1. ANATOMICAL POSITION: The body is standing upright with the feet parallel, the arms hanging at the sides with the palms directed forward.

2. PLANES OF THE BODY:
   a. Median: (Mid-Sagittal) Divides the body into symmetrical right and left halves.
   b. Sagittal: any plane parallel to the median plane
   c. Coronal: also called frontal. Any vertical plane that divides the body into anterior and posterior parts. It is perpendicular to the median plane.
   d. Transverse Plane: also called the horizontal plane. Divides the body into superior and inferior parts.
   e. Oblique Plane: divides a part at an angle

3. MOVEMENT OF BODY PARTS:
   a. Flexion: movement in a sagittal plane which takes a part of the body forward from the anatomical position, causing a decrease in the angle of a joint.
   b. Extension: movement in a sagittal plane which takes a part of the body backward from the anatomical position causing an increase in the angle of a joint.
   c. adduction: a movement in the frontal plane which takes a part of the body toward the median plane.
   d. abduction: a movement in the frontal plane which takes a part of the body away from the median plane.
      ** For the fingers and toes the reference points used is the axis of the hand (middle finger) or foot (second toe).
   e. lateral flexion: applies to the neck or trunk. Have movement in the frontal plane away from the median plane.
   f. external rotation: a movement in a transverse plane which takes a body part outward.
   g. internal rotation: a movement in a transverse plane which takes a part of the body inward.
   h. pronation: of the forearm, the palm faces backward
   I. supination: of the forearm, the palm faces forward
   K. Circumduction: combo of flex-ext and abd-add in succession
   l. protraction: drawing a structure forward
   m. retraction: drawing a structure backward

4. OTHER ANATOMICAL REFERENCE POINTS
   a. medial: closer to the median plane
   b. lateral: further from the median plane
   c. anterior: facing or located to the front
   d. posterior: facing toward or located at the back
   e. superior: facing toward or located at the top (closer to the head)
   f. inferior: facing toward or located at the bottom (further from the head)
   g. proximal: closer to the trunk or some major joint
   h. distal: further from the trunk or some major joint
   I. superficial: near the outside surface of the body, particular bone, or organ.
   j. deep: inside the body, particular bone, or organ

5. JOINTS: Joints are areas where bones are linked together. They have varying degrees of mobility. Three types:
   a. Synarthroses: Immovable joints: includes

1. sutures: fibrous joint composed of a thin layer of dense fibrous connective tissue that unite bones of the skull.
2. gomphosis: type of joint in which a cone-shaped peg fits into a socket. Ex teeth
3. synchonrosis: a cartilaginous joint in which the connecting material is hyaline cartilage. Example is the epiphyseal growth plate which connects the epiphysis and diaphysis of a growing bone.

b. Amphiarthrosis: slightly movable joints
1. syndesmosis: a fibrous joint with more fibrous connective tissue that there is in a suture, therefore allowing more flexiblity. An example is the distal articulation between the tibia and fibula.
2. Symphysis: connecting material is a broad, flat disc of fibrocartilage. Examples of this are IVD between vertebrae and the symphysis pubis between the pubic bones of the pelvis.

c. Diarthrosis: freely movable joints (synovial joints) contain a fluid filled cavity between the articulating surfaces. These surfaces are shaped so as to fit together but also allow movement. They are named based on the shape of the joint.

Six Types of diarthroses:
1. Ball and socket: one surface is spherical and the other is cup shaped. This allows movement in all directions. Ex hip and shoulder
2. Hinge: the convex surface of one bone fits against the concave surface of another bone in a clasping arrangement. Movement is in one plane of flexion and extension. Examples are the elbow, knee, MCP, DIP, PIP, and ankle.
3. Gliding: both surfaces are essentially flat and movement is limited. Examples intercarpal joints, intertarsal joints, rib-vertebral joint, acromioclavicular joint.
4. Ellipsoid: an oval shape of one bone fits into an elliptical cavity of the other. Movement in two planes which is flexion/extension and abduction/adduction. Examples are radio-carpal joint and the atlanto-occipital.
5. Saddle: both surfaces are saddle shaped. Movement is in two planes flexion/extension and abduction/adduction. Example is the carpo-metacarpal joint of the thumb.
6. Pivot: a pointed or rounded surface of one bone fits into a ring like structure of another bone. Rotation is the chief movement. Example is atlanto-axial joint.

HOW SKELETAL MUSCLES PRODUCE MOVEMENT:

1. Skeletal muscles produce movement by exerting force on tendons, which in turn pull on bones or

other structures such as the skin.
2. Most muscles cross at least one joint and are attached to the articulating bones that form that joint.
3. When this muscle contracts it draws one articulating bone toward the other.
4. The two articulating bones do no move equally; one is held nearly in its original position because opposing muscles contract pulling the bone in the opposite direction.

Def: Origin: The attachment of a muscle tendon to the stationary base. Is proximal in the limbs
Def: Insertion: The attachment of the other muscle tendon to the moveable bone. Distal in limbs
Def: Belly: the fleshy portion of the muscle between the two tendons of the origin and insertion

LEVER SYSTEM AND LEVERAGE

In producing a body movement bones act as levers and joints function as fulcrums of these levers.

Def: Lever: a rigid rod that moves about on some fixed point. Acted upon at two different points by two different forces. It is used to modify direction, force, motion used in moving or lifting objects to heavy or awkward to move unassisted.
Def: Resistance: The force that opposes movement (weight of a body part to be moved).
Def: Effort: The force exerted to achieve an action (the muscular contraction).
Def: Fulcrum: The fixed point that a lever moves around

Motion is achieved when the effort exceeds the resistance.

Three types of levers:

1. First class lever: The fulcrum is between the effort and the resistance.
   a. an example is a see-saw
   b. not many found in the human body. An example in the body is the head resting on the vertebral column. The resistance is the facial portion of the skull, the effort is the contraction of the posterior neck muscles, and the fulcrum is the C1-C2 joint of the spine.
   c. This type of lever provides increased speed and range of motion but decreased strength

2. Second class lever: The fulcrum is at one end, the effort is at the opposite end, and the resistance is between them.
   a. an example is a wheelbarrow
   b. very few in the body
   c. an example would be raising the body on the toes. The resistance is the weight of the body, fulcrum is the ball of the foot, and the effort is the contraction of the calf muscles.
   d. very strong but less speed and range of motion.

3. Third class lever: the fulcrum is located at one end, the resistance at the opposite end, and the effort located in-between them.
   a. most common lever located in the body.
   b. example is adduction of the thigh. The resistance is the weight of the thigh, the fulcrum is the hip joint, and the effort is the contraction of the adductor muscles.
   c. another example is flexing the forearm.

Leverage: defined: the mechanical advantage gained by using a lever. It is largely responsible for muscle strength and range of motion.
   a. The further away form a joint a muscle attaches the stronger the movement but the less range of motion the muscle will have. Strength depends upon placement of muscle attachment.

b. The closer a muscle attaches to a join the greater the range of motion and speed but the less strength of contraction. Motion depends on the placement of muscle attachment.

GROUP ACTIONS:

1. Most movements require several skeletal muscles acting in groups rather than individually.
2. skeletal muscles are arranged in opposing pairs at joints (flexors-extensors, abductors-adductors).

Def: Agonist: prime mover; a muscle that causes a desired action
Def: Antagonist: muscle which has an opposite effect on the prime mover
Def: Synergist: muscle which serves to steady movements thus preventing unwanted movements and also help the prime mover to function more efficiently. Usually located along side the agonist.
Def: Fixator: muscle which stabilizes the origin of the prime mover so that the prime mover can act more efficiently.

TYPES OF MUSCLE TISSUE:

1. Skeletal Muscle: is named so because it is attached primarily to bones and it moves parts of the

skeleton. Some skeletal muscles may attach to the skin, fascia, or other muscles. It is also called striated muscle because when viewed under a microscope it has visible striations. Skeletal muscle is under voluntary control, it can be made to work under conscious control.

2. Cardiac Muscle: It forms most of the muscle of the heart. It is also striated but it is under involuntary control. Not under conscious control.

3. Smooth Muscle: Located in the walls of the hollow internal structures such as blood vessels, stomach intestines, and other abdominal organs. Also found in the skin attached to hair follicles. Under a microscope the tissue looks non-striated or smooth. It is under involuntary control.

FUNCTIONS OF MUSCLE TISSUE

1. Motion: such as walking or running, these actions require not only muscles but the bones and joints as well. Muscles also control less noticeable motions such as the heart beating and the stomach churning food.

2. Stabilizes body position and regulates organ volume: positions such as standing or sitting are controlled by muscles that are in a sustained contraction. Also controls organ volume by closing off exit routes that food and waste will travel through.

3. Thermogenesis: as skeletal muscle contracts to perform work a by product produced is heat. Most of this heat released is used to maintain body temperature.

4. Movement of substances through the body: cardiac muscle moves blood, smooth muscle moves food and nutrients through the G-I tract, and skeletal muscle moves venous blood and lymph back to the heart.

CHARACTERISTIC OF MUSCLE TISSUE:

1. Excitability (Irritability): the ability to respond to certain stimuli by producing electrical signals called action potentials
2. Contractility: The ability of muscle tissue to shorten and thicken thus generating force to do work.
3. Extensibility: capability of a muscle to be stretched without damaging the tissue.
4. Elasticity: That muscle tissue can return to its original shape after contraction or extension.

CONNECTIVE TISSUE COMPONENTS OF SKELETAL MUSCLES:

- connective tissue surrounds and protects the muscle tissue.

Def: Fascia: a sheet or broad band of fibrous connective tissue beneath the skin or around muscles and other organs of the body: There are two types:

1. Superficial Fascia: immediately deep to the skin. Composed of areolar connective tissue.
   a. stores water and fat
   b. forms a layer of insulation that prevents heat loss
   c. provides mechanical protection against traumatic blows
   d. a pathway for nerves and blood vessels

2. Deep Fascia: composed of dense irregular connective tissue. It lines the body walls and extremities and also holds muscle together, separating then into functional groups. Three types of deep fascia.

   a. Epimysium: the outer most layer that surrounds the whole muscle.
   b. perimysium: surrounds bundles or fascicles of 10-100 or more individual muscle fibers.
   c. endomysium: separates each muscle fiber from each other.

Def: Tendon: a cord of dense connective tissue that attaches a muscle to the periosteum of a bone. All three layers of deep fascia may extend beyond the muscles fibers as a tendon.

Def: Aponeurosis: A tendon that extends as a broad flat layer that attaches to bone, another muscle, or skin. Example is the galea Aponeurotica

Def: Tendon Sheath: These are tubes of fibrous connective tissue which contain synovial fluid. They reduce friction as tendons slide back and forth. Found in the wrist and ankle.

THE MOTOR UNIT AND THE NEUROMUSCULAR JUNCTION

1. Nerve and blood supply: skeletal muscles are well supplied with nerves and blood vessels. Capillaries are plentiful in the epimysium and are responsible for delivering oxygen and nutrients and removal of waste products.
   Def: Motor Neuron: those neurons that stimulate muscles to contract
   Def: Motor unit: a motor neuron plus all the muscle fibers it stimulates.
   one motor neuron makes contact with an average of 150 muscle fibers. Muscles which require precise movements have many small motor units (approximately 2-3 muscle fibers) and muscles which are responsible for gross movements such as biceps and gastrocnemius may have as many as 2000 fibers per neuron.

2. Neuromuscular junction: A synapse formed between a motor neuron and a skeletal muscle. AKA myoneural junction.
   a. synapse: the place where neurons and muscle fibers communicate and make contact.
   b. synaptic cleft: the gap between the neuron and the muscle fiber. Since there is a gap between the nerve and the muscle fiber the nerve impulse cannot jump from one to the other, so they must communicate by means of chemical substances called <u>neurotransmitters.</u>

   c. axon terminals: this is the terminal end of a motor neuron.
   d. motor end plate: the region of the muscle fiber membrane that is adjacent to the axon terminal.
   e. synaptic vesicles: membrane enclosed sacs found at the distal end of the axon terminal. Inside each

vesicle are thousands of neurotransmitter molecules. The main neurotransmitter is Acetylcholine ACh.

f. Sequence of events at the NMJ:

1. actions potential reaches the axon terminal
2. this causes fusion of the synaptic vesicle with the plasma membrane which then liberates it ACh
3. ACh diffuses into the synaptic cleft
4. Acetylcholine joins to acetylcholine receptors on the motor end plate
5. This opens a channel which allows sodium (cations) to pass through
6. this influx of sodium causes a muscle action potential that travels along the muscle cell membrane and causes contraction.

MICROSCOPIC ANATOMY OF MUSCLE TISSUES

1. Histology of muscle tissue

a. Typical microscopic examination of a skeletal muscle reveals hundreds to thousands of very long, cylindrical cells called myofibers.
1. Sarcolemma: plasma membrane
2. Sarcoplasm: myofiber cytoplasm
3. Nuclei: typical cell has many nuclei because of early embryonic fusion of muscle cells. These are found at the periphery of the cells.
4. mitochondria: power house of the cell. Main site where ATP is produced. ATP is the principal energy transferring molecule in living systems. When it transfers energy to a reaction it decomposes to ADP, a phosphate group, and Energy. ATP is produced from ADP and phosphate group using energy supplied from various decomposition reactions, particularly glucose.

ATP ---------- ADP + Phosphate + Energy
ADP + Phosphate + Energy ---------- ATP

5. Sarcoplasmic reticulum: A fluid filled system of tubules that surround each myofibril. In relaxed muscles it stores calcium. During muscle contraction it releases calcium into the sarcoplasm.
6. Myofibril: are the contractile elements of skeletal muscle. They contain three smaller structures called filaments:
   a. thin filament: composed of actin
   b. thick filament: composed of myosin
   c. elastic filament: composed of titin

Def: Sarcomere: The arrangement of myofilaments into compartments within a muscle fiber. These compartments do no run the entire length of the muscle fiber. This is the contractile unit of the skeletal muscle.

a. Areas within the sarcomere:
   1. Z discs: separate one sarcomere from the other
   2. A bands: dark area which extends from one end of the thick filaments to the other and includes portion of the thin filaments where they overlap.
   3. I bands: contain the rest of the thin filament but no thick filaments; The Z discs pass through the center of the I band.
   4. H zone: found in the center of each A band, contains thick but no thin filaments.
   5. M line: Divides the H Zone, formed by protein molecules that connect adjacent thick filaments.

b. Myosin: contractile protein that forms the thick filament.
shaped like two golf clubs twisted together, the tails point toward the M line in the center of the sarcomere; the heads (cross bridges) extend out toward the thin filaments.

c. Actin: contractile protein that forms the thin filament
-extends from anchoring points within the Z discs.
-contains two regulatory proteins, tropomyosin and troponin.
-actin molecules are shaped like kidney beans; actin molecules joint to form a coil or helix.
- on each actin molecule is a myosin binding site where the head of the myosin molecule can attach.
-in relaxed muscle tropomyosin covers the myosin binding sites on actin and thus blocks the cross bridges from attaching to the actin molecule.

1. Regulatory proteins
   a. Tropomyosin: a regulatory protein that covers the myosin binding site on an actin molecule in relaxed muscle.

b. Troponin: a regulatory protein that binds calcium that is released during a muscle contraction. It helps to change the shape of actin by moving tropomyosin out of the way so that the myosin heads can bind to the actin molecule to allow muscle contraction.

d. Elastic Filament: composed of the protein Titin. It anchors the thick filaments to the Z discs.

ORDER OF FIBERS:
Whole muscle: covered by epimysium
Fascicles: covered by the perimysium
Myofibers: covered by endomysium. Sarcolemma (cell membrane) is covered by the endomysium
Myofibrils: contractile elements surrounded by the sarcoplasmic reticulum
Myofilaments: actin and myosin which are located within the myofibrils

SLIDING FILAMENT MECHANISM:
1. During the muscle contraction myosin cross bridges (heads) pull on the thin filaments and slide them toward the H zone (center of the A band contains only thick filaments).
2. The thin filaments meet and overlap at the center of the sarcomere (M line) as they slide
3. Z discs then come toward each other.

THE ROLE OF CALCIUM IN MUSCLE CONTRACTION:
1. The sliding filament mechanism explains the mechanism of contraction, but the substance which starts and stops contraction is calcium: An increase in calcium in the sarcoplasm causes the sliding filament to start and a decrease in calcium in the sarcoplasm causes the sliding filaments to turn off.
2. How calcium affects the muscle contraction: 6 steps:
   a. a muscle action potential travels along the sarcolemma
   b. calcium release channels open up in the SR
   c. calcium floods the sarcoplasm around the thick and thin filaments
   d. calcium combines with troponin
   e. this causes the troponin/tropomyosin complex to change shape and uncover the myosin binding site on the actin molecules.
   f. the muscle contracts

THE POWER STROKE AND THE ROLE OF ATP IN MUSCLE CONTRACTION:
1. ATP from the mitochondria attaches to the myosin cross bridges (heads)
2. ATP is slit into ADP and Phosphate via an enzyme ATPase. The Energy reorients the myosin heads placing the myosin cross bridges in an activated state.
3. When calcium levels increase the troponin/tropomyosin complex moves allowing the activated myosin heads to bind to the actin molecules.
4. The myosin heads then swivel toward the center of the sarcomere. This swiveling is called the power stroke. As the heads swivel they release ADP, allowing another molecule of ATP to attach to the myosin head.
5. This process repeats over and over as long as there is enough ATP and as long as there is enough calcium.

RELAXATION OF MUSCLE TISSUE
1. The action potential stops
2. Acetylcholine esterase breaks down any ACh left in the synaptic cleft

3. calcium release channels close in the SR
4. calcium active transport pumps turn on in the SR and remove calcium from the sarcoplasm
5. calsequestrin (calcium binding protein) binds to calcium in the SR
6. As calcium levels decrease, troponin/tropomyosin complex slides back into place over myosin binding sites.

SOURCES OF ATP:

1. Little ATP is found inside the muscle fibers, there is only enough for a few seconds of contraction.
2. So there are 3 mechanisms to provide an increase in ATP.
   a. Phosphogen System:
      1. There is a molecule found in muscle called creatine phosphate which can give up a phosphate to any ADP molecule found in the muscle. This will convert it to ATP
      2. This system will produce enough energy for muscles to contract maximally for about 15 seconds (100 meter dash).
      3. CP + ADP ---------- ATP and creatine
   b. Glycogen-Lactic Acid System
      1. When muscle activity continues and the supply of creatine phosphate is depleted then glucose is catabolized to generate ATP.
      2. glucose passes into the muscle and undergoes Glycolysis which splits the glucose into two molecules of pyruvic acid. This is an anaerobic process (requires no oxygen).
      3. The pyruvic acid enters the mitochondria and is oxidized to form large amounts of ATP by the process of cellular respiration which is an aerobic process (utilizes oxygen).
      4. During some activities there is not enough oxygen to completely break down pyruvic acid. When this happens the pyruvic acid is converted into Lactic Acid.
      5. The lactic acid diffuses out of the muscle and into the blood. It is then picked up by the heart, kidney, and liver which convert it back into ATP. In addition the liver converts this lactic acid back to glucose.
      6. This system produces enough energy for 30-40 seconds of maximal muscle activity. (300 meter race)
   c. Aerobic System:
      1. For activity longer than 1/2 minute muscles depend on an aerobic system which requires oxygen.
      2. If sufficient oxygen is present enzymes in the mitochondria completely oxidize pyruvic acid into carbon dioxide, water, ATP, and heat. This is called cellular respiration.
      3. Although cellular respiration is slower than glycolysis it yields more ATP (36 molecules) from each glucose molecule.
      4. source of oxygen for muscles:
         a. myoglobin: oxygen carrying protein located in the muscle
         b. hemoglobin: oxygen carrying protein located in the blood. Oxygen diffuses into the muscle tissue.
      5. this system will run as long as there is enough oxygen present as well as nutrients.
      6. in activities lasting more than 10 minutes the aerobic system provides more than 90% of the ATP. Example would be jogging.

SUMMARY OF SKELETAL CONTRACTION:

1. Nerve Impulse travels down the axon to the axon terminals
2. Acetylcholine is released from the axon terminal
3. Acetylcholine diffuses across the synaptic cleft and binds with receptor sites on the sarcolemma
4. Muscle impulse travels along the sarcolemma
5. calcium ions are released from the sarcoplasm reticulum
6. this rapid influx of calcium causes a change in the configuration of the troponin on the actin filaments and exposes the myosin binding sites.
7. Simultaneously, the ATP on the myosin heads is broken down via ATPase causing myosin to be energized.
8. the myosin heads bind with actin.
9. the myosin head rotate in a power stroke to pull the actin toward the center of the myosin.
10. because actin is firmly anchored to the Z line, the Z lines move closer together and the sarcomere shortens. Remember the length of each myofilament remains the same, actin just slides over the myosin to decrease the length of the sarcomere.
11. a new ATP binds with the myosin, the cross bridges detach, and myosin continues to pull actin toward the center of the A band in a step by step or ratchet like manner
12. the cycle is repeated as long as the sarcolemma is stimulated by acetylcholine and there is sufficient ATP

OXYGEN CONSUMPTION AFTER EXERCISE:

1. during muscular exercise blood vessels in the muscles dilate causing an increase in blood flow and oxygen.
2. Oxygen delivery is sufficient up to a point, but when exertion is great the oxygen supply is not fast enough and cellular respiration cannot produce enough ATP.
3. following exercise heavy breathing continues for a period of time. Oxygen consumption is above resting levels. This time varies with the intensity of the exercise.
4. oxygen debt: the added oxygen taken in after exercise over and above the resting oxygen consumption. This extra oxygen has several jobs.
    a. converts lactic acid back to glycogen in the lever
    b. resynthesize creating phosphate and ATP
    c. replace oxygen removed from myoglobin

5. muscle fatigue: is the inability of a muscle to maintain its strength of contraction or tension.
    a. if a skeletal muscle or a group of muscles is overstimulated, the strength of a muscle becomes progressively weaker until the muscle can longer respond.
    b. factors which contribute to muscle fatigue include: insufficient oxygen, depletion of glycogen, buildup of lactic acid, failure of action potentials in the motor neuron to release acetylcholine, and unexplained fatigue mechanisms in the central nervous system.

ADJUSTING TENSION IN WHOLE MUSCLES

1. Twitch Contraction: Brief contraction of all the muscle fibers in a motor unit in response to a single action potential. It is seen in the laboratory using a myogram, which is a graphic recording of a muscles response to different stimuli: four parts of a myogram

a. latent period (lag time): this is the short period between the application of a stimulus and the beginning of a muscle contraction. It is during this time that calcium is being released into the sarcoplasm.

b. contraction period: the upward tracing that is beginning of the muscle contraction. It ends at the peak.

c. relaxation period: the downward tracing when muscle is relaxing following movement. this is the time when calcium is actively being transported into the sarcoplasmic reticulum.

d. refractory period: the period of lost excitability after contraction in which the muscle temporarily lose its excitability.

2. All or None Principle: When a muscle fiber receives sufficient stimuli to contract, all the sarcomeres with the motor unit will shorten at the same time and to its fullest extent. A greater stimulus will not elicit a greater contraction.

If there is insufficient stimulus than none of the sarcomeres will shorten. This applies to a single muscle fiber and not to a whole muscle. A muscle as a whole can have graded contractions (your arm muscles do not contract to the same extend when you lift a paper vs. a book). The amount of tension (force) that a skeletal muscle can develop depends on the frequency of stimulation of fibers by motor neuron, the length of muscle fibers before contraction, the number of muscle fibers contracting, and structural component of the muscle itself.

a. Threshold stimulus: minimum stimulus necessary to cause muscle fiber contraction
b. Subthreshold stimulus: al lesser stimulus that is unable to cause a muscle contraction

3. Graded Muscle Responses:
   a. The muscles in our bodies do not contact as a single jerky twitch contractions, instead they are relatively smooth and vary in strength as different demands are placed on the muscles.
   b. Muscles are graded in two ways:
      1. frequency of stimulation
      2. changing the strength of the stimulus

   c. Frequency of stimulation
      1. Wave summation: If two identical stimuli are delivered to a muscle in rapid succession, the second twitch will be stronger than the first. On the myogram, the second twitch appears to ride on the back of the first twitch

         This occurs because the second contraction is induced before the muscle has completely relaxed from the first contraction.

         Since the muscle is already partially contracted and more calcium is being released to replace calcium going back into the SR the contraction will be stronger than the first.

Tetanus: If the muscle is stimulated at an increasingly faster rate, the relaxation time becomes shorter and shorter and the degree of calcium in the sarcoplasm will become greater causing the thedegree of summation greater and greater. The contractions fuse into a smooth, sustained contraction.

Tetanus reflects the usual way muscles contract in the body.

   d. Changing the strength of the stimulus:

1. Multiple motor unit summation: The primary function of wave summation is to produce smooth, continuous muscle contractions. The force of contraction is controlled by multiple motor unit summation. If a whole muscle receives a stronger stimulus it causes the recruitment of more motor units which increase the force of the muscle contraction.

   def: Maximal stimulus: the strongest stimulus that produces increased contractile force. It represents the point at which all the muscle's motor units are recruited. Increasing the stimulus intensity beyond maximal stiumulus does not produce a stronger contraction.

e. Treppe (staircase effect): This is an increase in the force of muscle contraction in response to successive threshold stimuli of the same intensity but to far apart for tetany. This occurs if the muscle has rested for a prolonged period. Each of the first few contractions is stronger than the last. The increased force of contraction is partially due to the presence of additional calcium in the sarcoplasm. Calcium is released into the sarcoplasm faster than active pumps can remove calcium. We see this during warming up.

Definitions relating to muscles:

7. Muscle tone: the involuntary activation of a small number of motor units which causes sustained, small contractions that give firmness to a relaxed skeletal muscle.

a. Hypotonia: aka: flaccid: This refers to decreased or lost muscle tone. The muscles appear loose and fattened rather than rounded. Certain nervous system disorders can result in flaccid paralysis which shows up as a loss in muscle tone, loss of tendon reflexes, and atrophy (wasting away) of muscles.

b. Hypertonia: this is an increase in muscle tone that can be expressed in two ways:

1. spasticity: increased muscle tone (stiffness) associated with increased tendon reflexes, and pathological reflexes (Babinski). Can result in spastic paralysis where there is partial paralysis in which muscles demonstrate spasticity.
2. rigidity: increased muscle tone that has no affect on the reflexes.

c. Atrophy: wasting away of muscles. It is where the individual muscle fibers decrease in size due to a progressive loss of myofibrils.

1. disuse atrophy: is where muscle is lost from not using them like when a person is in a cast or is bedridden (due to a decrease in nerve flow to the muscles).
2. denervation atrophy: is where the nerve flow to a muscle is cut. When this happens in six months to two years the muscle will be 1/4 its original size and be replaced with connective tissue.

d. Hypertrophy: increase in the diameter of muscle fibers due to the production of more myofibrils, mitochondria, and sarcoplasmic reticulum etc... They are capable of more forceful contraction and result from forceful repetitive muscular activity.

e. Isotonic contraction: moving a constant load through the ranges of motion possible at a joint. During this type of contraction tension is constant and the length of the muscle changes.

1. concentric: the overall length of the muscle decreases during contraction
2. eccentric: the overall length of the muscle increases on contraction

f. Isometric contraction: occurs when a muscle does no or cannot shorten but the tension on the muscle increases greatly. The tension of the muscle never exceeds the weight load.

***** most muscle activities involve both isotonic and isometric contractions.

Muscle spindles and Golgi tendon Organ

1. Muscle spindles: specialized group of muscle fibers interspersed among the regular muscle skeletal muscle fibers. They are oriented parallel to the fibers
   - anchored to the endomysium and perimysium
   - Ex. is the stretch reflex: when a muscle is stretched the spindle sends a reflex back to the spinal cord. The impulse synapses with a motor neuron which returns to the agonist muscle which counteracts the stretch.

2. Golgi tendon Organ: Proprioceptor found at the junction of the tendon and the muscle. Protects the muscle from excessive tension. Excessive tension causes sensory impulse to the spinal cord. This neuron synapses with a motor neuron which returns to the antagonist muscle which counteracts the tension.

HOMEOSTASIS OF BODY TEMPERATURE:

Both skeletal and smooth muscles play an important part in maintaining body temperature.

1. smooth muscle:
   a. when smooth muscles in the walls of arterioles relax the arterioles dilate allowing more blood to flow to the skin. The heat is lost to the environment.
   b. when heat conservation is needed smooth muscle in the blood vessels contract and as a result less blood flows to the skin and less heat is lost to the environment.
   c. arector pilli muscles: these muscles attach to the skin. When they contract the raise the hair on the skin (goose bumps) as a form of insulation.
2. skeletal muscle:
   a. when skeletal muscles contract only a small amount of energy stored in body chemicals is utilized for movement, as much as 85% of the energy is released as heat. Some of this helps to maintain normal body temperature and excess heat is released by the skin and lungs.
   b. when body temperature decreases, shivering occurs which causes involuntary thermogenesis. Initiated in the hypothalamus it can raise heat production by several hundred percent.

TYPES OF SKELETAL MUSCLE FIBERS

1. General comments:
   a. skeletal muscle fibers are not all alike, they vary in structure and function. They also vary in color depending on their content of myoglobin (oxygen binding protein). Skeletal muscles with high myoglobin contents are called red muscle fibers. Red muscle fibers also have more mitochondria and capillaries. Those muscle fibers with low contents of myoglobin are called white muscles fibers.
   b. Skeletal muscles contract and relax at different velocities. A fiber is determined to be slow-twitch or fast-twitch depending on how rapidly it splits ATP.
   c. Muscles are classified into three types.
      1. Slow oxidative (I) fibers: also called slow twitch or fatigue resistant fibers. They are smallest in diameter and contain large amounts of myoglobin, many mitochondria, and many capillaries, therefore they look red and have a high capacity to generate ATP by the aerobic system (oxidative). They split ATP at a slow rate thus having a slow contraction velocity. Found in large numbers in postural muscles as in the neck muscles which hold the head upright.
      2. Fast oxidative (IIA) fibers: also called fast twitch A or fatigue resistant fibers. Intermediate in diameter. They contain large amounts of myoglobin, many mitochondria, and many capillaries, therefore these are red to pink and can generate large amounts of ATP by oxidation. They split ATP very fast and contraction velocity is very fast. Sprinters tend to have a large proportion of fast oxidative fibers in their leg muscles.
      3. Fast glycolytic (IIB) fibers: also called fast twitch B or fatigable fibers: Largest in diameter They have a low
         myoglobin content, few mitochondria, and few blood capillaries, but they contain large amount of glycogen. They are white in color and need to generate ATP by anaerobic processes (glycolysis). They split ATP at a fast rate and contraction is strong and rapid. Muscles of the arms contain many of these fibers.
   d. More general comments:
      1. most skeletal muscles of the body are a mixture of all three types of skeletal muscle fibers, but there proportion varies depending on the usual action of the muscle.
         For example:
         a. postural muscles of the neck, back, and legs have a high proportion of slow oxidative fibers.
         b. Muscles of the shoulders and arms are not constantly active but are used intermittently, usually for short periods of time to produce large amounts of tension such lifting or throwing. These muscles have a high proportion of fast glycolytic fibers.
         c. leg muscles provide both support and are also used for walking and running and have large numbers of both slow and fast oxidative fibers.
         d. the skeletal muscles of any one motor unit is are all the same type. But, the different motor units in a muscle may be recruited at different times, depending on need.
         e. endurance type exercises can transform some fast glycolytic (IIB) fibers into fast oxidative (IIA) fibers. These types of exercises cause cardiovascular and respiratory changes they do not increase muscle mass. Exercises such as weightlifting produce an increase in the size and strength of fast glycolytic fibers. The increase in size is due to an increase in the amounts of thin and thick filaments.

CARDIAC MUSCLE:

a. General comments
- principle tissue in the walls of the heart
- similar to skeletal muscle in that it is striated but involuntary
- property of autorhythmicity: which is the inherent alternating contraction and relaxation of muscle cells

b. Differences between cardiac and skeletal muscles
1. shape: quadrangular
shorter in length
larger in diameter
Y shaped branches
2. sarcoplasmic reticulum: present but less than in skeletal muscle. Ca++ is also transported into the sarcoplasm from the ECF
3. mitochondria: more present and larger than in skeletal muscle
4. nucleus: centrally located nucleus, may have two
5. myofibrils: same arrangement as skeletal muscles: have actin, myosin, and the same zones, bands etc.
6. two networks of cardiac muscles: cardiac cells branch and contract with each other but form two separate networks:
   a. Atrial network: forms the muscular walls and partitions of the upper chambers of the heart
   b. Ventricular network: forms the muscular walls and partitions of the lower chambers of the heart
7. Intercalated discs: cardiac muscle cells are held together by intercalated discs which are thickenings of the sarcolemma: two parts
   a. desmosomes: points which hold the cells together
   b. gap junctions: allow muscle action potential to spread from one muscle fiber to another
      - result is when single fiber of either network is stimulated, all of the other fibers in the network will become stimulated., thus each network contracts as a functional unit.
      - when fibers of the atria contract blood moves into the ventricles
      - when fibers of the ventricles contract blood moves into the lungs and body

c. Physiology of cardiac muscle
1. since the heart beats about 75 bpm without stopping it requires a constant supply of oxygen. Therefore it has more mitochondria which are larger than skeletal muscle. This way cardiac muscle can generate more ATP aerobically. Cardiac muscle can also use lactic acid to produce ATP.
2. Autorhythmicity: this property is under the control of the S-A node located in the right atrium of the heart. These are self excitable cells which set the pace of normal heart rate.
3. Contraction of cardiac tissue:
   a. cardiac muscle contraction is 10 to 15 times longer than in skeletal muscles because of prolonged delivery of calcium in the sarcoplasm. Calcium enters from the SR and ECF this causes prolonged contraction and relaxation.
   b. cardiac muscle has a long refractory period which allows for the heart chambers to fill and relax. Long refractory period also prevents the heart from going into tetany

SMOOTH MUSCLE

a. types of smooth muscle:

1. visceral (single-unit) smooth muscle
   -found in wrap around sheet that form part of the walls of small arteries and veins and hollow viscera such as stomach, intestines, uterus, and urinary bladder
   -these smooth muscles have gap junctions which allow muscle impulse to spread from cell to cell
   -these sheets of smooth muscles form large networks that contract together.
2. multi-unit smooth muscle
   -found in the walls of larger arteries, larger airways, arrector pilli muscles, and muscles which adjust the pupil diameter
   -consists of individual fibers each with its own motor neurons and a few gap junctions
   -stimulation of one multi-unit fiber causes contraction of only that fiber

b. Differences between smooth muscle and skeletal muscle

1. striations: no apparent striations under the microscope
2. myofibrils: smooth muscle has both thin and thick filaments; ratio is different: 10 to 15 thin filaments for every thick filament. Skeletal muscle is 2:1
3. intermediate filaments: a third filament which attaches to structures known as dense bodies which are similar to Z discs in skeletal muscles. Dense bodies are dispersed in the sarcoplasm and attached to the sarcolemma.
   - bundles of intermediate filaments stretch form one dense body to another
   - when the muscle contracts the sliding filament mechanism generates tension that is transmitted to the intermediate filaments. These pull on the dense bodies and contraction occurs in a corkscrew manner.
4. sarcoplasmic reticulum: little found in smooth muscle similar to cardiac muscle. Calcium comes from the SR and ECF in a slow manor therefore contraction will be slow and prolonged.
5. nucleus: single centrally located
6. shape: smaller than skeletal muscle, thicker in the middle and tapered at the ends

c. Regulation of smooth muscle:

- smooth muscle contraction is under involuntary control
- effected in response to stretching, hormones, changes in ph, changes in oxygen, carbon dioxide, and temperature.

MUSCLES OF THE BACK:

a. distinguished by the direction of the fibers and partly by their length. The long muscles are placed more superficially, the intermediate muscles more deeply, and the short muscles lie directly against the vertebrae.

Five Groups Of Back Muscles:

Group 1. Two muscles which help to form the musculature of the back, but in reality belong to the upper limb muscles.

Trapezius
Latissimus Dorsi

Group 2. Consists of three muscles which connect the upper extremity to vertebral column. They lie under cover of the trapezius muscle.

Levator Scapulae
Rhomboideus Major
Rhomboideus Minor

Group 3. The splenius muscles make up part of the deep muscles of the back and are concerned with movements of the head and neck. The Serattus muscles are active in respiration, not so much in spinal movement.

Splenius Capitis
Splenius Cervicis
Serratus Posterior Superior
Serratus Posterior Inferior

STUDENT NAME _____

<u>Trapezius Muscle</u>:

Origin:

_____

Insertion: upper: _____

middle: _____

lower: _____

Action: upper: _____

middle: _____

lower: _____

combined: _____

Nerve: Spinal Accessory Nerve (Cranial nerve 11) and branches of C3 and C4

Palpation: Described on Page 53 in the Trail Guide

Referred: upper trigger points: cause pain along the posterolateral aspect of the neck, behind the ear, and to the temples.

middle trigger points: pain toward the vertebrae and interscapular region

lower trigger points: pain in neck, suprascapular region, and interscapular region.

Clinical: sudden trauma: -car accident causes whiplash which overstretches muscle

sustained flexion and lateral flexion of head and neck

sustained elevation of the shoulders

STUDENT NAME _____

<u>Latissimus Dorsi Muscle</u>:

Origin:

_____

_____

_____

Insertion: _____

Action: _____

Nerve: thoracodorsal nerve

Palpation: Described on Page 55 in Trail Guide

Referred: concentrated in the area of the inferior angle of the scapula and may extend to the back of the shoulder and down the medial arm and forearm to the ulnar aspect of the hand including the ring and little fingers.

Clinical: pulling on cords of drapes daily, gardening such as pulling weeds, or hanging from a swinging rope

STUDENT NAME _____

Levator Scapula Muscle:

Origin:

_____

Insertion: _____

Action: _____

Reversed muscle action: _____

_____

Nerve: cervical nerve roots and branches of the dorsal scapular nerve

Palpation: Described on Page 53 in the Trail Guide

Referred: concentrated in the angle of the neck and along the vertebral border of the scapula.

Clinical: number one cause of stiff necks which is a result of spasm of levator scapula: causes

- psychological stress(weight-of-the-world-on-my-shoulders),
- using a cane that is to long, sleeping with the neck in a tilted position (on a sofa with the head on the armrest without adequate pillow support)

STUDENT NAME _____

Rhomboid Muscles:

Origin: minor: _____
major: _____

Insertion: minor: _____
_____

major: _____
_____

Action: _____

Nerve: dorsal scapular nerve

Palpation: Described on Page 62 in the Trail Guide

Referred: pain is concentrated medially to the vertebral border of the scapula and extend to the supraspinus area of scapula.

Clinical: - prolonged leaning forward

- chest surgery
- poor posture caused by overpowering by pectoralis muscle if only work out anterior muscles.

Student Name _____

Splenius Capitis:

Origin: _____
_____
_____

Insertion: _____
Action: Bilaterally: _____
Unilaterally: _____
Nerve: dorsal branches of the cervical nerves
Palpation: page 143 Trail Guide:

C: trigger points result from sudden direct trauma, by holding head and neck forward crooked position for a prolonged period. This muscle is vulnerable when they are tired and the overlying skin is exposed to cold.

R: referred pain to the vertex of the head

Student Name: _____

Splenius Cervicis:

Origin: _____
Insertion: _____
Action: bilaterally: _____
unilaterally: _____
Nerve: dorsal banches of the cervical nerves
Palpation: page 143 of the Trail Guide:

C: same as capitis

R: pain projected up to the occiput, diffusely through the cranium, intensely to he back of the orbit, and sometimes downward to the shoulder girdle and the angle of the neck.

Student Name: _____

Serratus Posterior Superior: is a very thin muscle lying under cover of the rhomboid muscles.

Origin: _____
_____
Insertion: _____
Action: _____
Nerve:
Palpation: Palpate from origin to insertion under the rhomboids

C: from overloading of the thoracic respiratory effort as by coughing.

R: referred pain is felt strongly deep under the upper portion of the scapula, often with extension to the back of the shoulder, the upper triceps, the elbow, and the ulnar side of the forearm and hand to the pinkie.

Student Name: _____

Serratus Posterior Inferior: Also a very thin muscle which lies under cover of the latissimus dorsi

Origin:

_____

_____

Insertion: _____

Action: _____

_____

Nerve:

Palpation: palpate from origin to insertion under the latissimus dorsi

C: results from acute back strain

R: referred pain is relatively uncommon, will be an annoying ache that remains after the trigger points from associated paraspinal muscles have been relieved. The patient radiates over and around the muscle.

Student Name: _____

Iliocostalis Lumborum

Origin: _____
_____
_____

Insertion: _____
_____
_____

Action: bilaterally: _____
unilaterally:_____

Nerve: dorsal rami of the lumbar nerve roots

Palpation: page 140 of the Trail Guide

R: pain referred to the mid-buttock

C: in the paraspinal muscles is caused by either sudden overload, as when lifting objects with the back wisted and flexed, or by sustained overload during stooping, or when these back muscles are maintained in a fully shortened position.

Student Name: _____

Iliocostalis Dorsi

Origin: _____

_____

Insertion: _____

_____

_____

Action: bilaterally: _____

unilaterally: _____

Nerve: dorsal rami of the thoracic nerve roots

Palpation: see iliocostalis lumborum

R: at the mid-thoracic level trigger point pain is upward toward the shoulder and laterally to the chest wall which on the left side can be misdiagnosed at angina or pleurisy on either side. At the low thoracic level trigger points refer pain upward toward the scapula, around to the abdomen, and downward over the lumbar area.
C: same as iliocostalis lumborum
Student Name: _____

Iliocostalis Cervicis

Origin: _____
_____
Insertion: _____
_____
_____
Action: bilaterally: _____
unilaterally: _____
Nerve: dorsal rami of the cervical nerve roots
Palpation: see iliocostalis lumborum

Student Name: _____

Longissimus dorsi:

Origin: _____
_____
Insertion: _____
_____
_____
Action: bilaterally: _____
unilaterally: _____
Nerve: dorsal rami of the thoracic nerve roots
Palpation: see iliocostalis lumborum

R: myofascial trigger points at the low thoracic level in refer pain strongly low in the buttock and sacroiliac region.

Student Name: _____

Longissimus cervicis:

Origin: _____
_____

Insertion: _____
_____
_____

Action: bilaterally: _____
unilaterally: _____

Nerve: dorsal rami of the cervical nerve roots

Palpation: see iliocostalis lumborum

Student Name: _____

Longissimus capitis:

Origin: _____
_____
Insertion: _____
_____
_____
Action: bilaterally: _____
unilaterally: _____
Nerve: dorsal rami of the cervical nerve roots
Palpation: see iliocostalis lumborum

Student Name: _____

Spinalis Dorsi:

Origin: _____
_____

Insertion: _____
_____
_____

Action: bilaterally: _____
unilaterally: _____

Nerve: dorsal rami of the thoracic nerve roots

Palpation: see iliocostalis lumborum

Student Name: _____

Spinalis Cervicis:

Origin: _____
_____
Insertion: _____
_____
_____
Action: bilaterally: _____
unilaterally: _____
Nerve: dorsal rami of the cervical nerve roots
Palpation: see iliocostalis lumborum

Student Name: _____

Spinalis Capitis: this muscle is inseparably fused with the semispinalis capitis

Origin: _____
_____

Insertion: _____
_____
_____

Action: bilaterally: _____
unilaterally: _____

Nerve: dorsal rami of the cervical nerve roots

Palpation: see iliocostalis lumborum

Student Name: _____

Semispinalis thoracics

Origin: _____
_____
Insertion: _____
_____
Action: _____
Nerve: dorsal rami of the thoracic nerves
Palpation:
R: no information
C: no information

Student Name: _____

Semispinalis Cervicis: (Thick mass of muscle lying under cover of the semispinalis capitis)

Origin:
_____
Insertion: _____
_____
Action: bilaterally: _____
unilaterally: _____
Nerve: dorsal rami of the cervical nerves
P: not palpable

R: refers pain over the occiput and towards the vertex
C: caused by sustained partial neck flexion when reading, writing, or sewing, holding head in a stooped posture, or gross trauma.
Student Name: _____

Semispinalis Capitis: (thick powerful muscle. Lies along the median plane in the back of the neck and the upper part of the trunk under cover of the trapezius and splenius, and medial to the longissimus capitis and cervicis)

Origin:

_____

_____

Insertion: _____
Action: bilaterally: _____
unilaterally: _____
Nerve: dorsal rami of the cervical nerves
Palpation: _____

R: travels forward like a band that half encircles the head and reaches the forehead over the eye.
C: same as semispinalis cervicis

Student Name: _____

Multifidus: (deep to the semispinalis which it resembles, except the fibers are shorter being 2-4 vertebrae levels in length: These fill the groove or either side of the spinous processes from the sacrum to C2)

Origin:

_____

_____

Insertion: _____

_____

A: bilaterally: _____

unilaterally: _____

Nerve: dorsal rami of the spinal nerves

Palpation: _____

R: low trigger point: pain centers on the spinous process at the segment level of the trigger point or in the lumbar region may be referred a few segments below the trigger point.
cervical trigger point: pain up to suboccipital region and sometimes down neck to upper vertebral border of scapula.
C: sudden overload for the lower trigger points or head forward for the upper trigger points.

Student Name: _____

Rotatores:

Origin:

_____

Insertion: _____

Action: bilaterally: _____

unilaterally: _____

Nerve: dorsal rami of the spinal nerves

Palpation:

R: thoracic rotatores: pain centers on spinous process at the segmental level of the transverse process
lumbar rotatores: pain may be referred a segmental below
C: overload
Student Name: _____

Interspinalis:

- in the cervical region they are short muscles interconnecting spinous processes. They are well developed between C2-C3 and C7-T1.
- in the thoracic region they are usually absent except for the first two and the last two vertebrae.
- in the lumbar region there are four pairs between the five lumbar vertebrae.

Action:

_____

Nerve: dorsal rami of spinal nerves
Palption: cannot palpate

Student Name: _____

Intertransversarii: small muscles running between adjacent transverse processes.

- Cervical: best developed in the cervical region
  actually have anterior and posterior intertransversarii
  seven pairs: C1-C2 through C7-T1
- Thoracic: poorly developed in the thoracic region
- Lumbar: in the lumbar region have medial and lateral intertransversarii
  from L1-L2 through L5

Action: bilaterally: _____
unilaterally: _____
Nerve: dorsal rami of the spinal nerves
Palpation: cannot palpate
R: no information
C: no information

Suboccipital muscles

Student Name: _____

Rectus capitis posterior major

Origin: _____
Insertion: _____
Action: bilaterally extends head
unilaterally turns face to the same side
Nerve: posterior rami of spinal nerves
Palpation: cannot palpate

R: pain is poor in definition that radiates from the occiput to the orbit
C: head flexion, sustained upward tilt, and abuse of rotation and tilt of the skull
Student Name: _____

Rectus capitis posterior minor

Origin:
_____
Insertion: _____
Action: tilts head backwards
Nerve: posterior rami of spinal nerves
Palpation:

R: same as rectus capitis posterior major
C: same as rectus capitis posterior major
Student Name: _____

Obliquus capitis superior

Origin:

_____

Insertion:_____

Action: _____

Nerve: posterior rami of the spinal nerves

Palpation:

R: same as rectus capitis posterior major
C: same as rectus capitis posterior major

Student Name: _____

Obliquus capitis inferior

Origin:

_____

Insertion: _____
Action: _____
Nerve: dorsal rami of the spinal nerves
Palpation: _____

R: same as rectus capitis posterior major

C: same as rectus capitis posterior major

1. Splenius Capitis: (295)
   - O: Lower half of the Ligmentum nuchae, spinous process of C7, and the spinous processes of the T1-T3
   - I: Mastoid process of the temporal bone and occipital bone
   - A: bilaterally: extension of the neck
     unilaterally: rotation of the head to the same side
   - N: dorsal branches of the cervical nerves
   - P: page 143 Trail Guide:
     Prone; locate upper fibers of the trapezius, isolate the lateral edge of the trapezius by having your partner extend his head slightly, ask your partner to relax and palpate lateral to the trapezius for the splenius capitis muscle oblique fibers following it to the mastoid and inferiorly through the trapezius.
   - C: trigger points result from sudden direct trauma, by holding head and neck forward crooked position for a prolonged period. This muscle is vulnerable when they are tired and the overlying skin is exposed to cold.
   - R: referred pain to the vertex of the head

2. Splenius Cervicis: 295
   - O: spinous processes of T3-T6
   - I: transverse processes of C1, C2, C3
   - A: bilaterally: extension of the neck
     unilaterally: rotation of the head to the same side
   - N: dorsal banches of the cervical nerves
   - P: page 143 of the Trail Guide: Can't palpate alone, must be done in conjunction with the Capitis Cradle the head with one hand while the other hand locates the lamina groove of the upper thoracic and cervical vertebrae. Passively extend the neck and palpate through the overlying trapezius fibers. The density of both splenii will be felt in the lamina groove.
   - C: same as capitis
   - R: pain projected up to the occiput, diffusely through the cranium, intensely to the back of the orbit, and sometimes downward to the shoulder girdle and the angle of the neck.

3. Serratus Posterior Superior: is a very thin muscle lying under cover of the rhomboid muscles. (614)
   - O: lower ligamentum nuchae, spinous processes of C7 through T2, and the
   - I: cranial border of the 2 through 5 ribs

A: raises ribs to increase thoracic cavity
N:
P: Palpate from O to I under cover of the rhomboids
C: from overloading of the thoracic respiratory effort as by coughing.
R: referred pain is felt strongly deep under the upper portion of the scapula, often with extension to the back of the shoulder, the upper triceps, the elbow, and the ulnar side of the forearm and hand to the pinkie.

4. Serratus Posterior Inferior: Also a very thin muscle which lies under cover of the latissimus dorsi at the junction of the thoracic and lumbar regions. (631)
O: spinous process of T11, T12, and L1 and the supraspinal ligament.
I: inferior borders of the last four ribs
A: draws ribs outward and downward counteracting the inward pull of the diaphragm
N:
P: palpate from origin to insertion under the latissimus dorsi
C: results from acute back strain
R: referred pain is relatively uncommon, will be an annoying ache that remains after the trigger points from associated paraspinal muscles have been relieved. The patient radiates over and around the muscle.

Group 4. This group of deep muscles actually is represented by a single large muscle known as the Sacrospinalis (Erector Spinae). As the sacrospinalis ascends upwards, it divides into three columns which gradually diminish in size as they are inserted into the vertebrae and ribs.

Lateral Column	Intermediate Column	Medial Column
Iliocostalis Lumborum	Longissimus Dorsi	Spinalis Dorsi
Iliocostalis Dorsi	Longissimus Cervicis	Spinalis Cervicis
Iliocostalis Cervicis	Longissimus Capitis	Spinalis Capitis

1. Iliocostalis Lumborum (636)
O: anterior surface of a broad and thick tendon which originates from the sacrum, spinous processes of the lumbar and the T11 and T12 vertebrae, and from the medial lip of the iliac crest.
I: by tendinous slips into the inferior borders of the angles of the lower six ribs
A: bilaterally: extension of the spine
unilaterally: lateral flexion of the spine
N:
P: Palpation of the Erector Spinae Group: page 140 of the Trail Guide

R: pain referred to the mid-buttock
C: in the paraspinal muscles is caused by either sudden overload, as when lifting objects with the back wisted and flexed, or by sustained overload during stooping, or when these back muscles are maintained in a fully shortened position.

2. Iliocostalis Dorsi
O: by flat tendons from the upper borders of the angles of the six lower ribs (medial to the insertion of the iliocostalis lumborum)
I: into the upper borders of the angles of the upper six ribs and posterior surface of the transverse process of C7.
A: bilaterally: extension of the spine
unilaterally: lateral flexion of the spine
N:
P: see iliocostalis lumborum
R: at the mid-thoracic level trigger point pain is upward toward the shoulder and laterally to the

chest wall which on the left side can be misdiagnosed at angina or pleurisy on either side. At the low thoracic level trigger points refer pain upward toward the scapula, around to the abdomen, and downward over the lumbar area.

C: same as iliocostalis lumborum

3. Iliocostalis Cervicis

O: from the angles of the 3rd, 4th, 5th, and 6th ribs medial to the iliocostalis dorsi
I: into the transverse processes of the 4th, 5th, and 6th cervical vertebrae
A: bilaterally: extension of the spine
unilaterally: lateral flexion of the spine
N:
P: See iliocostalis lumborum
R: no information
C: no information

4. Longissimus dorsi:

O: through common tendons with iliocostalis and spinalis from the spinous processes of the sacrum and lumbar vertebrae.
I: into the tp's of the lumbar and thoracic vertebrae and into the lower ten ribs between their tubercles and angles
A: bilaterally: extension of the spine
unilaterally: lateral flexion of the spine
N:
P: See iliocostalis lumborum
R: myofascial trigger points at the low thoracic level in refer pain strongly low in the buttock and sacroiliac region.

5. Longissimus cervicis:

O: by long, thin tendons from the transverse processes of the upper six thoracic vertebrae
I: by long tendons into the second to the sixth cervical transverse processes
A: bilaterally: extension of the spine
unilaterally: lateral flexion of the spine
N:
P: see iliocostalis lumborum
R: no information
C: no information

6. Longissimus capitis:

O: from tp's of T4-T6 and the articular processes of the lower four cervical vertebrae
I: mastoid process
A: bilaterally: extension of the spine
unilaterally: lateral flexion of the spine
N:
P: see iliocostalis lumborum
R: no information
C: no information

7. Spinalis Dorsi:
   O: by means of three to four tendons from the spinous process of the lower two thoracic and upper two lumbar vertebrae
   I: the spinous processes of the upper six thoracic vertebrae
   A: bilaterally: extension of the spine
      unilaterally: lateral flexion of the spine
   N:
   P: see iliocostalis lumborum
   R: no information
   C: no information

8. Spinalis Cervicis:
   O: spinous processes from C7, T1, and T2
   I: spinous processes of C2 and C3
   A: bilaterally: extension of the spine
      unilaterally: lateral flexion of the spine
   N:
   P: see iliocostalis lumborum
   R: no information
   C: no information

9. Spinalis Capitis: this muscle is inseparably fused with the semispinalis capitis
   O: with the semispinalis capitis: C7 and T1-T6 transverse processes and the articular processes of the 4th, 5th, and 6th cervical vertebrae
   I: with the semispinalis capitis: occiput
   A: bilaterally: extension of the spine
      unilaterally: lateral flexion of the spine
   N:
   P: see iliocostalis lumborum
   R: no information
   C: no information

Group 5. The fifth group includes deep muscles of the back with fibers running mainly upward and medially and are relatively short muscles.

- Semispinalis
- Multifidus
- Rotatores
- Interspinalis
- Intertransversrii
- Sub-Occipital Muscles
  - Rectus Capitis Posterior Major
  - Rectus Capitis Posterior Minor
  - Obliquus Capitis Superior
  - Obliquus Capitis Inferior

1. Semispinalis thoracics
   O: transverse processes of the 6th through 10th thoracic vertebrae
   I: spinous processes of the 1st through the 4th thoracic and 6th and 7th cervical vertebrae
   A: extends the spine and rotates it toward the opposite side
   P: not palpable
   R: no information
   C: no information

2. Semispinalis Cervicis: Thick mass of muscle lying under cover of the semispinalis capitis
   O: transverse processes of the upper six thoracic vertebrae
   I: spinous processes of axis with some tendons inserting into the third, fourth, and fifth cervical spinous processes
   A: bilaterally: extends neck
   unilaterally: rotates neck and head to the opposite side
   P: not palpable
   R: refers pain over the occiput and towards the vertex
   C: caused by sustained partial neck flexion when reading, writing, or sewing, holding head in a stooped posture, or gross trauma.

3. Semispinalis Capitis: thick powerful muscle. Lies along the median plane in the back of the neck and

the upper part of the trunk under cover of the trapezius and splenius, and medial to the longissimus capitis and cervicis.

O: C7 and T1-T6 transverse processes and the articular processes of the 4th, 5th, and 6th cervical vertebrae
I: occiput
A: bilaterally: extends the head
unilaterally: rotates the head toward the opposite side
P: not palpable
R: travels forward like a band that half encircles the head and reaches the forehead over the eye.
C: same as semispinalis cervicis

4. Multifidus: deep to the semispinalis which it resembles, except the fibers are shorter being 2-4 vertebrae levels in length: These fill the groove or either side of the spinous processes from the sacrum to C2.

O: from the sacrum, PSIS's, and transverse processes of all the vertebrae
I: spinous processes of all the vertebrae, inserting 2-4 vertebrae above the origin.
A: bilaterally: extension of the spine
unilaterally: rotation of the spine to the opposite side
P: cannot palpate
R: low trigger point: pain centers on the spinous process at the segment level of the trigger point or in the lumbar region may be referred a few segments below the trigger point.
cervical trigger point: pain up to suboccipital region and sometimes down neck to upper vertebral border of scapula.
C: sudden overload for the lower trigger points or head forward for the upper trigger points.

5. Rotatores:

O: transverse processes of all vertebrae
I: into the spinous process directly above the origin
A: bilaterally: extension of spine
unilaterally: rotation of spine to opposite side
P: cannot
R: thoracic rotatores: pain centers on spinous process at the segmental level of the transverse process
lumbar rotatores: pain may be referred a segmental below
C: overload

6. Interspinalis:

- in the cervical region they are short muscles interconnecting spinous processes. They are well developed between C2-C3 and C7-T1.
- in the thoracic region they are usually absent except for the first two and the last two vertebrae.
- in the lumbar region there are four pairs between the five lumbar vertebrae.

A: extension of the spine
P: cannot palpate
R: no information
C: no information

7. Intertransversarii: small muscles running between adjacent transverse processes.
- Cervical: best developed in the cervical region
- actually have anterior and posterior intertransversarii
- seven pairs: C1-C2 through C7-T1
- poorly developed in the thoracic region
- in the lumbar region have medial and lateral intertransversarii from L1-L2 through L5

A: bilaterally makes spine rigid
unilaterally: lateral bending to the same side
P: cannot palpate
R: no information
C: no information

8. Suboccipital muscles

a. Rectus capitis posterior major
O: spinous process of axis
I: inferior nuchal line lateral to the rectus capitis minor
A: bilaterally extends head
unilaterally turns face to the same side
P: cannot palpate
R: pain is poor in definition that radiates from the occiput to the orbit
C: head flexion, sustained upward tilt, and abuse of rotation and tilt of the skull

b. Rectus capitis posterior minor
O: posterior tubercle of the atlas
I: medial nuchal line of occiput above the foramen magnum
A: tilts head backwards
P: cannot palpate
R: same as rectus capitis posterior major
C: same as rectus capitis posterior major

c. Obliquus capitis superior
O: upper C1 transverse process
I: lateral space between superior and inferior nuchal line
A: bends head backward and laterally to the same side
P: cannot palpate
R: same as rectus capitis posterior major
C: same as rectus capitis posterior major

d. Obliquus capitis inferior
O: spinous process of axis
I: transverse process of C1
A: rotate the atlas to the same side
P: cannot palpate
R: same as rectus capitis posterior major
C: same as rectus capitis posterior major

MYOLOGY 1
DR. STEVEN HAFFNER

Muscle tone: *the involuntary activation of a small number of motor units which causes sustained, small contractions that give firmness to a relaxed skeletal muscle.*

a. Hypotonia: aka: *flaccid: This refers to decreased or lost muscle tone. The muscles appear loose and fattened rather than rounded. Certain nervous system disorders can result in flaccid paralysis which shows up as a loss in muscle tone, loss of tendon reflexes, and atrophy (wasting away) of muscles.*

b. Hypertonia: *this is an increase in muscle tone that can be expressed in two ways:*
   1. spasticity: *increased muscle tone (stiffness) associated with increased tendon reflexes, and pathological reflexes (Babinski). Can result in spastic paralysis where there is partial paralysis in which muscles demonstrate spasticity.*
   2. rigidity: *increased muscle tone that has no affect on the reflexes*.

c. Atrophy: *wasting away of muscles. It is where the individual muscle fibers decrease in size due to a progressive loss of myofibrils.*
   1. disuse atrophy: *is where muscle is lost from not using them like when a person is in a cast or is bedridden (due to a decrease in nerve flow to the muscles).*
   2. denervation atrophy: *is where the nerve flow to a muscle is cut. When this happens in six months to two years the muscle will be 1/4 its original size and be replaced with connective tissue.*

d. Hypertrophy: *increase in the diameter of muscle fibers due to the production of more myofibrils, mitochondria, and sarcoplasmic reticulum etc... They are capable of more forceful contraction and result from forceful repetitive muscular activity.*

e. Isotonic contraction: *moving a constant load through the ranges of motion possible at a joint. During this type of contraction tension is constant and the length of the muscle changes.*

1. concentric: *the overall length of the muscle decreases during contraction*
2. eccentric: *the overall length of the muscle increases on contraction*

f. Isometric contraction: *the muscle con or does no shorten but the tension on it increases greatly. The tension of the muscle never exceeds the weight load.*

MYOLOGY 1
STEVEN HAFFNER, D.C.

Soft Tissue Injuries

A. Ligament injuries:
1. def of sprain: *overstretching of a ligament, caused by sudden twisting or wrenching of a joint while the muscles are off guard. A number fibers are ruptured. The more ruptured the more serious the sprain.*

2. Healing of ligaments: *is slow due to their poor blood supply and they are repaired with fibrous scar tissue. Complete ruptures must be surgically repaired. Adhesions can cause a loss of range of motion and ligaments can heal in a stretched position and joint stability can be lost.*
3. Clinical features:
   a. history: *a history of injury*
   b. pain: *increases when causative movement is repeated either passively or actively. With a chronic sprain, there is a dull ache which is constant or intermittent*.
   c. swelling: *rapid accumulation of tissue fluid when acute; with chronic sprain there is an area of thickened fluid over the injury.*
   d. bruising*: results from broken blood vessels*
   e. loss of function: *muscle splinting occurs to protect the area, joint instability may result from the injury; both passive and active movements are limited.*
4. Common sites of sprains: *cervical spine (whiplash), lumbar spine, and sacroiliac joint.*

B. Tendon injuries:
1. def of strain: *an overstretching of a tendon. These injuries are caused by trauma or can be spontaneous (degenerative changes).*
2. Clinical features
   a. type of pain: *sharp stabbing pain and tearing may be heard or felt*
   b. loss of function: *muscle will no longer produce function until healed*
   c. swelling and bruising:
3. Common sites of strains: *low back muscles, achilles tendon, hamstrings, rotator cuff, common*

extensor tendon (tennis elbow), and common flexor tendon (golfer's elbow).

C: Dislocations/Subluxations:

1. def of dislocation/luxation: *occurs when the articular surfaces are completely separated from each other so that all apposition is lost. Usually have serious injury around the joint.*
2. def of subluxation: *occurs when the articular surfaces are partially separated but there is still some part of each surface in contact. Usually there is little or no injury to the soft tissues around the joint. The joint is fixed (locked) in this malposition.*
3. causes of dislocations and or subluxations: *causes of both dislocations or subluxations is trauma, either direct or in the case of subluxation it can be due to repetitive minor trauma, toxins, or emotional stress.*
4. Clinical features:
   a. *pain, swelling, and loss of range of motion*
   b. *nerve or muscle injury*
   c. *recurrence is common*
5. Common sites of dislocations or subluxations: *vertebrae, shoulder, patella, and elbow*

Disc Disease

1. Anatomy of a disc: *consists of a layer of fibrocartilage called the annulus fibrosus surrounding a jelly-like center called the nucleus pulposus.*
2. Causes of disc injury: *damage to the annulus is due to trauma, degenerative changes, misalignment, and postural stress. These result in injury and possibly bulging or herniation of the disc. Most common low back disc to be injured is the L5-S1 disc.*
3. Clinical features: *disc herniation produces compression on nerve roots or the spine directly resulting in spasm and circulatory changes that lead to an inflammatory response and severe pain. In the low back features include severe pain often radiating down the lower extremity, antalgic posture, muscle splinting, and pain on coughing, sneezing, or bearing down.*

Spinal Deformities (Lordosis, kyphosis, and scoliosis)

1. Factors which cause postural spinal deformities
   a. *muscle imbalance of the hips, pelvis, and abdomen*
   b. *psychological factors- particularly in children*
   c. *poor physical health or tiredness*
   d. *compensation for another deformity or disorder*
2. Pathological kyphosis: def: *an increase in the posterior convexity of the thoracic spine*
   a. Hyperkyphosis:
      1. clinical findings: *contraction of chest muscles, protracted scapula, stretching of posterior spinal ligaments, traps, rhomboids, erector spinae, and shortening of the anterior spinal ligaments.*
      2. complications: *chronic lung conditions, cardiac problems, and psychological effects.*
   b. Dowager's hump: *common in elderly women with osteoporosis*
   c. Kyphosis Angularis/Hunchback: *caused by an inflammatory disease of the vertebral column, most commonly Pott's disease (TB of the spine).*
   d. Adolescent Kyphosis (Scheuermann's Disease): *A type of ischemic necrosis of unknown cause. Occurs in boys 12 to 16 years, usually affects the growth plate of three to five vertebrae in the mid-thoracic region, spontaneous remission results in wedge-shaped vertebrae.*
3. Pathological lordosis:
   a. Hypolordosis: *a decrease or loss of the cervical lordosis*.
   b. Hyperlordosis: *increase in the cervical lordosis. Caused by poor posture and an anterior pelvic tilt,*

the erector spinae, quadriceps, and psoas are hypercontracted and the abdominals, hamstrings, and gluteals are stretched.

4. Swayback: *pelvis tilts forward and instead of producing a lordosis the spine bend backward at the lumbosacral angle and produces a thoracic kyphosis.*
5. Flatback: *backward tilt of the pelvis causes all curves to decrease producing a "ramrod" spine. Abdominal muscles are tight and the low back muscles are stretched out.*
6. Scoliosis: def: *A lateral compensation or distortion of the vertebral column combined with rotation of the vertebrae.*
   a. Curves: *named for the side of convexity, can be "C" or "S" curves.*
   b. Causes:
      1. congenital: *misshapen vertebrae or pelvis or anatomical short leg*
      2. anatomical: *deformities that occur due to trauma or disease (fracture, Pott's disease, polio, or paralysis).*
      3. functional: *no organic reason. Can be caused by posture, occupation (dentist, mailman), or antalgic.*
      4. idiopathic scoliosis: *80% of all scoliosis is idiopathic, affecting predominantly girls 8 to 13 years of age. develop an abnormal gait or limp, misalignment of shoulders and hips, winged scapulas, uneven rib cage, etc..*

Arthropathies: Joint Disease

1. Arthritis: *Joint inflammation*
   a. 5 types:
      1. traumatic arthritis: *a.k.a. synovitis (Ex. could cause "water on the knee")*
      2. infectious arthritis: *can have rapid changes in the joint; an emergency condition, must have antibiotics as soon as possible, joint can be totally destroyed in two to three days or gradual destruction as in Lyme disease.*
      3. inflammatory arthritis: *arthritis of unknown cause, may be an autoimmune disease (Rheumatoid arthritis, Lupus, scleroderma, and ankylosing spondylitis)*
      4. degenerative arthritis: *a.k.a. DJD or Osteoarthritis: wear and tear on the joints produces non-inflammatory changes which lead to joint failure.*
      5. metabolic arthritis: *metabolic problem leads to the deposition of substances into the joint spaces producing joint pain. (Ex. Gout)*

Degenerative Spinal Disorders:

1. Spondylosis:
   a. def: *degenerative changes in the intervertebral joints between the bodies and the discs, often occurs with degenerative changes in the synovial joints of the articular facets.*
   b. etiology: *30 to 45 years of age, women more frequently than men, person is often anxious or worrying by nature.*
      1. predisposing factors: *poor posture associated with anxiety or habit, occupational stress, and body type.*
      2. common sites: *C4-T1, T4-T6, and L2-L5.*
   c. pathogenesis: *annulus fibrosus of the disc cracks, disc loses height, lipping of vertebral bodies, ligaments thicken and contract, and osteophytes form in the facets.*
   d. postural deformity: *head thrust forward, cervical spine is hyperextended, shoulder are held up and forward, kyphosis of the thoracic spine, lumbar spine flexed, pelvis tilted backwards, hips flexed, knees flexed, ankles dorsiflexed, and feet pronated.*
2. Spondylolysis:
   a. pars defect: *a defect in the pars interarticularis of the lumbar vertebrae. The pars is the portion of bone adjoining the inferior articular process and the lamina to the*

superior articular process and the pedicle.

b. etiology: *fatigue fracture or congenital abnormality, most common at L5-S1 and L4-L5. Usually an incidental finding on x-ray and no symptoms.*

3. Spondylolisthesis:

def: *condition in which the body of a vertebrae slips forward on the one below*

a. etiology: *depends on the integrity of the pedicle, pars interarticularis, and inferior articular facet*

1. separation: *spondylolysis leads to the separation of the pars interarticularis*
2. *subluxation: degenerative* changes lead to subluxation of the facet joints
3. underdevelopment: *congenital underdevelopment of the superior articular facets allows L5 to slip forward on the sacrum.*
4. fracture: *due to trauma*
5. pathological weakening: *either malignant or osteoporotic*

b. clinical features: *females more commonly than males, age 40+, backache with muscle spasm aggravated by standing or sitting. Relieved by lying down.*

Myofascial Trigger Points:

1. Trigger Point: def: *a nodule or knot in a taut band of fibers due to local ischemia and necrosis of tissue.*

2. Active vs. Latent: *if active the pain will radiate, if latent the nodule will be palpable*

3. Location of trigger point: *Trigger point can occur anywhere in a muscle or tendon*

4. Causes of trigger points

a. direct: *include acute overload, overwork, fatigue, chilling, or gross trauma*

b. indirect: *other trigger points, visceral disease, arthritic joints, and emotional distress*

5. Mechanism of trigger point: *abnormal or excessively stressful contraction of a muscle causes local compression of capillaries which produce local ischemia and results in inflammation of the area and necrosis of tissue. This local necrosis is palpable as a nodule with a taut band of fibers (local spasm due to inflammation). The pain of the trigger point causes a change in how a person moves or compensation of other muscles. This produces other trigger points called satellite trigger points. Treatment of the original trigger points will correct the satellite trigger points as well.*

6. Treatment: *correcting the local ischemia is the primary goal. Pressure is applied to flatten out the tissue but not enough to cause reflex contraction of the other parts of the body. The pressure is applied until a release of the tissue is felt. When the pressure is released the blood rushes back into the area and the ischemia is corrected. The pressure also helps to break up adhesions. Moist heat may be used in conjunction with manual pressure to improve circulation to the area.*

Muscles of the face and Scalp

Muscles in the Epicranial Area:

1. Frontalis:
Origin: Galea Aponeurotica
Insertion: skin superior to the supraorbital margin
Action: draws scalp forward
raises eyebrows
wrinkles skin of forehead horizontally
Palpation: O-I
Nerve: Facial Nerve
Referred: pain spreads upward and over the forehead on the same side
Clinical: trauma or secondary satellite trigger points from primary trigger points in the SCM

2. Occipitalis:
Origin: Occipital bone and mastoid process
Insertion: galea aponeurotica
Action: draws scalp backward
Palpation: O-I
Nerve: Facial Nerve
Referred: pain laterally and diffusely over the back of the head and through the cranium, causing deep pain in the orbit.
Clinical: from persistent contraction of the forehead and scalp muscles or eye strain.

3. Orbicularis Oculi:
Origin: medial wall of the orbit
Insertion: circular path around the orbit
Action: closes eye
Palpation: O-I
Nerve: Facial Nerve

Referred: pain to the nose
Clinical: results from secondary trigger point from the SCM or masticatory muscles

4. Corrugator Supercilii:
Origin: medial end of the superciliary arch of the frontal bone
Insertion: skin of the eyebrow
Action: draws eyebrow downward as in frowning
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

Student Name: _____

Muscles in the Epicranial Area:

1. **Frontalis**:

Origin: _____
Insertion: _____
_____
Action: 1. _____
2. _____
3. _____
Palpation: _____
Nerve: Facial Nerve
Referred: pain spreads upward and over the forehead on the same side
Clinical: trauma or secondary satellite trigger points from primary trigger points in the SCM

2. **Occipitalis**:

Origin:

_____

Insertion: _____

Action: _____

Palpation: _____

Nerve: Facial Nerve

Referred: pain laterally and diffusely over the back of the head and through the cranium, causing deep pain in the orbit.

Clinical: from persistent contraction of the forehead and scalp muscles or eye strain.

3. **Orbicularis Oculi**:

Origin:

_____

Insertion: _____

Action: _____

Palpation:

Nerve: Facial Nerve

Referred: pain to the nose

Clinical: results from secondary trigger point from the SCM or masticatory muscles

4. **Corrugator Supercilii**:

Origin:

_____

Insertion: _____

Action: _____

Palpation: _____

Nerve: Facial Nerve

Referred: None

Clinical: None

Student Name: _____

Muscles About the Nose

1. **Nasalis**:

Origin: Transverse part:

_____

Alar part: _____

Insertion: Transverse part: _____

_____

Alar part: _____

Action: _____

_____

Palpation:

Nerve: Facial Nerve

Referred: None

Clinical: None

2. **Procerus**:
Origin:
_____
Insertion: _____
Action: 1. _____
2. _____
Palpation: O-I
Nerve: Facial
Referred: None
Clinical: None

Student Name: _____

Muscles about the ear:

1. Temporoparietalis

Origin: _____
Insertion: _____
Action: _____
_____
Palpation:
Nerve: Facial Nerve
Referred: None

Clinical: None

2. Auriculares:

Origin: Anterior: _____
Superior: _____
Posterior: _____
Insertion: Anterior: _____
Superior: _____
Posterior: _____
Action: _____
Palpation: _____
Nerve: Facial Nerve
Referred: None
Clinical: None

Student Name: _____

Muscles about the mouth:

1. Buccinator:

Origin: _____
Insertion: _____
Action: 1. _____
2._____
Palpation:
Nerve: Facial Nerve
Referred: None
Clinical: None

2. Mentalis:

Origin: _____
Insertion: _____
Action: _____
Palpation: _____
Nerve: Facial Nerve
Referred: None
Clinical: None

3. Risorius:

Insertion: _____
Action: _____
_____
Palpation: _____
Nerve: Facial Nerve
Referred: None
Clinical: None

Student Name: _____

4. Zygomaticus: both major and minor

Origin: _____
Insertion:
_____
Action: _____
Palpation:
Nerve: Facial Nerve
Referred: Pain in an arc that extends along the side of the nose and upward over the bridge of the nose to the forehead.
Clinical: secondary to trigger points of the SCM and muscles of mastication

5. Levator Labii Superioris:

Origin: _____
Insertion: _____
Action: _____
Palpation: _____
Nerve: Facial Nerve
Referred: None
Clinical: None

6. Depressor Labii Inferioris:

Origin: _____
Insertion: _____
Action: _____
Palpation:
Nerve: Facial Nerve
Referred: None
Clinical: None

7. Depressor Anguli Oris:

Origin: _____
_____
Insertion: _____
Action: _____
Palpation:
Nerve: Facial Nerve
Referred: None
Clinical: None
Student Name: _____

8. Levator Anguli Oris:

Origin: _____
Insertion: _____
_____
Action: _____
Palpation:
Nerve: Facial Nerve
Referred: None
Clinical: None

9. Platysma:

Origin: _____
_____
_____
Insertion: _____
Action: _____
_____
Palpation:
Nerve: Facial Nerve
Referred: strange prickling pain to the skin over the lateral surface and below the mandible
Clinical: secondary trigger points to primary trigger points in the SCM

10. Orbicularis Oris:

Origin: _____
Insertion: _____
_____
Action: 1. _____
2. _____
3. _____
4. _____
Palpation:
Nerve: Facial Nerve
Referred: None
Clinical: None

Muscles About the Nose

1. Nasalis:
Origin: Transverse part: middle of maxilla
Alar part: alar cartilage and skin of the nose
Insertion: Transverse part: into the muscles on the opposite side over bridge of nose
Alar part: skin at the point of nose
Action: maintains opening of external nares during forceful inspiration
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

2. Procerus:
Origin: Fascia of nasal bone
Insertion: skin between and above eyebrows
Action: draws down medial part of eyebrows and produces horizontal wrinkles over the bridge of the

nose.
Palpation: O-I
Nerve: Facial
Referred: None
Clinical: None

Muscles about the ear:

1. Temporoparietalis
Origin: temporal fascia above and anterior to the ear
Insertion: lateral border of the galea aponeurotica
Action: tightens scalp and draws back the skin of the temples
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

2. Auriculares:
Origin: Anterior: fascia of the temporal region
Superior: galea aponeurotica
Posterior: superior surface of mastoid
Insertion: Anterior: medial helix of ear
Superior: superior surface of auricle
Posterior: posterior surface of auricle
Action: retract and elevate ear
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

Muscles about the mouth:

1. Buccinator:
Origin: alveolar processes of the maxilla and mandible
Insertion: orbicularis oris
Action: compresses cheek (blowing air out of the mouth)
causes cheek to cave in (sucking on a straw)
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

2. Mentalis:
Origin: mandible
Insertion: skin of the chin
Action: elevates and protrudes lower lip
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

3. Risorius:
Origin: fascia over parotid gland
Insertion: skin at the angle of the mouth
Action: draws the angle of the mouth laterally as in tenseness (not really a muscle for smiling)
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

4. Zygomaticus: both major and minor
Origin: zygomatic bone
Insertion: skin at the angle of the mouth and orbicularis oris muscle
Action: draws mouth upward and outward as in smiling
Palpation: O-I
Nerve: Facial Nerve
Referred: Pain in an arc that extends along the side of the nose and upward over the bridge of the nose to the forehead.
Clinical: secondary to trigger points of the SCM and muscles of mastication

5. Levator Labii Superioris:
Origin: superior to the infraorbital foramen of maxilla
Insertion: orbicularis oris
Action: elevates upper lip (like Elvis)
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

6. Depressor Labii Inferioris:
Origin: mandible
Insertion: skin of lower lip
Action: depresses lower lip
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

7. Depressor Anguli Oris:
Origin: continuous with the platysma and the oblique line of the mandible
Insertion: angle of the mouth into orbicularis and skin
Action: depresses angle of the mouth as in grief
Palpation: O-I
Nerve: Facial Nerve

Referred: None
Clinical: None

8. Levator Anguli Oris:
Origin: below the infraorbital foramen of the maxilla
Insertion: angle of mouth with the orbicularis oris, depressor anguli oris, zygomaticus
Action: elevates angle of mouth
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

9. Platysma:
Origin: fibers interlace with the orbicularis oris, corner of the mouth, other facial muscles, and lower margin of the mandible.
Insertion: subcutaneous fascia of the upper thorax
Action: pulls angle of the mouth downward and the thoracic skin upward
Palpation: O-I
Nerve: Facial Nerve
Referred: strange prickling pain to the skin over the lateral surface and below the mandible
Clinical: secondary trigger points to primary trigger points in the SCM

10. Orbicularis Oris:
Origin: alveolar border of maxilla, septum of nose, and lateral mandible
Insertion: becomes continuous with other muscles at the angle of the mouth
Action: closes lips
compresses lips against teeth
protrudes lips
shapes lips during speech
Palpation: O-I
Nerve: Facial Nerve
Referred: None
Clinical: None

MYOLOGY 1
DR. STEVEN HAFFNER CONDITIONS OF THE HEAD

1. Headache:
a. Tension Headache:
- most common type of headache.
- Usually a steady non-pulsitile, unilateral or bilateral ache of described as a tightness, band-like, weight, pressure, drawing, or soreness of the head.
- May last weeks, months, or years. Produced by prolonged muscle contraction in the neck, back, head, or jaw. Also caused by physical or emotional stress such as being hunched over a desk or computer screen, cradling a phone, jutting head forward when driving, propping head while reading or watching television, eyestrain due to poor light, anxiety, and frustration.

b. Vascular Headaches:
1. Toxic Headache: most common type of vascular headache. Triggered by toxic substances or conditions, such as food, drinks, chemicals, or fumes.
2. Migraine Headache:
-12-15 million Americans suffer with migraine of which approximately 70% are female.
- Most common sites are the temples or forehead, usually unilateral. Can last a few minutes

to a few days
- prodromal symptoms: hallucinations, blurred vision, vertigo, photophobia, floaters, flushing as blood vessels to brain constrict and then suddenly dilate causing pounding headache.
- 50% of migraine sufferers have a family history.
- Women who suffer migraines, smoke and are on birth control pills have a 4x increase in strokes.
- triggers: hormonal changes, pregnancy, BCP, menopause, and diet.

3. Bell's Palsy: injury to the facial nerve (CN VII) resulting in facial paralysis, loss of taste, and loss in the ability to close the eyes. Injury can be due to trauma, infection, and exposure to cold.

4. Tic Douloureux: also called Trigeminal Neuralgia. Severe facial pain along the distribution of the CN V. May have paralysis to the muscles of mastication and loss of sensation to touch and temperature on the face.

5. TMJ Dysfunction: joint has a disc similar to the disc seen in the spine. Degeneration of the disc, physical trauma or emotional stress to the jaw muscles can produce a painful grating, popping, or locking of the jaw.

MYOLOGY 1
DR. STEVEN HAFFNER CLINICAL CONDITIONS OF THE NECK

1. Thoracic Outlet Syndrome: A group of inconsistent disorders characterized by subjective complaints of pain and paresthesias in the neck, shoulder, arm, and hand.
Causes: a. Scalenus anterior syndrome: brachial plexus and subclavian artery are compressed as they pass between the scalenus anterior and medius.
b. costoclavicular syndrome: brachial plexus and subclavian artery are compressed as they pass between the clavicle and first rib.
c. hyperabduction syndrome: compression of the brachial plexus and sublclavian upon repeated and prolonged hyperabduction of the arm.
d. pectoralis minor syndrome: pectoralis minor muscle spasm compresses the brachial plexus and subclavian artery as they pass by.
e. cervical rib: an elongated cervical transverse process or an extra rib at the C7 level may compress the neurovascular elements.

2. Torticollis: aka. wry or stiff neck
Def: a lateral deviation of the neck due to unilateral shortening of the SCM. The trapezius, scalenes,

and levator scapulae may be involved.
a. congenital form: spastic torticollis due to birth trauma causing a small tear in the SCM, it may require surgery if not identified immediately.
b. acquired form: most common, due to trauma (whiplash, strain, sprain etc...).

3. Whiplash: a hyperextension/hyperflexion injury of the cervical spine. It can also be caused by a hyperflexion/hyperextension injury.
a. cause- deceleration injury (head on MVA) or hit from behind
b. pathology: - hyperflexion stresses and possible rupture of the posterior neck muscles, ligaments, facet joint capsules, and if severe enough the nerve roots. There is compression of the anterior structures of the anterior cervical spine.

- hyperextension stresses the anterior part of the annulus fibrosis, anterior longitudinal ligament, and anterior neck muscles.

- if the neck is rotated or laterally bent at the time of injury the damage is MUCH more extensive.

c. clinical features:
1. neck pain which may not manifest immediately and may get progressively worse 2-4 days after the injury.
2. referred pain: radiates into the shoulders, scapula, one or both arms, or head.
3. paresthesia
4. dizziness
5. spasms of the neck and shoulder girdle muscles
6. loss of cervical range of motion
7. dysphagia (difficulty swallowing) may occur

MYOLOGY 1
DR. STEVEN HAFFNER COMMON CONDITIONS/MYOPATHIES

1. Tenosynovitis: inflammation of the tendons, tendon sheaths, and synovial membranes surrounding certain joints. Due to trauma, overuse, and strain. Commonly affects the wrists, elbows, shoulders, ankles, feet, and fingers.

2. Rigor Mortis: chemical deterioration of muscle fibers after death produces a state of rigidity in the muscle lasting approximately 24 hours. Calcium leaks from the sarcoplasmic reticulum, the filaments slide together and myosin binds to actin and cannot detach producing rigidity.

3. Hypotonia and Hypertonia: hypotonia is a loss of muscle tone, results in flaccidity. Hypertonia is an increase in muscle tone expressed as spasticity or rigidity.

4. Atrophy and Hypertrophy: - Atrophy: wasting of muscle tissue, a decrease in muscle fiber size due to a loss of myofibrils. Cause by disuse or denervation of muscle
- Hypertrophy: an increase in muscle fiber size caused by moderate to heavy exercise of the muscle.

5. Fibromyalgia: common nonarticular rheumatic disorder more common in women. Pain, tenderness, and

stiffness of the muscles, tendons, and surrounding soft tissues. Caused or aggravated by physical or mental stress, trauma, exposure to cold or dampness, poor sleep, or a rheumatic condition.

6. Myopathies:
   a. general characteristics:
      1. gross and progressive muscle weakness
      2. contracture and deformity due to muscle imbalances (spasm and paralysis)
      3. all are "incurable"
      4. eventually involve the respiratory muscles leading to infection- the usual cause of death
   b. Muscular Dystrophy: inherited progressive degenerative disease of muscles.
      -Duchenne Muscular Dystrophy is the most common type.
      -Effects only males (past through female hereditary line)
      - onset is 5 to 8 years of age and the cause is unknown
      -characterized by pseudo-hypertrophy of the calf and gluteal muscles. These muscles appear to be well developed but are actually degenerating and filling with connective tissue and fight.
      -patient develops contractures and scoliosis
      -patient is wheel chair bound in the teen years and usually die in their 20's
   c. Myasthenia Gravis: grave or serious muscle weakness. A disease of the neuromuscular junction resulting in progressive muscle weakness.
      - occurs in both males and females at any age
      - cause is unknown, may be autoimmune disease
      - there is no pathological lesion of muscle or nerve tissue.
      - muscle contraction becomes less forceful with repetition. Facial muscles are effected first, they become droopy and than flaccid. Then there is trouble focusing eyes, dysphagia, trunk, and then extremities finally weaken, and finally respiratory muscles.
      - long period of remission
      - treatment is medication, general massage, passive movements, breathing exercises, and trying to stop disuse atrophy.

7. Abnormal Contractions
   a. Spasm: sudden involuntary contraction of a single muscle in a large group of muscles attended by pain, and interference with function producing involuntary movement and distortion.
   b. cramp: a painful spasmodic contraction
   c. tremor: a rhythmic, involuntary, purposeless contraction of opposing muscle groups
   d. tic: a spasmodic twitching made involuntarily by muscles that are ordinarily under voluntary control, usually under psychological origin.

MYOLOGY 1 OUTLINE
DR. STEVEN HAFFNER LECTURE 1

1. Anatomical Position: def

2. Planes of the body:
   a. median
   b. sagittal
   c. coronal
   d. transverse
   e. oblique

3. Movements of body parts:
   a. flexion
   b. extension
   c. adduction
   d. abduction
   e. lateral flexion
   f. external rotation
   g. internal rotation

h. pronation
I. supination
k. circumduction
l. protraction
m. retraction
n. plantarflexion
o. dorsiflexion

4. Other anatomical reference points:
   a. medial
   b. lateral
   c. anterior
   d. posterior
   e. superior
   f. inferior
   g. proximal
   h. distal
   I. superficial
   j. deep

5. Joints:
   a. Synarthroses
      1. suture
      2. gomphosis
      3. synchondrosis
   b. Amphiarthrosis
      1. syndesmosis
      2. symphysis
   c. Diarthrosis
      1. ball and socket
      2. hinge
      3. gliding
      4. ellipsoid
      5. saddle
      6. pivot

MYOLOGY 1 OUTLINE
DR. STEVEN HAFFNER LECTURE 2

1. How skeletal muscles produce movement:
   a. general comments
   b. Def: Origin
   c. Def: Insertion
   d. Def: Belly

2. Lever system and leverage:
   a. general comment
   b. Def: Lever
   c. Def: Resistance
   d. Def: Effort
   e. Def: Fulcrum

3. Types of levers:
   a. First Class Lever:
   b. Second Class Lever:
   c. Third Class Lever:
   d. Def: Leverage

e. general comments on leverage

4. Group Actions
   a. general comments on group actions
   b. Def: Agonist
   c. Def: Antagonist
   d. Def: Synergist
   e. Def: Fixator

5. Types of muscle tissue
   a. Skeletal muscle
   b. Cardiac muscle
   c. smooth muscle

6. Functions of muscle tissue:
   a. motion
   b. stabilization of body position and regulation of organ volume
   c. thermogenesis
   d. movement of substances through the body

7. Characteristics of muscle tissue:
   a. excitability (irritability)
   b. contractility
   c. extensibility
   d. elasticity

8. Connective tissue components of skeletal muscles:
   a. Def: Fascia
      1. Superficial Fascia
      2. Deep Fascia
         a. Epimysium
         b. Perimysium
         c. Endomysium
   b. Def: Tendon
   c. Def: Aponeurosis
   e. Def: Tendon Sheath

9. Motor Unit and the Neuromuscular junction
   a. Nerve and blood supply to muscles
      1. general comments
      2. Def: Motor Neuron
      3. Def: Motor Unit
   b. Neuromusclular junction: aka: myoneural junction
      1. Def: neuromuscular junction
      2. components of the neuromuscular junction:
         a. synapse
         b. synaptic cleft

c. axon terminals
d. motor end plate
e. synaptic vesicles
1. Acetylcholine (ACh)

3. Sequence of events at the neuromuscular junction

MYOLOGY 1 OUTLINE
DR. STEVEN HAFFNER LECTURE 3

MICROSCOPIC ANATOMY OF MUSCLE TISSUES

1. Histology of muscle tissue
   1. sarcolemma
   2. sarcoplasm
   3. nuclei
   4. mitochondria
      a. ATP
   5. sarcoplasmic reticulum
   6. myofibrils
      a. thin filament
      b. thick filament
      c. elastic filament
2. Def: Sarcomere
   a. Areas within the sarcomere:
      1. Z Discs
      2. A bands
      3. I bands

4. H zone
5. M line

b. Myosin
-general comments

c. Actin
1. general comments
2. regulatory proteins
a. tropomyosin
b. troponin

d. Elastic Filament

3. Order of fibers
a. whole fibers
b. fascicles
c. myofibers
d. myofibrils
e. myofilamens

4. Sliding filament mechanism

5. Role of calcium in muscle contraction
a. general comments
b. how calcium affects muscle contraction (6 steps)

MYOLOGY 1 OUTLINE
DR STEVEN HAFFNER

1. The power stroke and the role of ATP in muscle contraction
a. 5 steps
2. Relaxation
1. acetylcholine esterase
2. calsequestrin
3. Source of ATP in muscle contraction
a. Phosphogen System
1. creatine phosphate
b. Glycogen-Lactic Acid System
1. glycolysis
c. Aerobic System
1. general comments
2. sources of oxygen in muscles
a. hemoglobin
b. myoglobin
4. Summary of skeletal muscle contraction
5. Oxygen consumption after exercise

a. general comments
b. oxygen debt

6. Muscle fatigue
   a. general comments

7. Adjusting tension in whole muscles
   a. twitch contraction
      1. general comments
      2. parts of a myogram
         a. latent period
         b. contraction period
         c. relaxation period
         d. refractory period
   b. All or none principle
      1. general comments
      2. threshold stimulus
      3. subthreshold stimulus
   c. Graded Muscle Response
      1. general comments
      2. frequency of stimulation

wave summation

tetanus

      3. changing the strength of the stimulus
         a. multiple motor unit summation
   d. treppe (staircase effect): def and general comments
   g. muscle tone: def
      1. hypotonia
      2. hypertonia
      3. atrophy
      4. hypertrophy
      5. isotonic contraction
      6. isometric contraction

8. Muscle spindles and Golgi tendon Organs
   a. Muscle spindles: stretch reflex
   b. Golgi tendon organs

9. Homeostasis of body temperature
   1. role of smooth muscle
      a. vasodilatation
      b. vasoconstriction
      c. arector pilli
   2. role of skeletal muscle

MYOLOGY 1 OUTLINE
DR. STEVEN HAFFNER LECTURE 5

1. Types of skeletal muscles:
   a. general comments
   b. three types of muscle fibers
      1. slow oxidative (I) fibers: aka slow-twitch fatigue resistant fibers
      2. fast oxidative (IIA) fibers: aka fast-twitch fatigue resistant fibers
      3. fast glycolytic (IIB) fibers: aka fast-twitch B fatigable fibers
   c. more general comments about the three skeletal muscle fibers

2. Cardiac muscle
   a. general comments
   b. differences between cardiac and skeletal muscles
      1. shape
      2. SR
      3. mitochondria
      4. nucleus

5. myofibrils
6. two networks of cardiac muscle fibers
   a. atrial network
   b. ventricular network
7. intercalated discs
   a. desmosomes
   b. gap junctions

c. physiology of cardiac muscle
1. use of oxygen in cardiac muscle
2. control of cardiac contraction and the sino-atrial node
3. contraction of cardiac muscle

3. Smooth muscle
a. types of smooth muscle
1. visceral (single-unit) smooth muscle
2. multi-unit smooth muscle

b. differences between smooth muscle and skeletal muscle
1. striations
2. myofibrils
3. intermediate filaments and dense bodies
4. SR
5. nucleus
6. shape

c. regulation of smooth muscle

MYOLOGY 1
DR. STEVEN HAFFNER

MUSCLES OF THE BACK

MUSCLES OF THE BACK

1. General Comments
2. Five groups of back muscles
   a. Group 1: Trapezius
      Latissimus Dorsi

   b. Group 2: Levator Scapulae
      Rhomboideus Major
      Rhomboideus Minor

   c. Group 3: Splenius Capitis
      Splenius Cervicis
      Serratus Posterior Superior
      Serratus Posterior Inferior

d. Group 4:

Lateral column	Intermediate column	Medial column
Iliocostalis lumborum	Longissimus dorsi	Spinalis dorsi
Iliocostalis dorsi	Longissimus cervicis	Spinalis cervicis
Iliocostalis cervicis	Longissimus capitis	Spinalis capitis

e. Group 5: Semispinalis
Multifidus
Rotatores
Interspinalis
Intertransversarii
Sub-Occipital Muscles
Rectus Capitis Posterior Major
Rectus Capitis Posterior Minor
Obliqquus Capitis Superior
Obliquus Capitis Inferior

MYOLOGY 1
DR. STEVEN HAFFNER

CONDITIONS OF SPINE

Soft Tissue Injuries

A. Ligament injuries:
1. def of sprain:
2. Healing of ligaments:
3. Clinical features:
   a. history:
   b. pain:
   c. swelling:
   d. bruising:
   e. loss of function:
4. Common sites of sprains:

B. Tendon injuries:

1. def of strain:
2. Clinical features
    a. type of pain:
    b. loss of function:
    c. swelling and bruising:
3. Common sites of strains:

C: Dislocations/Subluxations:

1. def of dislocation/luxation:
2. def of subluxation:
3. causes of dislocations and or subluxations:
4. Clinical features:
    a.
    b.
    c.
5. Common sites of dislocations or subluxations:

Disc Disease

1. Anatomy of a disc:
2. Causes of disc injury:
3. results of herniation:
4. clinical features

Spinal Deformities

1. Factors which cause postural spinal deformities
    a.
    b.
    c.
    d.
2. Pathological kyphosis: def
    a. Hyperkyphosis:
        1. clinical findings
        2. complications
    b. Dowager's hump:
    c. Kyphosis Angularis/Hunchback:
    d. Adolescent Kyphosis (Scheuermann's Disease:
3. Pathological lordosis: def
    a. Hypolordosis:
    b. Hyperlordosis:
4. Swayback: def
5. Flatback: def

6. Scoliosis: def:
   a. Clinical findings:
   b. Curves
   c. Causes:
      1. congenital:
      2. anatomical:
      3. functional:
      4. idiopathic scoliosis:

Arthropathies: Joint Disease

1. Arthritis:
   a. 5 types:
      1. traumatic arthritis: a.k.a. synovitis
      2. infectious arthritis:
      3. inflammatory arthritis
      4. degenerative arthritis: a.k.a. DJD or Osteoarthritis
      5. metabolic arthritis
   b. Inflammatory Arthritis: Rheumatoid Arthritis (RA),
      def:
      1. etiology:
      2. pathogenesis:
      3. clinical findings:
         a. initial findings:
         b. pain:
         c. tenderness:
         d. swelling
         e. warmth
         f. loss of motion
         g. muscle atrophy
         h. deformity

   c. Degenerative arthritis:
      def:
      1. etiology:
      2. predisposing factors:
         a.
         b.
         c.
         d.
         e.
         f.

      3. Pathogenesis:
         a. articular cartilage erosion
         b. bone eburnation
         c. synovial membrane

d. capsule
e. ligaments
f. muscles

4. Clinical findings:
   a. pain
   b. muscle spasm
   c. stiffness
   d. loss of range of motion
   e. muscle wasting and weakness:
   f. joint enlargement
   g. deformity
   h. crepitus
   I. loss of function

Degenerative Spinal Disorders:

1. Spondylosis:
   a. def:
   b. etiology
      1. predisposing factors:
      2. common sites
   c. pathogenesis:
   d. postural deformity:

2. Spondylolysis:
   a. pars interarticularis defect
   b. etiology
3. Spondylolisthesis:
   def:
   a. etiology:
      1. separation:
      2. subluxation:
      3. underdevelopment
      4. fracture
      5. pathological weakening
   b. clinical features:

Myofascial Trigger Points:

1. Trigger Point: def:
2. Active vs. Latent
3. Location of trigger point
4. Causes of trigger points

a. direct:
b. indirect
5. Mechanism of trigger point:
6. Treatment

MYOLOGY 1
DR. STEVEN HAFFNER

MUSCLES OF THE FACE/SCALP

1. Epicranius:
a. Frontalis
b. Occipitalis
c. Orbicularis Oculi
d. Corrugator Supercilii

2. Muscles around the nose:
Nasalis
1. Transverse Part
2. Alar Part
Procerus

3. Muscles around the ear:
a. Temporoparietalis
b. Auriculares

4. Muscles around the mouth:
a. Buccinator

b. Mentalis
c. Risorius
d. Zygomaticus
e. Levator Labii Superioris
f. Depressor Labii Inferioris
g. Depressor anguli Oris
h. Levator anguli Oris
I. Platysma
j. Orbicularis Oris

5. Muscles of Mastication: On Handout
   a. Temporalis
   b. Masseter
   c. Medial Pterygoid
   d. Lateral Pterygoid

6. Muscles that move the eyeball: On Handout
   a. Superior Rectus
   b. Inferior Rectus
   c. Superior Oblique
   d. Inferior Oblique

7. Conditions of the head and face:
   a. headache b. Bell's Palsy c. Tic Doloureux (Trigeminal Neuralgia) d. TMJ Dysfunction

MYOLOGY 1
DR. STEVEN HAFFNER MUSCLES OF THE NECK, THORAX, AND ABDOMEN

MUSCLES OF THE NECK

1. Anterior cervical
   a. Platysma
   b. Sternocleidomastoid
2. Suprahyoid:
   a. Digastricus
   b. Stylohyoid
   c. Mylohyoid
   d. Geniohyoid
3. Infrahyoid:
   a. Sternohyoid
   b. Sternothyroid
   c. Thyrohyoid
   d. Omohyoid
4. Anterior Vertebral
   a. Longus colli
   b. Longus capitis

c. Rectus capitis anterior
d. Rectus capitis lateralis
5. Lateral Vertebral
a. Scalenus anterior
b. Scalenus medius
c. Scalenus posterior
6. Conditions of the neck:
a. Thoracic outlet syndrome
b. Torticollis
c. Whiplash

MUSCLES OF THE THORAX
1. External Intercostals
2. Internal Intercostals
3. Subcostals
4. Transverse thoracics
5. Levator costarum
6. Serratus posterior superior
7. Serratus posterior inferior
8. Diaphragm

MUSCLES OF THE ABDOMEN
1. External Oblique
2. Internal Oblique
3. Transverse abdominis
4. Rectus abdominis
5. Quadratus lumborum

COMMON CONDITIONS/MYOPATHIES
1. Tenosynovitis 3. hypertonia/hypotonia 5. fibromyalgia 7. myasthenia gravis
2. Rigor mortis 4. hypertrophy 6. muscular dystrophies 8. abnormal contractionsStudent Name: _____

Longus Colli

O: Inferior Oblique Part: 1st, 2nd, or 3rd thoracic vertebral bodies
Superior Oblique Part: Anterior tubercles of the 3rd, 4th, and 5th cervical tp's
Vertical Part: Anterior aspects of the 5th, 6th, and 7th cervical vertebrae and the 1st, 2nd, and 3rd thoracic vertebral bodies.

I: Inferior Oblique Part: Anterior tubercles of the 5th, 6th, or 7th cervical tp's
Superior Oblique Part: Anterolateral surface of the anterior tubercle of C1.
Vertical Part: Anterior aspects of the 2nd, 3rd, and 4th cervical vertebrae.
A: Bilaterally: flexes the cervical vertebrae
Unilaterally: Assits in contralateral rotation and in lateral flexion
P: Not palpable
R: None
C: None

2. Longus Capitis

O: Anterior tubercles of the tp's of the 3rd-6th cervical vertebrae
I: Inferior surface of the basilar portion of the occipital bone

A: Bilaterally: Flexes the head and cervical spine
Unilaterally: Rotates and laterally flexes the head to the same side
P: Not palpable
R: None
C: None

3. Rectus Capitis Anterior

O: Anterior surface of the lateral mass of the atlas and the root of its tp.
I: Inferior surface of the basilar part of the occipital bone anterior to the occipital condyle
A: Aids in flexion of the head at the neck
P: Not palpable
R: None
C: None

4. Rectus Capitis Lateralis

O: Superior surface of the tp of the atlas
I: inferior surface of the jugular process of the occipital bone
A: Aids in lateral flexion of the head on the neck
P: Not palpable
R: None
C: None

Scalenus Anterior (This muscle is a secondary muscle of inspiration)

O: Anterior tubercles of the tp's of C2 through C6
I: Anterior surface of the first rib on the scalene tubercle
A: From above assists in elevating the first rib. From below flexes the neck and rotates the head to the opposite side (by pulling the tp's forward)
P: Not Palpable
R: From all three scalanes the pain can radiate anteriorly, laterally, or posteriorly.
Anteriorly: persistent aching pain through the pectoral region
Laterally: down the front and back of the arm, skipping the elbow to the radial forearm, and extending to the thumb and index finger.
Posteriorly: pain is referred to the upper vertebral border of the scapula
C: Pulling, lifting, tugging, by overuse of these secondary respiratory muscles as in coughing

Scalenus Medius (This muscle is a secondary muscle of inspiration)

O: Posterior tubercles of the tp's of C2 through C7
I: Superoir surface of the first rib behind the sublcavian groove
A: From above assists in elevating the first rib. From below flexes bilaterally and laterally flexes the neck unilaterally
P: Not Palpable
R: See Scalenus Anterior

Scalenus Posterior (This muscle is a secondary muscle of inspiration)

O: Outer surface of the 2nd rib behind the insertion of the Scalenus Anterior
I: Posterior tubercles of the tp's of C4-C6.
A: Lateral flexion to the same side and elevaton of the second rib.
P: Not Palpable
R: See Scalenus Anterior

Student Name: _____

Sternocleidomastoid:

Origin: _____
_____

Insertion: _____
_____

Action: Bilaterally: _____
Unilaterally: _____

Nerve: ventral rami of the cervical nerves and CN XI

P: Described on page 172 of the Trail Guide

Referred Pain: Sternal Portion: pain to vertex, occiput, across cheek, over the eye, to throat, and the sternum
Clavicular Portion: frontal headaches and earache
Clinical: mechanical overload, trauma

Student Name: _____

Suprahyoid muscles:

1. **Mylohyoid**
Origin: _____
Insertion:
_____
Action: _____
Nerve: CN V
P: Described on page 178 of the Trail Guide

2. **Geniohyoid**
Origin: _____
Insertion: _____
Action: _____
Nerve: CN IX

P: Not palpable: located deep to mylohyoid

3. **Digastric**
Origin: Anterior Belly: _____
Posterior Belly: _____
Insertion: _____
Action: _____
Nerve: Anterior belly CN V
Posterior belly CN VII
P: Described on page 179 of the Trail Guide

4. **Stylohyoid**
Origin:_____
Insertion: _____
Action: _____
Nerve: CN VII
P: Palpate from origin to insertion

Student Name: _____

Infrahyoid muscles:

1. **Thyrohyoid**
Origin: _____
Insertion:
_____
Action: _____
Nerve: CN XII and ansa cervicalis
P: Palpate from origin to insertion

2. **Sternohyoid**
Origin: _____
Insertion: _____

Action: _____
Nerve: ansa cervicalis
P: Described on page 180 of the Trail Guide

3. **Sternothyroid**
Origin: _____
Insertion: _____
Action: _____
Nerve: ansa cervicalis
P: Described on page 180 of the Trail Guide

4. **Omohyoid**
Origin:_____
Insertion: _____
Action: _____
Nerve: ansa cervicalis
P: Palpate from origin to insertion

Student Name: _____

Longus Colli
Origin: Inferior Oblique Part: _____
_____
Superior Oblique Part: _____
_____
Vertical Part: _____
_____
_____

Insertion: Inferior Oblique Part: _____
_____

Superior Oblique Part: _____

_____

Vertical Part: _____

_____

Action: Bilaterally: _____

Unilaterally: _____

Nerve: ventral rami of the cervical nerves

P: Not palpable

Longus Capitis

Origin: _____

_____

Insertion: _____

_____

Action: Bilaterally: _____

Unilaterally: _____

Nerve: ventral rami of the cervical nerves

P: Not palpable

Student Name: _____

Rectus Capitis Anterior

Origin: _____

_____

Insertion: _____

_____

Action: _____

Nerve: Ventral rami of the cervical nerves

P: Not palpable

Rectus Capitis Lateralis

Origin: _____

_____

Insertion: _____

_____

Action: _____

Nerve: Ventral rami of the cervical nerves

P: Not palpable

Student Name: _____

Scalenus Anterior (This muscle is a secondary muscle of inspiration)

Origin: _____

_____

Insertion: _____

_____

Action: _____

Nerve: Ventral rami of the cervical nerves

Palpation: Described on page 174 of the Trail Guide

Referred: From all three scalanes the pain can radiate anteriorly, laterally, or posteriorly.

Anteriorly: persistent aching pain through the pectoral region

Laterally: down the front and back of the arm, skipping the elbow to the radial forearm, and extending to the thumb and index finger.

Posteriorly: pain is referred to the upper vertebral border of the scapula
Clinical: Pulling, lifting, tugging, by overuse of these secondary respiratory muscles as in coughing

Scalenus Medius (Also a secondary muscle of inspiration)
Origin: _____
_____
Insertion: _____
_____
Action: _____
Nerve: Ventral rami of the cervical nerves
Palpation: Described on page 174 of the Trail Guide

Scalenus Posterior (Also a secondary muscle of inspiration)
Origin: _____
_____
Insertion: _____
_____
Action: _____
Nerve: Ventral rami of the cervical nerves
Palpation: Described on page 174 of the Trail Guide

Muscles of the thorax and abdomen:

Muscles involved during breathing:

1. Inspiratory Muscles: diaphragm, external intercostals, serratus posterior superior, and levator costarum
2. Expiratory Muscles: internal intercostals, subcostals, transverse thoracics, and serratus posterior inferior
3. Accessory Muscles of Inspiration: SCM, lats, serratus anterior, scalenes, and pectoralis major.
4. Accessory Muscles of Expiration: abdominals, quadratus lumborum, and levator ani

1. Diaphragm
O: Xiphoid process, costal cartilage of the last 6 ribs, and the lumbar vertebrae.
I: Central tendon (A strong aponeurosis that serves as insertion for the diaphragm)
A: Pulls central tendon down during inspiration
P: Not palpable

2. External Intercostals
   O: Inferior border of the rib below
   I: Superior border of the rib below
   A: elevates the ribs during inspiration
   P: between the ribs
   R: None
   C: None

3. Internal Intercostals
   O: Superior border of the rib below
   I: Inferior border of the rib above
   A: lowers ribs during forced expiration
   P: Not palpable
   R: None
   C: None

4. Serratus Posterior Superior
5. Serratus Posterior Inferior

6. Levator Costarum:

O: Tp's from C7 through T11
I: between tubercle and angle of the ribs on the outside of the rib below the vertebrae of origin
A: elevates ribs during inspiration
P: Not palpable

7. Transverse Thoracics

O: Inner surface of the xiphoid process and the inner surface of the body of the sternum
I: Lower borders and inner surfaces of T2-T6 costal cartilage's
A: depresses costal cartilage's, assists in expiration
P: Not palpable

ABDOMINAL MUSCLES:

def: Linea alba: line formed by the fusion of the fascia of the Rectus Abdominis muscles in the midline.
def: Abdominal Aponeurosis: fascia surrounding the external abdominal oblique, internal abdominal oblique, and the transverse abdominis.
Anterior abdominal wall consists of four flat broad muscles.

a. anterior muscle- Rectus abdominis
b. lateral muscles (superficial to deep)- External abdominal oblique, Internal abdominal oblique, and Transverse abdominis

1. Rectus Abdominis

Comment: each rectus abdominis muscle is separated by the linea alba in the midline. Each rectus muscle is also crossed by three connective tissue bands called tendinous intersections.
O: pubic bones
I: 5-7 costal cartilage's
A: flexes trunk
P: Anteromedial abdomen from sternum to pubis
R: 1. upper half of muscle: refers pain to the mid-back and may give a feeling of abdominal fullness, nausea, and vomiting.
middle rectus: produces abdominal cramping or colic
lower rectus: may refer pain to the sacroiliac and low back regions and the right side may mimic acute appendicitis
C: trigger points may be activated secondary to visceral disease (peptic ulcer, intestinal parasites, dysentery, ulcerative colitis, diverticulitis, etc...), emotional stress, occupational strian, faulty posture, and over enthusiasm for abdominal exercises.

2. External Abdominal Oblique
   O: lower 8 ribs
   I: abdominal aponeurosis, lineal alba, and iliac crest
   A: unilaterally: lateral flexion of the trunk and rotation to the opposite side
      bilaterally: flexes trunk and compresses the abdominal contents
   P: Lateral sides of the abdomen
   R: Upper: likely to produce "heartburn" and other symptoms commonly associated with hiatal hernia. Also may produce deep epigastric pain that occasionally extends to other parts of the abdomen.
      Lower: refers pain to the groin and testicle and may project fingers of pain to other parts of the abdomen.
   C: Same as rectus abdominus

3. Internal Abdominal Oblique (deep to the external oblique)
   O: inguinal ligament and anterior iliac crest
   I: lower 4 ribs, abdominal aponeurosis, and linea alba
   A: unilaterally: lateral flexion of the trunk and rotation to the same side
      bilaterally: flexes trunk and compresses the abdominal contents
   P: Cannot
   R: None

4. Transverse Abdominis
   O: inguinal ligament, iliac crest, thoracolumbar aponeurosis, and lower margin of the rib cage
   I: pubis and linea alba
   A: compresses the abdominal contents
   P: Cannot
   R: None

5. Quadratus Lumborum: (forms the posterior abdominal wall)
   O: iliac crest
   I: lower border of the 12th rib and tp's of the first four lumbar vertebrae
   A: stabilizes 12th rib and laterally flexes trunk.
   P: cannot
   R: none

MYOLOGY I FINAL REVIEW GUIDELINE

1. Be able to name 7 ways muscles are named. Be able to identify examples of each:
2. Anatomy of the spine:
   a. # of cervical vert
   b. # of thoracics
   c. # of lumbars
   d. know parts of vertebrae: spinous, transverse processes, facets, bodies etc... be able to label or identify (look over handout on vertebral anatomy)
   e. know curves of the spine: which areas are lordotic vs. kyphotic
3. Muscles of the back:
   a. know the five layers from superficial to deep
   b. know which layers have longer fibers vs. shorter fibers
   c. know thoracolumbar aponeurosis
   d. know which muscles are anatomically located on the back but do not functionally affect the spine (respiration or upper extremity)
   e. be able to identify any muscle from either coloring or handouts
   f. layer 1: trapezius: know three parts, O/I, action of all three parts
      latissimus: know O/I and action
   g. layer 2: levator scapula: O/I, action, remember action changes if insertion is fixed, clinical condition

associated with levator scapula

Rhomboids: major, minor: O/I, actions, relationship to each other

h. layer 3: Splenius capitus: know O/I, action
Splenius cervicis: know O/I, action
Serratus posterior superior: know O/I, action, which muscle it is deep to
Serratus posterior inferior know O/I, action

i. layer 4: Know common name for this group, know actions bilaterally and unilaterally, know relationships of the three columns to each other, know relationship of muscles within each column, know O/I generally

iliocostalis lumborum	longissimus thoracis	spinalis thoracic
iliocostalis thoracic	longissimus cervicis	spinalis cervicis
iliocostalic cervicis	longissimus capitis	spinalis capitis

j. layer 5: know common name for this group, know actions bilaterally and unilaterally
1. semispinalis group, multifidus, and rotatores: have same action
2. segmental muscles: rotatores, intertransversarii, and interspinalis, know why they are called segmental muscles
3. know the difference between multifidus and segmental muscles: length of muscles
4. Suboccipital group: know O/I of all, actions, able to identify
rectus capitis major
rectus capitis minor
obliquus capitis superior
obliquus capitis inferior

Facial muscles:

a. know muscles which are responsible and/or synergistic for facial expressions (smiling, tenseness, pouting, grief, opening eyes, frowning, closing eyes, compressing cheek etc....)
b. know nerve innervation for all facial muscles and muscles of mastication
c. know five muscles responsible for mastication: BITEM
d. be able to identify muscles on the Sybil diagram (from coloring book)
e. know O/I of all facial, masticatory, and eye muscles
f .know action of all facial, masticatory, and eye muscles
g. know differences between tension vs. vascular headaches
h. Bells Palsy: symptoms and which nerve is damaged
I. Tic Douloureux symptoms and which nerve is damaged

5. Muscles of the neck:

a. SCM: O/I, action, named on which characteristic of naming muscles
if you look up to the right hand corner of the room which SCM is contracting? right or left

b. Suprahyoid Muscles: know action of the group as a group
mylohyoid
geniohyoid
digastric
stylohyoid

c. Infrahyoid Muscles: know action of the group as a group
thyrohyoid
sternohyoid
sternothyroid
omohyoid

d. Deep anterior neck muscles
longus colli — longus colli also does contralateral rotation

longus capitis Flexion of the head longus cap also does ipsilateral rotation
rectus capitis anterior
rectus capitis lateralis: lateral flexion only

e. Scalenes: Anterior, Medius, and Posterior: know O/I on all three, and secondary muscles of respiration
Scaleneus anterior and medius insert on first rib
Scaleneus posterior originates from second rib
actions of scalenes: flexion of neck, elevates ribs
know causes of thoracic outlet syndrome and symptoms manifested.

f. know what whiplash and torticollis generally are:

6. Respiratory muscles:
a. which muscles cause inspiration
b. which muscles cause expiration
c. diaphragm: O/I, action, primary muscle of respiration
d. external intercostals: O/I, action
e. internal intercostals: O/I, action
f. serratus posterior superior: O/I, action
g. serratus posterior inferior: O/I, action
h. levator costarum: O/I, action
I. transverse thoracics: inside chest: O/I, action

7. Abdominal muscles: know O/I and actions of all
a. rectus abdominis
b. external oblique All compress the abdominal contents External Oblique: contra. rotation
c. internal oblique Internal Oblique: ipsilat. rotation
d. transverse abdominis
e. quadratus lumborum: posterior abdominal wall
f. def of abdominal fascia
g. def of linea alba

8. Common muscular conditions:
a. tenosynovitis,
b. hypo/hypertonic
c. atrophy/hypertrophy
d. muscular dystrophy's
e. myasthenia gravis
f. fibromyalgia
g. spasm
h. cramp
I. tremor
j. tic