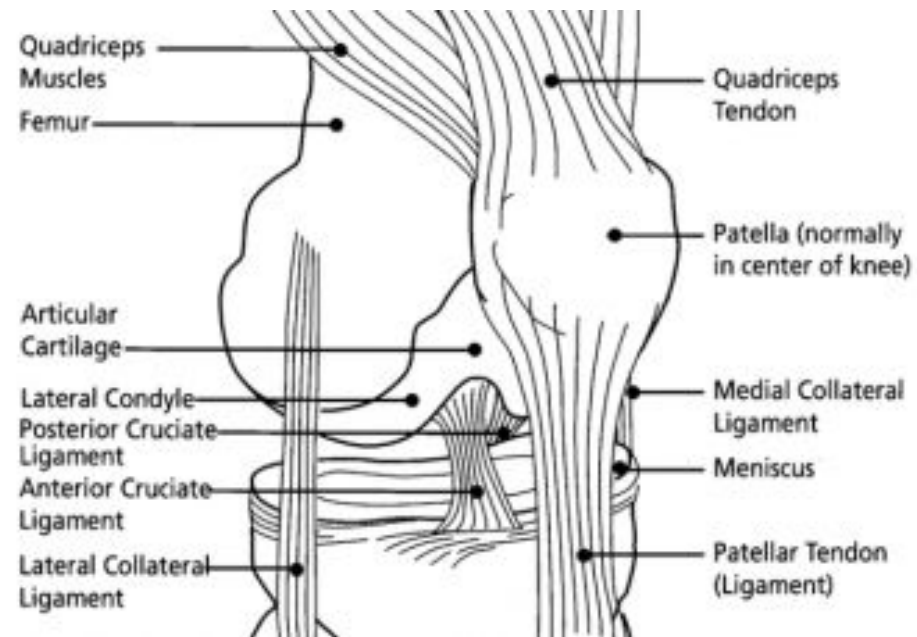
**(f) Opposition**

# Joint Disorders

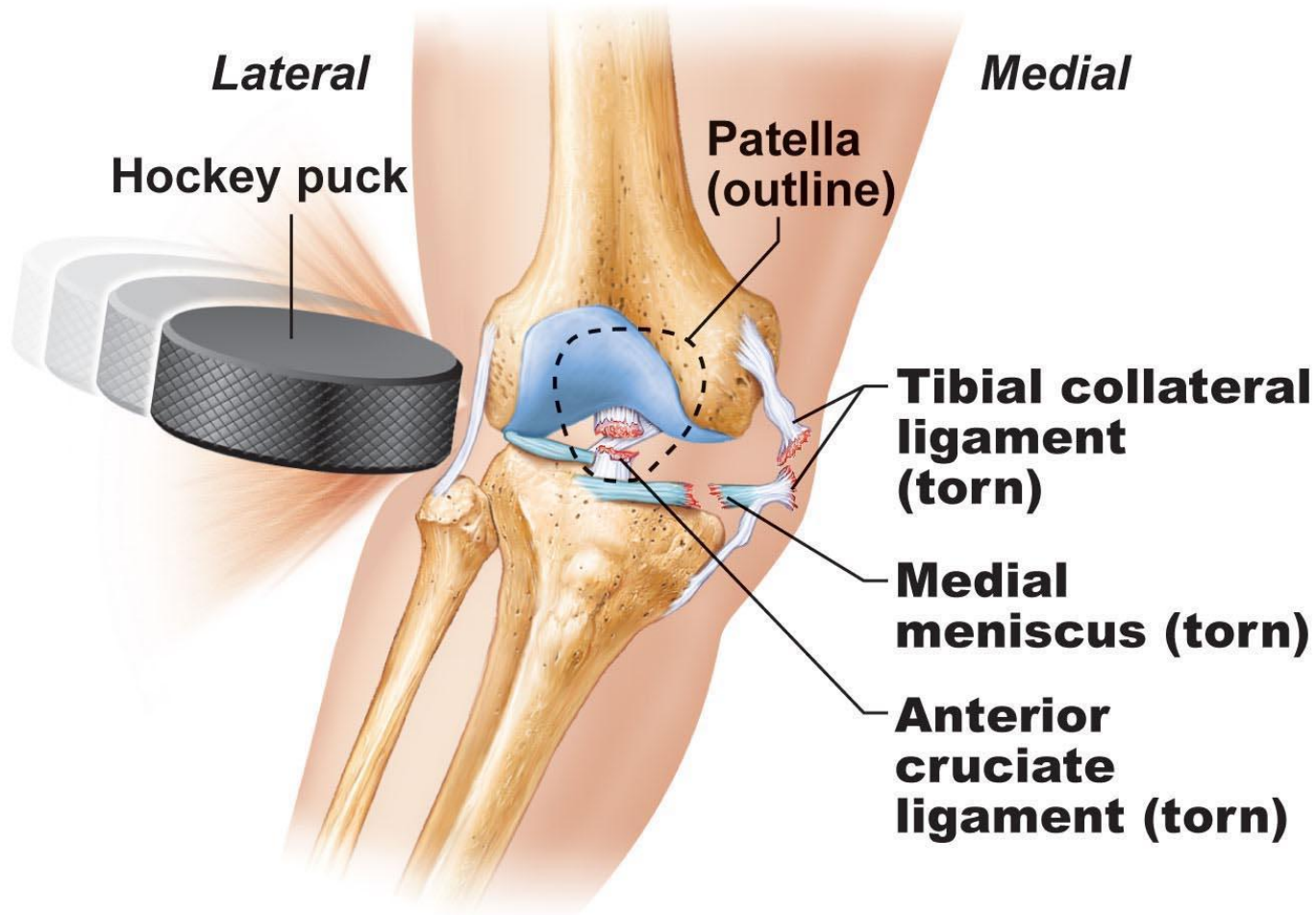
- **Arthritis** (joint inflammation)
  - **Osteoarthritis**: wear-and-tear, degeneration
  - **Rheumatoid arthritis**: chronic inflammation, autoimmune
- **Gout**: uric acid deposits in soft tissue of joints
- **Sprain**: ligaments stretched or torn
- **Dislocation**: bones forced out of alignment
- **Bursitis**: inflammation of bursa
- **Tendonitis**: inflammation of tendons (overuse)
- **Lyme Disease**: tick bite → joint pain, arthritis, skin rash, flu-like symptoms

# Robert Griffin III (RGIII)

- Repaired lateral collateral ligament (LCL)
- Reconstructed anterior cruciate ligament (ACL) 2<sup>nd</sup> time



# Common Knee Injury: Hockey Puck



# Knee Repair: ACL Surgery

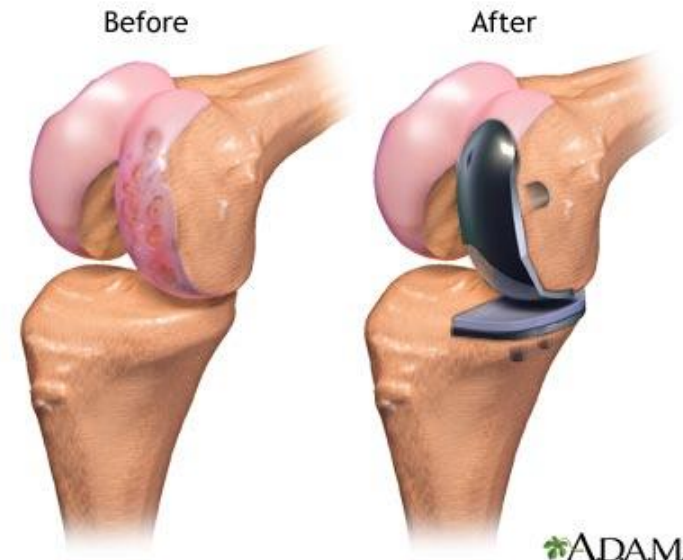
[YouTube Video: ACL Surgery](#)

# Knee Replacements



**X ray of right knee showing total knee replacement prosthesis (co-designed by Kenneth Gustke, M.D., of Florida Orthopedic Institute).**

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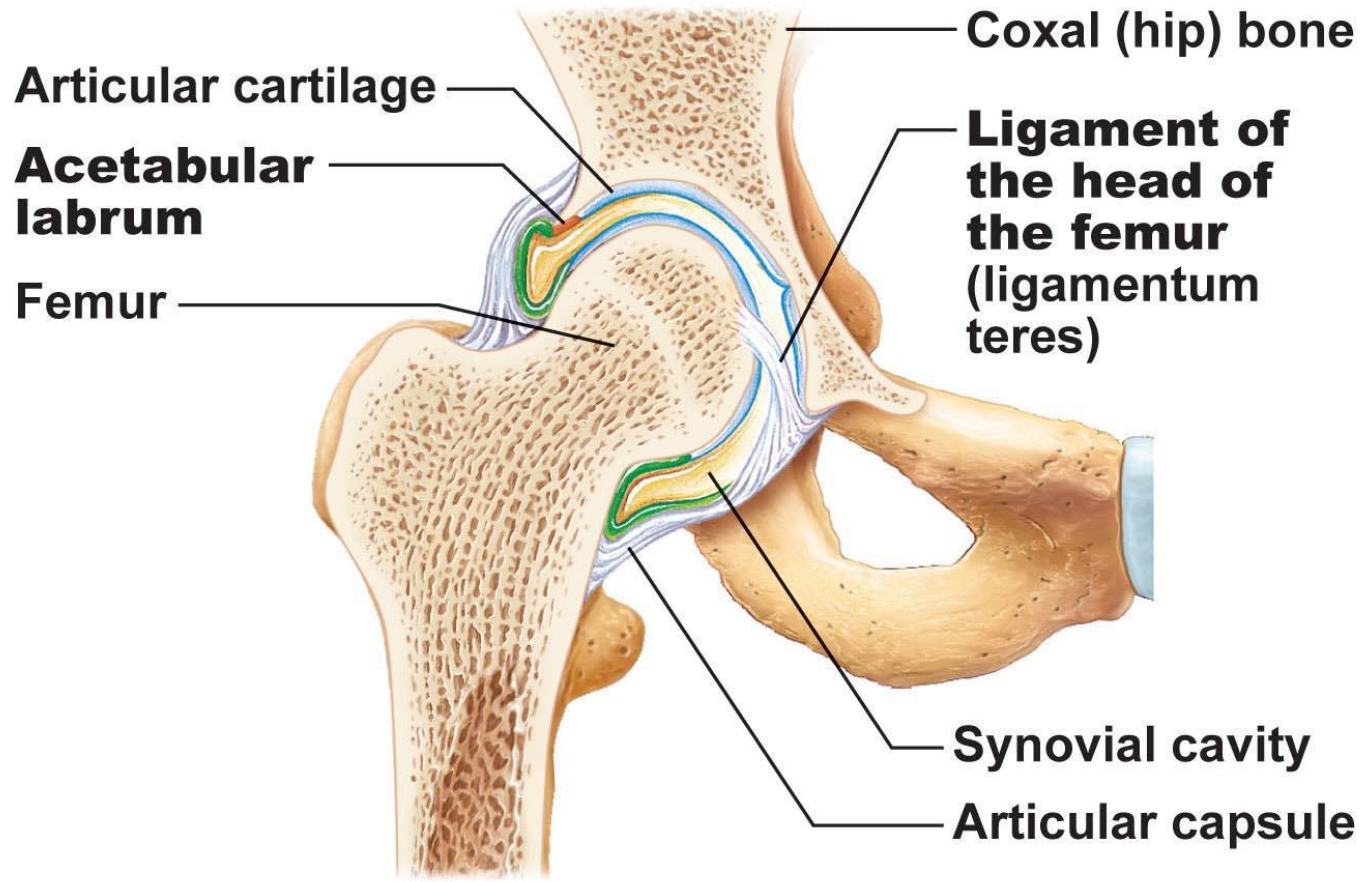
ADAM



# Knee Replacement Surgery

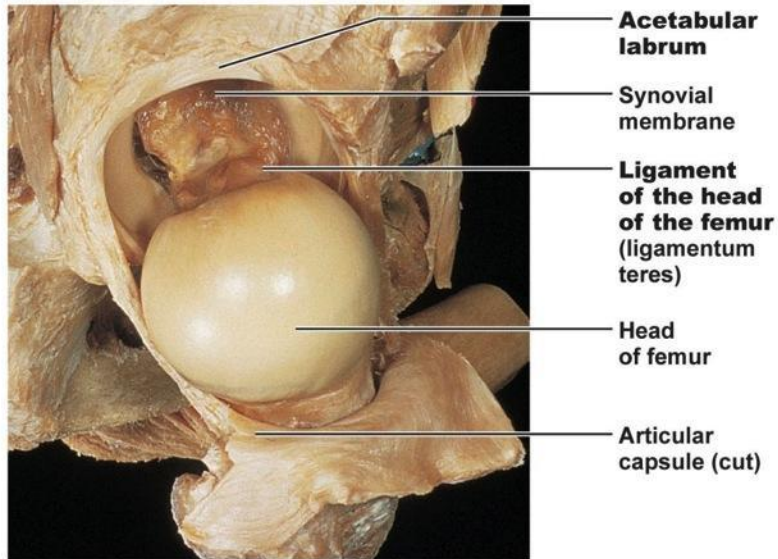
[Knee Replacement Surgery \(Pre-Op Video\)](#)

# Hip Joint



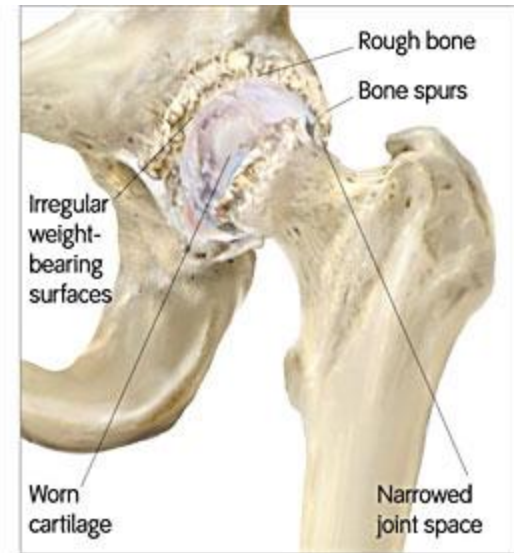
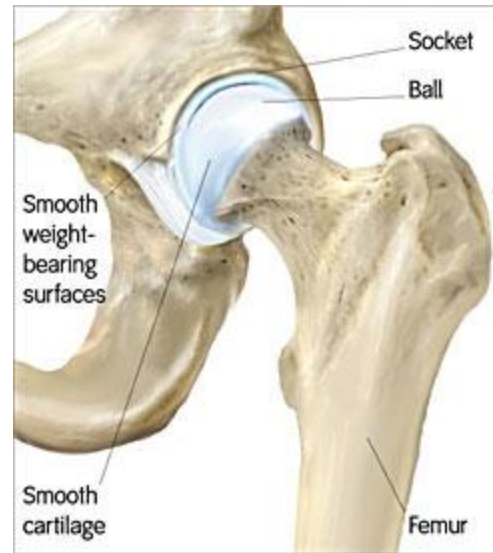
**(a) Frontal section through the right hip joint**

# Hip Arthritis

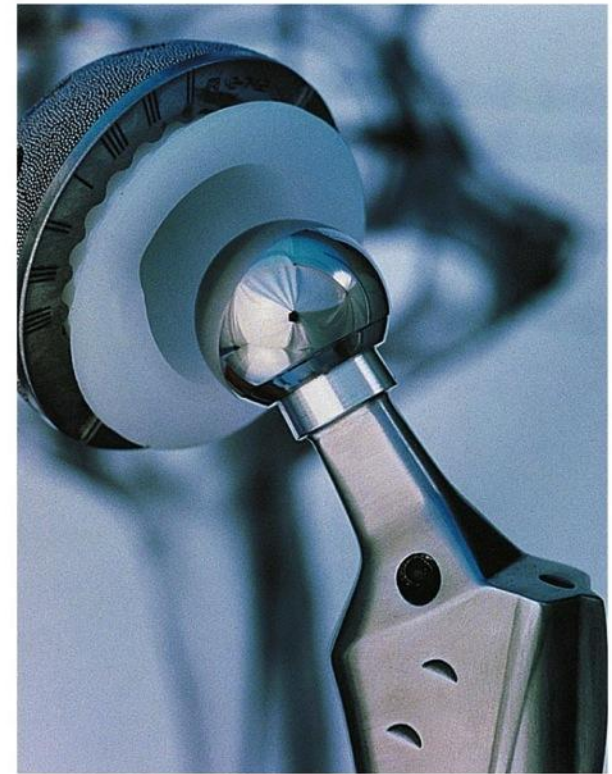


**(b) Photo of the interior of the hip joint, lateral view**

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# Hip Replacements



**A hip prosthesis.**

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