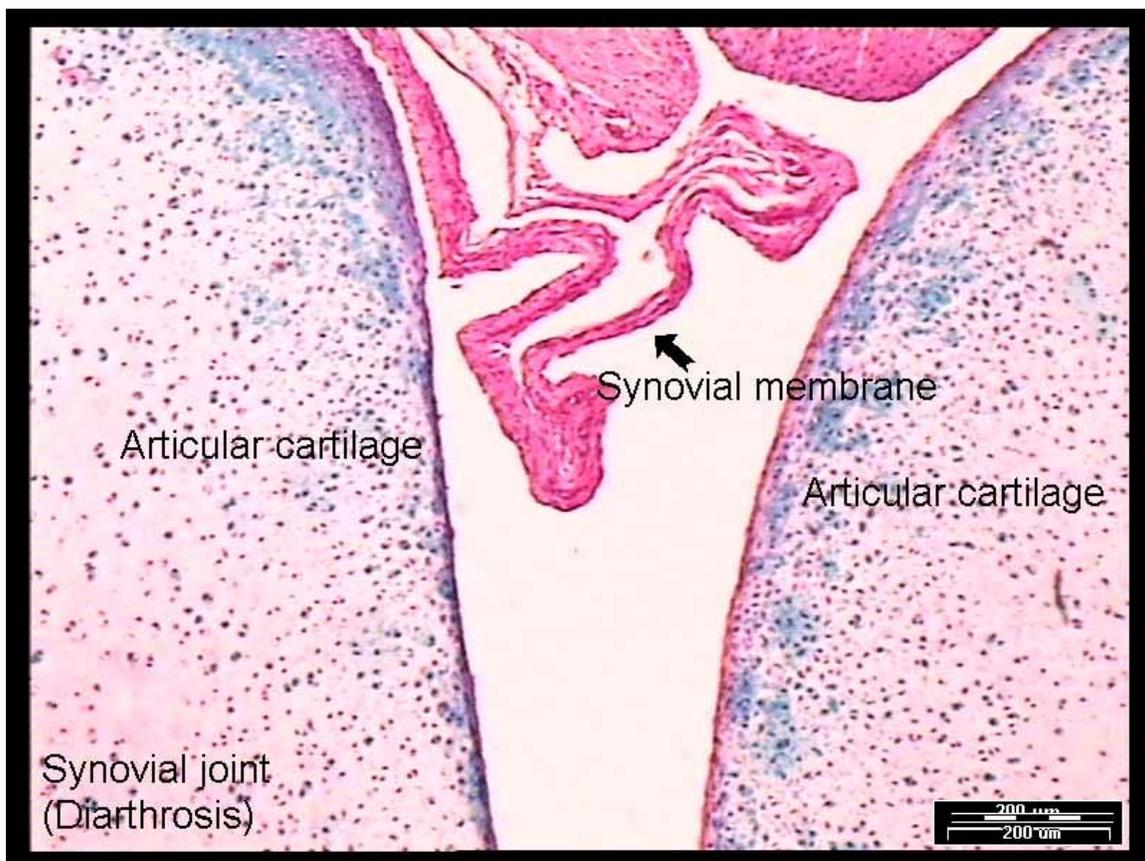


Articulations or Joints

- Bones are connected to each other by joints.
 - The most common joint type is the **diarthrosis** of articulating joints, which has a fibrous connective tissue capsule (**ligament**), continuous with the periosteum of the two bones and which permits a degree of freedom of movement between the two bones.
 - The inner part of the capsule consists of the **synovial membrane**, which may extend as a fold (**synovial fold**).
 - The synovial membrane is well vascularised with both blood and lymph vessels.
 - The main cell type present in the synovial membrane, are fibroblast-like cells, and involved in the formation of the **synovial fluid**.
 - This fluid is rich in **hyaluronic acid** and fills the joint cavity.
 - Macrophage-like cells are also found in the synovial membrane and are responsible for keeping the synovial fluid clean and free of cell fragments.
 - The synovial fluid plays an important role in the lubrication of the joint and in providing nutrition for the articular cartilage of the epiphyses.
 - **Fat deposits** or pads, found between the synovial membrane and the ligament, function as mechanical shock absorbers.
 - Aging changes to joints, in particular pathological changes of the articular cartilage (**osteoarthritis**), are very common in the elderly.



• Function

- Hold skeleton together

- Provide mobility
- Weakest part of the skeleton

FIBROCARTILAGE

Fibrocartilage is found in areas of the body subject to high mechanical stress or weightbearing. It lacks the flexibility of the other cartilage types.

Fibrocartilage is present in:

- (a) intervertebral disks
- (b) pubic symphysis
- (c) temporo-mandibular joints
- (d) at sites of connection of many ligaments to bones
(e.g. *Ligamentum teres femoris*)
- (e) tendon insertions.

Fibrocartilage is characterized by large numbers and concentrations of **collagen fibers** in the matrix. These collagen fibers are the dominant feature of the matrix and with relatively little amorphous matrix. The large amounts of collagen fibers result in the matrix appearing **acidophilic** in histological sections after H&E staining. Fibrocartilage is not surrounded by perichondrium.

The **intervertebral disks** consist of fibrocartilage plates between the vertebrae and act as mechanical shock absorbers. In sections they are seen to be formed of two components:

- (a) the **annulus fibrosus**, which is the outer region consisting of orderly concentric arrangements of cells and matrix dominated by type I collagen (as in tendons)
- (b) the **nucleus pulposus** (large vacuolated cells, that are vestiges of the embryonic notochord).

– **Two main functional groups of joints**

- **synovial** (NL; between oval surfaces)= diarthroses (Gk. to fasten by a joint): extensive movement at articular surfaces; maintained in apposition by fibrous capsule and ligaments; surfaces lubricated by synovial fluid
- **synovium**: specialized layer of collagenous tissue lining inner aspect of capsule; inner surface discontinuous layer cells up to four synovial cells deep; no junctional complexes

or basement membrane; mesenchymal origin; type A synovocytes: plump, majority; extensive Golgi complex, numerous lysosomes suggestive of macrophages; type B synovocytes: profuse rER; represent fibroblasts;

- areolar synovium: synovium of loose CT
 - fibrous synovium: denser collagenous type; rich network of capillaries and thick strands of collagen
 - adipose synovium: composed of fat; intra-articular fat pads
-
- **synovial fluid:** fluid from synovial extracellular matrix (not a secretion); hyaluronic acid and associated glycoproteins secreted by type B synovocytes; transudate from synovial capillaries; also small number of leucocytes, predominantly monocytes.
 - **articular cartilages:** no perichondrium; collagen of type I (in contrast to type II collagen of hyaline cartilage)
 - **bony end plate; lacks osteons and canaliculi; osteocytes** occupy large lacunae; thick layer of glycoprotein-rich substance (resembles cement lines between osteons) demarcates bony plate from articulate surface.
 - **temporomandibular and knee joints:** fibrocartilage completely or partially interposed btwn articular surfaces but unattached
 - **intervertebral joints:** thick ligaments extending down anterior aspect of spinal column merges with annulus fibrosus; thinner ligament posterior;
 - **zygoapophyseal joints:** (zyg = yoked) synovial joints btwn vertebral arches; stabilized by strong elastic ligaments connecting bony processes
 - **intervertebral disk = symphysial joints** (i.e., fibrocartilage type); fibrocartilage arranged in concentric rings - annulus fibrosus reinforced peripherally by circumferential ligaments; central cavity containing viscous fluid = nucleus pulposus containing physaliphorous cells (nucleus pulposus remnant of notochord)
 - **slipped disk:** fibrocartilage of annulus fibrosus thins and weakens; nucleus pulposus extruded, particularly postero-lateral aspect.
 - **tendon:** densest form of collagenous supporting tissue

nonsynovial: limited movement; no free articular surfaces; joined by dense collagenous tissue

dense fibrous tissue: sutures btwn bones of skull; syndesmoses = fibrous tissue joints; synostoses = after replacement by bone

hyaline cartilage: synchondrosis or primary cartilaginous joint; unites first rib with sternum

fibrocartilage: hyaline cartilage at ends of apposed bones connected to each other by plate of fibrocartilage; = symphyses or secondary cartilaginous joints; public symphysis (develops central cavity) and intervertebral disks (have fluid-filled central cavity)

Joints are accordingly classified

1. fibrous and cartilaginous joints where two bones are separated by a deformable intermediate
2. synovial joints where one surface slides freely over another.

Fibrous joints. We have already mentioned the joint between the bony shaft and cartilage at the ends of long bones. This is a synchondrosis, a cartilage sandwich with bone on either side: bone and cartilage fit together perfectly and the whole thing is cup shaped. If movement occurs the growing bone will be damaged (slipped epiphysis) and this is countered by putting in a long nail to fix it again.

Sutures: are limited to the skull. They resemble a synchondrosis, but with fibrous tissue instead of cartilage between the bones. Sutures are necessary for skull growth: consequently well marked in the young less so in the adult. The only movement in sutures is at birth when the cranial bones overlap to allow passage through the maternal pelvis. After this movement is discouraged by increasing complexity of the suture, which becomes serrated or denticulate. Later in life, when growth is complete they fuse.

gomphoses: are peg and socket joints as seen between teeth and jaws. The joint is maintained by the periodontal ligament which gives only a little to act as a shock absorber when we bite on a ball bearing.

syndesmosis: only one of these in the body, the inferior tibio-fibular joint. In this type there is a little movement, limited by a tight ligament. Since many joints are limited by ligaments this is probably a special definition we can do without. symphysis: two bones united by cartilage, but designed to give a bit. The symphysis pubis with ligaments and fibrocartilage is normally closed, but opens in childbirth due to hormonal influences.

Synovial joints have different parameters. Joint surfaces almost in contact but discontinuous, as a great range of movement is often possible, and the surfaces slide over each other. The sliding surfaces are covered with a thin layer of cartilage. This gives a coefficient of friction of <0.002 . The joint cavity is sealed by a synovial membrane which secretes synovial fluid, a lubricant and nutrient. Around this, in turn, is a tough fibrous joint capsule which keeps the ends of the bones in

proper orientation. This is often locally thickened to form joint ligaments. The synovial cavity is very small between articular surfaces but larger round the edges where it may form a bursa, a sack-like extension which may be in contact with the joint cavity.

Various inclusions may be present in the joint cavity: a tendon may pass through, sheathed in synovial membrane. Fat pads may be present, packing the large gaps which occur in some joints between bone ends. Pieces of cartilage are also found, in addition to articular cartilage. These may form

1. a labrum or lip deepening a bony socket
2. menisci - incomplete discs or crescents increasing the size of articular surfaces
3. complete, or nearly complete articular discs of fibrocartilage. This will convert a joint into two in parallel, which can then move in independent directions. The temporomandibular joint of the jaw is a good example of this.

Limitation of movement is also important. Usually achieved by

1. tension in ligament, which have strain and pain receptors
2. tension of muscles around a joint - passive resistance to stretch followed by reflex contraction when stimuli from mechanoreceptors becomes critical. These explain Hilton's law: that joints and the muscles acting on them share a nerve supply. Paralysis of muscles thus affects joints. In spastic paralysis muscle tone is increased and movement restricted. In other paralysees joints become lax, flail joints or actually disrupted. Charcot elbow in syphilis.
3. Running out of articular surface.
4. approximation of soft parts.

Skeletal Articulations: Joint Architecture

Classification according to MOVEMENT:

- **Synarthrosis** - immovable, fibrous joints
 - **sutures** - bone sheets mate closely and held by fibers (skull)
 - **syndemosis** - held by ligaments (mid-radioulnar, mid-tibiofibular)
- **Amphiarthrosis** - slightly movable, cartilaginous joint
 - **synchondroses** - held by thin layer of hyaline cartilage (sternocostal, epiphyseal plate)
 - **symphyses** - thin plate of hyaline cartilage separates disc of fibrocartilage from bone (vertebral, pubic symphysis)
- **Diarthroses** - freely movable, synovial joints

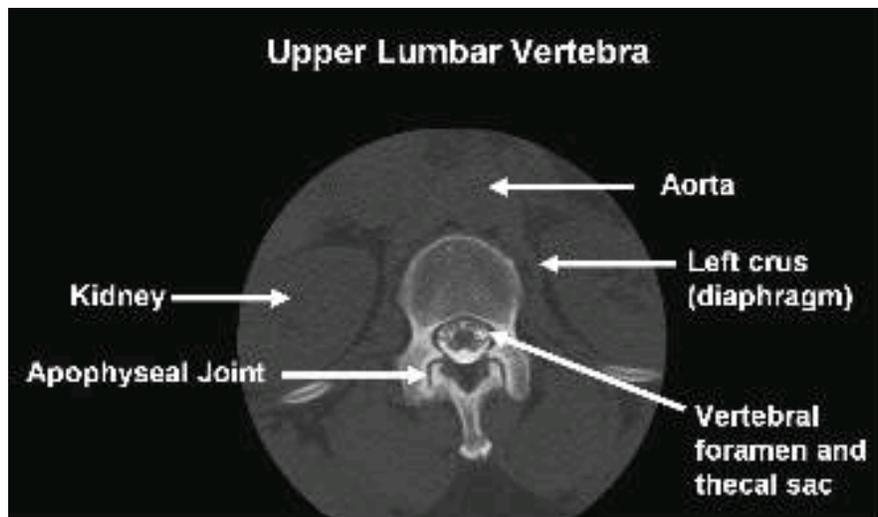
Synovial joints (or **diarthroses**, or **diarthroidal joints**) are the most common and most moveable type of joints in the body.

The whole of a diarthrosis is contained by a ligamentous sac, the joint capsule or articular capsule.

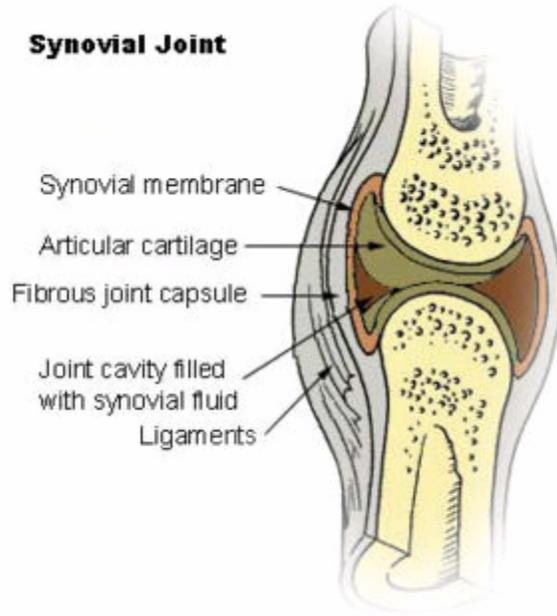
The surfaces of the two bones at the joint are covered in cartilage. The thickness of the cartilage varies with each joint, and sometimes may be of uneven thickness. Articular cartilage is multi-layered. A thin superficial layer provides a smooth surface for the two bones to slide against each other. Of all the layers, it has the highest concentration of collagen and the lowest concentration of proteoglycans, making it very resistant to shear stresses. Deeper than that is an intermediate layer, which is mechanically designed to absorb shocks and distribute the load efficiently. The deepest layer is highly calcified, and anchors the articular cartilage to the bone.

In joints where the two surfaces do not fit snugly together, a meniscus or multiple folds of fibrocartilage within the joint correct the fit, ensuring stability and the optimal distribution of load forces.

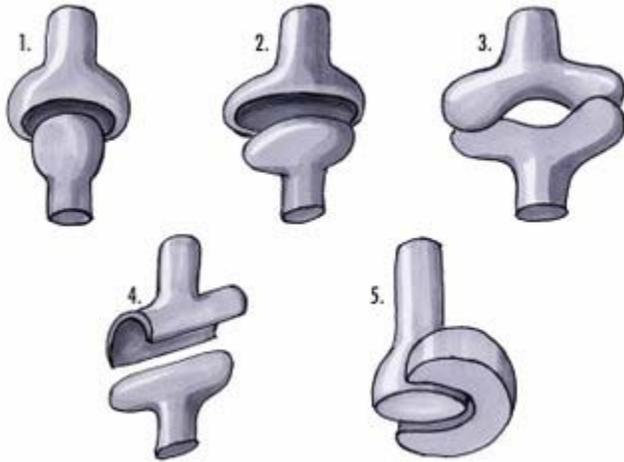
The synovium is a membrane that covers all the non-cartilaginous surfaces within the joint capsule. It secretes synovial fluid into the joint, which nourishes and lubricates the articular cartilage. The synovium is separated from the capsule by a layer of cellular tissue that contains blood vessels and nerves.



Synovial Joint



- - **Articular cartilage** - protective layer of dense white connective tissue covering articulating bone surfaces that spreads load over wider area, thereby reducing contact stress
 - **Articular capsule** - double layered membrane that surrounds the joint
 - **Synovial fluid** - clear, slightly yellow liquid that provides lubrication inside the articular capsule
 - **Bursae (and tendon sheath)** - small capsules filled with synovial fluid that reduce friction between tendon and bone
 - **Meniscus** - articular fibrocartilage (soft tissue that intervenes between articulating bones) that may
 1. distribute load over wider area
 2. improve "fit" of articulating surfaces
 3. limit translation ("slip") of one bone in relation to another
 4. protection of periphery of joint
 5. lubrication
 6. shock absorption



1. Ball and socket 2. Condyloid (ellipsoid) 3. Saddle 4. Hinge 5. Pivot

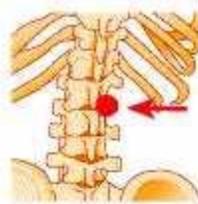
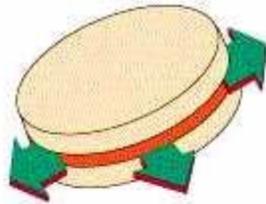
Synovial joints can be further grouped by their shape, which controls the movement they allow.

1. **Ball and socket joints**, such as the shoulder and hip joints. These allow a wide range of movement.
2. **Condyloid joints** (or **ellipsoid**), such as the thumb. A condyloid joint is where two bones fit together with an odd shape (e.g. an ellipse), and one bone is concave, the other convex. Some classifications make a distinction between condyloid and ellipsoid joints.
3. **Saddle joints**, such as at the thumb (between the metacarpal and carpal). Saddle joints, which resemble a saddle, permit the same movements as the condyloid joints.
4. **Hinge joints**, such as the elbow (between the humerus and the ulna). These joints act like a door hinge, allowing flexion and extension in just one plane.
5. **Pivot joints**, such as the elbow (between the radius and the ulna). This is where one bone rotates about another.
6. **Gliding joints**, such as in the carpals of the wrist. These joints allow a wide variety of movement, but not much distance.
7. **Plane joints**, such as the synovial joint between the ribs and vertebrae at the intraarticular ligament.

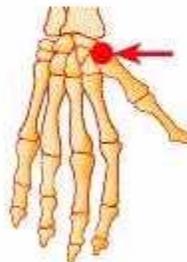
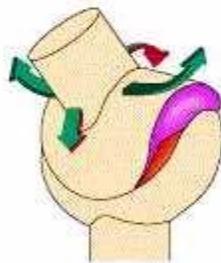
- **Tendons** (muscle to bone) and **Ligaments** (bone to bone)
- Types include
 - **gliding** (plane; arthrodiar) - allows non-axial gliding only (intermetatarsal, intercarpal, facet joints of vertebrae)
 - **hinge** (ginglymus) - convex vs. concave (humeroulnar, interphalangeal)
 - **pivot** (screw; trochoid) - allows rotation around one axis (proximal and distal radioulnar, atlanto-axial [between first and second cervical vertebrae])

- **condyloid** (ovoid; ellipsoidal) - modified ball-and-socket (not as deep)
(radiocarpal, 2-5 metacarpophalangeal)
- **saddle** (sellar) - shape of riding saddle (carpometacarpal of thumb)
- **ball and socket** (spheroidal) - reciprocally convex and concave (hip and shoulder)

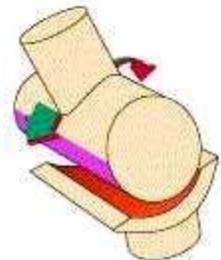
(a) Plane



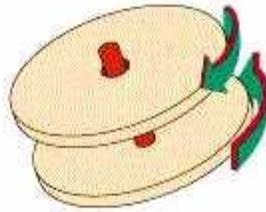
(b) Saddle



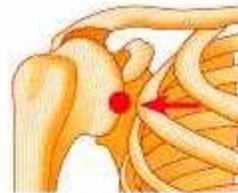
(c) Hinge



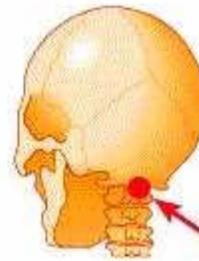
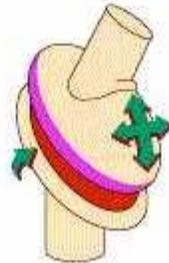
(d) Pivot



(e) Ball-and-Socket



(f) Elipsoid



- **Major joints in Human Body**
 - *shoulder* (glenohumeral) - articulation of glenoid fossa and humerus (ball-and-socket)
 - *elbow* (humeroulnar) - articulation of humerus and ulna (hinge)
 - *wrist* (radiocarpal) - articulation of radius and carpals (condyloid)
 - *hip* (acetabularfemoral) - articulation of acetabulum and femoral head (ball-and-socket)
 - *knee* (tibiofemoral) - articulation of femur and tibia (hinge)
 - *ankle* (talocrural) - articulation of tibia and fibula with talus (hinge)
 - *spine* (intervertebral) - intervertebral disc (symphysis - amphiarthrosis)
 - *forearm* (proximal and distal radioulnar) - articulation of heads of radius and ulna (pivot)
 - *neck* (atlanto-occipital and atlanto-axial)
 - atlanto-occipital - articulation of atlas (C1) and occipital bone (skull) = condyloid joint
 - atlanto-axial - articulation of atlas (C1) and axis (C2) = pivot joint

Functional Aspects of the Joint

- **Joint Stability** - ability to resist abnormal displacement of articulating bones
 - prevents injuries to surrounding ligaments, muscles, and tendons
 - high stability is desired

Factors affecting joint stability:

- Joint structure

- reciprocally shaped = tend to fit tightly together
 - Contact area
 - wide contact area = high stability (shoulder vs. hip)
 - different among joints and among individuals
 - change in joint angle --> change in contact area --> change in stability
 - maximal area of contact at the **close-packed position**
 - Connective tissues
 - weak and lax connective tissues = low stability
 - strengthening of tissues --> increase in stability
 - muscle activity and fatigue --> decrease in stability
 - Example: iliotibial tract of fascia latae crosses lateral aspect of knee and contributes to knee stability
- **Joint Flexibility** - range of motion (ROM) allowed at a joint
 - ROM - the angle through which a joint moves from anatomical position to the extreme limit of segment motion
 - is joint specific

Factors affecting joint flexibility:

- shapes of articulating bone surfaces
- intervening muscle or fatty tissue
- laxity
- extensibility of the collagenous tissue and muscles
- fluid contents in cartilagenous disc
- temperature of collagenous tissues (warm-up?)
- stretching program

Flexibility vs. injury

- sources of injury
 - extremely low flexibility = high chance of tear or rupture
 - extremely high flexibility = low stability
 - imbalance between dominant and non-dominant sides
- injury prevention - high strength and flexibility desired
- stretching program
 - Golgi Tendon Organs (GTO's) - sensory receptors that sense tension
 - when activated cause antagonist to contract and muscle being stretched to relax
 - Muscle Spindles - sensory receptors that monitor changes in length of muscle
 - when activated cause contraction of muscle being stretched and inhibit tension development in antagonist
 - Goal of stretching program is to maximize GTO effect and minimize muscle spindle effect
 - regular stretching --> flexibility increases

- active (produced by active tension in antagonist muscle) vs. passive (produced by force other than muscles)
- ballistic vs. static vs. proprioceptive neuromuscular facilitation (PNF) stretching

Common joint Injuries and Pathologies

- **Sprains** - stretching or tearing of connective tissue around a joint
- **Dislocations** - displacement of articulating bones
- **Bursitis** - inflammation of bursa sacs
- **Arthritis** -inflammation of joint with pain and swelling
 - rheumatoid - most debilitating and painful (immune system attacks healthy tissues)
 - osteoarthritis - cartilage becomes rough and wears away

1. A **joint** or **articulation** or **arthrosis** is a point of contact between neighboring bones, between cartilage and bones, or between teeth and bones.
2. **Arthrology** is the study of joints; **kinesiology** is the study of motion of the body.
3. Structural characteristics of a specific joint affect the strength, magnitude of movement, and types of movement that may occur at a specific joint.

B. Classification of Joints

1. Based on the presence or absence of a joint (synovial) cavity and the type of connective tissue that binds the bones together, the structural classification of joints categorizes joints into three major families:
 - i. **fibrous joints**
 - ii. **cartilaginous joints**
 - iii. **synovial joints**
2. Based on the magnitude of movement permitted, the functional classification of joints categorizes joints into three major groups:
 - i. **synarthrosis** is an immovable joint
 - ii. **amphiarthrosis** is a slightly movable joint
 - iii. **diarthrosis** is a freely movable joint

C. Fibrous Joints

1. Fibrous joints lack a synovial cavity, and the articulating bones are held very closely together by fibrous connective tissue; they permit little or no movement.
2. There are three types of fibrous joints:
 - i. **Suture**
 - a. consists of a thin layer of dense fibrous connective tissue that strongly connects the bones
 - b. located exclusively between (most) neighboring skull bones (e.g., coronal suture)
 - c. functionally classified as a synarthrosis
 - d. a **synostosis** is a childhood suture that is replaced by bone in the adult
 - ii. **Syndesmosis**
 - a. contains more fibrous connective tissue than in a suture
 - b. example is distal articulation between tibia and fibula
 - c. functionally is classified as an amphiarthrosis
 - iii. **Gomphosis**
 - a. joint in which a cone-shaped peg fits into a socket

- b. only example is root of tooth connected by periodontal ligament to alveolus of mandible or maxilla
- c. functionally is classified as a synarthrosis

D. Cartilaginous Joints

1. Cartilaginous joints lack a synovial cavity, and the articulating bones are tightly connected by cartilage; they permit little or no movement.
2. There are two types of cartilaginous joints:
 - i. **Synchondrosis**
 - a. the connecting tissue is hyaline cartilage
 - b. an example is an epiphyseal plate
 - c. functionally is classified as a synarthrosis
 - ii. **Symphysis**
 - a. the connecting tissue is a disc of fibrocartilage
 - b. an example is the pubic symphysis
 - c. functionally is classified as an amphiarthrosis

E. Synovial Joints

1. Synovial joints are characterized by the presence of a **synovial (joint) cavity**; they are functionally classified as diarthroses.
2. Additional important characteristics include:
 - i. **articular cartilage**
 - ii. **articular capsule** composed of two layers:
 - a. outer **fibrous capsule** that may have **ligaments**
 - b. inner **synovial membrane** which secretes lubricating **synovial fluid** that fills the synovial cavity
 - iii. many synovial joints also contain:
 - a. **accessory ligaments**, including **extracapsular ligaments** and **intracapsular ligaments**
 - b. **articular discs** or **menisci**
 - iv. rich blood and nerve supply
3. Fluid-filled sacs called **bursae** as well as tubelike bursae called **tendon sheaths** reduce friction at some joints during movements.
4. Types of synovial joints include:
 - i. **planar joint** at which gliding movements may occur
 - a. articulating surfaces are usually flat or slightly curved
 - b. only side-to-side and back-and-forth movements are permitted without movement around any axis; it is a **nonaxial** joint
 - c. example is joint between clavicle and sternum
 - ii. **hinge joint**
 - a. **monaxial** or **uniaxial** joint at which convex surface of one bone fits into concave surface of another bone
 - b. flexion and extension (and sometimes hyperextension) may occur
 - c. examples include knee joint, elbow joint, and ankle joint
 - iii. **pivot joint**
 - a. monaxial joint at which rounded or pointed surface of one bone articulates within a ring formed partly by another bone and partly by a ligament
 - b. rotation may occur

- c. example is rotation of atlas around dens of axis when turning the head
- iv. **condyloid or ellipsoidal joint**
 - a. **biaxial** joint at which an oval-shaped condyle of one bone rests against an elliptical cavity of another bone
 - b. the four angular movements (and circumduction) may occur
 - c. example is the wrist joint
- v. **saddle joint**
 - a. biaxial joint at which articular surface of one bone is saddle-shaped and the articular surface of the other bone resembles the legs of a rider sitting in a saddle
 - b. is technically a modified ellipsoidal joint in which movement is somewhat freer
 - c. example is joint between trapezium and base of the first metacarpal
- vi. **ball-and-socket joint**
 - a. **multiaxial** (or polyaxial) joint at which ball-like surface of one bone rests against cuplike depression of another bone
 - b. the four angular movements and rotation may occur
 - c. the only examples are the shoulder and hip joints

F. Types of Movements at Synovial Joints

1. The general kinds of motion that occur at synovial joints include:
 - i. gliding motion in which articulating surfaces slide across each other
 - ii. angular movements in which there is a change in the angle between articulating bones
 - iii. rotation movement in which a bone turns around its own longitudinal axis
 - iv. special movements which occur only at certain joints
2. Specific types of movements that may occur at synovial joints include
 - i. **gliding** movements occur at **planar joints**
 - a. one surface moves back-and-forth and from side-to-side over another surface without changing the angle between the bones
 - b. examples include joints between neighboring carpals
 - ii. **angular movements** change the angle between bones; there are several types including:
 - a. **flexion** decreases the angle (e.g., bending the elbow joint)
 - **lateral flexion** is bending of the spine in the frontal plane
 - b. **extension** increases the angle (e.g., straightening the knee joint);
 - **hyperextension** is extension beyond the anatomical position (e.g., bending the head posteriorly)
 - c. **abduction** is movement of a bone away from the midline of the body (e.g., moving the humerus laterally)
 - for fingers a line drawn through the middle finger is used, and for toes a line drawn through the second toe is used, as the line of reference
 - d. **adduction** is movement of a bone toward the midline of the body (e.g., returning the humerus to the anatomical position after previous abduction)
 - for fingers and toes, the lines of reference described above are used
 - e. **circumduction** is a movement in which the distal end of a bone moves in a circle while the proximal end remains stable (e.g., winding up to

pitch a ball); it is typically a combination of the four angular movements and rotation

- iii. **rotation** is movement of a bone around its own longitudinal axis; there are two types:
 - a. **medial** (or **internal**) **rotation**
 - b. **lateral** (or **external**) **rotation**
- iv. **special movements** occur only at certain joints:
 - a. **elevation** and **depression** are, respectively, an upward movement of a part of the body (e.g., elevating the mandible to close the mouth), and a downward movement of a part of the body (e.g., depressing the mandible to open the mouth)
 - b. **protraction** and **retraction** are movements of the mandible or shoulder girdle forward or backward, respectively, on a plane parallel to the ground
 - c. **inversion** and **eversion** are movements of the sole of the foot medially or laterally, respectively
 - d. **dorsiflexion** and **plantar flexion** are bending of the ankle joint so that the foot moves in a dorsal or plantar (sole) direction, respectively
 - e. **supination** and **pronation** are movements of the forearm in which the palm turns anteriorly/superiorly or posteriorly/inferiorly, respectively
 - f. **opposition** is movement of a thumb across the palm to touch the fingertips on the same hand.

G. Selected Joints of the Body

- 1. Selected joints are characterized by the following:
 - i. definition, i.e., description of the type of joint and the bones that form the joint
 - ii. anatomical components
 - iii. movements that may occur
- 2. The selected joints that are described in detail include:
 - i. **temporomandibular joint (TMJ)**
 - ii. **shoulder (humeroscapular or glenohumeral) joint**
 - iii. **elbow joint**
 - iv. **hip (coxal) joint**
 - v. **knee (tibiofemoral) joint**
 - vi. **ankle (talocrural) joint**
- 3. The important characteristics of other major joints are also described

H. Factors Affecting Contact and Range of Motion at Synovial Joints

- 1. Factors which contribute to keeping the articular surfaces in contact and, therefore, determine the type and range of motion (ROM) possible, include:
 - i. structure or shape of the articulating bones
 - ii. strength and tension (tautness) of the joint ligaments
 - iii. arrangement and tension of muscles around the joint
 - iv. apposition of neighboring soft parts
 - v. effect of hormones (e.g., relaxin relaxes pelvic joints toward the end of pregnancy)
 - vi. disuse of a joint

I. Aging and Joints

1. The effects of aging on joints are variable among individuals and are affected by genetic factors and wear and tear; the aging process usually results in:
 - i. decreased production of synovial fluid
 - ii. thinning of articular cartilage
 - iii. shortening of ligaments and a decrease in their flexibility
 - iv. degenerative changes in the knees, elbows, hips and shoulders

J. Arthroplasty

1. Severely damaged joints may be replaced surgically with artificial joints in a procedure called **arthroplasty**.
2. The most commonly replaced joints are the hips, knees, and shoulders.

K. Key Medical Terms Associated with Joints

1. Students should familiarize themselves with the glossary of key medical terms.

Key Terms:

active stretching	the stretching of muscles, tendons, and ligaments produced by active development of tension in the antagonist muscles
articular capsule	double layered membrane that surrounds every synovial joint
articular cartilage	protective layer of dense white connective tissue covering the articulating bone surfaces at diarthrodial joints
articular fibrocartilage	soft tissue discs or menisci that intervene between articulating bones
ballistic stretching	a series of quick, bouncing-type stretches
close-packed position	joint orientation for which the contact between the articulating bone surfaces is maximum
Golgi tendon organ	sensory receptor that inhibits tension development in a muscle
joint flexibility	a term indicating the relative ranges of motion allowed at a joint
joint stability	the ability of a joint to resist abnormal displacement of the articulating bones
loose-packed position	any joint orientation other than the close-packed position
muscle spindle	sensory receptor that provokes reflex contraction in a stretched muscle and inhibits tension development in antagonist muscles
passive stretching	the stretching of muscles, tendons, and ligaments produced by a stretching force other than tension in the antagonist muscles
proprioceptive neuromuscular facilitation	a group of stretching procedures involving alternating contraction and relaxation of the muscles being stretched
range of motion	the angle through which a joint moves from anatomical position to the extreme limit of segment motion in a particular direction
reciprocal inhibition	the inhibition of the antagonist muscles resulting from activation of muscle spindles
static stretching	maintaining a slow, controlled, sustained stretch over time, usually about 30 seconds
stretch reflex	a monosynaptic reflex initiated by stretching of muscle spindles and

	resulting in immediate development of muscle tension
synovial fluid	clear, slightly yellow liquid that provides lubrication inside the articular capsule at synovial joints