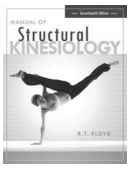


Chapter 1
Foundations of Structural Kinesiology

Manual of Structural Kinesiology

R.T. Floyd, EdD, ATC, CSCS

Kinesiology & Body Mechanics

- Kinesiology - study of motion or human movement
- Anatomic kinesiology - study of human musculoskeletal system & musculotendinous system
- Biomechanics - application of mechanical physics to human motion

Kinesiology & Body Mechanics

- Structural kinesiology - study of muscles as they are involved in science of movement
- Both skeletal & muscular structures are involved
- Bones are different sizes & shapes – particularly at the joints, which allow or limit movement

Kinesiology & Body Mechanics

- Muscles vary greatly in size, shape, & structure from one part of body to another
- More than 600 muscles are found in human body

Who needs Kinesiology?

- Anatomists, coaches, strength and conditioning specialists, personal trainers, nurses, physical educators, physical therapists, physicians, athletic trainers, massage therapists & others in health-related fields

Why Kinesiology?

- should have an adequate knowledge & understanding of all large muscle groups to teach others how to strengthen, improve, & maintain these parts of human body
- should not only know how & what to do in relation to conditioning & training but also know why specific exercises are done in conditioning & training of athletes

Why Kinesiology?

- Through kinesiology & analysis of skills, physical educators can understand & improve specific aspects of physical conditioning
- Understanding aspects of exercise physiology is also essential to coaches & physical educators

Reference positions

- basis from which to describe joint movements
  - *Anatomical position*
  - *Fundamental position*

Reference positions

- *Anatomical position*
  - most widely used & accurate for all aspects of the body
  - standing in an upright posture, facing straight ahead, feet parallel and close, & palms facing forward
- *Fundamental position*
  - is essentially same as anatomical position except arms are at the sides & palms facing the body

Reference Lines

To further assist in understanding the location of one body part in relation to another

- Mid-axillary line
  - A line running vertically down the surface of the body passing through the apex of the axilla (armpit)
- Anterior axillary line
  - A line that is parallel to the mid- axillary line and passes through the anterior axillary skinfold
- Posterior axillary line
  - A line that is parallel to the mid- axillary line and passes through the posterior axillary skinfold

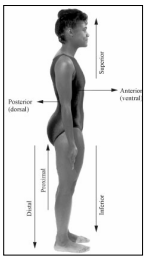
Reference Lines

To further assist in understanding the location of one body part in relation to another

- Mid-clavicular line
  - A line running vertically down the surface of the body passing through the midpoint of the clavicle
- Mid-inguinal point
  - A point midway between the anterior superior iliac spine and the pubic symphysis

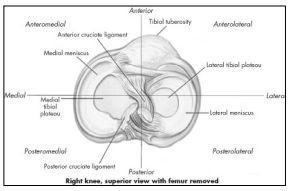
Anatomical directional terminology

- Anterior
  - in front or in the front part
- Anteroinferior
  - in front & below
- Anterosuperior
  - in front & above



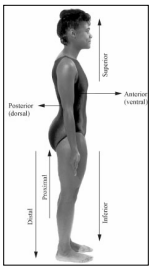
Anatomical directional terminology

- Anterolateral
  - in front & to the side, especially the outside
- Anteromedial
  - in front & toward the inner side or midline
- Anteroposterior
  - relating to both front & rear



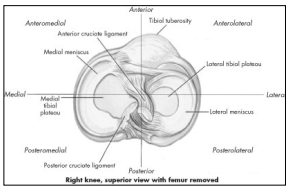
Anatomical directional terminology

- Posterior
  - behind, in back, or in the rear
- Posteroinferior
  - behind & below; in back & below
- Posterolateral
  - behind & to one side, specifically to the outside



Anatomical directional terminology

- Posteromedial
  - behind & to the inner side
- Posterosuperior
  - behind & at the upper part

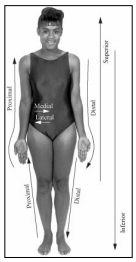


Anatomical directional terminology

- Contralateral
  - pertaining or relating to the opposite side
- Ipsilateral
  - on the same side
- Bilateral
  - relating to the right and left sides of the body or of a body structure such as the right & left extremities

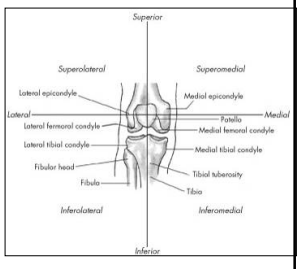
Anatomical directional terminology

- Inferior (infra)
  - below in relation to another structure; caudal
- Superior (supra)
  - above in relation to another structure; higher, cephalic



Anatomical directional terminology

- Inferolateral
  - below & to the outside
- Inferomedial
  - below & toward the midline or inside
- Superolateral
  - above & to the outside
- Superomedial
  - above & toward the midline or inside



Anatomical directional terminology

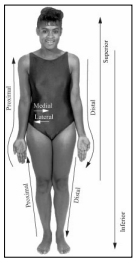
- Caudal
  - below in relation to another structure; inferior
- Cephalic
  - above in relation to another structure; higher, superior

Anatomical directional terminology

- Deep
  - beneath or below the surface; used to describe relative depth or location of muscles or tissue
- Superficial
  - near the surface; used to describe relative depth or location of muscles or tissue

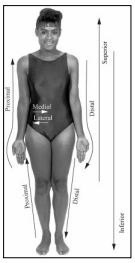
Anatomical directional terminology

- Distal
  - situated away from the center or midline of the body, or away from the point of origin
- Proximal
  - nearest the trunk or the point of origin



Anatomical directional terminology

- Lateral
  - on or to the side; outside, farther from the median or midsagittal plane
- Medial
  - relating to the middle or center; nearer to the medial or midsagittal plane
- Median
  - Relating to the middle or center; nearer to the median or midsagittal plane



Anatomical directional terminology

- Dexter
  - relating to, or situated to the right or on the right side of something
- Sinister
  - relating to, or situated to the left or on the left side of something

Anatomical directional terminology

- Prone
  - the body lying face downward; stomach lying
- Supine
  - lying on the back; face upward position of the body

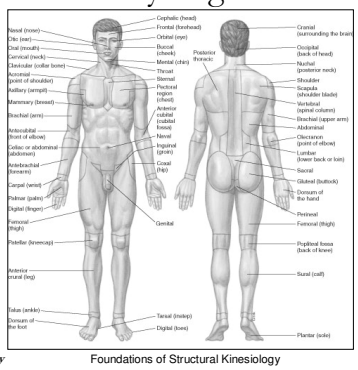
Anatomical directional terminology

- Dorsal
  - relating to the back; being or located near, on, or toward the back, posterior part, or upper surface of
- Ventral
  - relating to the belly or abdomen, on or toward the front, anterior part of

Anatomical directional terminology

- Palmar
  - relating to the palm or volar aspect of the hand
- Volar
  - relating to palm of the hand or sole of the foot
- Plantar
  - relating to the sole or undersurface of the foot

Body Regions



Body regions

- Axial
  - Cephalic (Head)
  - Cervical (Neck)
  - Trunk
- Appendicular
  - Upper limbs
  - Lower limbs

Body regions

- Axial
  - Cephalic (Head)
    - Cranium & Face
  - Cervical (Neck)
  - Trunk
    - Thoracic (Thorax), Dorsal (Back), Abdominal (Abdomen), & Pelvic (Pelvis)

Body regions

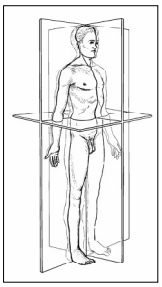
- Appendicular
  - Upper limbs
    - Shoulder, arm, forearm, & manual
  - Lower limbs
    - Thigh, leg, & pedal

Planes of Motion

- Imaginary two-dimensional surface through which a limb or body segment is moved
- Motion through a plane revolves around an axis
- There is a ninety-degree relationship between a plane of motion & its axis

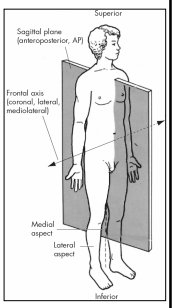
Cardinal planes of motion

- 3 basic or traditional
  - in relation to the body, not in relation to the earth
- Anteroposterior or Sagittal Plane
- Lateral or Frontal Plane
- Transverse or Horizontal Plane



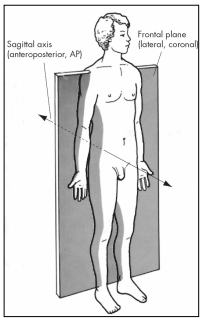
Cardinal planes of motion

- Sagittal or Anteroposterior Plane (AP)
  - divides body into equal, bilateral segments
  - It bisects body into 2 equal symmetrical halves or a right & left half
  - Ex. Sit-up



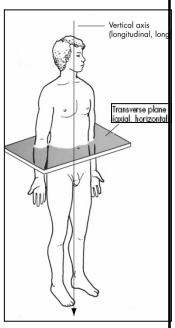
Cardinal planes of motion

- Frontal, Lateral or Coronal Plane
  - divides the body into (front) anterior & (back) posterior halves
  - Ex. Jumping Jacks



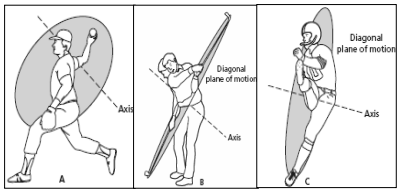
Cardinal planes of motion

- Transverse, Axial or Horizontal Plane
  - divides body into (top) superior & (bottom) inferior halves when the individual is in anatomic position
  - Ex. Spinal rotation to left or right



Diagonal Planes of Motion

- High Diagonal
- Low Diagonal
- Low Diagonal

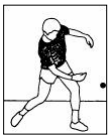


Diagonal Planes of Motion

- High Diagonal
  - Upper limbs at shoulder joints
  - Overhand skills
  - EX. Baseball Pitch

Diagonal Planes of Motion

- Low Diagonal
  - Upper limbs at shoulder joints
  - Underhand skills
  - EX. Discus Thrower



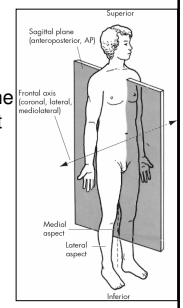
- Low Diagonal
  - Lower limbs at the hip joints
  - EX. Kickers & Punters

Axes of rotation

- For movement to occur in a plane, it must turn or rotate about an axis as referred to previously
- The axes are named in relation to their orientation

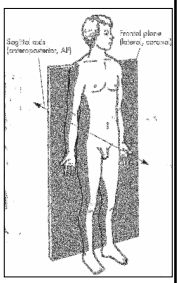
Axes of rotation

- Frontal, coronal, lateral or mediolateral axis
  - Has same orientation as frontal plane of motion & runs from side to side at a right angle to sagittal plane of motion
  - Runs medial / lateral
  - Commonly includes flexion, extension movements



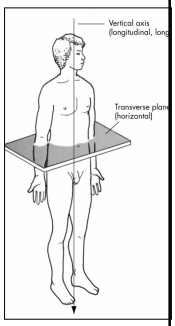
Axes of rotation

- Sagittal or anteroposterior axis
  - Has same orientation as sagittal plane of motion & runs from front to back at a right angle to frontal plane of motion
  - Runs anterior / posterior
  - Commonly includes abduction, adduction movements



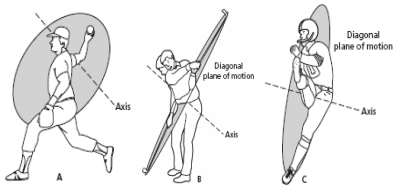
Axes of rotation

- Vertical, long or longitudinal axis
  - Runs straight down through top of head & is at a right angle to transverse plane of motion
  - Runs superior/ inferior
  - Commonly includes internal rotation, external rotation movements

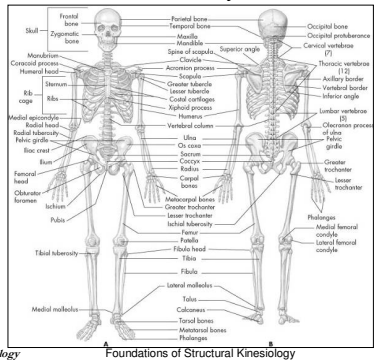


Axes of rotation

- Diagonal or oblique axis
  - also known as the oblique axis
  - runs at a right angle to the diagonal plane



Skeletal System



Osteology

- Adult skeleton
- 206 bones
  - Axial skeleton
    - 80 bones
  - Appendicular
    - 126 bones
- occasional variations

Skeletal Functions

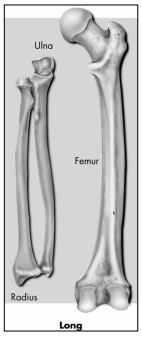
1. Protection of heart, lungs, brain, etc.
2. Support to maintain posture
3. Movement by serving as points of attachment for muscles and acting as levers
4. Mineral storage such as calcium & phosphorus
5. Hemopoiesis – in vertebral bodies, femurs, humerus, ribs, & sternum
   - process of blood cell formation in the red bone marrow

Types of bones

- Long bones - humerus, fibula
- Short bones - carpals, tarsals
- Flat bones - skull, scapula
- Irregular bones - pelvis, ethmoid, ear ossicles
- Sesamoid bones - patella

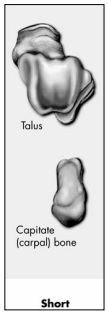
Types of bones

- Long bones
  - Composed of a long cylindrical shaft with relatively wide, protruding ends
  - shaft contains the medullary canal
  - Ex. phalanges, metatarsals, metacarpals, tibia, fibula, femur, radius, ulna, & humerus



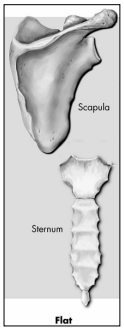
Types of bones

- Short bones
  - Small, cubical shaped, solid bones that usually have a proportionally large articular surface in order to articulate with more than one bone
  - Ex. are carpals & tarsals



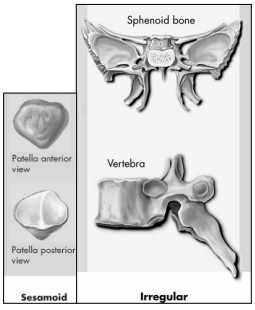
Types of bones

- Flat bones
  - Usually have a curved surface & vary from thick where tendons attach to very thin
  - Ex. ilium, ribs, sternum, clavicle, & scapula



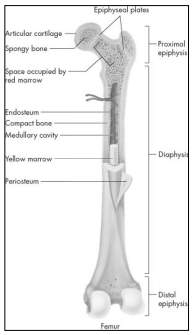
Types of bones

- Irregular bones
  - Include bones throughout entire spine & ischium, pubis, & maxilla
- Sesamoid bones
  - Patella, 1st metatarsophalangeal



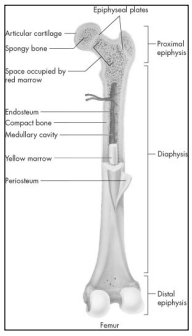
Typical Bony Features

- Diaphysis – long cylindrical shaft
- Cortex - hard, dense compact bone forming walls of diaphysis
- Periosteum - dense, fibrous membrane covering outer surface of diaphysis



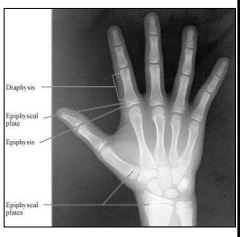
Typical Bony Features

- Endosteum - fibrous membrane that lines the inside of the cortex
- Medullary (marrow) cavity – between walls of diaphysis, containing yellow or fatty marrow



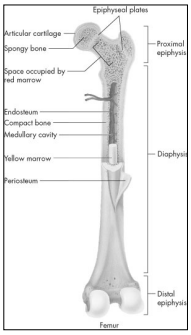
Typical Bony Features

- Epiphysis – ends of long bones formed from cancelleous (spongy or trabecular) bone
- Epiphyseal plate - (growth plate) thin cartilage plate separates diaphysis & epiphyses



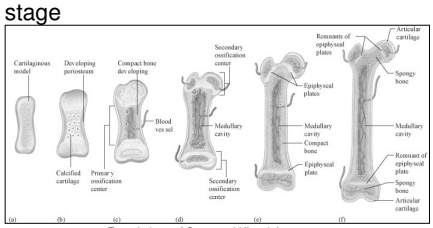
Typical Bony Features

- Articular (hyaline) cartilage – covering the epiphysis to provide cushioning effect & reduce friction



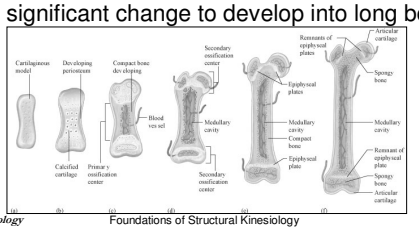
Bone Growth

- Endochondral bones
  - develop from hyaline cartilage
  - hyaline cartilage masses at embryonic stage



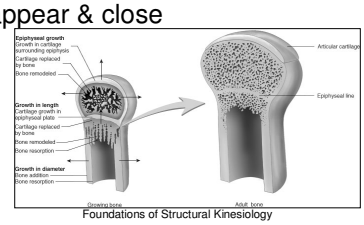
Bone Growth

- Endochondral bones
  - grow rapidly into structures shaped similar to the bones which they will eventually become
  - growth continues and gradually undergoes significant change to develop into long bone



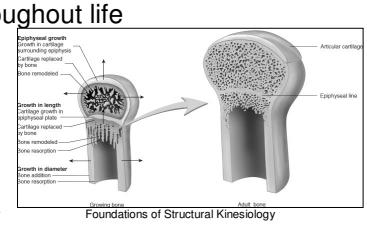
Bone Growth

- Longitudinal growth continues as long as epiphyseal plates are open
- Shortly after adolescence, plates disappear & close



Bone Growth

- Most close by age 18, but some may be present until 25
- Growth in diameter continues throughout life



Bone Growth

- Internal layer of periosteum builds new concentric layers on old layers
- Simultaneously, bone around sides of the medullary cavity is resorbed so that diameter is continually increased
- Osteoblasts - cells that form new bone
- Osteoclasts - cells that resorb old bone

Bone Properties

- Composed of calcium carbonate, calcium phosphate, collagen, & water
  - 60-70% of bone weight - calcium carbonate & calcium phosphate
  - 25-30% of bone weight - water
- Collagen provides some flexibility & strength in resisting tension
- Aging causes progressive loss of collagen & increases brittleness

Bone Properties

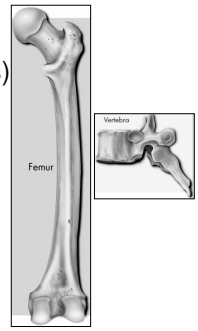
- Most outer bone is cortical with cancellous underneath
- Cortical bone – low porosity, 5 to 30% nonmineralized tissue
- Cancellous – spongy, high porosity, 30 to 90%
- Cortical is stiffer & can withstand greater stress, but less strain than cancellous
- Cancellous is spongier & can undergo greater strain before fracturing

Bone Properties

- Bone size & shape are influenced by the direction & magnitude of forces that are habitually applied to them
- Bones reshape themselves based upon the stresses placed upon them
- Bone mass increases over time with increased stress

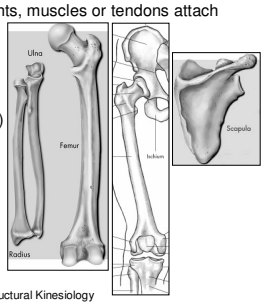
Bone Markings

- Processes (including elevations & projections)
  - Processes that form joints
    - Condyle
    - Facet
    - Head



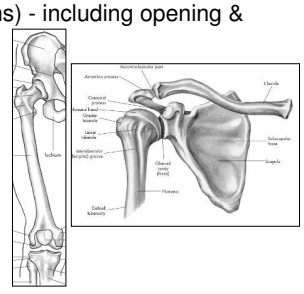
Bone Markings

- Processes (elevations & projections)
  - Processes to which ligaments, muscles or tendons attach
    - Crest
    - Epicondyle
    - Line
    - Process
    - Spine (spinous process)
    - Suture
    - Trochanter
    - Tubercle
    - Tuberosity



Bone Markings

- Cavities (depressions) - including opening & grooves
  - Facet
  - Foramen
  - Fossa
  - Fovea
  - Meatus
  - Sinus
  - Sulcus (groove)



Classification of Joints

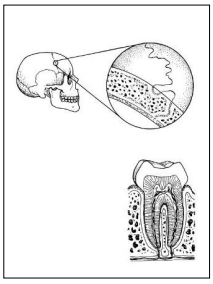
- Articulation - connection of bones at a joint usually to allow movement between surfaces of bones
- 3 major classifications according to structure & movement characteristics
  - Synarthrodial
  - Amphiarthrodial
  - Diarthrodial

Classification of Joints

		Structural classification		
		Fibrous	Cartilagenous	Synovial
Functional classification	Synarthrodial	Gomphosis Suture	-----	-----
	Amphiarthrodial	Syndesmosis	Symphysis Synchondrosis	-----
	Diarthrodial	-----	-----	Arthrodial Condyloidal Enarthrodial Ginglymus Sellar Trochoidal

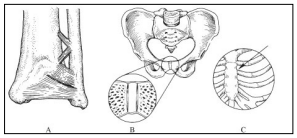
Synarthrodial

- immovable joints
- Suture such as Skull sutures
- Gomphosis such as teeth fitting into mandible or maxilla



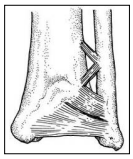
Amphiarthrodial

- slightly movable joints
- allow a slight amount of motion to occur
  - Syndesmosis
  - Synchondrosis
  - Symphysis



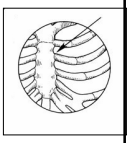
Amphiarthrodial

- Syndesmosis
  - Two bones joined together by a strong ligament or an interosseus membrane that allows minimal movement between the bones
  - Bones may or may not touch each other at the actual joint
  - Ex. Coracoclavicular joint, distal tibiofibular jt.



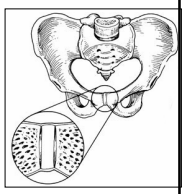
Amphiarthrodial

- Synchondrosis
  - Type of joint separated by hyaline cartilage that allows very slight movement between the bones
  - Ex. costochondral joints of the ribs with the sternum



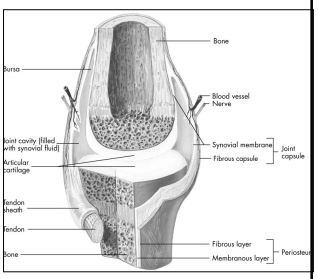
Amphiarthrodial

- Symphysis
  - Joint separated by a fibrocartilage pad that allows very slight movement between the bones
  - Ex. Symphysis Pubis & intervertebral discs



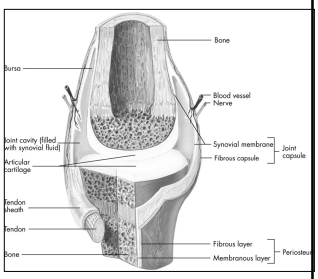
Diarthrodial Joints

- known as synovial joints
- freely movable
- composed of sleevelike *joint capsule*
- secretes synovial fluid to lubricate *joint cavity*



Diarthrodial Joints

- capsule thickenings form tough, nonelastic ligaments that provide additional support against abnormal movement or joint opening



Diarthrodial Joints

- Articular or *hyaline cartilage* covers the articular surface ends of the bones inside the joint cavity
  - absorbs shock
  - protect the bone
- slowly absorbs synovial fluid during joint unloading or distraction
- secretes synovial fluid during subsequent weight bearing & compression
- some diarthrodial joints have specialized fibrocartilage disks

Diarthrodial Joints

- Diarthrodial joints have motion possible in one or more planes
- Degrees of freedom
  - motion in 1 plane = 1 degree of freedom
  - motion in 2 planes = 2 degrees of freedom
  - motion in 3 planes = 3 degrees of freedom

Diarthrodial Joints

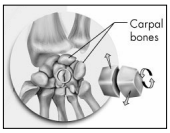
- six types
- each has a different type of bony arrangement
  - Arthrodial
  - Condyloid
  - Ginglymus
  - Enarthrodial
  - Trochoid
  - Sellar

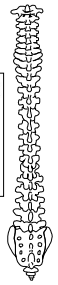
Diarthrodial Joints

- Arthrodial (Gliding) joints
  - 2 plane or flat bony surfaces which butt against each other
  - Little motion possible in any 1 joint articulation
  - Usually work together in series of articulations

Diarthrodial Joints

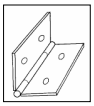
- Arthrodial (Gliding) joints
  - Ex. Vertebral facets in spinal column, intercarpal & intertarsal joints
  - Motions are flexion, extension, abduction, adduction, diagonal abduction & adduction, & rotation, (circumduction)

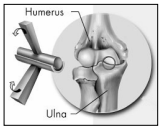




Diarthrodial Joints

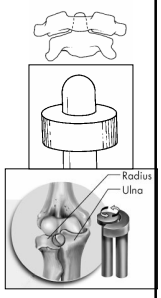
- Ginglymus (Hinge) joint
  - a uniaxial articulation
  - articular surfaces allow motion in only one plane
  - Ex. Elbow, knee, talocrural (ankle)





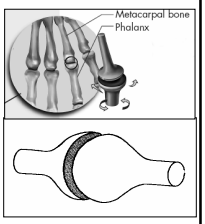
Diarthrodial Joints

- Trochoid (Pivot) joint
  - also uniaxial articulation
  - Ex. atlantoaxial joint - odontoid which turns in a bony ring, proximal & distal radio-ulnar joints



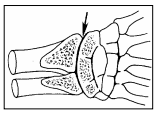
Diarthrodial Joints

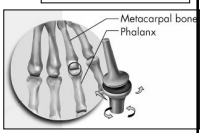
- Condyloid (Knuckle Joint)
  - biaxial ball & socket joint
  - one bone with an oval concave surface received by another bone with an oval convex surface



Diarthrodial Joints

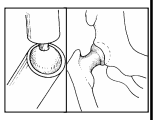
- Condyloid (Knuckle Joint)
  - EX. 2nd, 3rd, 4th, & 5th metacarpophalangeal or knuckles joints, wrist articulation between carpals & radius
  - flexion, extension, abduction & adduction (circumduction)

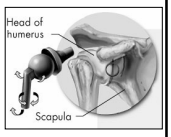




Diarthrodial Joints

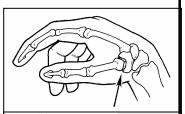
- Enarthrodial
  - Multiaxial or triaxial ball & socket joint
  - Bony rounded head fitting into a concave articular surface
  - Ex. Hip & shoulder joint
  - Motions are flexion, extension, abduction, adduction, diagonal abduction & adduction, rotation, and circumduction

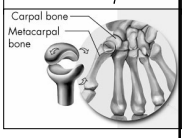




Diarthrodial Joints

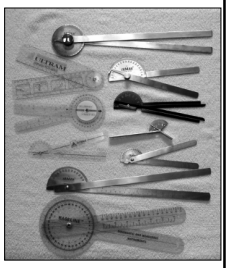
- Sellar (Saddle) Joint
  - unique triaxial joint
  - 2 reciprocally concave & convex articular surfaces
  - Only example is 1st carpometacarpal joint at thumb
  - Flexion, extension, adduction & abduction, circumduction & slight rotation





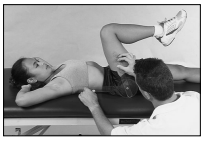
Movements in Joints

- Some joints permit only flexion & extension
- Others permit a wide range of movements, depending largely on the joint structure
- *Goniometer* is used to measure amount of movement in a joint or measure joint angles



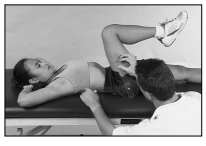
Range of Motion

- area through which a joint may normally be freely and painlessly moved
- measurable degree of movement potential in a joint or joints
- measured with a goniometer in degrees 0^0 to 360^0



Movements in Joints

- Goniometer axis is placed even with the axis of rotation at the joint line
- As joint is moved, goniometer arms are held in place either along or parallel to long axis of bones on either side of joint
- Joint angle is then read from goniometer
- Normal range of motion for a particular joint varies in people



Movements in Joints

- Terms are used to describe actual change in position of bones relative to each other
- Angles between bones change
- Movement occurs between articular surfaces of joint
  - "Flexing the knee" results in leg moving closer to thigh
  - "flexion of the leg" = flexion of the knee

Movements in Joints

- Movement terms describe movement occurring throughout the full range of motion or through a very small range
  - Ex. 1 flex knee through full range by beginning in full knee extension (zero degrees of knee flexion) & flex it fully so that the heel comes in contact with buttocks, which is approximately 140 degrees of flexion

Movements in Joints

- Ex. 2 begin with knee in 90 degrees of flexion & then flex it 30 degrees which results in a knee flexion angle of 120 degrees, even though the knee only flexed 30 degrees
- In both ex. 1 & 2 knee is in different degrees of flexion

Movements in Joints

- Ex. 3 begin with knee in 90 degrees of flexion and extend it 40 degrees, which would result in a flexion angle of 50 degrees
- Even though the knee extended, it is still flexed

Movements in Joints

- Some movement terms describe motion at several joints throughout body
- Some terms are relatively specific to a joint or group of joints
  - Additionally, prefixes may be combined with these terms to emphasize excessive or reduced motion
    - *hyper-* or *hypo-*
  - Hyperextension is the most commonly used

Movement Terminology

GENERAL

- Abduction
  - Lateral movement away from midline of trunk in lateral plane
  - raising arms or legs to side horizontally

GENERAL

- Adduction
  - Movement medially toward midline of trunk in lateral plane
  - lowering arm to side or thigh back to anatomical position

GENERAL

- Flexion
  - Bending movement that results in a ▼ of angle in joint by bringing bones together, usually in sagittal plane
  - elbow joint when hand is drawn to shoulder

GENERAL

- Extension
  - Straightening movement that results in an ▲ of angle in joint by moving bones apart, usually in sagittal plane
  - elbow joint when hand moves away from shoulder

GENERAL

- Circumduction
  - Circular movement of a limb that delineates an arc or describes a cone
  - combination of flexion, extension, abduction, & adduction
  - when shoulder joint & hip joint move in a circular fashion around a fixed point
  - also referred to as circumflexion

GENERAL

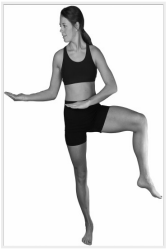
- Diagonal abduction
  - Movement by a limb through a diagonal plane away from midline of body
- Diagonal adduction
  - Movement by a limb through a diagonal plane toward & across midline of body

GENERAL

- External rotation
  - Rotary movement around longitudinal axis of a bone away from midline of body
  - Occurs in transverse plane
  - a.k.a. rotation laterally, outward rotation, & lateral rotation

GENERAL

- Internal rotation
  - Rotary movement around longitudinal axis of a bone toward midline of body
  - Occurs in transverse plane
  - a.k.a. rotation medially, inward rotation, & medial rotation



ANKLE & FOOT

- Eversion
  - Turning sole of foot outward or laterally
  - standing with weight on inner edge of foot
- Inversion
  - Turning sole of foot inward or medially
  - standing with weight on outer edge of foot

ANKLE & FOOT

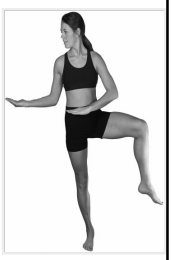
- Dorsal flexion
  - Flexion movement of ankle that results in top of foot moving toward anterior tibia bone
- Plantar flexion
  - Extension movement of ankle that results in foot moving away from body

ANKLE & FOOT

- Pronation
  - A combination of ankle dorsiflexion, subtalar eversion, and forefoot abduction (toe-out)
- Supination
  - A combination of ankle plantar flexion, subtalar inversion, and forefoot adduction (toe-in)

RADIOULNAR JOINT

- Pronation
  - Internally rotating radius where it lies diagonally across ulna, resulting in palm-down position of forearm
- Supination
  - Externally rotating radius where it lies parallel to ulna, resulting in palm-up position of forearm



SHOULDER GIRDLE

- Depression
  - Inferior movement of shoulder girdle
  - returning to normal position from a shoulder shrug
- Elevation
  - Superior movement of shoulder girdle
  - shrugging the shoulders

SHOULDER GIRDLE

- Protraction
  - Forward movement of shoulder girdle away from spine
  - Abduction of the scapula
- Retraction
  - Backward movement of shoulder girdle toward spine
  - Adduction of the scapula

SHOULDER GIRDLE

- Rotation downward
  - Rotary movement of scapula with inferior angle of scapula moving medially & downward
- Rotation upward
  - Rotary movement of scapula with inferior angle of scapula moving laterally & upward

SHOULDER JOINT

- Horizontal abduction
  - Movement of humerus in horizontal plane away from midline of body
  - also known as horizontal extension or transverse abduction
- Horizontal adduction
  - Movement of humerus in horizontal plane toward midline of body
  - also known as horizontal flexion or transverse adduction

SPINE

- Lateral flexion (side bending)
  - Movement of head and / or trunk laterally away from midline
  - Abduction of spine
- Reduction
  - Return of spinal column to anatomic position from lateral flexion
  - Adduction of spine

WRIST & HAND

- Palmar flexion
  - Flexion movement of wrist with volar or anterior side of hand moving toward anterior side of forearm
- Dorsal flexion (dorsiflexion)
  - Extension movement of wrist in the sagittal plane with dorsal or posterior side of hand moving toward posterior side of forearm

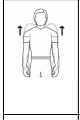
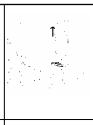
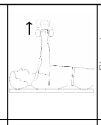
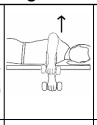
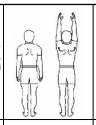
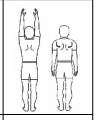
WRIST & HAND

- Radial flexion (radial deviation)
  - Abduction movement at wrist of thumb side of hand toward forearm
- Ulnar flexion (ulnar deviation)
  - Adduction movement at wrist of little finger side of hand toward forearm

WRIST & HAND

- Opposition of the thumb
  - Diagonal movement of thumb across palmar surface of hand to make contact with the hand and/or fingers
- Reposition of the thumb
  - Diagonal movement of the thumb as it returns to the anatomical position from opposition with the hand and/or fingers

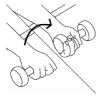
Movement Icons

Shoulder girdle					
					
Scapula elevation	Scapula depression	Scapula abduction	Scapula adduction	Scapula upward rotation	Scapula downward rotation

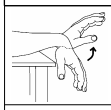
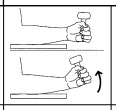
Movement Icons

Glenohumeral							
							
Shoulder flexion	Shoulder extension	Shoulder abduction	Shoulder adduction	Shoulder horizontal abduction	Shoulder horizontal adduction	Shoulder external rotation	Shoulder internal rotation

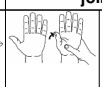
Movement Icons

Elbow		Radioulnar joints	
			
Elbow flexion	Elbow extension	Radioulnar supination	Radioulnar pronation

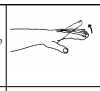
Movement Icons

Elbow		Radioulnar joints	
			
Wrist extension	Wrist flexion	Wrist abduction	Wrist adduction

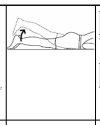
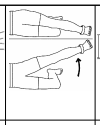
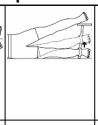
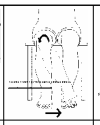
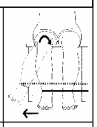
Movement Icons

Thumb carpometacarpal joint			Thumb metacarpophalangeal joint		Thumb interphalangeal joint	
						
Thumb CMC flexion	Thumb CMC extension	Thumb CMC abduction	Thumb MCP flexion	Thumb MCP extension	Thumb IP flexion	Thumb IP extension

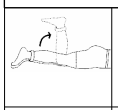
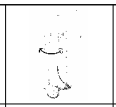
Movement Icons

2nd, 3rd, 4th, and 5th MCP, PIP, & DIP joints		2nd, 3rd, 4th, and 5th MCP & PIP joints	2nd, 3rd, 4th, and 5th metacarpophalangeal joints		2nd, 3rd, 4th, and 5th PIP joints	2nd, 3rd, 4th, and 5th DIP joints
						
2-5th MCP, PIP, & DIP flexion	2-5th MCP, PIP, & DIP extension	2-5th MCP & PIP flexion	2-5th MCP flexion	2-5th MCP extension	2-5th PIP flexion	2-5th DIP flexion

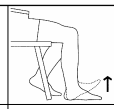
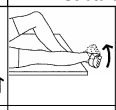
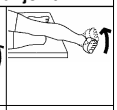
Movement Icons

Hip					
					
Hip flexion	Hip extension	Hip abduction	Hip adduction	Hip external rotation	Hip internal rotation

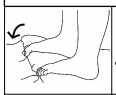
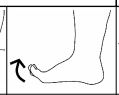
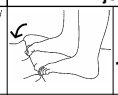
Movement Icons

Knee			
			
Knee flexion	Knee extension	Knee external rotation	Knee internal rotation

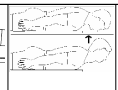
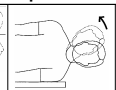
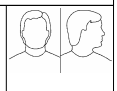
Movement Icons

Ankle		Transverse tarsal and subtalar joint	
			
Ankle plantar flexion	Ankle dorsal flexion	Transverse tarsal & subtalar inversion	Transverse tarsal & subtalar eversion

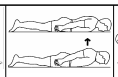
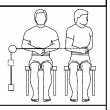
Movement Icons

Great toe metatarsophalangeal and interphalangeal joints		2-5th metatarsophalangeal, proximal interphalangeal, and distal interphalangeal joints	
			
Great toe MTP & IP flexion	Great toe MTP & IP extension	2-5th MTP, PIP & DIP flexion	2-5th MTP, PIP & DIP extension

Movement Icons

Cervical spine			
			
Cervical flexion	Cervical extension	Cervical lateral flexion	Cervical rotation unilaterally

Movement Icons

Lumbar spine			
			
Lumbar flexion	Lumbar extension	Lumbar lateral flexion	Lumbar rotation unilaterally

Physiological movements vs. accessory motions

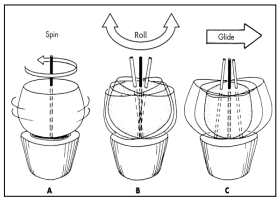
- Physiological movements - flexion, extension, abduction, adduction, & rotation
  - occur by bones moving through planes of motion about an axis of rotation at joint
- *Osteokinematic* motion - resulting motion of bones relative to 3 cardinal planes from these physiological

Physiological movements vs. accessory motions

- For osteokinematic motions to occur there must be movement between the joint articular surfaces
- *Arthrokinematics* - motion between articular surfaces

Physiological movements vs. accessory motions

- 3 specific types of *accessory motion*
  - *Spin*
  - *Roll*
  - *Glide*

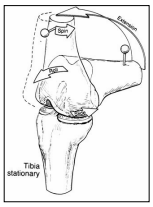


Physiological movements vs. accessory motions

- If accessory motion is prevented from occurring, then physiological motion cannot occur to any substantial degree other than by joint compression or distraction
- Due to most diarthrodial joints being composed of a concave surface articulating with a convex surface roll and glide must occur together to some degree

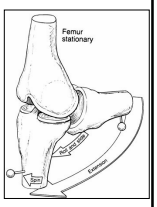
Physiological movements vs. accessory motions

- Ex. 1 as a person stands from a squatted position the femur must roll forward and simultaneously slide backward on the tibia for the knee to extend
  - If not for the slide the femur would roll off the front of the tibia
  - If not for the roll, the femur would slide off the back of the tibia



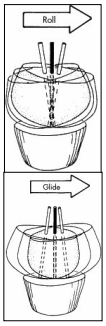
Physiological movements vs. accessory motions

- Spin may occur in isolation or in combination with roll & glide
- As the knee flexes & extends spin occurs to some degree
  - In Ex. 1, the femur spins medially or internally rotates as the knee reaches full extension



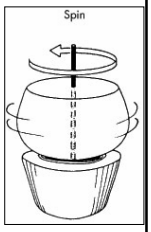
Physiological movements vs. accessory motions

- **Roll (rock)** - a series of points on one articular surface contacts with a series of points on another articular surface
- **Glide (slide) (translation) -** a specific point on one articulating surface comes in contact with a series of points on another surface



Physiological movements vs. accessory motions

- **Spin -** A single point on one articular surface rotates about a single point on another articular surface
  - Motion occurs around some stationary longitudinal mechanical axis in either a clockwise or counterclockwise direction



Web Sites

BBC Science & Nature
www.bbc.co.uk/science/humanbody/body/interactives/3djigsaw_02/index.shtml?skeleton
- Allows interactive placement of bone and joint structures

Skeletal system
www.bio.psu.edu/faculty/strauss/anatomy/skel/skeletal.htm
- Pictures of dissected bones and their anatomical landmarks

ExRx Articulations
www.exrx.net/Lists/Articulations.html
- Detailed common exercises demonstrating movements of each joint and listing the muscles involved

Human Anatomy Online
www.innerbody.com/image/skelfov.html
- Interactive skeleton labeling

Web Sites

Radiographic Anatomy of the Skeleton
www.rad.washington.edu/radanat/
- X-rays with and without labels of bony landmarks

Virtual skeleton
www.uwyo.edu/RealLearning/4210qtvr.html
- A 3-dimensional human osteology with Quicktime movies of each bone

Forensic Anthropology
www-personal.une.edu.au/~pbrown3/skeleton.pdf
- A detailed discussion of skeletal anthropology with excellent pictures of dissected bones

Web Sites

Anatomy & Physiology Tutorials:
www.gwc.maricopa.edu/class/bio201/index.htm

BBC Science & Nature
www.bbc.co.uk/science/humanbody/body/factfiles/skeleton_anatomy.shtml
- Describes each bone and allows viewing of each from different angles

BBC Science & Nature
www.bbc.co.uk/science/humanbody/body/factfiles/joints/ball_and_socket_joint.shtml
- Describes each type of joint and allows viewing of how the joint moves within the body.

Web Sites

University of Michigan Learning Resource Center, Hypermuscle: Muscles in action
www.med.umich.edu/lrc/Hypermuscle/Hyper.html#flex
– Describes each motion and allows viewing of the motion preformed.

Articulations
http://basic-anatomy.net/
– A thorough discussion of the articulations

Foss Human Body
http://sv.berkeley.edu/showcase/pages/bones.html
– An interactive site which allows assembly of the skeleton

Functions of the Skeletal System
http://training.seer.cancer.gov/module_anatomy/unit3_1_bone_functions.html
– Several pages with information on bone tissue, bone development and growth, and the joints

Web Sites

Wireframe Skeleton
www.2flashgames.com/f/f-220.htm
– Move around the skeleton's limbs arms legs body and make it do funny things

eSkeletons Project
www.eskeletons.org/
– An interactive site with a bone viewer showing the morphology, origins, insertions, and articulations of each bone

Skeleton Shakedown
www.harcourtschool.com/activity/skel/skel.html
– Help put a disarticulated skeleton back together

KLB Science Department Interactivities
www.klbschool.org.uk/interactive/science/skeleton.htm
– Skeleton labeling exercises

Web Sites

Introductory Anatomy: Joints
www.leeds.ac.uk/chb/lectures/anatomy4.html
– Notes on joint articulations

The Interactive Skeleton
www.pdh-odp.co.uk/skeleton.htm
– Point and click to detailed skeletal illustrations

Radiographic Anatomy of the Skeleton
www.szote.u-szeged.hu/Radiology/Anatomy/skeleton.htm
– X-rays with and without labels of bony landmarks

Skeleton: The Joints
www.zoology.ubc.ca/~biomania/tutorial/bonejt/outline.htm
– Point and click to detailed joint illustrations

TeachPE.com
www.teachpe.com/Interactivelearning.htm
– Interactive questions on bones, joints, muscles