The Muscular System

- Muscles are responsible for
- Three basic muscle types are found in the body
- Skeletal muscle
- Cardiac muscle
- Smooth muscle

Characteristics of Muscles

- Skeletal and smooth muscle cells are _____ (muscle cell = muscle fiber)
- Contraction of muscles is due to the movement of _____.
- All muscles share some terminology
  - Prefixes *myo* and *mys* refer to "_____"
  - Prefix *sarco* refers to "_____"

Skeletal Muscle Characteristics

- Most are attached by _____ to _____
- Cells are _____
- _____—have visible banding
- Voluntary—subject to conscious control

Connective Tissue Wrappings of Skeletal Muscle

- Cells are surrounded and bundled by connective tissue
  - Endomysium—encloses a
  - Perimysium—wraps around a _____ (bundle) of muscle fibers
  - Epimysium—covers the entire skeletal muscle
  - Fascia—on the outside of the epimysium

Skeletal Muscle Attachments

- Epimysium blends into a connective tissue attachment
  - Tendons—cord-like structures
    - Often cross a joint due to toughness and small size
  - Aponeuroses—sheet-like structures
    - Attach muscles indirectly to bones, cartilages, or connective tissue coverings
- Sites of muscle attachment
  - Bones
  - Cartilages

Smooth Muscle Characteristics

- Lacks _____
- Spindle-shaped cells
- _____—no conscious control
- Found mainly in the walls of

Cardiac Muscle Characteristics

- Striations
- Usually has a

- Branching cells
- Joined to another muscle cell at an
- Involuntary
- Found only in the heart

Skeletal Muscle Functions

- Produce movement
-
- Stabilize joints
-

Microscopic Anatomy of Skeletal Muscle

- _____—specialized plasma membrane
- _____—long organelles inside muscle cell
- Sarcoplasmic reticulum—specialized smooth endoplasmic reticulum
- Myofibrils are aligned to give distinct bands
  - I band =
    - Contains only _____ filaments
  - A band =
    - Contains the entire length of the _____ filaments
- _____—contractile unit of a muscle fiber
- Organization of the sarcomere
- Myofilaments
  - Thick filaments = _____ filaments
  - Thin filaments = _____ filaments
- Thick filaments = myosin filaments
  - Composed of the protein myosin
  - Has _____ase enzymes
  - Myosin filaments have heads (_____)
  - Myosin and actin overlap somewhat
- Thin filaments = actin filaments
  - Composed of the protein actin
  - Anchored to the
- At rest, there is a bare zone that lacks actin filaments called the
- Sarcoplasmic reticulum (SR)
  -
  - Surrounds the myofibril

Stimulation and Contraction of
Single Skeletal Muscle Cells

- Excitability (also called responsiveness or irritability)—
- Contractility—ability to shorten when an adequate stimulus is received
- Extensibility—ability of muscle cells to be stretched
- Elasticity—ability to recoil and resume resting length after stretching

The Nerve Stimulus and Action Potential

- Skeletal muscles must be stimulated by a _____ (nerve cell) to contract
- Motor unit—one motor neuron and all the skeletal muscle cells stimulated by that neuron
- _____ junction
  - Association site of axon terminal of the motor neuron and muscle
- Synaptic cleft
  - _____ between nerve and muscle
  - Nerve and muscle do not
  - Area between nerve and muscle is filled with

Transmission of Nerve Impulse to Muscle

- _____—chemical released by nerve upon arrival of nerve impulse
- The neurotransmitter for skeletal muscle is _____ (ACh)
- Acetylcholine attaches to receptors on the sarcolemma
- Sarcolemma becomes permeable to _____ (Na+)
- Sodium rushes into the cell generating an _____
- Once started, muscle contraction cannot be stopped

The Sliding Filament Theory
of Muscle Contraction

- Activation by nerve causes _____ (cross bridges) to attach to binding sites on the thin filament
- Myosin heads then bind to the next site of the thin filament and
- This continued action causes a sliding of the myosin along the actin
- The result is that the muscle is shortened (contracted)

Contraction of Skeletal Muscle

- Muscle fiber contraction is "_____"
- Within a skeletal muscle, not all fibers may be stimulated during the same _____
- Different combinations of muscle fiber contractions may give differing responses
- Graded responses—different degrees of skeletal muscle _____
- Graded responses can be produced by changing
  - The _____ of muscle stimulation
  - The _____ of muscle cells being stimulated at one time

Types of Graded Responses

- Twitch

- Single, brief contraction
-

- _____ (summing of contractions)
  - One contraction is immediately followed by another
  - The muscle does not completely

    return to a _____ state

  - The effects are _____
- Unfused (incomplete) tetanus
  - Some _____ occurs between contractions
  - The results are _____
- Fused (complete) tetanus
  - No evidence of _____ before the following contractions
  - The result is a _____ muscle contraction

Muscle Response to Strong Stimuli

- Muscle force depends upon the number of fibers _____
- More fibers contracting results in greater muscle _____
- Muscles can continue to contract unless they

Energy for Muscle Contraction

- Initially, muscles use stored _____ for energy
  - ATP bonds are broken to release energy
  - Only _____ worth of ATP is stored by muscles
- After this initial time, other pathways must be utilized to produce ATP
- Direct _____ of ADP by _____ (CP)
  - Muscle cells store CP
    - CP is a _____ molecule
  - After ATP is depleted, ADP is left
  - CP transfers energy to ADP, to regenerate ATP
  - CP supplies are exhausted in less than _____
- Aerobic respiration
  - _____ is broken down to carbon dioxide and water, releasing _____
  - This is a slower reaction that requires continuous _____
  - A series of metabolic pathways occur in the mitochondria
- Anaerobic glycolysis and lactic acid formation
  - Reaction that breaks down glucose without _____
  - Glucose is broken down to _____ to produce some ATP
  - Pyruvic acid is converted to _____

- This reaction is not as efficient, but is fast
    - Huge amounts of _____ are needed
    - Lactic acid produces _____

Muscle Fatigue and Oxygen Deficit

- When a muscle is fatigued, it is unable to _____ even with a stimulus
- Common cause for muscle fatigue is _____
    - Oxygen must be "repaid" to tissue to remove oxygen deficit
    - Oxygen is required to get rid of accumulated _____
- Increasing _____ (from lactic acid) and lack of _____ causes the muscle to contract less

Types of Muscle Contractions

- _____ contractions
    - Myofilaments are able to slide past each other during contractions
    - The muscle shortens and movement occurs
- _____ contractions
    - Tension in the muscles increases
    - The muscle is unable to shorten or produce movement

Muscle Tone

- Some fibers are _____ even in a _____ muscle
- Different fibers contract at different times to provide muscle tone
- The process of stimulating various fibers is under _____ control

Effect of Exercise on Muscles

- Exercise increases muscle _____, _____, and _____
    - Aerobic (endurance) exercise (biking, jogging) results in stronger, more _____ muscles with greater resistance to _____
        - Makes body metabolism more efficient
        - Improves digestion, coordination
    - Resistance (isometric) exercise (weight lifting) increases muscle size and strength

Five Golden Rules of Skeletal Muscle Activity

1. With a few exceptions, all skeletal muscles _____ at least one joint.
2. Typically the bulk of a skeletal muscle lies _____ to the joint crossed.
3. All skeletal muscles have at least two attachment sites: the _____ and the _____.
4. Skeletal muscles can only _____; they never _____.
5. During contraction a skeletal muscle insertion moves toward the origin.

Muscles and Body Movements

- Movement is attained due to a muscle moving an attached bone
- Muscles are attached to at least two points
    - Origin
        - Attachment to a _____ bone

- Insertion
  - Attachment to an _____ bone

Types of Ordinary Body Movements

- _____
  - Decreases the angle of the joint
  - Brings two bones closer together
  - Typical of hinge joints like knee and elbow
- _____
  - Opposite of flexion
  - Increases angle between two bones
- _____
  - Movement of a bone around its longitudinal axis
  - Common in ball-and-socket joints
  - Example is when you move atlas around the dens of axis (shake your head "no")
- _____
  - Movement of a limb away from the midline
- _____
  - Opposite of abduction
  - Movement of a limb toward the midline
- _____
  - Combination of flexion, extension, abduction, and adduction
  - Common in ball-and-socket joints

Special Movements

- _____
  - Lifting the foot so that the superior surface approaches the shin
- _____
  - Depressing the foot (pointing the toes)
- _____
  - Turn sole of foot medially
- _____
  - Turn sole of foot laterally
- _____
  - Forearm rotates laterally so palm faces anteriorly
- _____
  - Forearm rotates medially so palm faces posteriorly
- _____
  - Move thumb to touch the tips of other fingers on the same hand

Types of Muscles

- _____—muscle with the major responsibility for a certain movement
- Antagonist—muscle that opposes or reverses a prime mover

- _____—muscle that aids a prime mover in a movement and helps prevent rotation
- Fixator—stabilizes the origin of a prime mover

Naming Skeletal Muscles

- By direction of muscle fibers
  - Example: *Rectus* (straight)
- By relative size of the muscle
  - Example: *Maximus* (largest)
- By location of the muscle
  - Example: *Temporalis* (temporal bone)
- By number of origins
  - Example: *Triceps* (three heads)
- By location of the muscle's origin and insertion
  - Example: *Sterno* (on the sternum)
- By shape of the muscle
  - Example: *Deltoid* (triangular)
- By action of the muscle
  - Example: *Flexor* and *extensor* (flexes or extends a bone)

Head and Neck Muscles

- _____ muscles
  - Frontalis—raises eyebrows
  - Orbicularis oculi—closes eyes, squints, blinks, winks
  - Orbicularis oris—closes mouth and protrudes the lips
  - Buccinator—flattens the cheek, chews
  - Zygomaticus—raises corners of the mouth

- _____ muscles
  - Masseter—closes the jaw and _____ mandible
  - Temporalis—synergist of the masseter, closes jaw

- _____ muscles
  - Platysma—pulls the corners of the _____ inferiorly
  - Sternocleidomastoid—flexes the neck, rotates the head

Muscles of Trunk, Shoulder, Arm

- Anterior muscles
  - Pectoralis major—_____ and _____ the humerus
  - Intercostal muscles
    - _____ intercostals—raise rib cage during inhalation
    - _____ intercostals—depress the rib cage to move air out of the lungs when you exhale forcibly

- Muscles of the _____ girdle
  - Rectus abdominis—flexes vertebral column and compresses abdominal contents (defecation, childbirth, forced breathing)
  - External and internal obliques—flex vertebral column; rotate trunk and bend it laterally
  - Transversus abdominis—compresses abdominal contents

- _____ muscles
  - Trapezius—elevates, depresses, adducts, and stabilizes the scapula
  - Latissimus dorsi—extends and adducts the humerus

- Erector spinae—back extension
- Quadratus lumborum—flexes the spine laterally
- Deltoid—arm abduction

Muscles of the Upper Limb

- Biceps brachii—supinates forearm, _____ elbow
- Brachialis—elbow flexion
- Brachioradialis—weak muscle
- Triceps brachii—elbow extension (antagonist to biceps brachii)

Muscles of the Lower Limb

- _____maximus—hip extension
- Gluteus medius—hip abduction, steadies pelvis when walking

- _____—hip flexion, keeps the upper body from falling backward when standing erect
- Adductor muscles—adduct the thighs
- Muscles causing movement at the knee joint
  - Hamstring group—thigh extension and knee flexion

    - _____ femoris
    - Semimembranosus
    - Semitendinosus
- Muscles causing movement at the knee joint

  - _____—flexes the thigh
  - Quadriceps group—extends the knee
    - Rectus femoris
    - Vastus muscles (three)
- Muscles causing movement at ankle and foot

  - _____ anterior—dorsiflexion and foot inversion
  - Extensor digitorum longus—toe extension and dorsiflexion of the foot
  - Fibularis muscles—plantar flexion, everts the foot

  - _____—plantar flexion