Basics of Joint Design and Function

Joint Overview

Joint (articulation): connects parts of a structure.

Design depends on function.

Function depends on design.

Effective body function depends on integrated action of many joints.

Stability before mobility

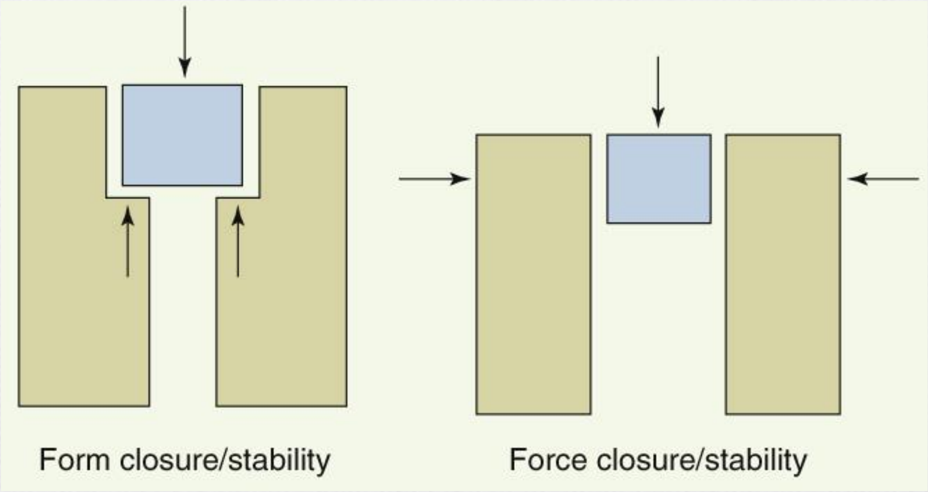
Joints range from simple to complex.

A simple joint might be the sutures that connect the bones of the skull; joints such as the hip and shoulder are more complex.

Force and Force Stability

Form closure/stability – dependent on shape of bones of joint and fit

Force closure/stability – action of muscle contraction to stabilize joint



Excessive form stability results in a stuck or fixed joint.

Excessive force stability can result in excess form stability by jamming the joint surfaces.

Decreased form stability results in increased muscle contraction to produce force stability.

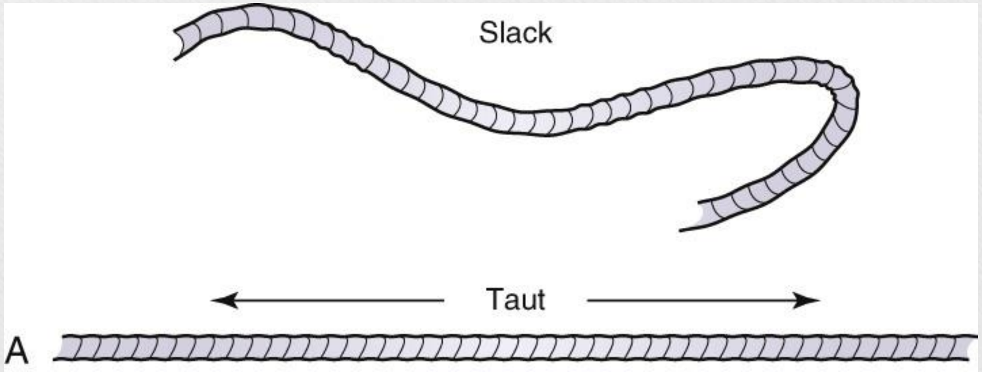
Decreased force stability results in strain on the joint capsule.

Connective Tissue and Joint Structure

Collagen (white fibrous tissue)

- Tensile strength similar to steel
- Nonelastic, but limited mobility
- Piezoelectric properties
- Think "rope."

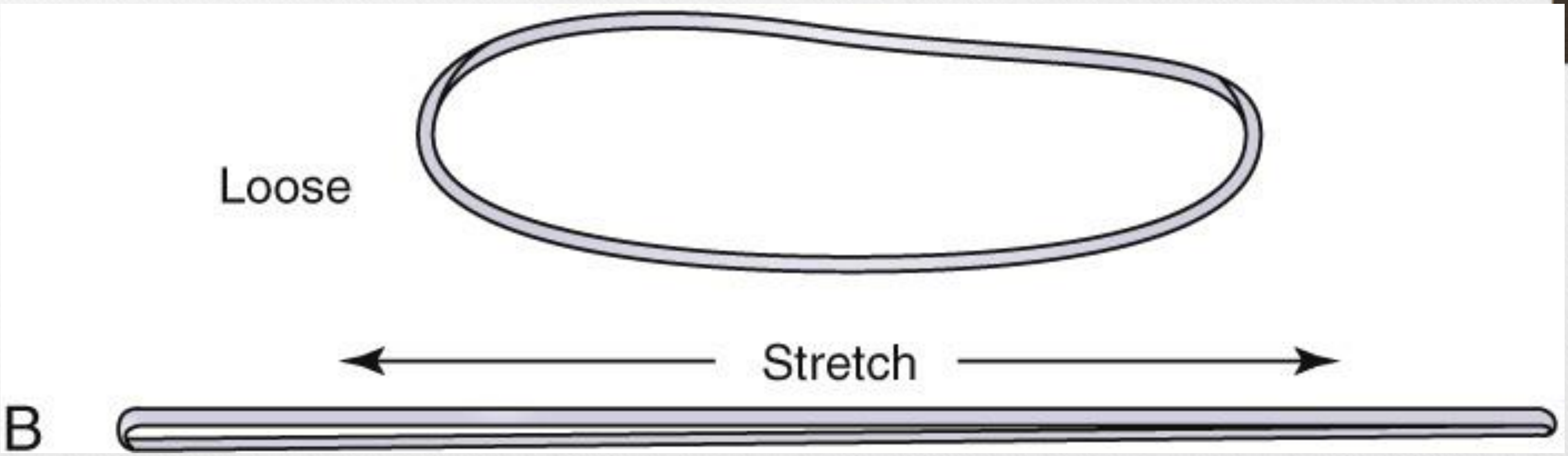
When collagen is deformed, it produces a small electric current. Collagen oscillates or vibrates if an electric current travels through it. These are piezoelectric properties



Elastin (yellow fibrous tissue)

Elastic properties

Think “rubber band.”



Connective Tissue and Joint Structure

Joint capsule

- Seals joint space
- Provides passive stability

Ligaments

- 70%-80% collagen
- Avascular

The extracellular fibers of ligaments are arranged in the same direction, forming a regular arrangement.

Tendons

- Connect bone to muscle
- Help stabilize joints, but can limit ROM

Bursae

- Flat sacs of synovial membrane
- Located where moving structures rub against each other

In addition to the usual connective tissue components associated with tendons, loose areolar connective tissue forms complete or partial sheaths around them.

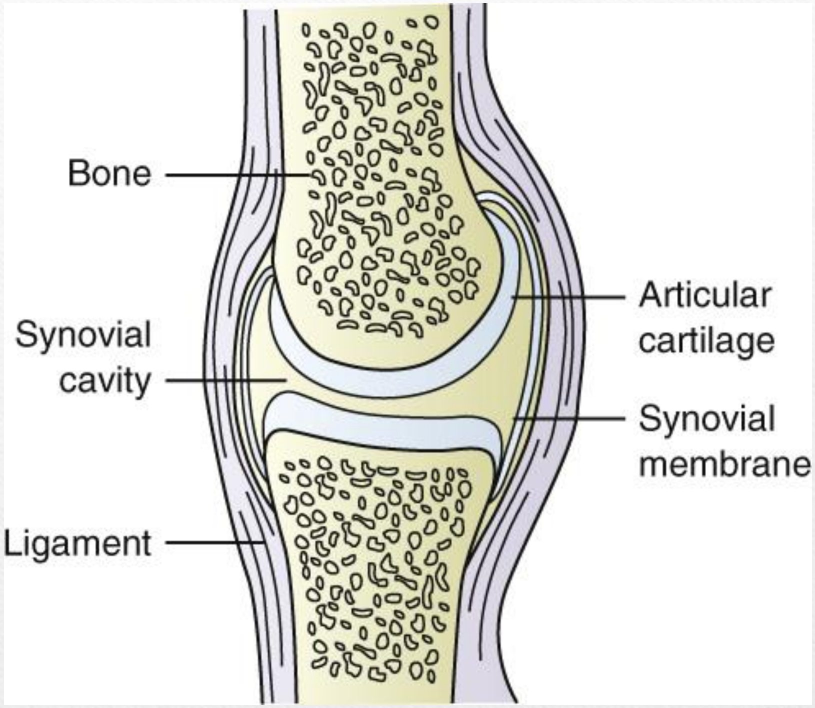
The sheath protects the tendon and produces synovial fluid, which helps reduce friction.

Cartilage

Fibrocartilage

Yellow elastic cartilage

Hyaline cartilage



White fibrocartilage forms the cement in joints that permit little motion.

Yellow elastic cartilage is more elastic than white fibrocartilage and can be found in the ears and epiglottis.

Hyaline cartilage forms a thin covering on the ends of bones, reducing friction between them.

Bone

Hardest of all connective tissues

Consists of cellular component and fibrous component

Viscoelasticity of Connective Tissue

All connective tissue is viscoelastic.

Elasticity

- Ability of a material to return to its original state after deformation (pulling)

Viscosity

- Resistance to a change of form offered by a fluid

When a constant compressive or tensile force deforms connective tissue, the tissue moves in the direction of the force and then attempts to return to its original state.

Under normal conditions viscoelastic materials initially modify in the direction of the force applied and then slowly return to their original state; this is called creep.

If a connective tissue structure is held in a deformed position for an extended period, over days or weeks, the viscous creep pattern may become permanent, thus altering the structure and therefore the function of a joint.

Deformation

Tendons > ligaments > cartilage > bone

Plastic range

Connective tissue exceeds its elastic limits.

Laxity

Connective tissue is too long (prolonged stretching or trauma).

Shortening

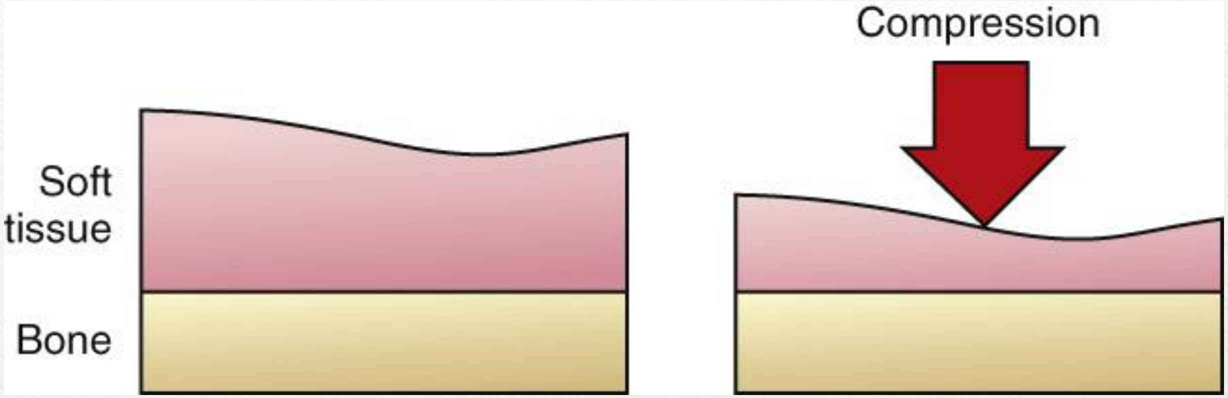
Connective tissue shortens and dehydrates.

Tendons can deform more than ligaments, ligaments can deform more than cartilage, and cartilage can deform more than bone.

The use of certain types of frictioning techniques on individual connective tissue structures can create a therapeutic inflammation process. Inflammation triggers the formation of connective tissue, and combined with moderate immobilization and appropriate rehabilitative exercise it creates a broadening of the muscles or connective tissue structures of the area.

Mechanical Forces: Compression

Compression forces occur when two structures are pressed together.



Compression is a common way that tissues become injured. While tendons and ligaments resist compressive force injury, muscles do not and may rupture or tear.

Compression is a major mechanical force used in the application of massage to support circulation, stimulate nerve function, and restore connective tissue pliability.

Mechanical Forces: Tension

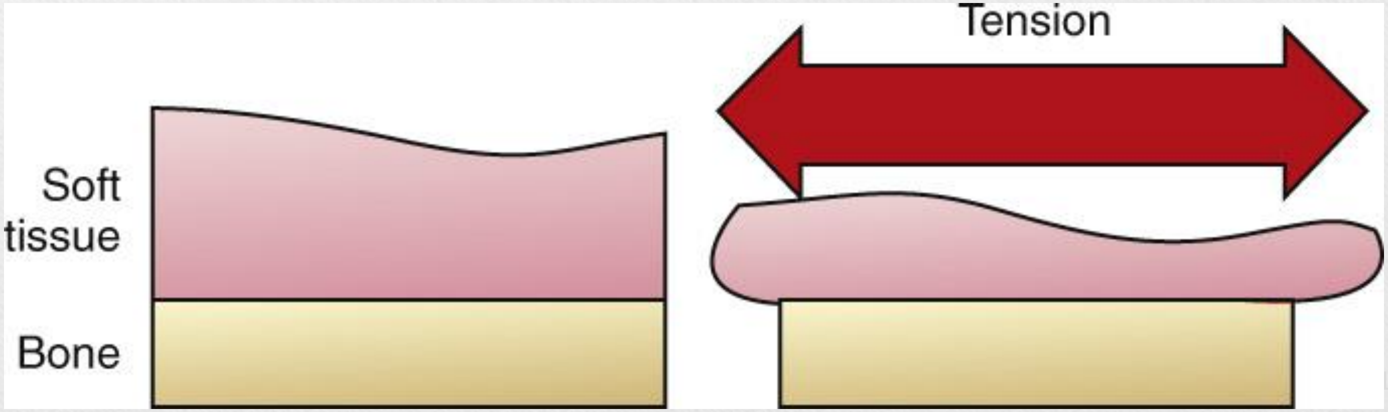
Tension forces occur when two ends of a structure are pulled away from each other.

Tensile stress injuries:

First degree (mild)

Second degree (moderate)

Third degree (severe)

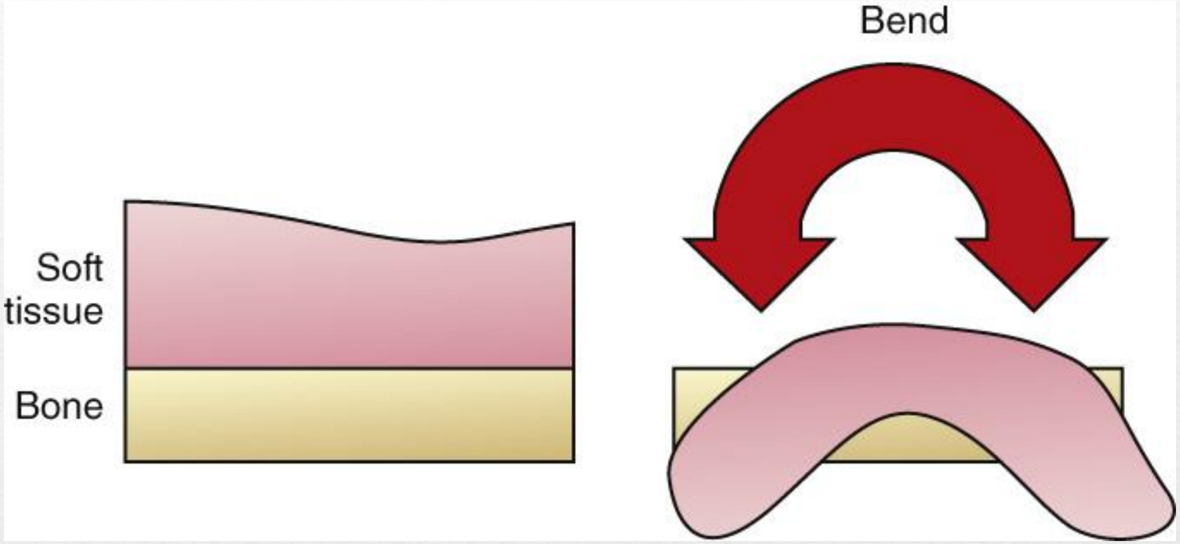


Tensile stress injuries are the most common way soft tissues are damaged. Examples of tensile stress injuries include avulsion (complete tearing of attachment), muscle strains, ligament sprains, tendinitis, fascial pulling or tearing, and nerve traction injuries.

Tensile force is applied during massage, particularly during gliding and traction. Therapeutically, tensile force supports proper alignment of fiber structures and can increase pliability in connective tissue.

Mechanical Forces: Bending

Bending forces are a combination of compression and tension.

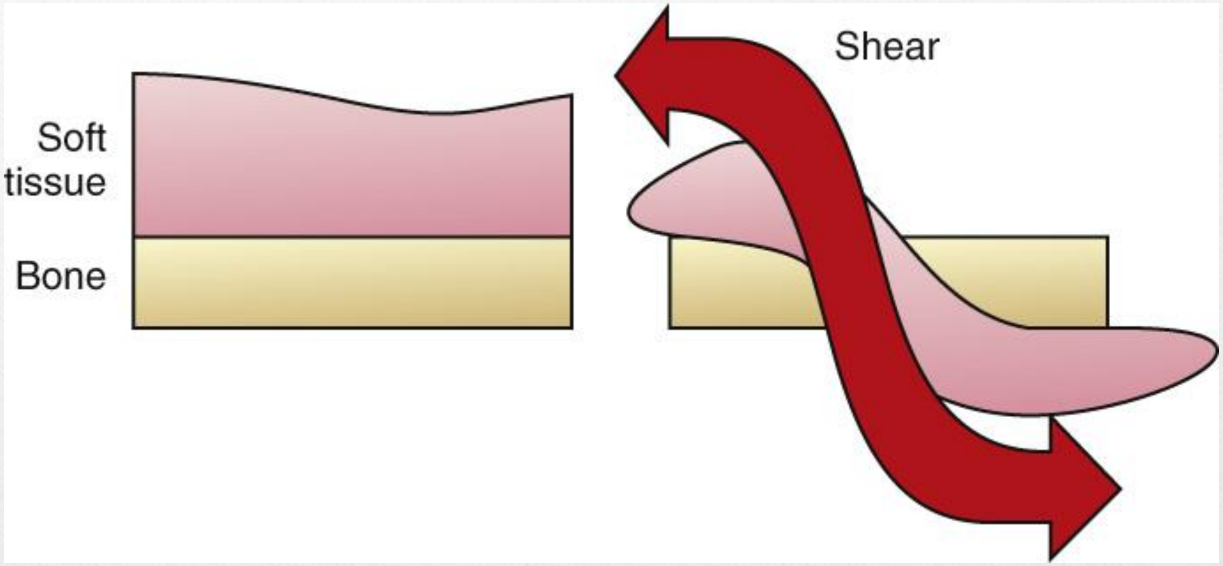


Bending forces are a common cause of bone fractures and ligament injuries but seldom harm other soft tissues.

Bending is used during massage when kneading methods are applied.

Mechanical Forces: Shear

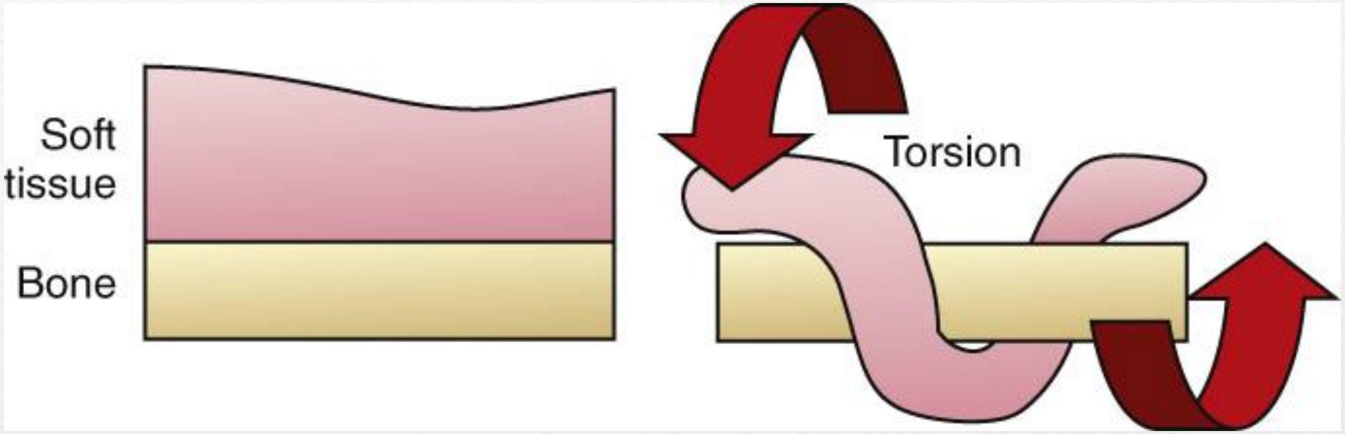
Shear is a sliding mechanical force with friction created between structures that are sliding against each other.



Cross fiber friction uses specific force to create therapeutic inflammation to reverse fibrotic connective tissue changes

Mechanical Forces: Torsion

Torsion forces are twisting forces that occur with other forces.



Torsion stress applied to a joint is likely to cause significant injury.

Kneading massage methods introduce torsion force into tissue and are especially effective in increasing pliability of connective tissue.

Joint Categories

Synarthrosis

Nonsynovial, fibrous, limited-movement joint

Amphiarthrosis

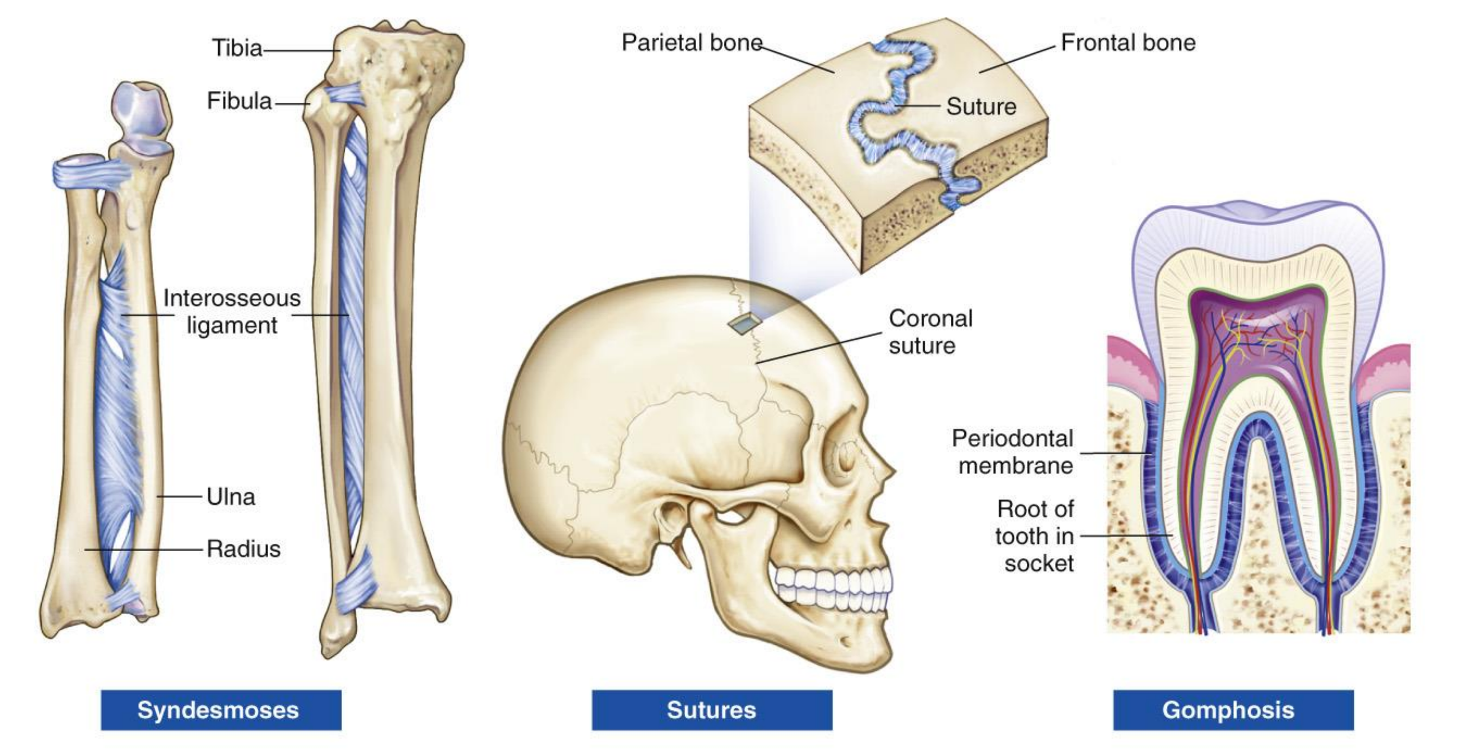
Nonsynovial cartilaginous joint that is slightly movable

Diarthrosis

Synovial, freely movable joint

The joints of the human body are divided into three categories according to the type of motion allowed at the joint and the material connecting the joint.

Synarthroses (Fibrous Joints)

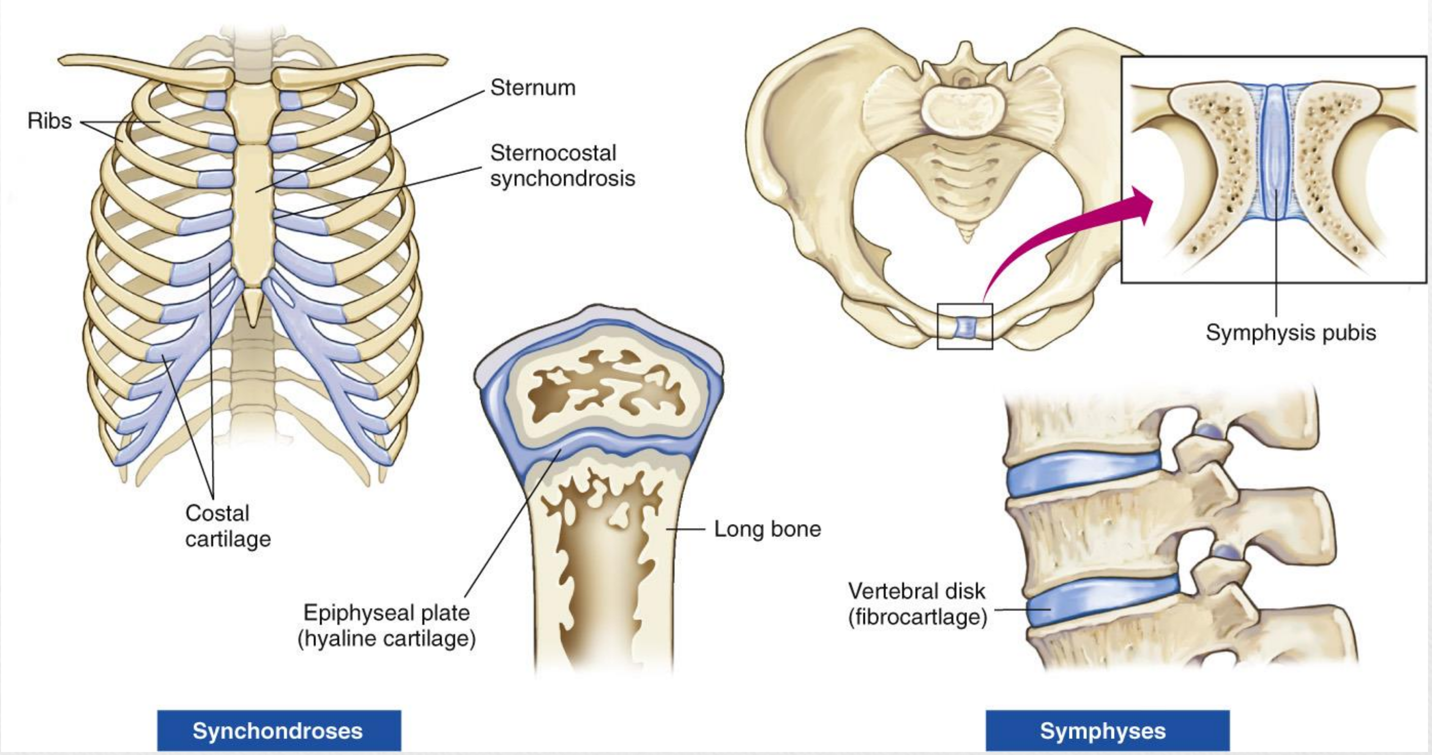


The fibrous tissue in these types of joints connects bone directly to bone.

This previous figure depicts the three different types of fibrous joints found in the body.

Joints connect parts of a structure. A suture connects two articulating bones that are held together by a thin layer of dense fibrous material. This type of joint is found only in the skull.)

Amphioarthroses (Cartilaginous Joints)



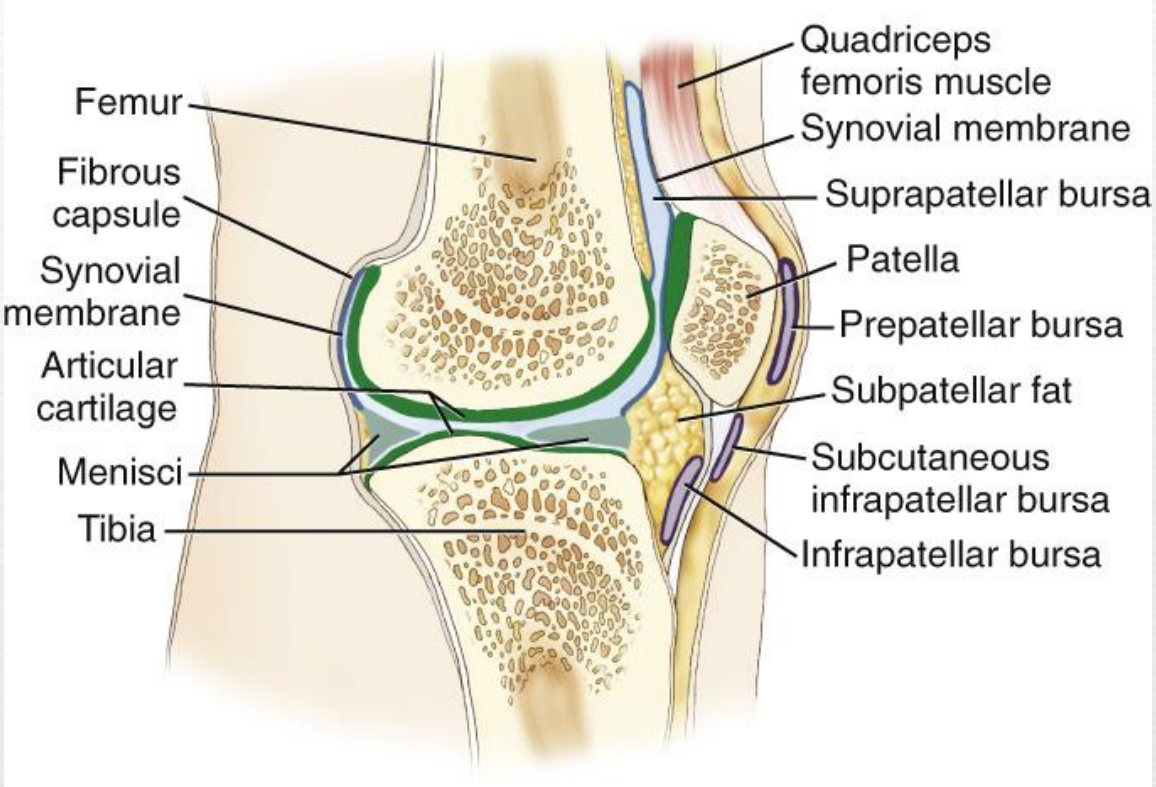
The two types of cartilaginous joints are shown here.

What distinguishes amphioarthroses from synarthroses?

Amphioarthroses permit limited movement.

The structure of the symphysis pubis allows for good stability. The thick fibrocartilage provides a stable union between the two bones.

Diarthroses (Synovial Joints)



Synovial joints share the following features:

A joint capsule formed of fibrous tissue surrounds the joint.

A joint capsule encloses a joint cavity.

Synovial fluid forms a lubricating film over joint surfaces.

A synovial membrane lines the inner surface of the capsule.

Hyaline cartilage covers the joint surfaces.

The Principles of Joint Motion

Categories of Joint Movement

Arthrokinematic movement

- Small, involuntary movements that occur inside the joint capsule at the joint surfaces

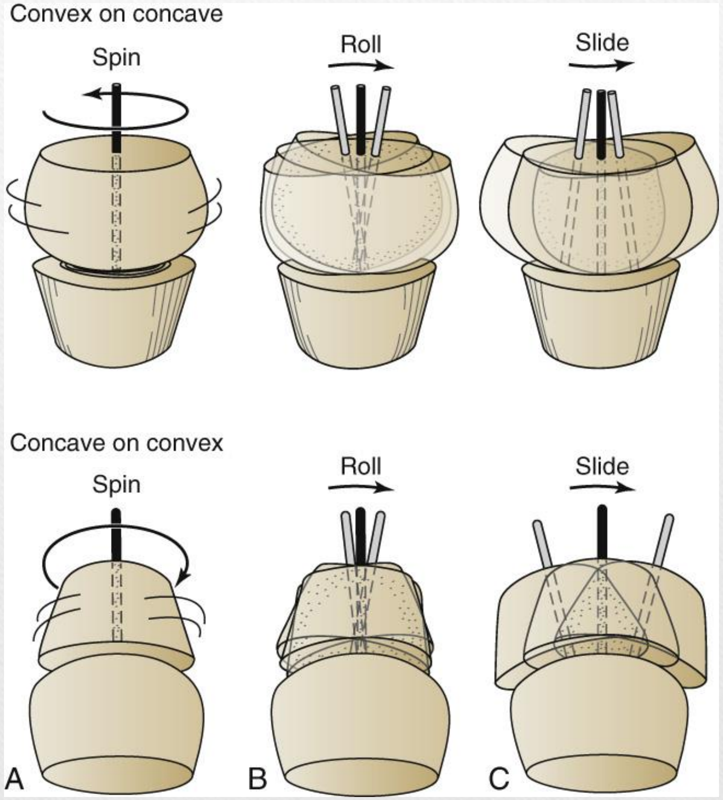
Osterokinematic movement

- Actual direction the bones move
- Includes extension, flexion, adduction, abduction, and internal and external rotation

Arthrokinematics

Accessory movements of the articulating surfaces of the bones at joint surfaces

Roll, spin, and slide are the three words that describe the type of motion performed by the moving part. They are illustrated here under A (spin), B (roll), and C (slide).



Joint Play

Involuntary movements

Nothing to do with range of motion produced by muscles

Rolling and sliding movements, usually not visible

Too much play, unstable joints

Too little play, restricted motion

The amount of joint play in most people is almost always approximately 1/8 inch

Osteokinematics

Range of motion (ROM): amount of movement available through which a joint can be moved

- Anatomic ROM – amount of motion available to joint within structural limits
- Physiologic ROM – active ROM; usually less than anatomic ROM to prevent injury
- Pathologic ROM – normal physiologic range is not reached or is exceeded

Osteokinematics refers to the movement of bones by the action of the muscles

Pathologic ROM

Hypomobility: ROM falls short of what would be permitted structurally.

Hypermobility: ROM exceeds normal, safe limits.

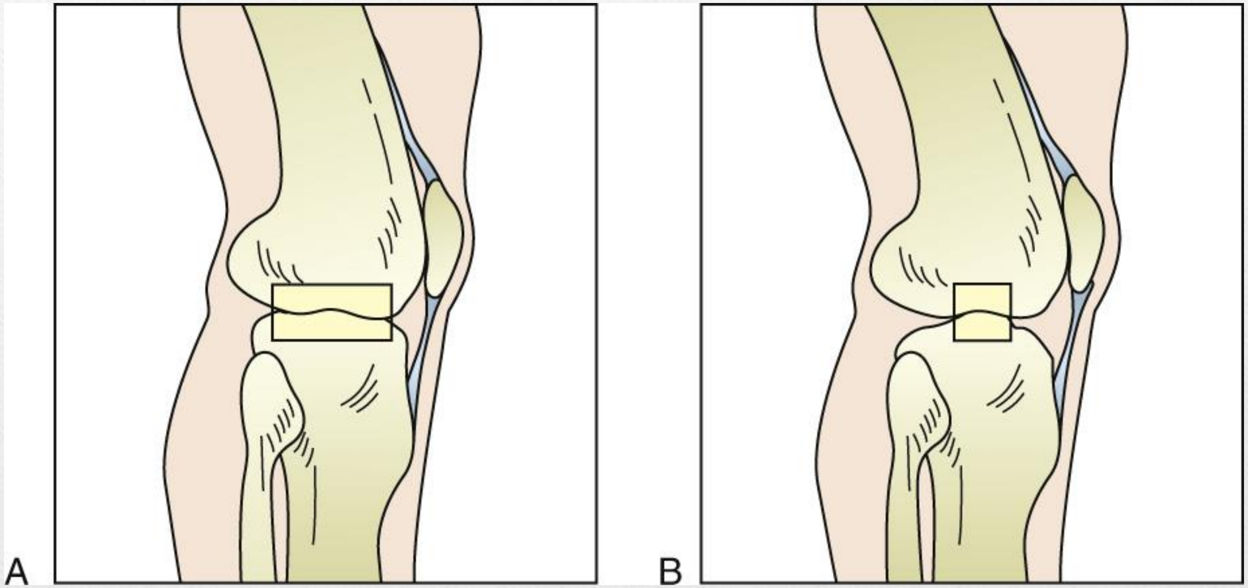
End feel: soft, hard, or capsular

Arthrokinematics refers to the movement of the articular surfaces

Joint Positions and Stability

Close-packed

Loose-packed



The close-packed position allows no movement. Fully extended knees and elbows are in the close-packed position.

When not in the close-packed position, a joint is in the loose-packed position, or unlocked, where the amount of contact is reduced and movements of spin, roll, and glide may occur.

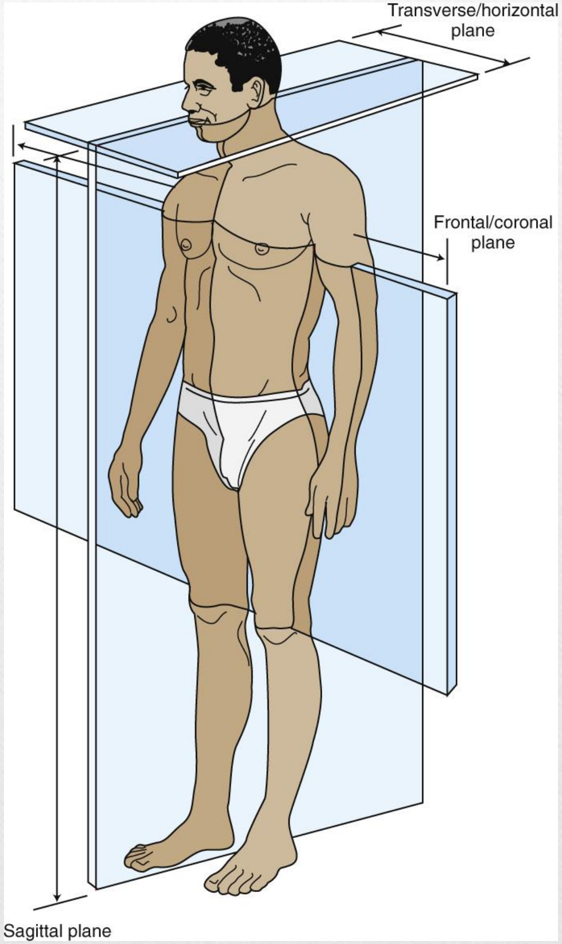
Each joint also has a least-packed position in which the capsule is at its most lax.

Movements of Joints

Named for plane in which the movements occur

What are the three planes?

Frontal/coronal, transverse/horizontal, and median/sagittal.



Frontal/coronal plane – divides body into front and back parts

Abduction and adduction

Sagittal plane – divides body into right and left sides

Flexion and extension

Horizontal/transverse plane – divides body into upper and lower parts; like a view from above

Medial rotation, pronation, supination

Sagittal, frontal, and transverse planes may be laid through any point of the body

General Joint Movements

Flexion

Extension

Abduction

Adduction

Diagonal abduction

Diagonal adduction

Horizontal abduction

Horizontal adduction

Circumduction

Rotation

Medial rotation

Lateral rotation

Joint design permits many different types of movement.

Flexion is a bending movement that results in a decrease in the angle of a joint by bringing bones together.

Extension is a straightening movement that results in an increase in the angle of a joint by bringing bones apart.

Forerearm/Wrist/Thumb/Ankle/Foot

Pronation

Supination

Radial deviation

Ulnar deviation

Opposition of the thumb

Eversion

Inversion

Dorsiflexion

Plantar flexion

What is opposition of the thumb?

The diagonal movement of the thumb across the palmar surface of the hand to make contact with the fingers.

Learning these movements works well when students move body parts while saying the movement (It "labels" the movement for kinesthetic learners.).

Shoulder and Shoulder Girdle

Elevation

Depression

Protraction

Retraction

Downward rotation

Upward rotation

When you shrug your shoulders, your shoulder girdle is engaged in elevation.

An analogy is considering the shoulder (scapula) as a platform (moveable) with a crane attached. These movements are what "move" this "platform."

Spine/Pelvis/Synovial Joints

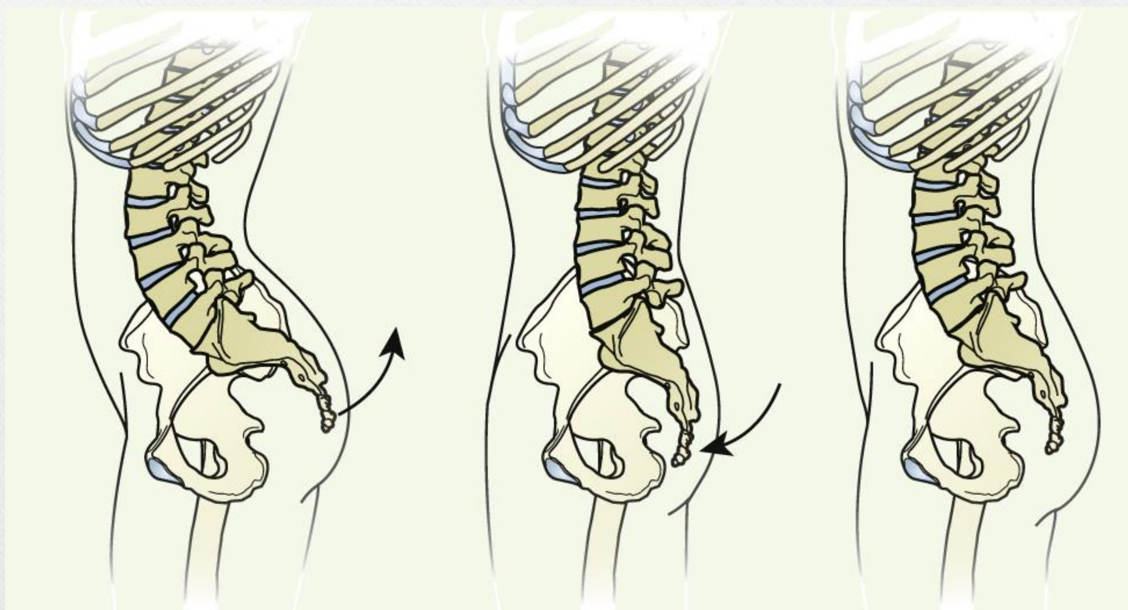
Lateral flexion

Nutation

Counternutation

Iliosacral motion

Sacroilial motion

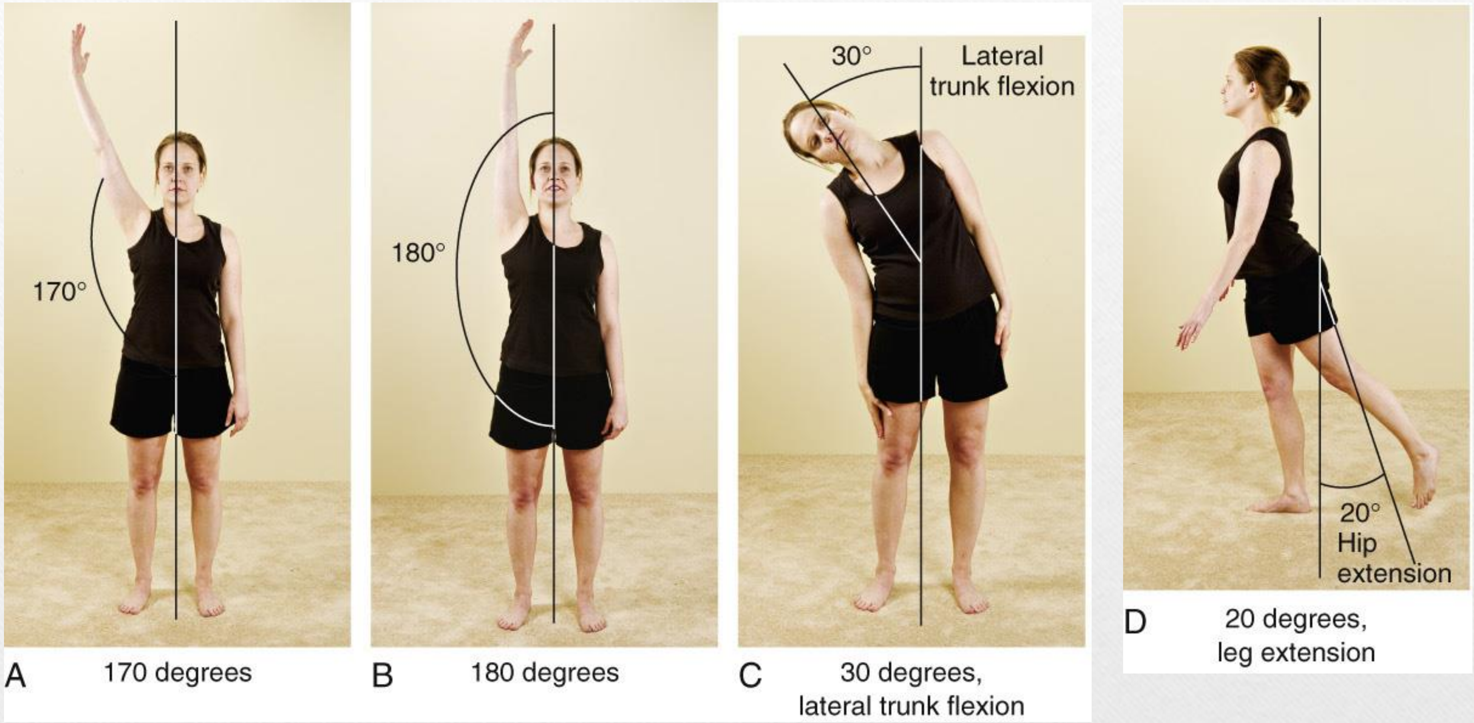


A, Counternutation **B**, Nutation **C**, Neutral position

Movements of the ilium include anterior/posterior rotation, superior/inferior movement, and medial/lateral flaring.

Movements of the sacrum include flexion/extension and rotation.

Measured in Degrees

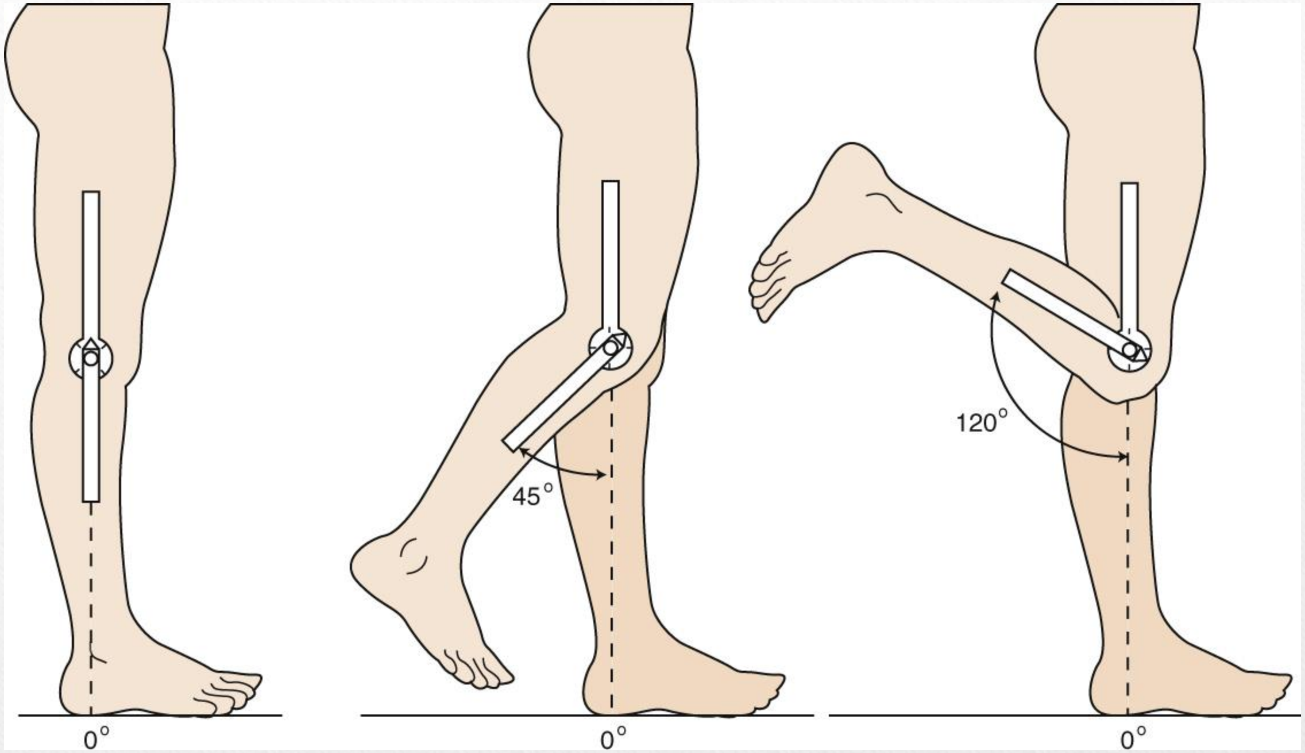


Joint movement is measured in degrees. Zero degrees refers to standard anatomic position.

A goniometer is used to measure the movement of joints.

E 30 degrees, hip adductor
F 90 degrees, hip flexion
G 10 degrees, dorsiflexion
H 40–45 degrees, internal hip rotation

The movement is the same as in the picture on the lower left: rotation, but the position has changed from supine to standing.



This image shows measurement of knee positions in the sagittal plane.

Classification of Synovial Joints by Movements

Uniaxial joints

Hinge

Pivo

Biaxial joints

Condyloid

Saddle

Triaxial joints

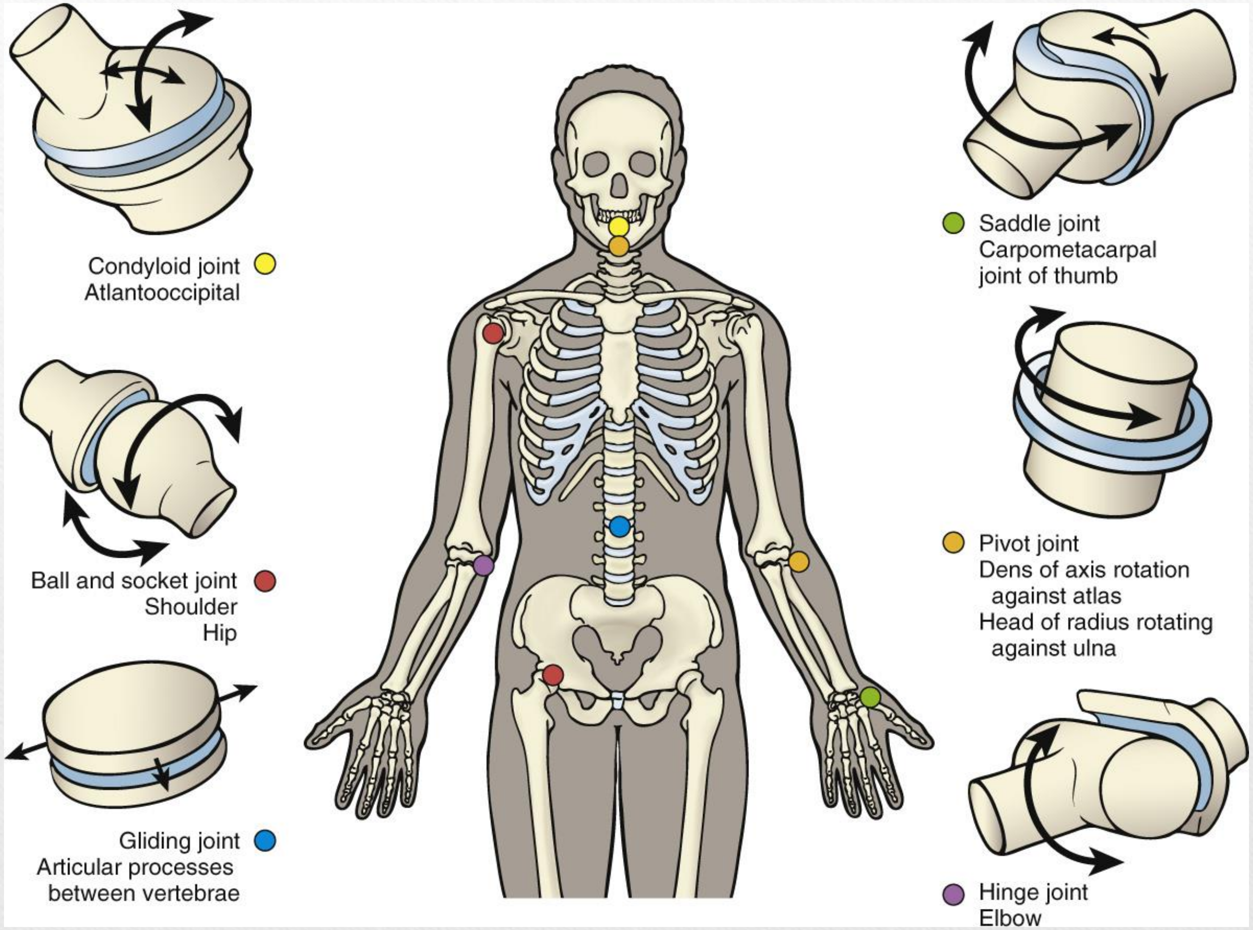
Ball-and-socket

Gliding

The elbow is a hinge joint.

The knee is a condyloid joint.)

Synovial Joint Types



The hip and shoulder are both ball-and-socket joints.

This type of joint allows the greatest freedom of movement but is also the easiest to dislocate.

Kinematic Chains

Describe the association between related joints.

Closed kinematic chain – motion at one joint is accompanied by motion at an adjacent joint.

Open kinematic chain – ends of limbs or body parts are free to move without causing motion in another joint.

Why is the concept of kinematic chains useful?

It aids in analyzing human motion and the effects of injury and disease on the joints.

To Test

Access Code: B3LN

Please write down case sensitive code. You will be asked for it. This course is 6 CE.

Once you have successfully passed the test (70% correct), please email us at cehotschool@gmail.com. We will email you your CE certificate within 7 business days.