Kinesiology Notes
These are NOT inclusive

for visual aids and technical support, please refer to:
http://biology.unm.edu/anatomy/
http://webanatomy.net/anatomy/bio237.htm

Initial terms to keep in mind:

Anterior

Posterior

Medial

Lateral

Superior

Inferior

Prone

Supine

Dorsal

Ventral

FUNCTION OF BONE:

1) Support internal organs
2) Provide for muscular attachment
3) Provide levers for movement
4) Red blood cell production
5) Protection/Defense
6) Storage of minerals

BONE COMPOSITION:

-20-25% water
-60-70% calcium phosphate, calcium carbonate, protein matrix, salts (provides density and resists compression)
-the remaining is collagen, an elastic protein that resists forces of tension (that which pulls apart)
-capable of resisting up to 6 times its mass if healthy

ORGANIZATION OF SKELETAL SYSTEM:

-206 bones in the body

-Axial skeleton
1) Skull
2) Vertebral column
3) Bony thorax (ribs and sternum)
    - supports the head, neck, torso
    - protects brain, spinal cord, heart, lungs

-Appendicular

Bone Is ALIVE
-there is a continuous process of bone deposition and destruction (resorption)

Skeletal Integrity
-regulated by steroid hormones (estrogen, testosterone), growth hormone, calcitonin, parathyroid hormone

Bone Growth Known as OSSIFICATION

primary location-DIAPHYSIS growth occurs in 2 dimensions
secondary location-EPIPHYSIS

Epiphysis tends to close between ages 18-20
(may differ based on sex and endocrinological status)

WOLFF'S LAW
The status of a bone or any tissue is related to the stress imposed upon it.
-"Use it or lose it"

Bone Specific Terms:

a) Articular surface- part of bone that forms joint with another bone
b) Tuberosity, tubercle or process- an obvious lump on a bone that serves as a site for muscle attachment
c) Notch-usually serves as pathway for nerves or other vessels
d) Spine-obvious bone projection (longer than a tuberosity)
e) Fossa-hollowed out area, may be articular surface
f) Foramen-complete hole in bone
g) Condyles-articular surfaces, expanded portion
h) Epicondyle-(epi=above) articular surface above condyle
i) Concave
j) Convex

CLASSIFICATION

1) LONG-for weight-bearing
Humerus, ulna, femur, tibia, metacarpals

Typical Long Bone made of 2 parts

a) compact bone-also called cortical bone forms entire thickness of wall diaphys thins at ends
b) spongy bone-laid in layers of bony plates (trabeculae) and branching tubules containing blood vessels (Haversian system)

STRUCTURE OF LONG BONE

Epiphysis-expanded portion-articulates with other bones

Diaphysis-shaft, between epiphyses

Periosteum-encases bone (not articular cartilage), fibrous, vascular tissue continous with tendons and ligaments

Articular cartilage-outer layer of epiphysis designed as joint surface provides a smooth and lubricated surface

Processes-bony projections providing sites for attachment of tendons and ligaments

Medullary cavity-hollow space within diaphysis for blood cell production

2) SHORT - cubical shared tarsals, carpals

3) FLAT - more surface area for muscular attachment and enclose cavities scapula, skull, ribs, ilium, sternum

4) IRREGULAR - allows for muscular attachment at varied angles pubis, ischium, vertebrae, maxilla

5) SESAMOID-pulley action to improve leverage patella, sesamoids in foot and hand

FACTORS AFFECTING BONE GROWTH AND DEVELOPMENT

-nutrition-Vitamin D necessary for calcium absorption
-hormones
-exercise-stress increases bone deposition; inactivity increases resorption
-disease-some exaggerate bone mineral loss (rickets)

JOINTS
-An articulation of two or more connecting bones

3 CLASSES OF JOINTS

1) SYNARTHRODIAL joints-immovable, fibrous
    a. sutures-skull; interdigitation, long bands/fiber

2) AMPHIARTHRODIAL joints- slightly movable, fibro-cartilaginous
    a) Syndesmosis
        -tight ligamentous structure
        -Acromio-clavicular joint
    b) Synchondrosis
        -jointed by hyaline cartilage temporary between epiphysis & diaphysis permanent-1st 10 ribs & cartilages, manubrium, xiphoid & body
    c) Symphysis
        -acromial/clavicular, distal radio/ulnar, sacroiliac, symphysis pubis, anterior inter-vertebral

3) DIARTHRODIAL-freely movable
    -Also known as synovial joints (fluid)
    -capsule
    -synovial membrane
    -joint cavity
    -hyaline cartilage=more collagen
    a) articular surfaces-bone portions in contact with and move upon each other; denser than rest of bone; no haversian system; not covered with periosteum

b) articular cartilage-layer of original cartilage that persists over articular surfaces after ossification is complete; smooth surface reduces friction; thus, thick over areas of greatest pressure
c) articular capsule-sleeve-like fibrous sheath attached to circumference of articular extremity forming envelope; outer layer is fibrous connective tissue continuous with periosteum near borders of articular surfaces; tends to bind bones together but loose enough to permit some freedom of movement
d) ligaments-accessory strengthening fibrous bands; may appear incorporated in articular capsule or appear as independent structures; if blends, then appear as local thinkenings of capsule; limit, guide movement STABILITY
e) articular disc-additional cartilage in some joints may interposition to smooth incongruities-meniscus separate surfaces-vertebrae divide articular cavity-sterno-clavicular deepen socket-labrum of hip
f) synovial membrane-folded, loose connective tissue, inner side filled with capillaries; inner layer contains SYNOVIAL FLUID: thick viscous fluid forming film over cartilage; lubricates, nourishes, cushions. Like consistency of egg whites
g) bursae-small sacs lined with synovial membrane and filled with synovial fluid; cushion; lie between tendon and bone
h) tendon sheaths-reduces friction where tendons cross joints; like cylindrical synovial sacs

80% of joints are diarthrodial
They have the greatest range of motion

Cartilage
-contains high degree of collagen
-found in: intervertebral disks, menisci, symphysis pubis

TYPES OF JOINTS

1) GLIDING (Arthrodia) Joints
-gliding movement
-limited movement
-tarsals, carpals

2) HINGE Joints
-convex surface of one bone fits against concave surface
-elbow, knee, ankle

3) PIVOT Joints
-rotation around long axis
-atlas-axis, radius-ulna

4) CONDYLOID (biaxial and socket) Joints
   -no rotation
   -knuckles, toes

5) SADDLE Joints
   -thumb
6) BALL AND SOCKET
   -rotation (only joint)
   -shoulder, hip

PLANES

- 3 planes of motion
- each plane goes through the center of mass (gravity)

*If movement passes through the center of gravity it is going through a cardinal plane

1) SAGITTAL Plane
   -bisects the body into right and left half
   -walking, running
   -moves you forward and backward

2) FRONTAL Plane
   -moving side to side
   -jumping jacks

3) HORIZONTAL Plane
   -moving in circle
   -turning head to say no
   -spinning

Joint Movements

A) Sagittal Plane
   -flexion: decrease of angle, bones come together
   -extension: increase in angle, straightening motion
   -hyperextension
B) Frontal Plane
   -abduction: lateral movement away from midline
   -adduction: movement medially toward midline
C) Horizontal Plane
   -external rotation: rotation away from midline
   -internal rotation: rotation toward midline

Joint Movements-the complications

A) Horizontal abduction: movement in horizontal plane away from midline

B) Horizontal Flexion: movement in horizontal plane toward/across midline

C) Circumduction: Circular movement, combination of flexion, extention, abduction and adduction

D) Pronation: palm down

E) Supination: palm up

F) Dorsal Flexion: top of foot pulled

G) Plantar Flexion: point toes down

Shoulder Girdle and Joint

H) Elevation: superior movement of shoulder girdle

I) Depression: inferior movement of shoulder girdle

J) Horizontal Abduction: movement of humerus toward midline

K) Protraction: abduction of scapula

L) Retraction: adduction of scapula

M) Rotation Upward: inferior angle of scapula moves lateral and upwar

N) Rotation Downward: inferior angle of scapula moves downward

SPINE

O) Lateral Flexion: movement of trunk laterally away from midline

P) Spinal Flexion: movement of trunk towards hip

Q) Spinal Extension: movement of trunk to neutral from spinal flexion

R) Rotation: movement of spine laterally or medially

MUSCLE CHARACTERISTICS

Irritability: ability to respond to stimulation
Contractility: muscle can generate force by lengthening and shortening tension
Extensibility: a muscle can lengthen and shorten
Elasticity: ability of muscle cell to return to resting length after stretch

40-45% of body weight is muscle

-Origin-perceived to be immovable end
-Insertion-perceived to be movable end

FUNCTIONAL REVERSIBILITY: when a muscle "reverses" the moving end (sit-ups)

MUSCLES DO NOT PULL-THEY PUSH

Isometric action: muscle tension is generated against a resistance to maintain position
-used to stabilize a body part

Isotonic: joint angle visibly shortens/lengthens

1) Concentric Action: muscle contracts, fibers shorten, joint angle decreases

2) Eccentric Action: muscle contracts, fibers lengthen, joint angle increases

-Example: Push up-when going down=eccentric
-when pushing back up=concentric

Isokinetic-"equal motion," joint moves through some range of motion with accommodating resistance
-special equipment required, concentric only speed of device set regardless of muscle force

Note:
-most muscle soreness arises from eccentric training (not lactic acid)
-eccentric might be more efficient training form
-eccentric contractions essential to dynamic stabilization of body segments by controlled displacement in landing; precision of execution
-plyometrics

*Note: On a HORIZONTAL PLANE the movement is ALWAYS CONCENTRIC (no gravitational pull)

ROLES OF MUSCLES

AGONIST-prime mover, responsible for most force necessary to produce movement

MOST TWO JOINT MUSCLES ARE AGONISTS AT THE DISTAL END

ANTAGONIST-muscle in opposition to agonist

ASSISTANT MOVER-aids in a given joint action if greater force necessary

STABILIZER-static, fixes other body parts

TRUE SYNERGIST-2nd muscle cancels out undesired movement of agonist
-triceps, biceps
-flexion CANCELS extension

HELPING SYNERGIST-two muscles contract simultaneously with one action in common and one action in opposition

NERVOUS SYSTEM
-provides control over movement
1) Central Nervous System-brain and spinal cord
2) Peripheral Nervous System-all others

-Sensory (Afferent)-feel it

-Motor (Efferent)-doing it (acting)

Nerve Structure:
Dendrite
Axon
Axon Hillock
Nucleus
Node of Ranvier
Myelin Sheath

-Unmyelinated: speed sensation is dull
-Myelinated: speed sensation is strong
-MYELINATED FIBERS-fibers covered by a myelin sheath that serves to protect and insulate

***not all nerves are myelinated: unmyelinated sense crude touch and pressure, tickle sensation, aching pain, cold, warmth, they are slower in their conductance.

*Note: When you are born you are almost completely UNmyelinated
Process of myelinated=riding a bike, discovering right and left hand, etc.

MOTOR UNIT

-motor neuron and all fibers attached to it

ALL OR NONE LAW: when the motor neuron fires, all fibers will fire

-singular motor neuron fires and all attached to it

Muscle Fiber Types:

A) Type I- oxidative (runner), slow twitch, red
   -stores fatty acids instead of glycogen, poorly developed sarcoplasmic reticulum, smaller than type II, produces less force overall, has more mitochondria
B) Type IIA- fast oxidative glycolytic (weight lifter), anaerobic, moderate force, fatigue resistant
   -more enzyme activity, developed sarcoplasmic reticulum, dependent on blood supply as external source of energy
   -larger motor neurons, faster conduction velocity, higher capacity for electrochemical transmission of action potential, high level of activity of myosin ATPase, rapid level of Ca++ release and uptake in sarcoplasmic reticulum
C) Type IIB- glycolytic (sprinter), truly “anaerobic”

Proprioception

1) Kinesthesic- the way your limbs are in space (movement in space)
2) Vestibular-inner ear, fluid balance
3) Visual

Muscle Spindles

-sense change in muscle length and rate of change, covered by connective tissue and interwoven with “extrafusal” muscle fibers. The “interfusal” fibers sense stretch and velocity

Golgi Tendon Organ

-located in junction of muscle and tendon, sensitive to contractile force, identifies level of tension of muscle, reflex is inhibitory in that it limits force developed to that which can be tolerated by tissues being stressed, (so depresses activity of motorneuron) reduces tension in muscles being stretched or contracted tension

RECIPROCAL INHIBITION: when my bicep contracts, my tricep lets it
(Agonist:contracts, Antagonists:allows it to happen)

NERVE FUNCTION

Axon- carries impulse away from nerve cell
Dendrite-receives information
Nodes of Ranvier- permits depolarization, interruption in myelin sheath
***SALTATORY EFFECT-impulses jump across these nodes
Neurotransmitter- a chemical released at a synapse in response to the depolarization of the pre-synaptic membrane

SYNAPSE-junction between end of axon of one nerve and dendrite of another nerve impulses are transmitted chemically here (electrical within the cell)
The gap is called the SYNAPTIC CLEFT

Neuromuscular Junction

-place where the axon meets the muscle
-synaptic vesicles have actelycholine (ACH)

1) Action potential arrives at axon terminal
    a. Ca+ ions enter axon terminal
2) Acetylcholine binds to receptors on motor end plate, causing opening of channels
    a. open channels allows influx of Na+ and efflux of K+ ions
    b. this exchange causes depolarization of the motor end plate
3) Depolarized motor end plate initiates action potential along sarcolemma
    a. down T-tubules
4) sarcolemma release Ca+ ions into cytosol
5) Ca+ ions trigger muscle contractions

CROSS STRUCTURE OF MUSCLE

Epimysium-ensheaths the entire muscle
Perimysium-collects bundles of fibers into fascicles
Endomysium-surrounds individual fibers

SARCOLEMMA-cell membrane encircling myofilaments, comprising elongated cell of muscle fiber

SARCOMERE

-smallest functional unit

1) ACTIN - thin, light, within I bands
    a. twisted into double helix
    b. each subunit has specific binding sites to which the myosin crossbridge binds
    c. TROPOMYOSIN: protein molecule that intertwines around action and blocks the myosin binding sites (binding sites are covered by the tropomyosin)
    d. TROPONIN: a 3-polypeptide complex that binds Ca+ ions and drags tropomyosin off
2) MYOSIN - thick, dark, within A bands
    a. includes two heads and a tail region (golf club with two heads)
    b. head is called a crossbridge (moves back and forth)
    c. POWERSTROKE: flexing of the heads
3) I-Band
    a. from the end of one myosin to the beginning of another myosin
4) A-Band
    a. the actual myosin
5) M Line
6) H Zone
7) Z Line

SARCOPLASM-fluid enclosed within the fiber, fuel sources within

Role of Calcium

- Ca+ ions are released from sarcoplasmic reticulum (SR)
- Binds with troponin
- Shifts tropomyosin
- Active sites of actin now open
- Myosin crossbridges attach
- Contract (powerstroke)

SLIDING FILAMENT THEORY

- Actin slides past myosin
- Z-Lines pulled in (concentric)
- I-Band decreases
- No change in A-Band
- H-Zone decreases

ATP converted to ADP in what is known as Hydrolysis, myosin attach to active sites which creates the POWERSTROKE

-breaking of actin-myosin is with a new ATP, therefore powerstroke stops

Basic Summary of Muscle Contraction

1) impulse to Neuromuscular Junction
    a. depolarization=action potential
2) ACH released
3) Impulse travels down T-tubules and SR
4) Ca+ released
5) Ca+ binds to troponin
6) Tropomyosin shifts, active sites available
7) ATPase splits ATP to ADP
8) Crossbridge units bind to actin
9) Powerstroke
10) Impulse stops, Ca+ to SR
11) Tropomyosin returns over active sites

BASIC BIOMECHANICS

Simple Machines:

- Screw
- Wedge
- Inclined Plane
- Wheel & Axial
- Pulley
- Levers

3 Machines in Musculoskeletal System

1) Lever- bone/joint
2) Wheel & Axial- humerus and head of radius
   Pronator teres, head- produces rotation
3) Pulley- alters direction of force application
   Patella
   Sesamoid bones

4 Functions of Levers

1) magnification of force
2) increase in speed and range of motion- possible when resistance arm is longer than force arm
3) balancing of forces
4) change direction to applied muscular force

The mechanical advantage of a lever is represented by the ratio of the length of the force (moment) arm to the length of the resistance (weight) arm.

The longer the force arm, the greater the MOMENT OF FORCE.

The shorter the force arm in proportion to the length of the resistance arm, the smaller the moment of force but the more immediate the action.

Moment of Force: tendency of a force to rotate the affected body about its axis of rotation

Moment Arm: distance from the point of application of a force to the axis of rotation

Torque: rotary effect created by an applied force

- it is most effective to initiate rotation perpendicular and as far away as possible

MORE BIOMECHANICS…

Internal and External Forces

Internal-forces on various structures of the body
Causes it to change shape

External-forces exerted outside system
Gravity

FORCE IS A VECTOR

FORCE has vertical and horizontal component
A muscle's angle of pull changes with every degree change of motion

Body's anatomical pulleys – SESAMOID BONES

Purpose:
Change direction of force by changing the angle of pull

Linear Force

Parallel Force

Concurrent (opposing forces)

THE LEVER

-Operates according to torque
-purpose: to overcome resistance
-3 parts to a lever (Axis, Force, Resistance)

FARFA

1) First Class Lever-power, strength, maintain posture or balance
    a. Scissors, hemostats, seesaw
    b. Tricep, Hip, Head, Ankle
2) Second Class Lever-magnification of force
    a. Wheel barrow, nutcracker, jaw
    b. NONE in the human body
3) Third Class Lever-speed, range of motion
    a. Tweezers, shovel, racket
    b. Most joint systems in the body

Newtons Laws of Motion

1st Law: Law of inertia
- a body in motion tends to remain in motion unless acted upon by force

2nd Law: Law of acceleration
- rate of change of velocity
- acceleration of an object is directly proportional to force causing it

3rd Law: Law of Reaction
- for every action there is an opposite and equal reaction

UNIT EXAM

SHOULDER GIRDLE

-scapula and clavicle
-has NOTHING to do with the humerus

Joints of the shoulder girdle:

1) Sternoclavicular joint
2) Scapulothoracic joint (not a true joint, no bone to bone articulation)
3) Acromio-clavicular joint

SCAPULO-HUMERAL RHYTHM

Muscles of the shoulder girdle:

Anterior

Pectoralis minor (downward rotation, depression, abduction)
Serratus anterior (protraction, upward rotation)
Subclavius (stabilizes)

Posterior

Levator scapulae
Rhomboids (retraction, downward rotation, elevation)
Trapezuis (elevation, upward rotation, depression, adduction)

Shoulder Joint (Gleno-humeral joint)

Deltoid (this muscle is broken down into, anterior deltoid, medial deltoid, posterior deltoid) (abduction, flexion, horizontal abduction)

Coracobrachialis (flexion, adduction, horizontal adduction)

Teres major (extension, internal rotation, adduction)

Rotator Cuff (this muscle is broken down into 4 muscles) SITS

1) S-supraspinatus
2) I-infraspinatus (external rotator)
3) T-teres minor (external rotator)
4) S-subscapularis (internal rotator)

Latissimus Dorsi (adduction, extension, internal rotation, horizontal abduction)

Pectoralis Major (internal rotation, horizontal adduction, flexion, abduction)

ELBOW & RADIO-ULNAR JOINT

CARRYING ANGLE

Elbow: flexion and extension

Proximal Radial-Ulnar Joint: Supination and pronation

1) Bicep brachii (flexion, supination)
2) Brachialis (flexion)
3) Brachioradialis (flexion, pronation, supination)
4) Tricep brachii (extension, adduction)
5) Pronator teres (pronation)
6) Pronator quadratus (pronation)
7) Supinator (supination)

HIP JOINT AND PELVIC GIRDLE

Hip Joint:

Iliofemoral ligament (Y-ligament)
Ischiofemoral ligament
Pubofemoral ligament

Q angle (frontal plane)
-measured from the ASIS to the tibia tuberosity then to the center of the patella
-8-10 degrees in men
-15 degrees in female

Femoral angle (frontal plane)
-125-135 degrees

Anteversion (horizontal plane)
-15 degrees forward from shaft of femur

Muscles:

1) Iliopsoas (flexion)
    a. origin=last thoracic vertebrae (T12)
    b. insertion=lesser trochanter
2) Sartorius (flexion)
3) Rectus femoris (flexion)
    a. only quadricep muscle that crosses the hip (inguinal ligament)
4) TFL (abduction, flexion)
5) Deep lateral rotators (flexion, abduction)
    a. 6 – you must know them all
6) Gluteus medius (abduction)
7) Gluteus minimus (abduction)
8) Gluteus maximus (extension)
9) Hamstrings (extension)
    a. Biceps femoris
    b. Semitendinosis
    c. Semimembranosus
10) Adductors (adduction)
    a. Adductor brevis
    b. Adductor longus
    c. Adductor magnus
11) Gracilis (adduction)

KNEE

-posterior cruciate ligament
-anterior cruciate ligament
-lateral meniscus
-medial meniscus
-lateral collateral ligament
-medial collateral ligament

1) Quadraceps (extension)
    a. Rectus femoris
    b. Vastus lateralis
    c. Vastus medialis
    d. Vastus intermedius
2) Hamstring (flexion)
    a. Biceps femoris
    b. Semimembranosus
    c. Semitendiosis

"Screw Home" Mechanism

-in extension, tibia externally rotates

-in flexion, tibia internally rotates

ANKLE

Anterior (dorsiflexion)

1) Tibialis anterior (inversion)
2) Toe extensors

Lateral (plantar flexion)

1) Peroneus longus (eversion)
2) Peroneus brevis (eversion)

Posterior (plantar flexion)

1) Gastrocnemius
2) Soleus

Medial (plantar flexion)

1) TOM-Tibialis posterior (inversion)
2) DICK-Flexor digitorum longus
3) HARRY-Flexor halicus longus

BOWSTRING EFFECT

*Note: Flexor hallicus longus

-two sesamoid bones

Dick and Harry Cross

-Flexor digitorum longus

-Flexor halicus longus

Medial sprains are fewer

-Deltoid Ligament

-fibula will break before deltoid ligament breaks that's why medial sprain are fewer

VERTEBRAL COLUMN

Erector Spinae 3-4 times cross sectional area of abdominals

Muscles:

POSTERIOR- Erector Spinae

ANTERIOR - Abdominals

a. Internal Oblique-intermediates, oblique course, A-shaped
b. External Oblique-superficial, oblique course, V-shaped
c. Transverse Abdominus-deepest layer; originates at lumbar transverse processes and surrounds organs
d. Rectus Abdominus-linea alba and semi-lunar line