Lesson Plan: Muscular System 1

5 minutes: Breath of Arrival and Attendance

10 minutes: Gluteus Maximus and Gluteus Medius

40 minutes: Muscular System 1
Lesson Plan: Muscular System 2

5 minutes: Breath of Arrival and Attendance

10 minutes: Sartorius and Tensor Fascia Latae

40 minutes: Muscular System 2
Lesson Plan: Muscular System 3

5 minutes: Breath of Arrival and Attendance

50 minutes: Muscular System 3
Classroom Rules

Punctuality - everybody's time is precious:

- Be ready to learn by 9:00, we'll have you out of here by 1:30
- Tardiness: arriving late, late return after breaks, leaving early

The following are not allowed:

- Bare feet
- Side talking
- Lying down
- Inappropriate clothing
- Food or drink except water
- Phones in classrooms, clinic or bathrooms

You will receive one verbal warning, then you'll have to leave the room.
Gluteus Maximus and Gluteus Medius
Gluteus Maximus

Origin:
- Posterior iliac crest
- Posterior sacrum and coccyx

Insertion:
- Gluteal tuberosity of femur
- IT tract

Actions:
- Extend the hip
- Abduct the hip
- Adduct the hip
- Laterally rotate the hip
Gluteus Medius

Origin:
Upper posterior ilium

Insertion:
Greater trochanter of femur

Actions:
Abduct the hip
Flex the hip
Extend the hip
Medially rotate the hip
Laterally rotate the hip
Gluteus Maximus and Gluteus Medius
Sartorius

Origin:

Anterior superior iliac spine
(ASIS)

Insertion:

Medial proximal tibia
(pes anserinus)

Actions:

Flex the hip
Abduct the hip
Flex the knee

Anterior View
Tensor Fascia Latae (TFL)

Origin:
Iliac crest posterior to ASIS

Insertion:
IT tract

Actions:
Abduct the hip
Flex the hip
Medially rotate the hip
TFL and Sartorius
“If there is one door in the castle you have been told not to go through, you must. Otherwise you’ll just be rearranging furniture in rooms you’ve already been.”

-Anne Lamott
What are some visible signs of the muscular system at work?
What are some visible signs of the muscular system at work?

- Rise and fall of the chest during breathing.
- The feel of your heart beating.
- Facial expressions communicating how we feel.
- Locomotion to get us from here to there.
Skeletal muscles.
Related fascial structures including tendons and aponeuroses.
Tendon
Humerus
Fascia (deep)
Muscle
Epimysium
Perimysium
Endomysium
Blood vessel (artery)
Motor neuron
Muscle fiber (muscle cell)
Fascicle
Sarcolemma
Nucleus
Sarcoplasmic reticulum
Thick filaments
Thin filaments
Myofilaments
Muscle fiber (muscle cell)
Physiology

Movement
Posture maintenance
Moving substances
Heat production
Movement  Skeletal muscle ___contractions___ produce movement of the body as a whole (locomotion) and movement of its parts.
Physiology

**Posture maintenance**  Skeletal muscles must contract to maintain static postures, such as in sitting and __standing__.
Physiology

**Posture maintenance**  Skeletal muscles must contract to maintain static postures, such as in sitting and ___standing___.

![Diagram of posture maintenance](image)
Moving substances  Contraction of skeletal muscles promotes lymphatic flow and blood flow from the extremities to the ___heart__.
Physiology

**Moving substances**  Contraction of skeletal muscles promotes lymphatic flow and blood flow from the extremities to the **heart**.
Physiology

**Heat production**  Muscle contractions produce and release heat that is important for homeostasis. AKA: ____thermogenesis____.
Organization: Muscle Cells into Muscle Organs

myofilaments → sacromere → myofibril → muscle fiber (cell) → fascicle → skeletal muscle (organ)

- Myofilaments
- Sacromere
- Myofibrils
- Muscle fiber
- Fasciculi
Organization: Muscle Cells into Muscle Organs

**Myofilaments**  Thick and thin protein strands within each sarcomere. Consist of actin and myosin.
Organization: Muscle Cells into Muscle Organs

**Sarcomere**  A muscle's contractile unit. Found within myofibrils.
Sarcomere  A muscle's contractile unit. Found within myofibrils.
Organization: Muscle Cells into Muscle Organs

Myofibrils  Thin strands within each muscle fiber. Contain myofilaments.
Organization: Muscle Cells into Muscle Organs

Muscle fiber  Thread-like muscle cell.
Organization: Muscle Cells into Muscle Organs

**Fasciculi**  Groups of muscle fibers or neurons. Singular is fascicle.
NOTE: In the muscular system fasciculi are groups of muscle fibers, but in the nervous system fasciculi are groups of neurons.
Connective Tissues

Endomysium
Perimysium
Epimysium
Deep fascia

Myofascial
Tendon
Tendon sheath
Aponeurosis
Retinacula
Endomysium, Perimysium, Epimysium, Deep Fascia
Connective Tissues

**Endomysium**  Connective tissue layer that surrounds individual muscle fibers.
Perimysium  Connective tissue layer that surrounds ___fasciculi__.
Epimysium  Connective tissue layer surrounding an entire muscle.
Connective Tissues

**Deep fascia** Connective tissue layer that surrounds muscle groups.
Superficial Fascia
Connective Tissues

**Myofascial**  Referring to skeletal muscles and related fascia in the ___muscular___ system.
Connective Tissues

**Tendon**  Cord-like structure anchoring the end of a ___muscle___ to a bone.
Connective Tissues

**Tendon sheath (AKA: synovial sheath)**  Tube-like structure lined with synovial membrane that surround long tendons.
Connective Tissues

**Aponeurosis (p. aponeuroses)** Broad, flat tendon. Attaches skeletal muscle to bone, another muscle, or skin.
Connective Tissues

**Retinacula (s. retinaculum)** — Bandage-like retaining bands of connective tissue found primarily around the elbows, knees, ankles, and wrists. May also act as a pulley for tendons.
Muscle Cells

Sarcoplasm
Sarcolemma
Sarcoplasmic reticulum
T-tubules
Sarcomere
Connective Tissues

**Sarcoplasm**  Muscle cell ____cytoplasm____.

**Sarcolemma**  Muscle cell ____membrane____.
Connective Tissues

Sarcoplasm  Muscle cell ___cytoplasm___.
Sarcolemma  Muscle cell ___membrane____.
Connective Tissues

**Sarcoplasmic reticulum**  A fluid-filled system of sacs similar to endoplasmic reticulum. Stores and releases **calcium** ions.
**Connective Tissues**

**T-tubule**  Runs **transversely** across the sarcoplasmic reticulum, forming inward channels. Transports stored calcium ions from the sarcoplasmic reticulum into the interior of the muscle cell.
Sarcomere  A muscle's __contractile__ unit. Found within myofibrils.
Myofilaments

Thin myofilaments
  Actin
  Tropomyosin
  Troponin

Thick myofilaments
  Myosin
**Myofilaments**

**Thin myofilaments**

**Actin**  Protein molecules within a muscle cell that contain binding sites used during skeletal muscle contraction; help make up thin myofilaments.

**Tropomyosin**  Protein molecules.

**Troponin**  Protein molecules.
**Myofilaments**

**Thick myofilaments**

**Myosin**  Protein molecules within a muscle cell that attach to actin during skeletal muscle contraction. Make up the bulk of thick myofilaments.
Muscle Cell Properties

**Excitability**  The ability to respond to a __stimulus__.

**Contractility**  The ability to __shorten__.

**Extensibility**  The ability to __lengthen__.

**Elasticity**  The ability to return to its original __shape__ after movement.
Mechanism of Contraction

“Sliding Filament Mechanism”
Mechanism of Contraction

“Sliding Filament Mechanism”

Nerve impulse  An electrical signal that conveys information along a neuron.
Mechanism of Contraction
“Sliding Filament Mechanism”

Motor neuron  Neuron that sends a nerve impulse to a muscle cell.
Mechanism of Contraction
“Sliding Filament Mechanism”

Motor unit Single motor neuron plus all the muscle ___fibers___ it innervates.

Note: one motor neuron can innervate 2 to 2000 muscle fibers.
Mechanism of Contraction
“Sliding Filament Mechanism”

**Motor end plate**  Folded sections of the sarcolemma where motor neurons attach.
Mechanism of Contraction
“Sliding Filament Mechanism”

Neuromuscular junction  Junction between a **motor** neuron and a motor end plate.
Mechanism of Contraction

“Sliding Filament Mechanism”

Synaptic cleft (AKA: synaptic gap)  Space between the end of a motor neuron and another neuron, a muscle cell, or a gland.
Mechanism of Contraction
“Sliding Filament Mechanism”

**Acetylcholine**  Neurotransmitter that crosses the synaptic cleft.
Mechanism of Contraction
“Sliding Filament Mechanism”

- **Non-contracting state**
- **Cross-bridging** (if calcium present)
- **Power stroke**
- **Detachment** (if ATP present)
- **Non-contracting state**
Mechanism of Contraction
“Sliding Filament Mechanism”

Non-Contracting State: “Two protein molecules, troponin and tropomyosin, are positioned on thin myofilaments to block myosin binding sites. Without these regulatory proteins, muscles would be in a constant state of contraction.”
Mechanism of Contraction
“Sliding Filament Mechanism”

**Excitation of the Sarcolemma:** “The contraction of a skeletal muscle begins with a nerve impulse sent from the central nervous system through a motor unit (messages of inhibition are sent by different neurons and this will be covered in Somatic Nervous system). When the nerve impulse reaches the neuromuscular junction, acetylcholine is released into the synaptic cleft. It crosses the gap and binds with receptor sites on the motor end plate. From there an impulse is sent through the t-tubules into the sarcomeres triggering the release of calcium ions from the sarcoplasmic reticulum.”
Mechanism of Contraction
“Sliding Filament Mechanism”

Excitation of the Sarcolemma
**Mechanism of Contraction**

*“Sliding Filament Mechanism”*

**Cross-Bridging:** “Now that calcium is present in the sarcomere, it binds to troponin causing tropomyosin to slide off and expose the site allowing myosin heads to bind to thin myofilaments.”
Mechanism of Contraction
“Sliding Filament Mechanism”

**Power Stroke:** “Myosin heads, which are hinged at their base, then toggle in a mechanism similar to a light switch. This action causes thin myofilaments to slide toward the center of the sarcomere which shortens the overall length of the muscle fiber. Yeah! We have contraction!”
Mechanism of Contraction
“Sliding Filament Mechanism”

All or None Response: “When a motor neuron delivers a stimulus of contraction, all the muscle fibers of the motor unit receive the same signal at the same time. IF the stimulus is sufficient, THEN all muscle fibers associated with the motor unit will contract to its fullest extent; there is no partial contraction. Conversely, IF the stimulus is below the required threshold, THEN muscle contraction will not occur and the muscle fiber will remain at full resting length.”
Mechanism of Contraction
“Sliding Filament Mechanism”

**Recruitment:** “Numerous motor units are linked to a single skeletal muscle. The nervous system regulates the amount of muscular contraction by activating only the motor units needed to perform a given action. IF more strength is required, THEN additional motor units are recruited resulting in a stronger muscle contraction.”
Mechanism of Contraction

“Sliding Filament Mechanism”

**Relaxation:** “Almost immediately after the sarcoplasmic reticulum releases calcium ions into the sarcomeres, it begins to actively pump them back into its sacs. Freed from its chemical bond with the calcium ions, the tropomyosin slides back to cover the myosin binding sites on thin myofilaments. This action releases the myosin heads and returns them to their pre-contraction resting state. The muscle is now at rest.”
Energy Sources for Contraction

Adenosine triphosphate
Fuel
Oxygen
Energy Sources for Contraction

Adenosine triphosphate (AKA: ATP) The body's energy storage molecule.

Fuel Glucose, fat, or, rarely, protein; used to form ATP in the mitochondria. By-products are CO2 and water (from aerobic metabolism), or, from the initial anaerobic process (which only uses carbohydrate, and not O2), lactic acid.

Oxygen Combined with fuel in the mitochondria during aerobic metabolism, yielding energy (for making ATP) plus CO2 plus H2O.
Types of Skeletal Muscle Fibers

- Slow twitch
- Fast twitch
- Intermediate twitch
Types of Skeletal Muscle Fibers

**Slow twitch**  Skeletal muscle fibers that contract slowly and are fatigue resistant. AKA: red muscle. Examples: postural muscle, core muscle, legs of long distance runners.
Types of Skeletal Muscle Fibers

**Fast twitch**  Skeletal muscle fibers that contract forcefully and fatigue rapidly.  
AKA: white muscle.  Examples: arm muscles.
Intermediate twitch  Skeletal muscle fibers that are more fatigue resistant than fast twitch, and more forceful than slow twitch. AKA: pink muscle. Examples: legs of world class sprinters and arms of world class boxers.
Parts of a Skeletal Muscle

Belly
Origin
Insertion
**Parts of a Skeletal Muscle**

**Belly** The wide central portion of a skeletal muscle that contains the sarcomeres.
Parts of a Skeletal Muscle

**Origin**  Tendinous muscle attachment on the ___less___ movable bone or other structure. Typically medial or proximal to the insertion.
Parts of a Skeletal Muscle

**Insertion**  Tendinous muscle attachment on the _____more____ movable bone or structure. Typically lateral or distal to the origin.
Functional reversibility  Property of some muscles that reverse the roles of the origins and insertions. Examples: iliopsoas during hip flexion.
Parts of a Skeletal Muscle

**Uniarticular**  Crosses one joint.

**Biarticular**  Crosses two joints and acts on both joints.

**Multiarticular**  Crosses more than two joints and acts on all joints.
Muscles Actions

Prime mover
Antagonist
Synergist
Fixator
Muscle Actions

Prime mover

Muscle responsible for causing a specific or desired action. AKA: agonist. Example: biceps brachii during elbow flexion.
Muscle Actions

Anatagonist

Muscles that must relax and lengthen or eccentrically contract and lengthen to allow actions of the prime mover to occur.

Example: triceps brachii during elbow flexion.
Muscle Actions

Synergist

Muscle that aids movement by contracting at the **same** time as the prime movers.

Example: pronator teres during elbow flexion with the forearm pronated.
Muscle Actions

**Fixator**

Specialized synergist muscles that act as a ___stabilizer____. Example: deltoid during elbow flexion.
Types of Muscle Contractions

- Isotonic contraction
  - Concentric contraction
  - Eccentric contraction
- Isometric contraction
Types of Muscle Contractions

Isotonic contraction  Contraction in which muscle changes _______.

Concentric contraction  Type of isotonic contraction where the muscle ______shortens_____.

Eccentric contraction  Type of isotonic contraction where the muscle ______lengthens_____.
Types of Muscle Contractions

- **Concentric contraction**: Muscle shortens and thickens to raise load.
- **Eccentric contraction**: Muscle lengthens and helps control lowering of load.

**ISOTONIC**
Same tension; changing length.
Types of Muscle Contractions

Isometric contraction  Contraction in which muscle length remains the same.
Stretching and Stretch Receptors
Stretching and Stretch Receptors

**Stretching**  Method that lengthens/elongates soft tissues.
Hyperflexibility  Flexibility beyond a joint's normal range of motion.
Contributes to joint instability. AKA: hypermobility.
Stretching and Stretch Receptors

**Muscle spindle**  Stretch receptor located within the muscle **belly**. Detects sudden stretching, causing the nervous system to respond by reflexively **contracting** the muscle.
**Stretching and Stretch Receptors**

**Golgi tendon organ**  Receptor located at the musculotendinous junction. Detects tension and excessive stretch, causing the nervous system to respond by **inhibiting** contraction.
Posture and Muscle Tone
Posture and Muscle Tone

**Posture**  How the body distributes itself in relation to gravity over a base or bases of support.
**Posture and Muscle Tone**

**Good posture**  Keeping the body's center of gravity over its base. This helps to avoid unnecessary soreness and fatigue by reducing strain on muscles, ligaments, and bones.
Posture and Muscle Tone

**Muscle tone**  Continued **partial** contraction of skeletal muscle. AKA: tonus.
Flaccid  Skeletal muscle with _____less_____ tone than normal. First stage of muscle atrophy.
Posture and Muscle Tone

Spastic  Skeletal muscle with ___more___ than normal tone.
Effects of Massage Therapy on the Muscular System
Effects of Massage Therapy on the Muscular System

“Decrease tension within the muscle-tendon unit.”

By increasing circulation to muscles and block nerve impulses.

This may allow muscle to elongate.
Effects of Massage Therapy on the Muscular System

“Assist in the treatment of tendonitis.”

Reducing inflammation with circulatory work.
Effects of Massage Therapy on the Muscular System

“Increase scar tissue strength to aid in tendon healing.”

Deep cross fiber friction can reweave and remodel the scar tissue so that the fibers are parallel to each other.
“Increase range of motion (ROM).”

The mechanism of action is not clear, but may be due to:
- Decreased pain or stiffness
- Decreased muscle tightness
- Increased muscle length

Increased ROM is an important treatment goal.
Effects of Massage Therapy on the Muscular System

“Decrease delayed onset muscle soreness (DOMS).”

Due to flushing out of toxins through circulatory work.

Studies have produced contradictory results.
Effects of Massage Therapy on the Muscular System

“Decrease electromyography (EMG) activity, suggesting increased muscle relaxation and decreased muscle fatigue.”

A fatigued muscle recruits additional motor units to complete the task resulting in increased electrical activity.

A lower EMG signal can represent a more efficient muscular contraction.
“Decrease pain and may activate the parasympathetic nervous system, causing relaxation and reduction of trigger point activity.”

This can be accomplished through trigger point work.

**Trigger point**  Localized areas of hyperirritability. When pressed, may refer sensations (usually pain) to other areas of the body.
Effects of Massage Therapy on the Muscular System

“Reduce chronic tension headaches.”

Using trigger point work.
Effects of Massage Therapy on the Muscular System

“Reduce lower back pain.”

Using trigger point work.
Effects of Massage Therapy on the Muscular System

“Reduce pain and other symptoms of fibromyalgia.”

Although many clients request deep pressure, this often provokes strong reactions for several days following treatment.

A very slow increment in depth of massage strokes, from session to session, with careful deactivation of tender areas is recommended.
“If there is one door in the castle you have been told not to go through, you must. Otherwise you’ll just be rearranging furniture in rooms you’ve already been.”

-Anne Lamott

Muscular System 3
“If there is one door in the castle you have been told not to go through, you must. Otherwise you’ll just be rearranging furniture in rooms you’ve already been.”

-Anne Lamott