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Human Anatomy & Physiology

Ninth Edition

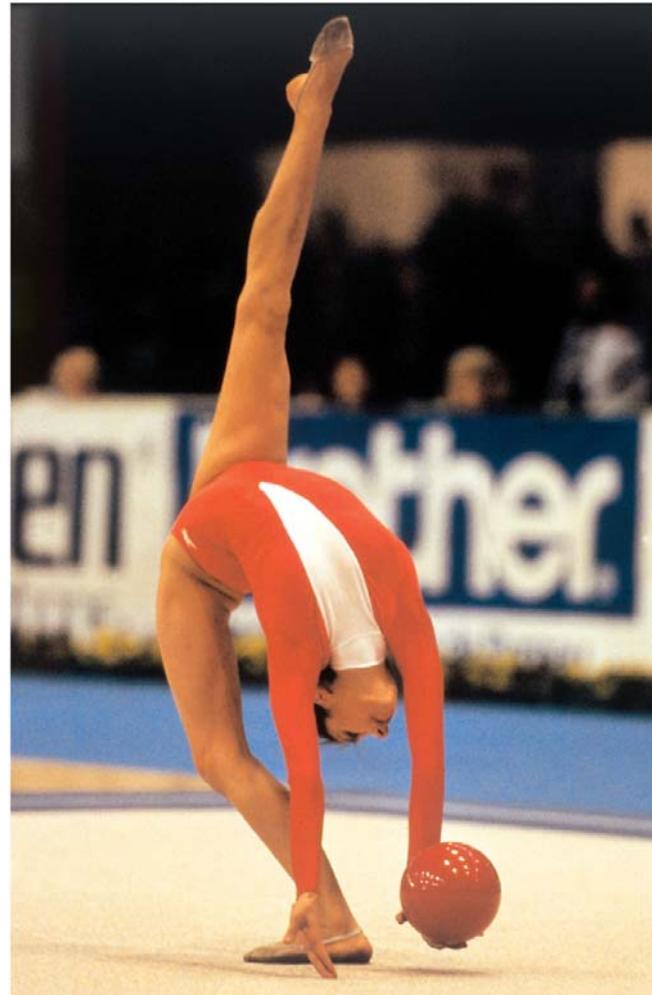
PowerPoint® Lecture Slides
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CHAPTER 8

Joints: Part A

Joints (Articulations)

- joint (articulation) – any point where two bones meet, whether or not the bones are movable at that interface
- arthrology – science of joint structure, function, and dysfunction
- kinesiology – the study of musculoskeletal movement
 - a branch of biomechanics
 - deals with a broad variety of movements and mechanical processes in the body, including the physics of blood circulation, respiration, and hearing



Joints (Articulations)

- **Articulation**
 - Site where two or more bones meet
- Functions of joints
 - Give skeleton mobility
 - Hold skeleton together
- Two classifications
 - **Functional** (degree of movement)
 - **Structural**

Functional Classification of Joints

- Based on
 - Amount of movement joint allows
- Three functional classifications:
 - **Synarthroses**—immovable joints
 - **Amphiarthroses**—slightly movable joints
 - **Diarthroses**—freely movable joints

Structural Classification of Joints

- Based on
 - Material binding bones together
 - Presence/absence of joint cavity
- Three structural classifications:
 - Fibrous joints
 - Cartilaginous joints
 - Synovial joints

Fibrous Joints

- Bones joined by dense fibrous connective tissue
- No joint cavity
- Most synarthrotic (immovable)
 - Depends on length of connective tissue fibers
- Three types:
 - **Sutures**
 - **Syndesmoses**
 - **Gomphoses**

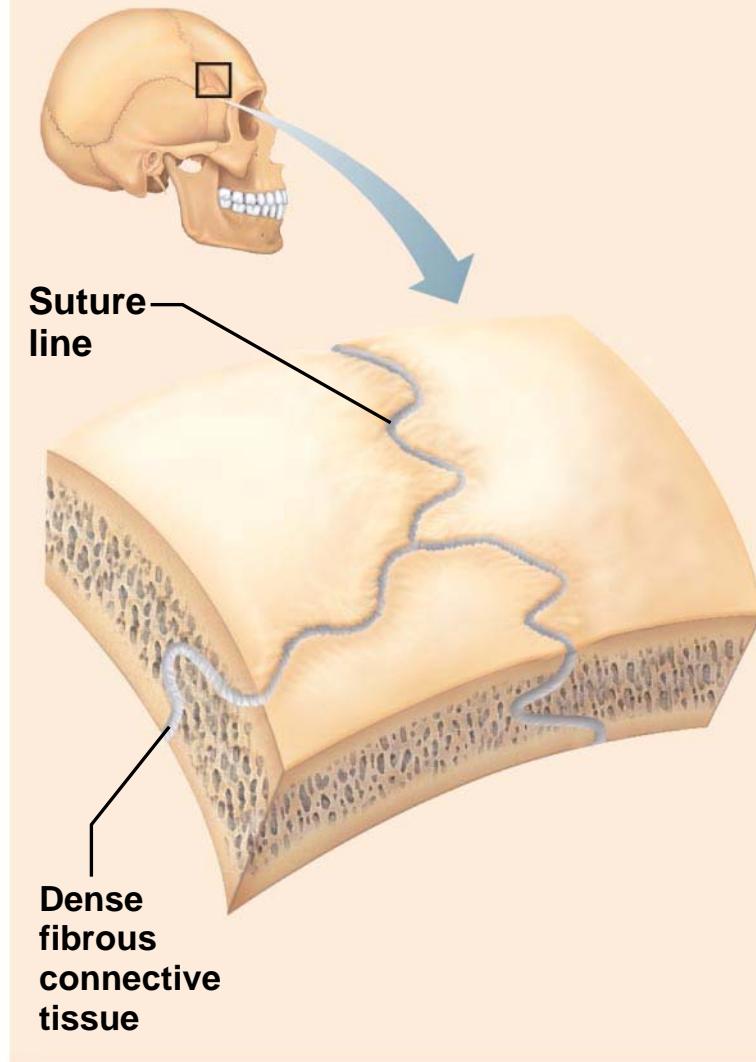
Fibrous Joints: Sutures

- Rigid, interlocking joints
- Immovable joints for protection of brain
- Contain short connective tissue fibers
- Allow for growth during youth
- In middle age, sutures ossify and fuse
 - After they fuse = **Synostoses**
 - Synarthrotic and amphiarthrotic joints may change to synostoses type joints

Fibrous Joints.

(a) Suture

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

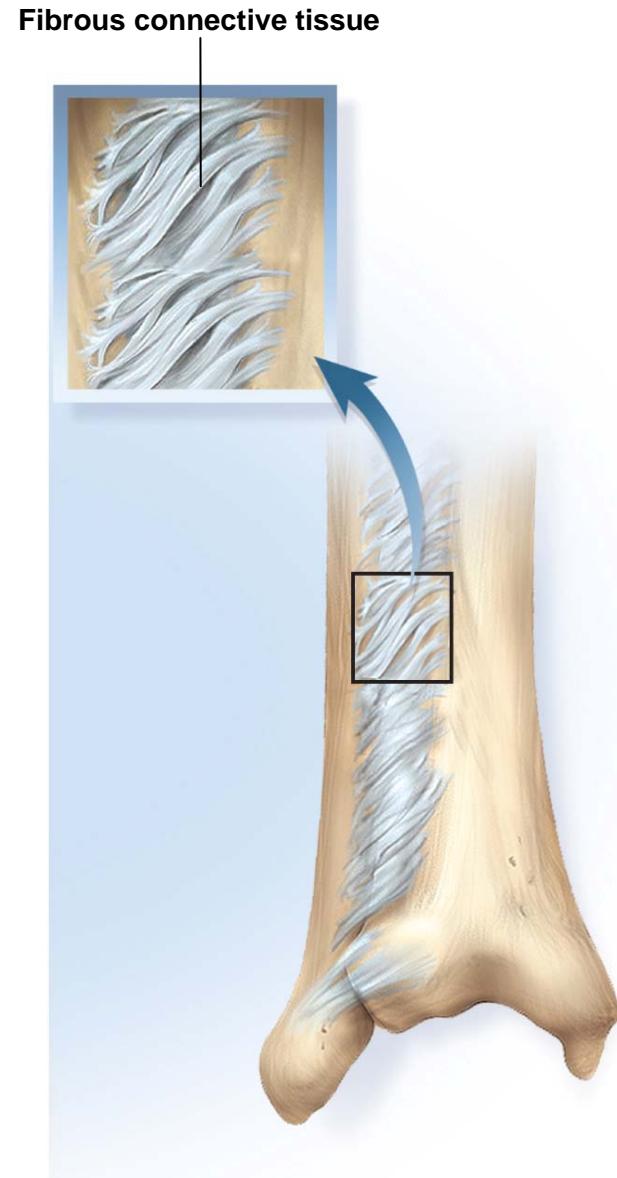


Fibrous Joints: Syndesmoses

- Bones connected by ligaments
 - bands of fibrous tissue
- Fiber length varies
 - determines amount of movement varies
 - Large amount of movement at **interosseous membrane** connecting radius and ulna
 - Little to no movement at distal **tibiofibular joint**

Fibrous Joint - Syndesmosis

- **interosseous membranes**
 - most movable syndesmosis joint
 - unite radius to ulna
 - Permits supination and pronation



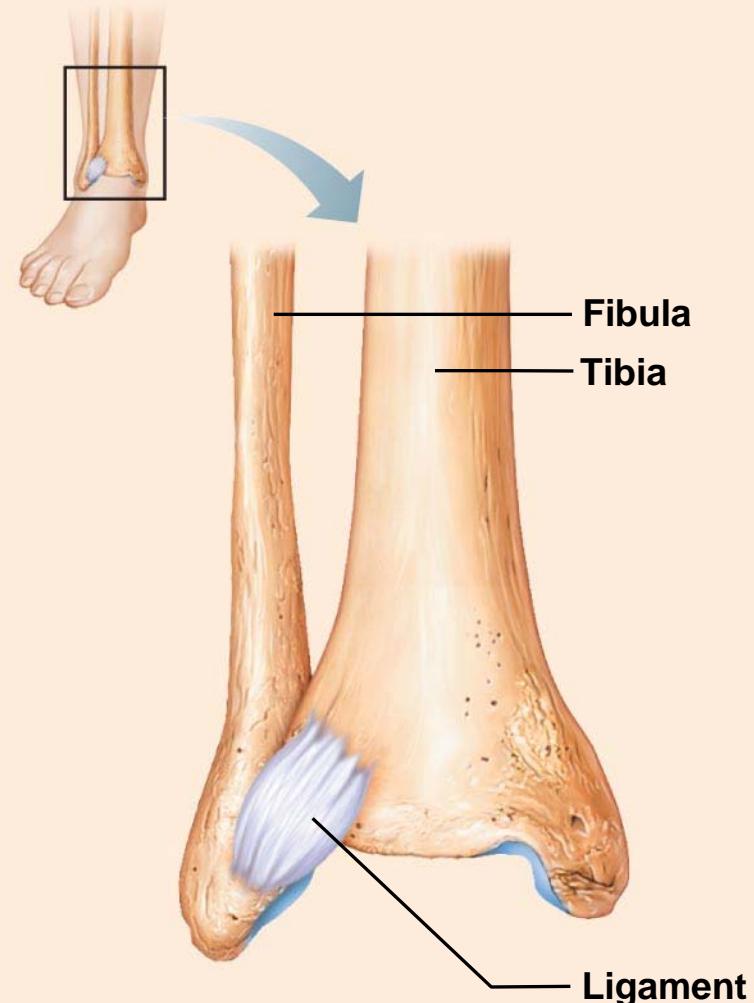
(c) Syndesmosis

Fibrous Joint - Syndesmosis

A less movable syndesmosis between tibia to fibula

(b) Syndesmosis

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



Fibrous Joints = Syndesmosis / eg: Gomphoses

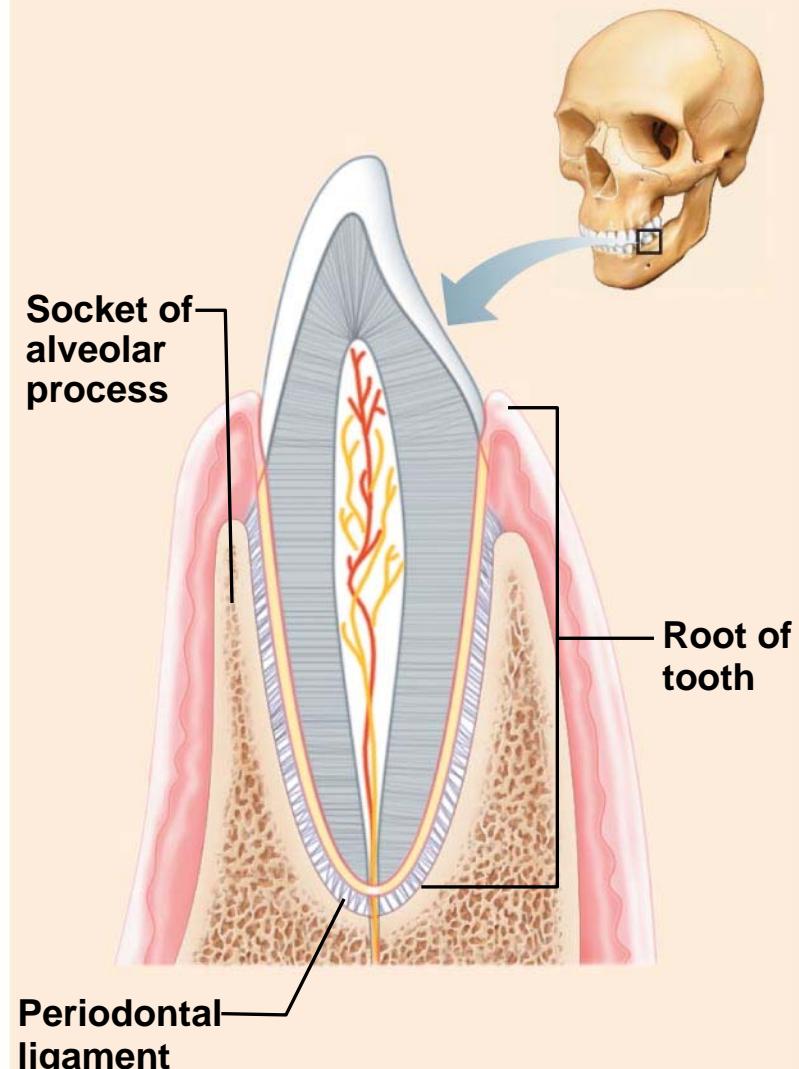
- Peg-in-socket joints of teeth in alveolar sockets
- A tooth is technically not a bone
- Tooth is held in place within the alveolar socket of maxilla and mandible
- Fibrous connection = **periodontal ligament**

Fibrous joints.

3rd Syndesmoses type

(c) Gomphosis

"Peg in socket" fibrous joint.
Periodontal ligament holds
tooth in socket.



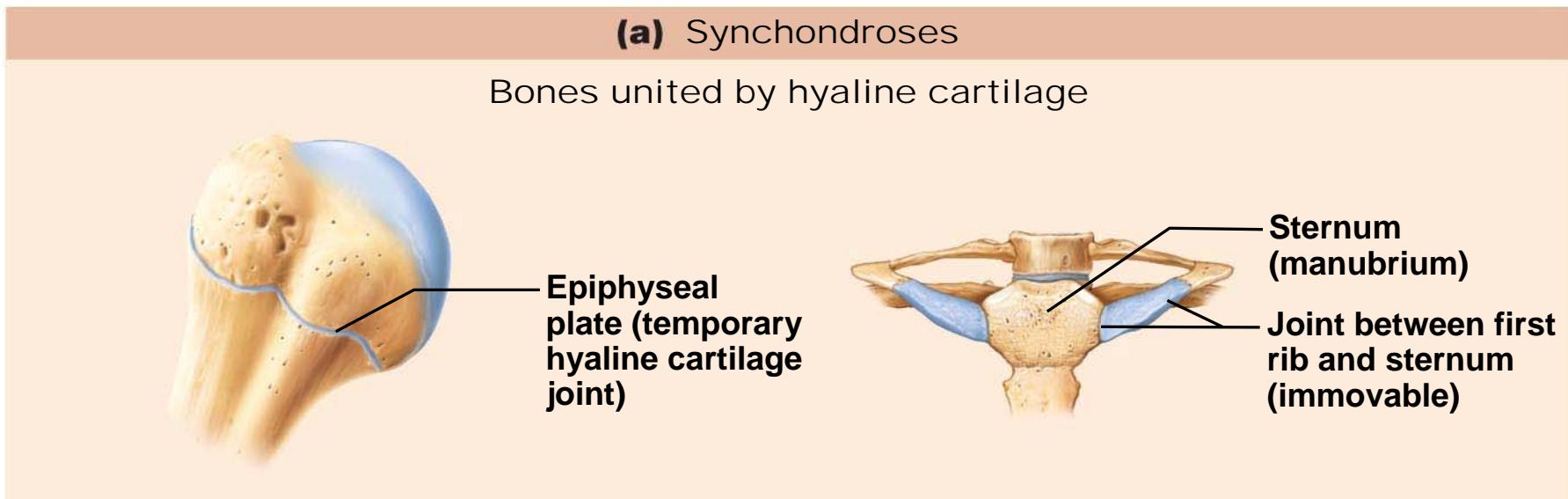
Cartilaginous Joints

- Bones united by cartilage
- No joint cavity
- Not highly movable
- Two types:
 - **Synchondroses**
 - **Symphyses**

Cartilaginous Joints: Synchondroses

- Described as a bar or plate of hyaline cartilage
 - unites two osseous tissues
 - Temporary epiphyseal plate joints
 - Become synostoses after plate closure
 - Cartilage of 1st rib with manubrium
- All are synarthrotic

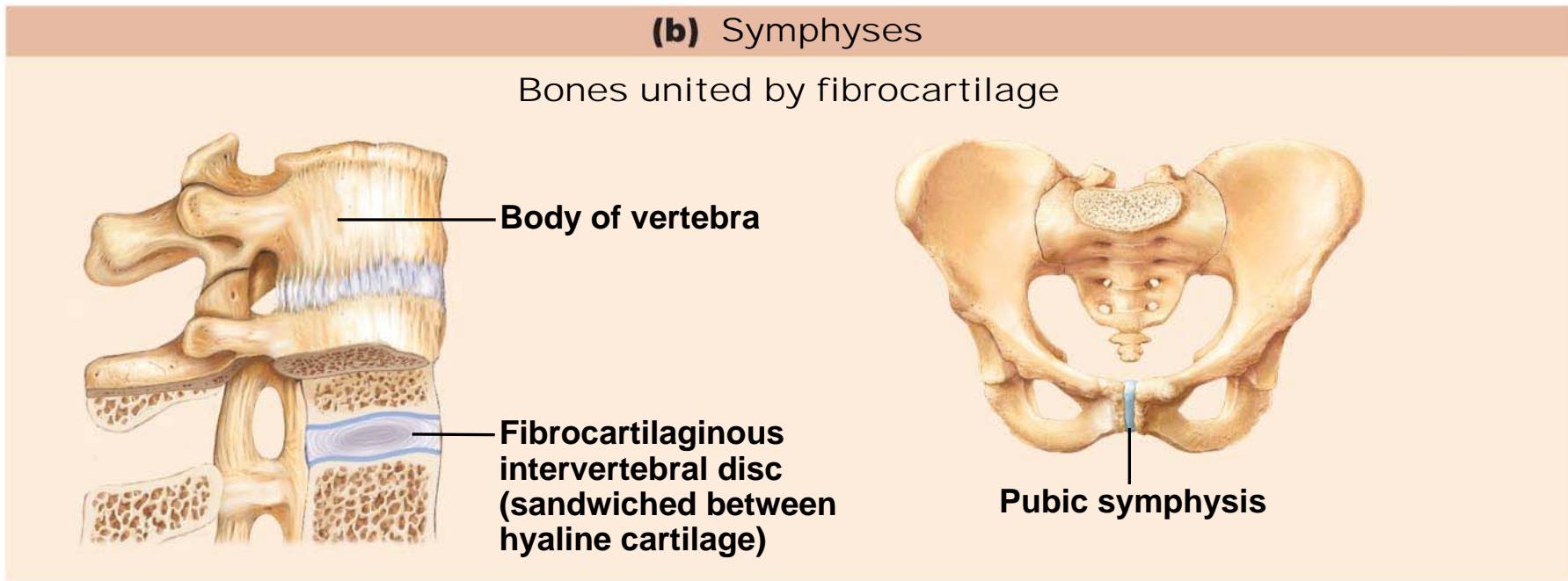
Cartilaginous joints.



Cartilaginous Joints: Symphyses

- Fibrocartilage unites bone
 - Hyaline cartilage present as articular cartilage
- Strong, flexible, and amphiarthrotic

Cartilaginous joints.



Synovial Joints

- Bones separated by fluid-filled joint cavity
- All are **diarthrotic**
- Include
 - all limb joints
 - most joints of body

Synovial Joints: Six Distinguishing Features

1. Articular cartilage: hyaline cartilage
 - Prevents crushing of bone ends
2. Joint (synovial) cavity
 - Small, fluid-filled potential space
3. Articular (joint) capsule
 - Two layers
 - External **Fibrous layer**
 - Dense irregular connective tissue
 - Inner **Synovial membrane**
 - Loose connective tissue
 - Makes synovial fluid

4. Synovial fluid

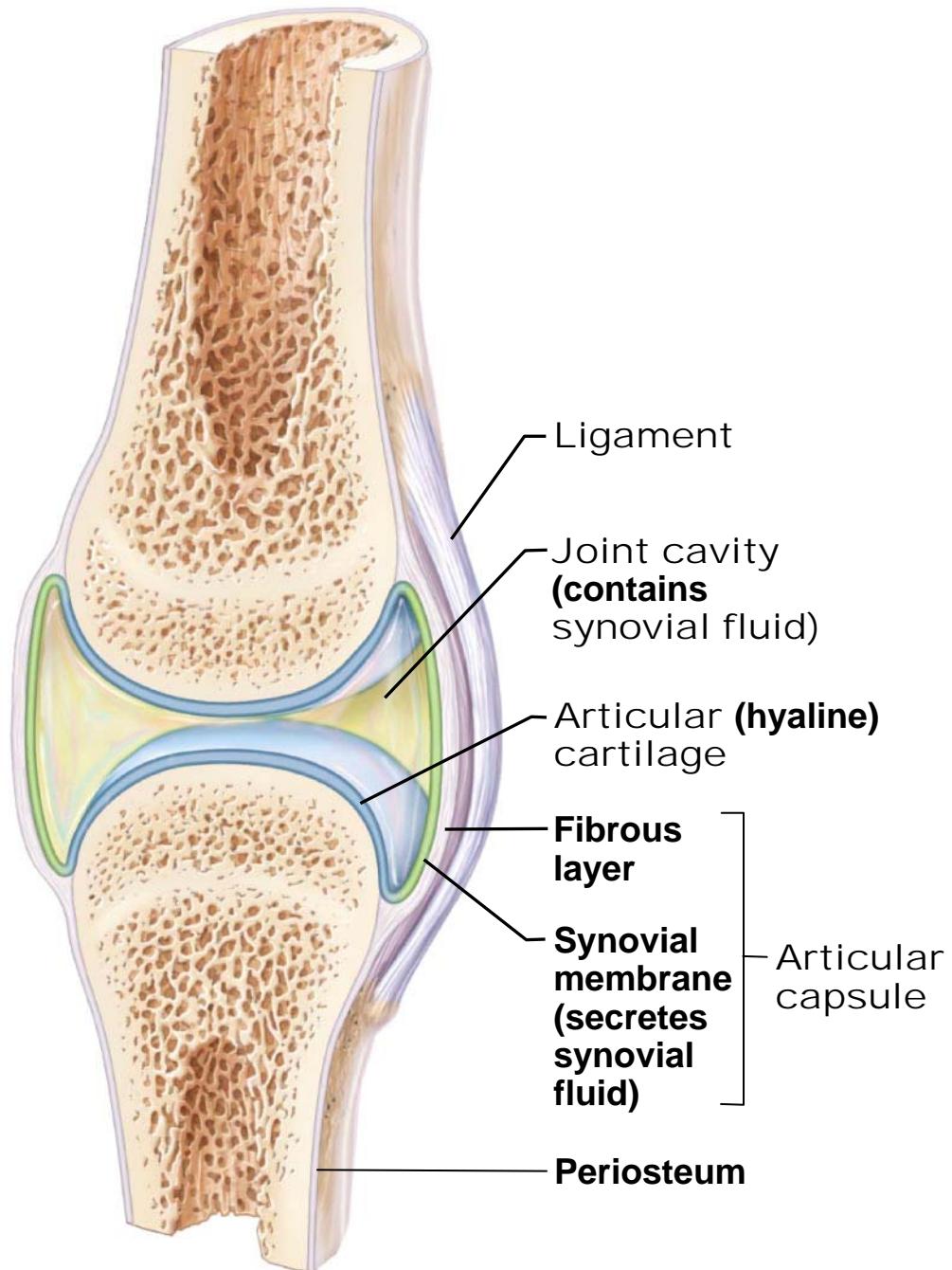
- Viscous, slippery filtrate of plasma and hyaluronic acid
- Lubricates and nourishes articular cartilage
- Contains phagocytic cells to remove microbes and debris

5. Different types of reinforcing ligaments

- **Capsular**
 - Thickened part of fibrous layer
- **Extracapsular**
 - Outside the capsule
- **Intracapsular**
 - Deep to capsule; covered by synovial membrane

6. Nerves and blood vessels

- Nerve fibers detect pain, monitor joint position and stretch
- Capillary beds supply filtrate for synovial fluid

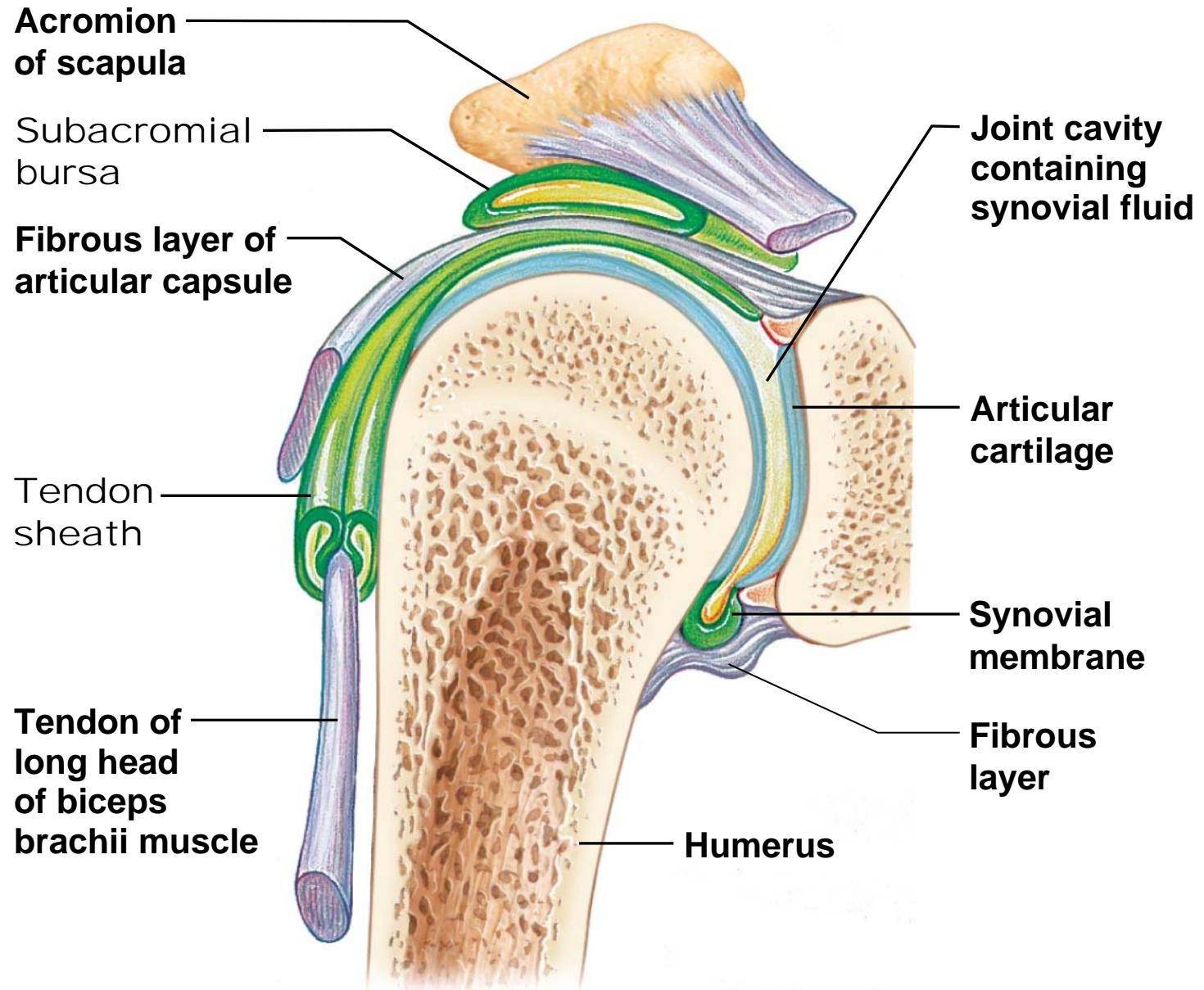


Other Features of Some Synovial Joints

- **Fatty pads**
 - For cushioning between fibrous layer and synovial membrane or bone
- **Articular discs (menisci)**
 - Fibrocartilage separates articular surfaces
 - improve "fit" of bone ends
 - stabilize joint
 - reduce wear and tear

Structures Associated with Synovial Joints

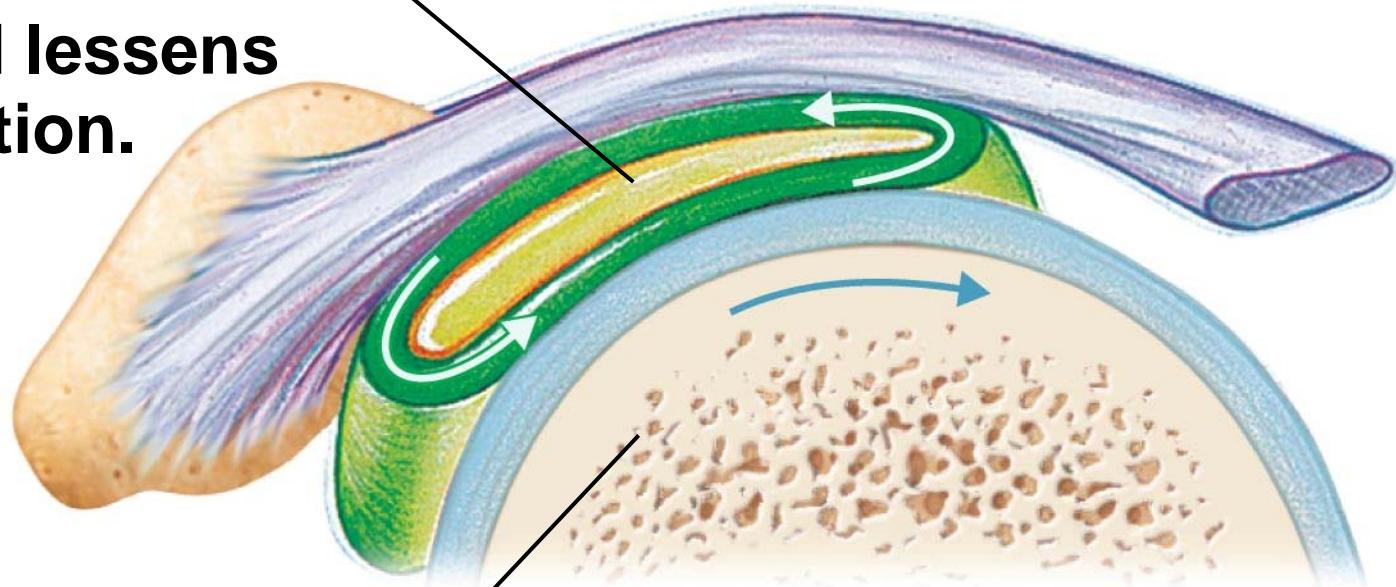
- **Bursae**
 - Sacs lined with synovial membrane
 - Contain synovial fluid
 - Reduce friction where ligaments, muscles, skin, tendons, or bones rub together
- **Tendon Sheaths**
 - Elongated bursa wrapped completely around tendon subjected to friction



(a)

Frontal section through the right shoulder joint

**Bursa rolls
and lessens
friction.**



**Humerus head
rolls medially as
arm abducts.**

Humerus moving

Enlargement showing how
a bursa eliminates friction where
a ligament (or other structure) would
rub against a bone

Three Stabilizing Factors at Synovial Joints

- Shapes of articular surfaces (minor role)
- Ligament number and location (limited role)
- Muscle tendons that cross joint (most important)
 - Muscle tone keeps tendons taut
 - Extremely important in reinforcing
 - Shoulder
 - Knee joints
 - Arches of the foot

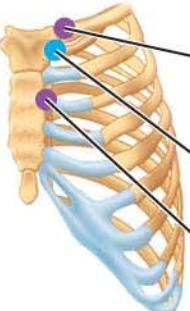
Table 8.2 Structural and Functional Characteristics of Body Joints

ILLUSTRATION	JOINT	ARTICULATING BONES	STRUCTURAL TYPE*	FUNCTIONAL TYPE; MOVEMENTS ALLOWED
	Skull	Cranial and facial bones	Fibrous; suture	Synarthrotic; no movement
	Temporo-mandibular	Temporal bone of skull and mandible	Synovial; modified hinge [†] (contains articular disc)	Diarthrotic; gliding and uniaxial rotation; slight lateral movement, elevation, depression, protraction, and retraction of mandible
	Atlanto-occipital	Occipital bone of skull and atlas	Synovial; condylar	Diarthrotic; biaxial; flexion, extension, lateral flexion, circumduction of head on neck
	Atlantoaxial	Atlas (C_1) and axis (C_2)	Synovial; pivot	Diarthrotic; uniaxial; rotation of the head
	Intervertebral	Between adjacent vertebral bodies	Cartilaginous; symphysis	Amphiarthrotic; slight movement
	Intervertebral	Between articular processes	Synovial; plane	Diarthrotic; gliding
	Costovertebral	Vertebrae (transverse processes or bodies) and ribs	Synovial; plane	Diarthrotic; gliding of ribs

***Fibrous joints** indicated by orange circles; **cartilaginous joints** by blue circles; **synovial joints** by purple circles.

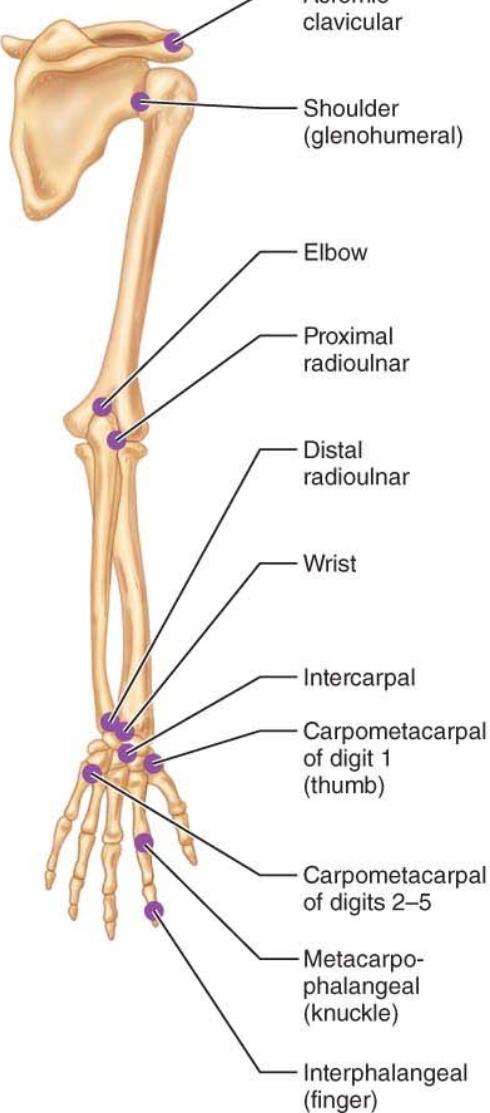
[†]These modified hinge joints are structurally bicondylar.

Table 8.2 Structural and Functional Characteristics of Body Joints (continued)

ILLUSTRATION	JOINT	ARTICULATING BONES	STRUCTURAL TYPE*	FUNCTIONAL TYPE; MOVEMENTS ALLOWED
	Sternoclavicular	Sternum and clavicle	Synovial; shallow saddle (contains articular disc)	Diarthrotic; multiaxial (allows clavicle to move in all axes)
	Sternocostal (first)	Sternum and rib 1	Cartilaginous; synchondrosis	Synarthrotic; no movement
	Sternocostal	Sternum and ribs 2–7	Synovial; double plane	Diarthrotic; gliding

*Cartilaginous joints by blue circles; synovial joints by purple circles.

Table 8.2 Structural and Functional Characteristics of Body Joints (continued)

ILLUSTRATION	JOINT	ARTICULATING BONES	STRUCTURAL TYPE*	FUNCTIONAL TYPE; MOVEMENTS ALLOWED
	Acromio-clavicular	Acromion of scapula and clavicle	Synovial; plane (contains articular disc)	Diarthrotic; gliding and rotation of scapula on clavicle
	Shoulder (glenohumeral)	Scapula and humerus	Synovial; ball-and-socket	Diarthrotic; multiaxial; flexion, extension, abduction, adduction, circumduction, rotation of humerus
	Elbow	Ulna (and radius) with humerus	Synovial; hinge	Diarthrotic; uniaxial; flexion, extension of forearm
	Proximal radioulnar	Radius and ulna	Synovial; pivot	Diarthrotic; uniaxial; pivot (convex head of radius rotates in radial notch of ulna)
	Distal radioulnar	Radius and ulna	Synovial; pivot (contains articular disc)	Diarthrotic; uniaxial; rotation of radius around long axis of forearm to allow pronation and supination
	Wrist	Radius and proximal carpal	Synovial; condylar	Diarthrotic; biaxial; flexion, extension, abduction, adduction, circumduction of hand
	Intercarpal	Adjacent carpal	Synovial; plane	Diarthrotic; gliding
	Carpometacarpal of digit 1 (thumb)	Carpal (trapezium) and metacarpal 1	Synovial; saddle	Diarthrotic; biaxial; flexion, extension, abduction, adduction, circumduction, opposition of metacarpal I
	Carpometacarpal of digits 2–5	Carpal(s) and metacarpal(s)	Synovial; plane	Diarthrotic; gliding of metacarpals
	Metacarpophalangeal (knuckle)	Metacarpal and proximal phalanx	Synovial; condylar	Diarthrotic; biaxial; flexion, extension, abduction, adduction, circumduction of fingers
Interphalangeal (finger)	Adjacent phalanges	Synovial; hinge	Diarthrotic; uniaxial; flexion, extension of fingers	

*Synovial joints by purple circles.

Table 8.2 Structural and Functional Characteristics of Body Joints (continued)

ILLUSTRATION	JOINT	ARTICULATING BONES	STRUCTURAL TYPE*	FUNCTIONAL TYPE; MOVEMENTS ALLOWED
	Sacroiliac	Sacrum and coxal bone	Synovial; plane in childhood, increasingly fibrous in adult	Diarthrotic in child; amphiarthrotic in adult; (more movement during pregnancy)
	Pubic symphysis	Pubic bones	Cartilaginous; symphysis	Amphiarthrotic; slight movement (enhanced during pregnancy)
	Hip (coxal)	Hip bone and femur	Synovial; ball-and-socket	Diarthrotic; multiaxial; flexion, extension, abduction, adduction, rotation, circumduction of thigh
	Knee (tibiofemoral)	Femur and tibia	Synovial; modified hinge [†] (contains articular discs)	Diarthrotic; biaxial; flexion, extension of leg, some rotation allowed in flexed position
	Knee (femoropatellar)	Femur and patella	Synovial; plane	Diarthrotic; gliding of patella
	Superior tibiofibular	Tibia and fibula (proximally)	Synovial; plane	Diarthrotic; gliding of fibula
	Inferior tibiofibular	Tibia and fibula (distally)	Fibrous; syndesmosis	Synarthrotic; slight "give" during dorsiflexion
	Ankle	Tibia and fibula with talus	Synovial; hinge	Diarthrotic; uniaxial; dorsiflexion, and plantar flexion of foot
	Intertarsal	Adjacent tarsals	Synovial; plane	Diarthrotic; gliding; inversion and eversion of foot
	Tarsometatarsal	Tarsal(s) and metatarsal(s)	Synovial; plane	Diarthrotic; gliding of metatarsals
Metatarso-phalangeal	Metatarsal and proximal phalanx	Synovial; condylar	Diarthrotic; biaxial; flexion, extension, abduction, adduction, circumduction of great toe	
Interphalangeal (toe)	Adjacent phalanges	Synovial; hinge	Diarthrotic; uniaxial; flexion; extension of toes	

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[†] These modified hinge joints are structurally bicondylar.

Synovial Joints: Movements Allowed

- All muscles attach to bone or connective tissue at no fewer than two points
 - **Origin**—attachment to immovable bone
 - **Insertion**—attachment to movable bone
- Muscle contraction causes insertion to move toward origin
- Movements occur along transverse, frontal, or sagittal planes

Synovial Joints: Range of Motion

- **Nonaxial**—slipping movements only
- **Uniaxial**—movement in one plane
- **Biaxial**—movement in two planes
- **Multiaxial**—movement in or around all three planes

Three General Types of Movements at Synovial Joints

1. Gliding

2. Angular movements

- Flexion, extension,
hyperextension
- Abduction, adduction
- Circumduction

3. Rotation

- Medial and lateral rotation

Gliding Movements

- One flat bone surface glides or slips over another similar surface
- Examples:
 - Intercarpal joints
 - Intertarsal joints
 - Between articular processes of vertebrae

Angular Movements

- Increase or decrease angle between two bones
- Movement along sagittal plane
 - **Flexion**—decreases the angle of the joint
 - **Extension**—increases the angle of the joint
 - **Hyperextension**—excessive extension beyond normal range of motion

Angular Movements

- Movement along frontal plane
 - **Abduction**—movement away from the midline
 - **Adduction**—movement toward the midline
- **Circumduction**
 - Involves flexion, abduction, extension, and adduction of limb
 - Limb describes cone in space

Rotation

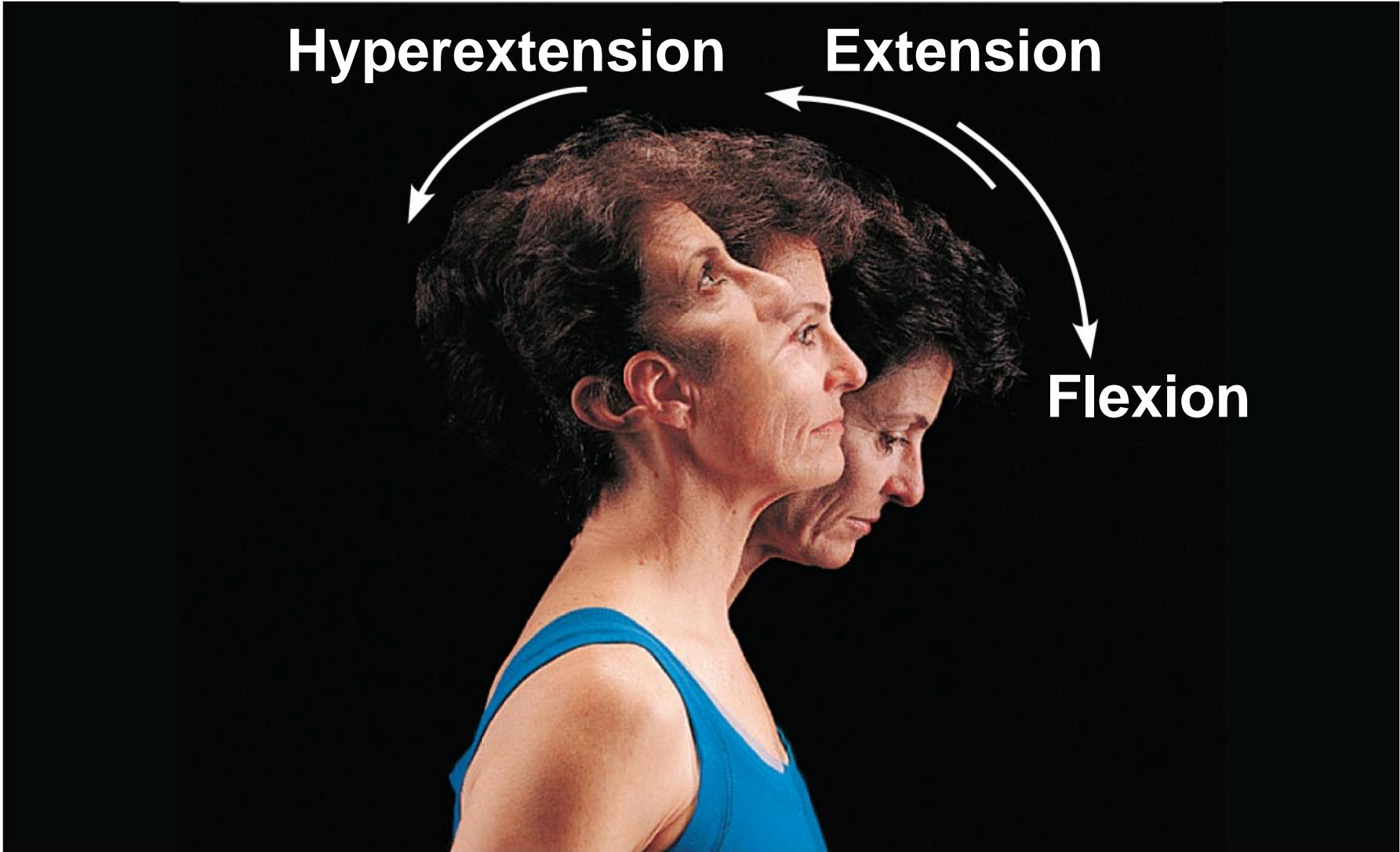
- Turning of bone around its own long axis
 - Toward midline or away from it
 - **Medial and lateral rotation**
- Examples:
 - Between C₁ and C₂ vertebrae
 - Rotation of humerus and femur

Movements allowed by synovial joints.



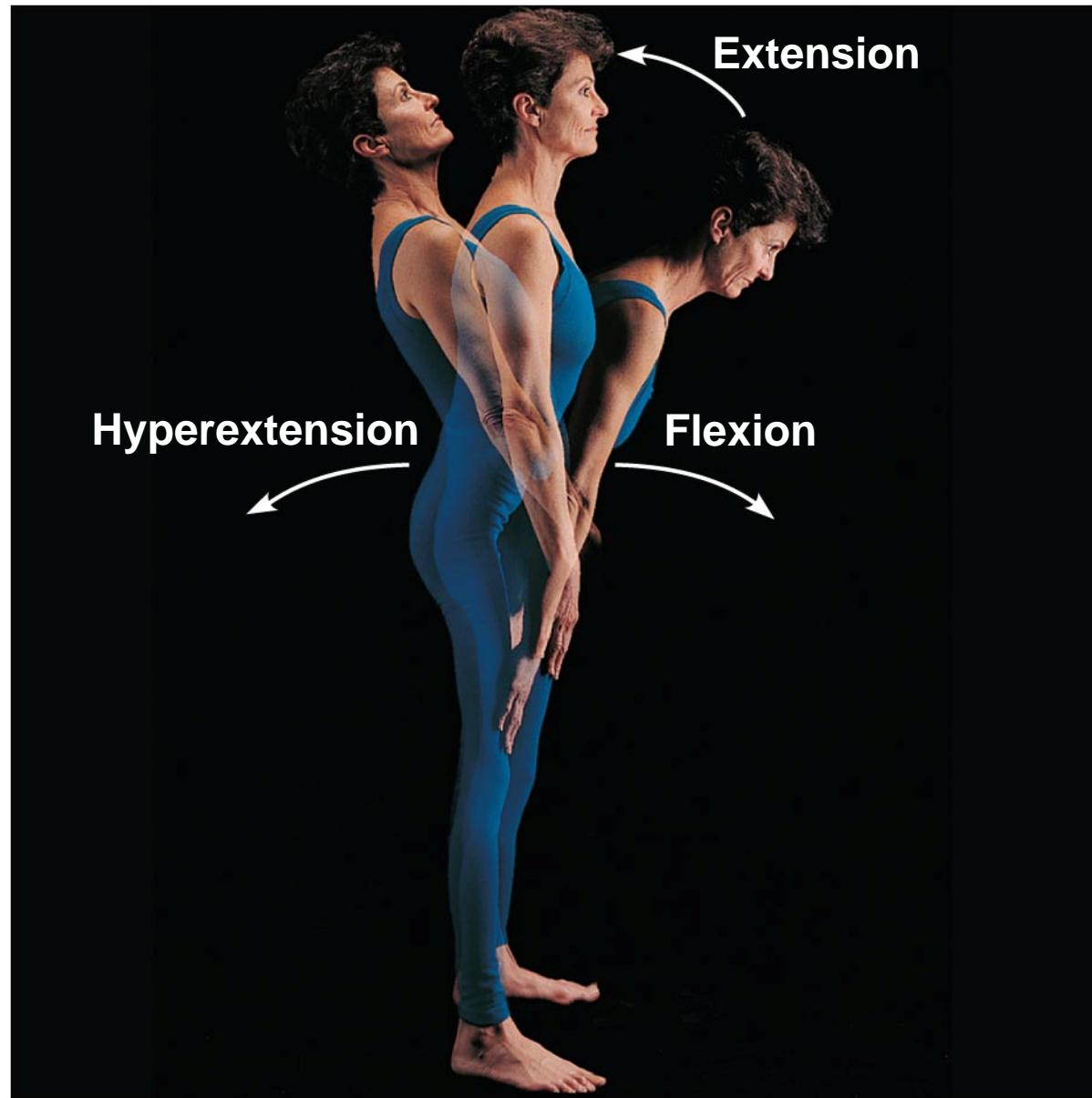
(a) Gliding movements at the wrist

Movements allowed by synovial joints.



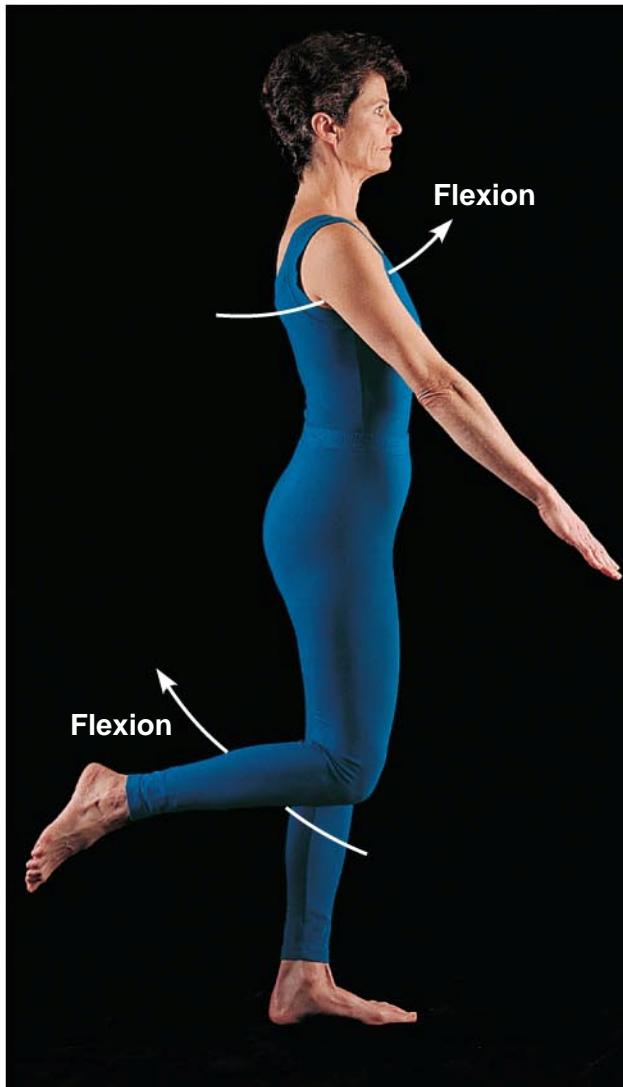
(b) Angular movements: flexion, extension, and hyperextension of the neck

Movements allowed by synovial joints.



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

Movements allowed by synovial joints.



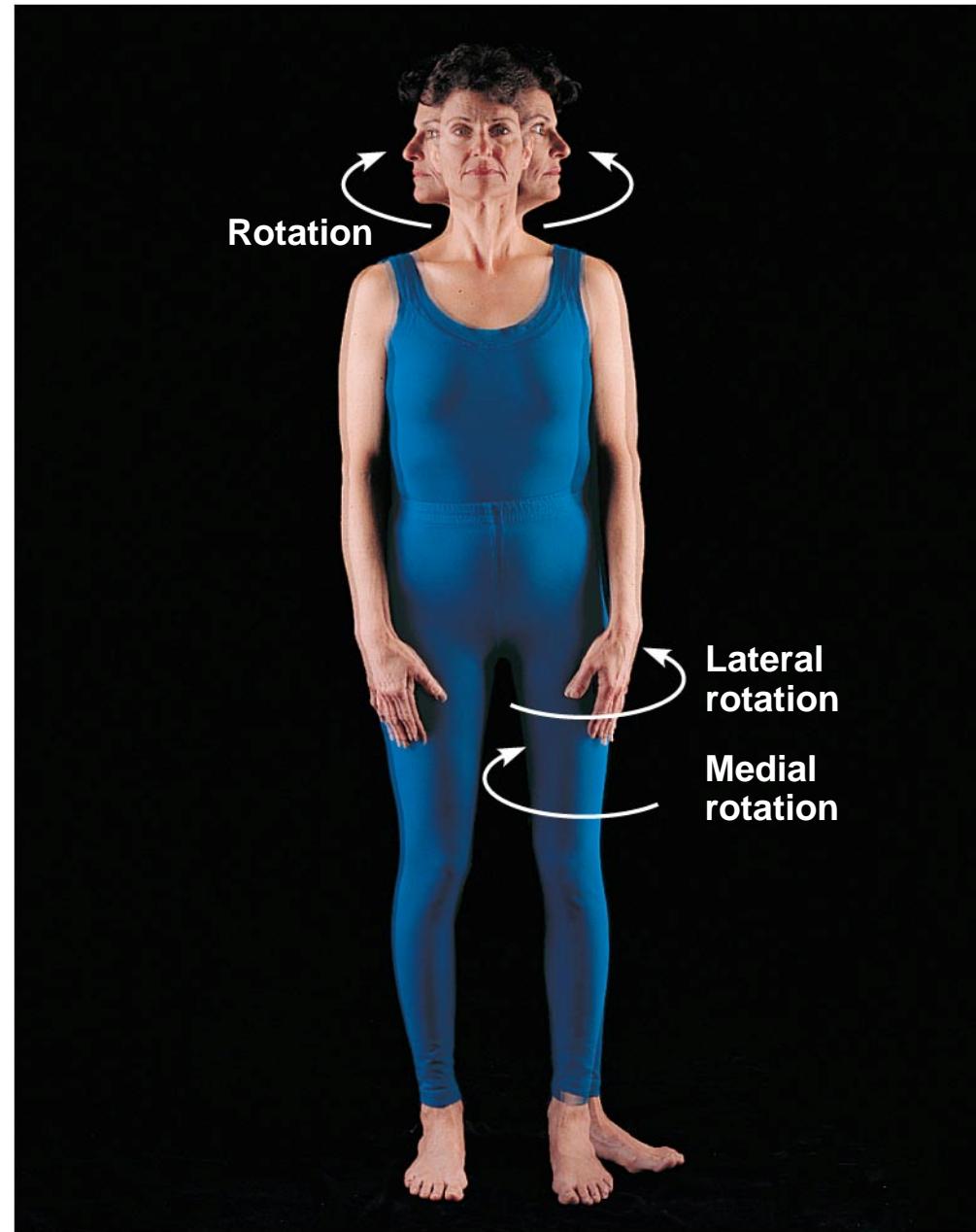
(d) Angular movements: flexion, extension, and hyperextension at the shoulder and knee

**Movements allowed
by synovial joints.**



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

Movements allowed by synovial joints.

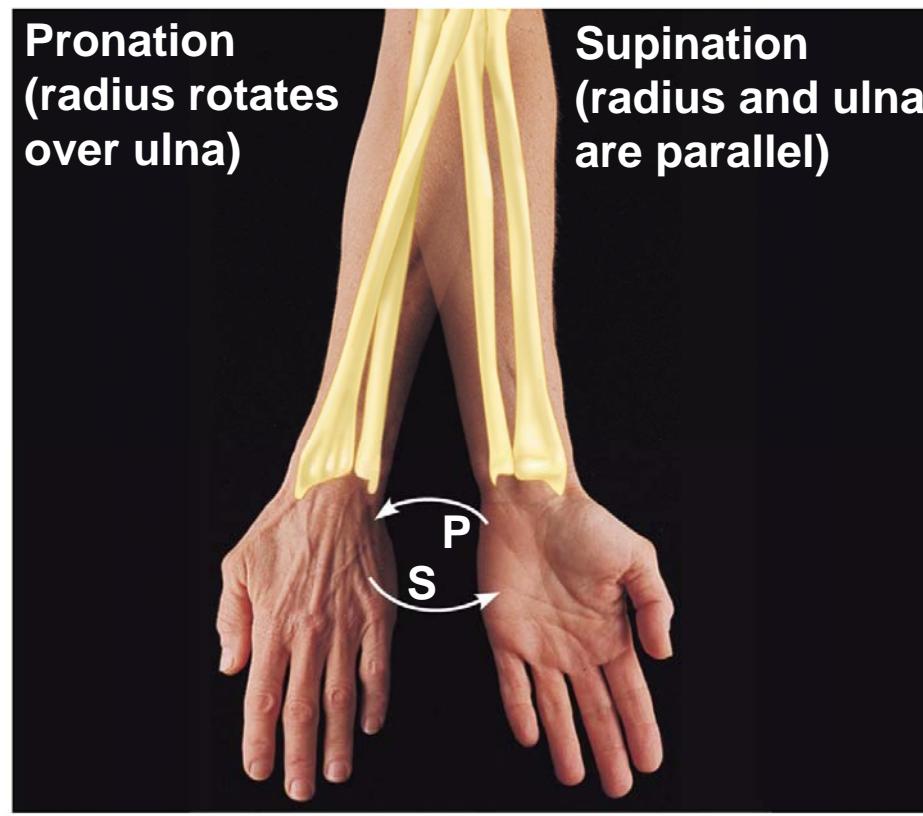


(f) Rotation of the head, neck, and lower limb

Special Movements at Synovial Joints

- **Supination and pronation** of radius and ulna
- **Dorsiflexion and plantar flexion** of foot
- **Inversion and eversion** of foot
- **Protraction and retraction**
- **Elevation and depression** of mandible
- **Opposition** of thumb of mandible

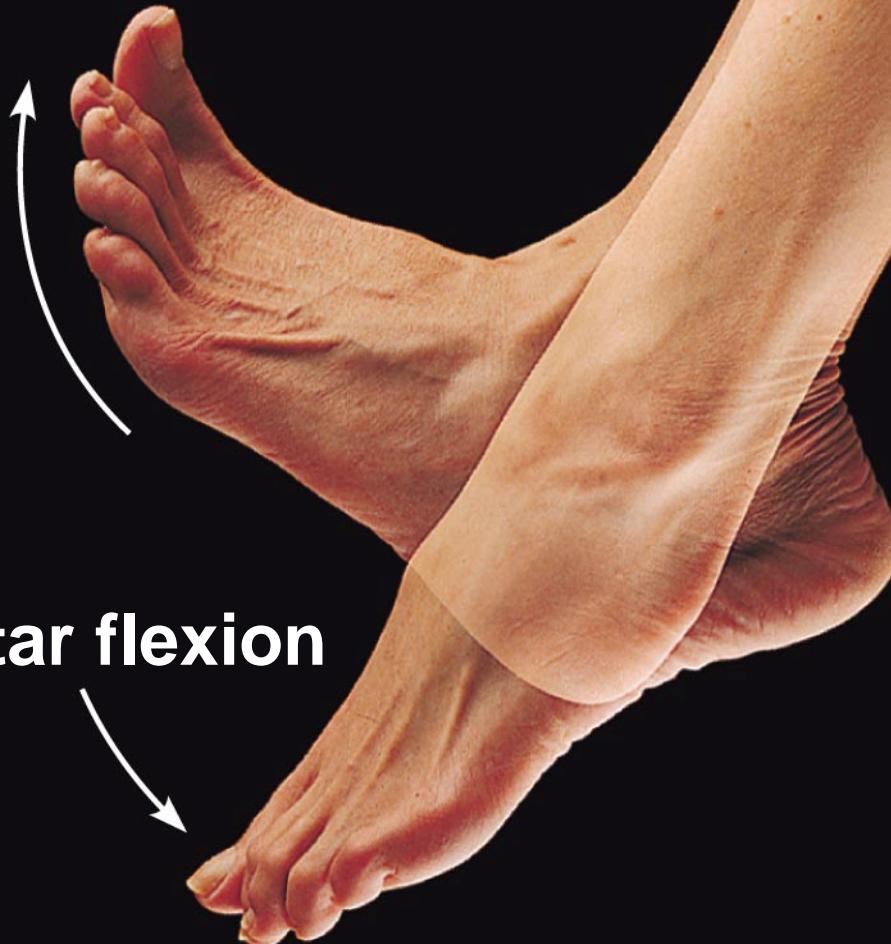
Special body movements.



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

Special body movements.

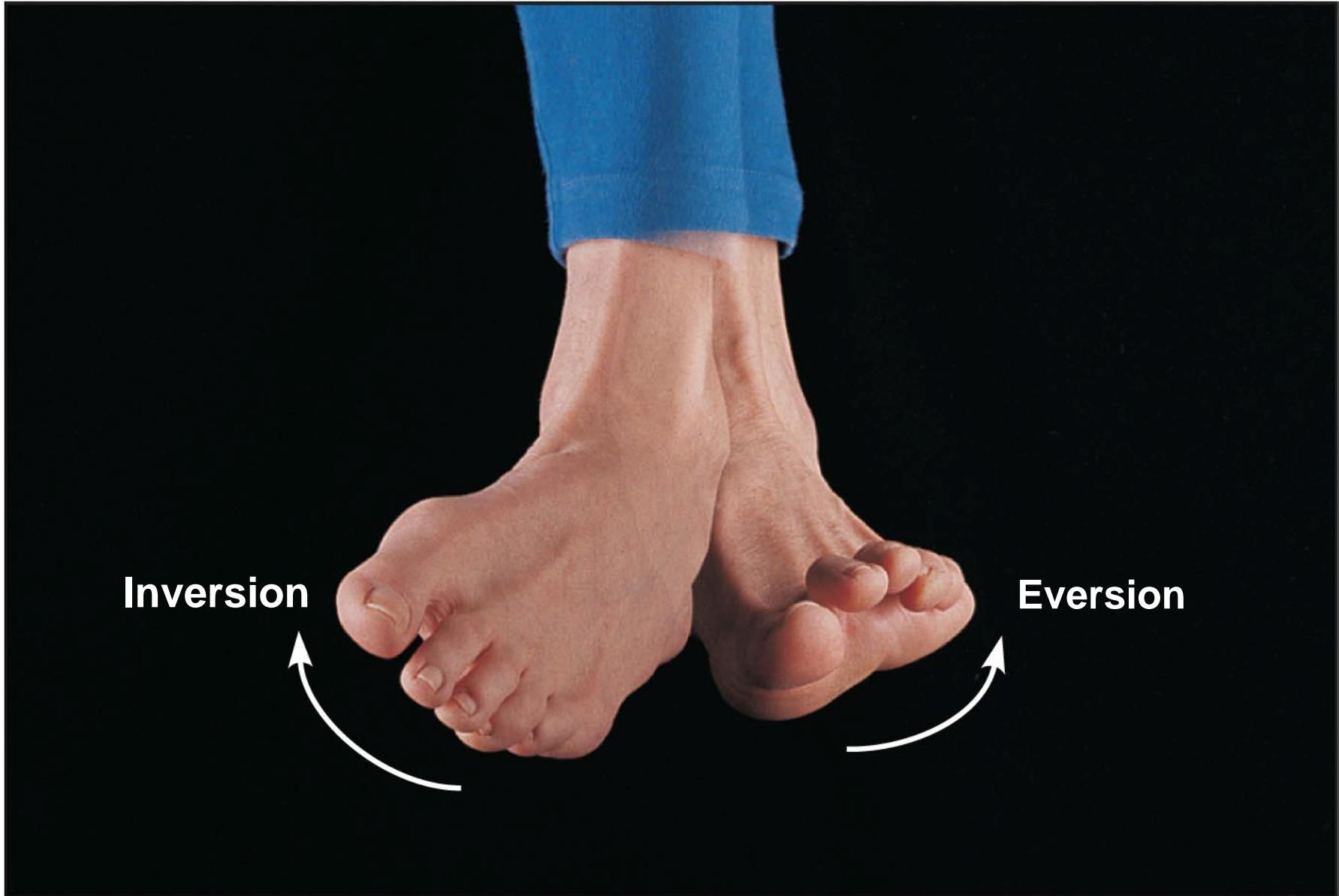
Dorsiflexion



Plantar flexion

(b) Dorsiflexion and plantar flexion

Special body movements.



(c) Inversion and eversion

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Special body movements.



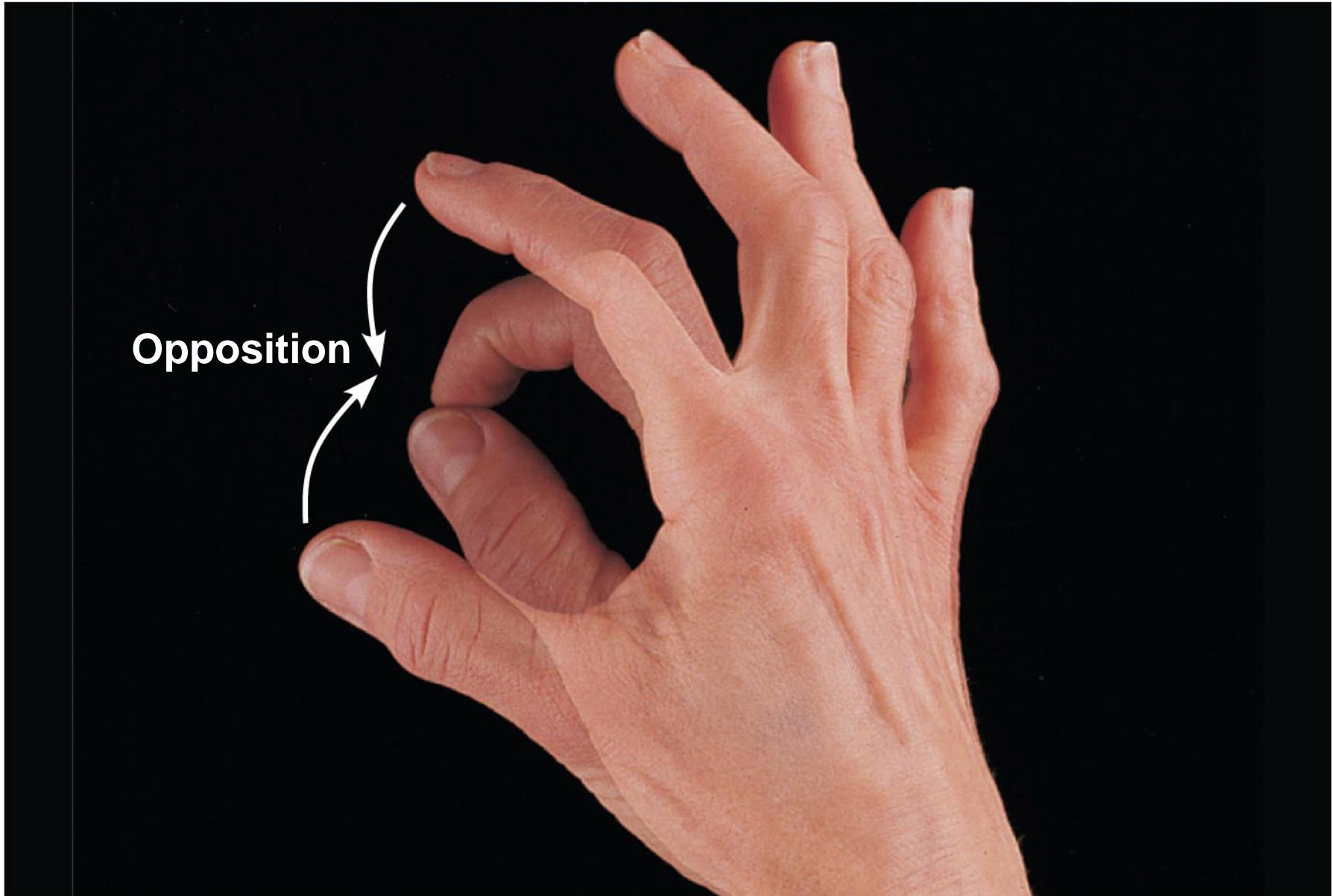
(d) Protraction and retraction

Special body movements.



(e) Elevation and depression

Special body movements.



(f) Opposition

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