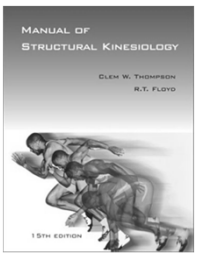


Chapter 2
Neuromuscular Fundamentals

Manual of Structural Kinesiology

R.T. Floyd, EdD, ATC, CSCS

Skeletal Muscles

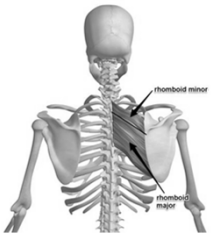
- Responsible for movement of body and all of its joints and Muscle contraction produces force that causes joint movement
- Muscles also provide
  - protection
  - posture and support
  - produce a major portion of total body heat

Skeletal Muscles

- Over 600 skeletal muscles comprise approximately 40 to 50% of body weight
- 215 pairs of skeletal muscles usually work in cooperation with each other to perform opposite actions at the joints which they cross

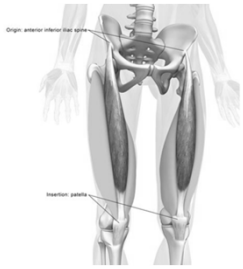
Muscle Nomenclature

- Muscles are usually named due to
  - visual appearance
  - anatomical location
  - function
- Shape – deltoid, rhomboid
- Size – gluteus maximus, teres minor
- Number of divisions – triceps brachii
- Direction of its fibers – external oblique



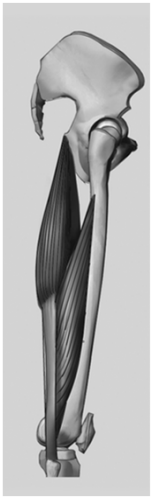
Muscle Nomenclature

- Location - rectus femoris, palmaris longus
- Points of attachment - coracobrachialis, extensor hallucis longus, flexor digitorum longus
- Action - erector spinae, supinator, extensor digiti minimi
- Action & shape – pronator quadratus



Muscle Nomenclature

- Action & size – adductor magnus
- Shape & location – serratus anterior
- Location & attachment – brachioradialis
- Location & number of divisions – biceps femoris



Muscle Nomenclature

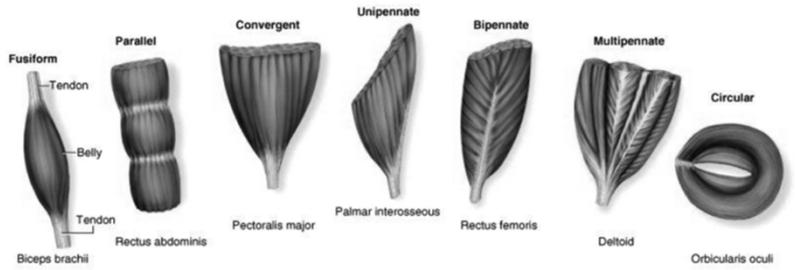
- Muscle grouping & naming
  - Shape – Hamstrings
  - Number of divisions – Quadriceps, Triceps Surae
  - Location – Peroneals, Abdominal, Shoulder Girdle
  - Action – Hip Flexors, Rotator Cuff

Shape of Muscles & Fiber Arrangement

- Muscles have different shapes & fiber arrangement that affects
  - muscle's ability to exert force
  - range through which it can effectively exert force onto the bones
    - Cross section diameter
  - longer muscles can shorten through a greater range
  - more effective in moving joints through large ranges of motion

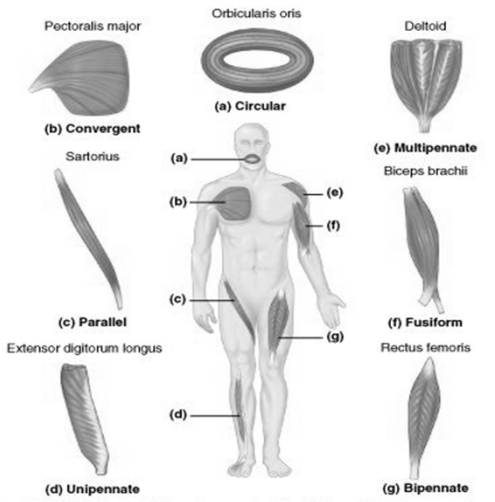
Shape of Muscles & Fiber Arrangement

- 2 major types of fiber arrangements
  - parallel & pennate
- Parallel muscles
  - fibers arranged parallel to length of muscle
  - produce a greater range of movement than similar sized muscles with pennate arrangement



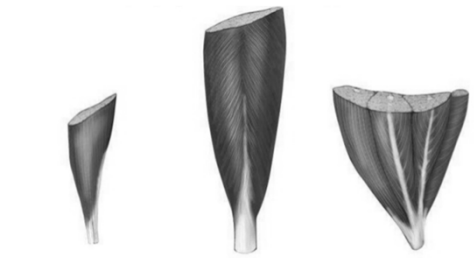
Fiber Arrangement - Parallel

- Categorized into following shapes
  - Flat
  - Fusiform
  - Strap
  - Radiate
  - Sphincter or circular



Fiber Arrangement - Pennate

- Pennate muscles
  - have shorter fibers
  - arrangement increases the cross sectional area of the muscle, thereby increasing the power.
  - Unipennate
  - Bipennate
  - Multipennate



Pennate muscles are so named because their tendons and muscle fibers resemble a large feather.

Muscle Tissue Properties

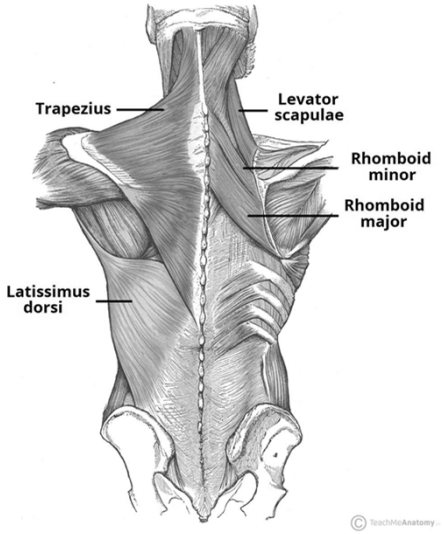
- *Irritability* - property of muscle being sensitive or responsive to chemical, electrical, or mechanical stimuli
- *Contractility* - ability of muscle to contract & develop tension or internal force against resistance when stimulated
- *Extensibility* - ability of muscle to be stretched back to its original length following contraction
- *Elasticity* - ability of muscle to return to its original length following stretching

Muscle Terminology

- *Action* - specific movement of joint resulting from a concentric contraction of a muscle which crosses joint
  - Ex. biceps brachii has the action of flexion at elbow
- *Intrinsic* - pertaining usually to muscles within or belonging solely to body part upon which they act

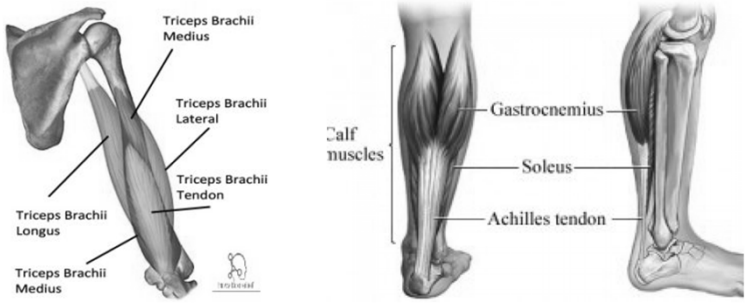
Muscle Terminology

- *Extrinsic* - pertaining usually to muscles that arise or originate outside of (proximal to) body part upon which they act



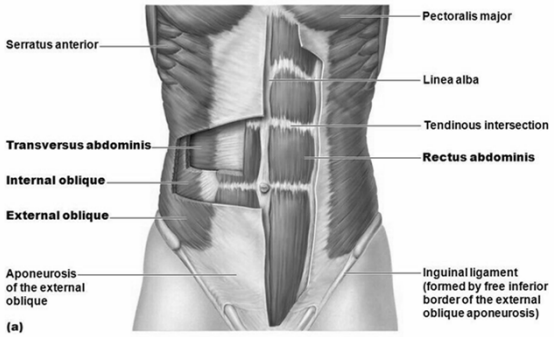
Muscle Terminology

- *Tendon* - Fibrous connective tissue, often cordlike in appearance, that connects muscles to bones and other structures
  - Two muscles may share a common tendon
  - A muscle may have multiple tendons



Muscle Terminology

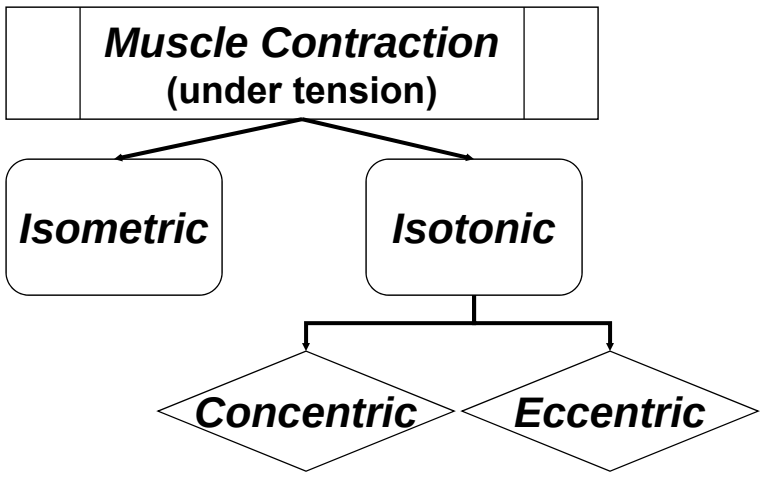
- *Aponeurosis*
  - A tendinous expansion of dense fibrous connective tissue that is sheet- or ribbon like in appearance and resembles a flattened tendon



Muscle Terminology

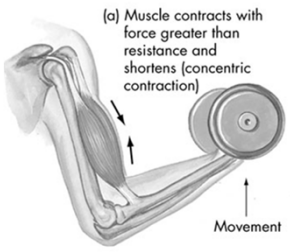
- *Origin* - proximal attachment, generally considered the least movable part or the part that attaches closest to the midline or center of the body
- *Insertion* - distal attachment, generally considered the most movable part or the part that attaches farthest from the midline or center of the body

Types of muscle contraction



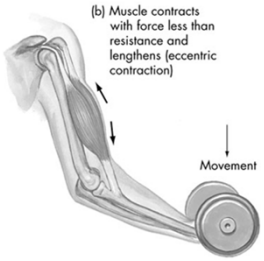
Types of muscle contraction

- *Concentric contraction*
  - muscle develops tension as it shortens
  - occurs when muscle develops enough force to overcome applied resistance
  - causes movement against gravity or resistance
  - described as being a positive contraction



Types of muscle contraction

- *Eccentric contraction*
  - muscle lengthens under tension
  - described as a negative contraction
  - weight or resistance overcomes muscle contraction
  - causes body part to move with gravity or external forces (resistance)

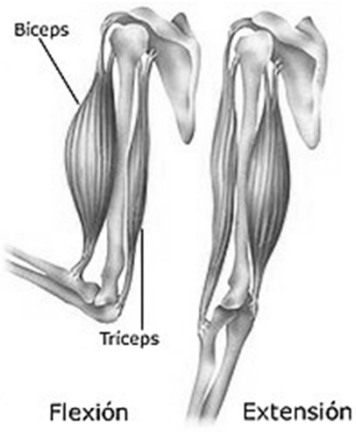


Types of muscle contraction

- *Isokinetics* - a type of dynamic exercise using concentric and/or eccentric muscle contractions
  - the speed (or velocity) of movement is constant
  - Ex. Biodex, Cybex, Lido

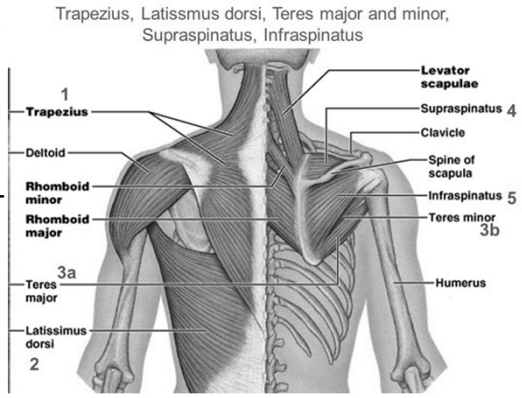
Role of Muscles

- *Agonist* muscles
  - cause joint motion through a specified plane of motion when contracting concentrically
- *Antagonist* muscles
  - located on opposite side of joint from agonist



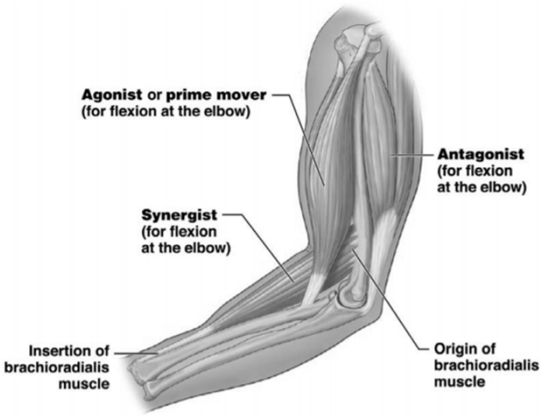
Role of Muscles

- *Stabilizers*
  - surround joint or body part
  - known as fixators
  - essential in establishing a relatively firm base for the more distal joints to work from when carrying out movements



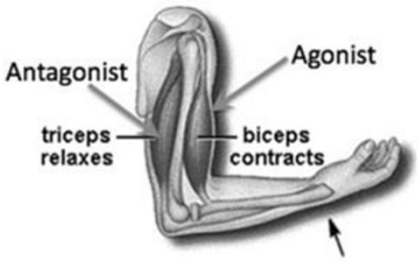
Role of Muscles

- *Synergist*
  - assist in action of agonists
  - not necessarily prime movers for the action
  - known as guiding muscles



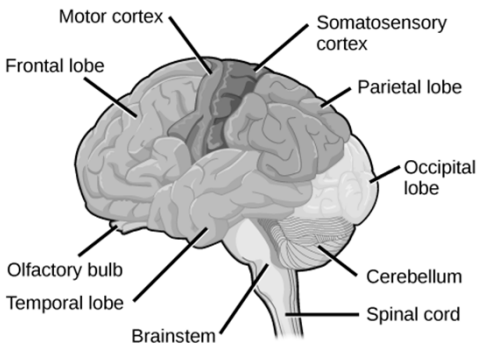
Role of Muscles

- *Neutralizers*
  - Ex. when only supination action of biceps brachii is desired, the triceps brachii contracts to neutralize the flexion action of the biceps brachii



Neural control of voluntary movement

- Cerebral cortex
  - highest level of control
  - provides for the creation of voluntary movement as aggregate muscle action, but not as specific muscle activity



Neural control of voluntary movement

- Cerebellum
  - a major integrator of sensory impulses
  - provides feedback relative to motion
  - controls timing & intensity of muscle activity to assist in the refinement of movements

Neural control of voluntary movement

- Brain stem
  - integrates all central nervous system activity through excitation & inhibition of desired neuromuscular functions
  - functions in arousal or maintaining a wakeful state

Neural control of voluntary movement

- Spinal cord
  - common pathway between CNS & PNS
  - has the most specific control
  - integrates various simple & complex spinal reflexes
  - integrates cortical & basal ganglia activity with various classifications of spinal reflexes

Neural control of voluntary movement

- Functionally, PNS is divided into sensory & motor divisions
  - Sensory or afferent nerves bring impulses from receptors in skin, joints, muscles, & other peripheral aspects of body to CNS
  - Motor or efferent nerves carry impulses to outlying regions of body from the CNS

Neural control of voluntary movement

- Efferent nerves further subdivided into
  - voluntary or somatic nerves which are under conscious control & carry impulses to skeletal muscles
  - involuntary or visceral nerves, referred to as the autonomic nervous system (ANS) which carry impulses to the heart, smooth muscles, and glands

Neural control of voluntary movement

- Spinal nerves
  - 31 pairs originate from the spinal cord
  - provide both motor & sensory function for their respective portions of body
  - named for the location from which they exit vertebral column
  - from each of side of spinal column
    - 8 cervical nerves
    - 12 thoracic nerves
    - 5 lumbar nerves
    - 5 sacral
    - 1 coccygeal nerve

Proprioception & Kinesthesis

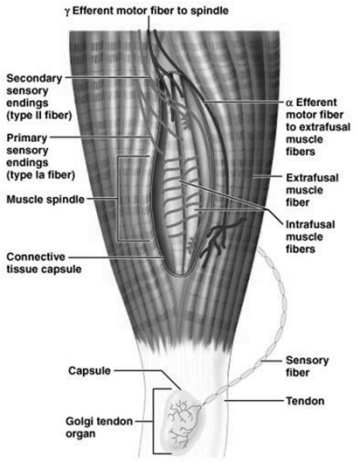
- Proprioceptors - internal receptors located in skin, joints, muscles, & tendons which provide feedback relative to tension, length, & contraction state of muscle, position of body & limbs, and movements of joints

Proprioceptors continued

Muscle spindles:
- Intrafusal fibers – rate & degree of stretch

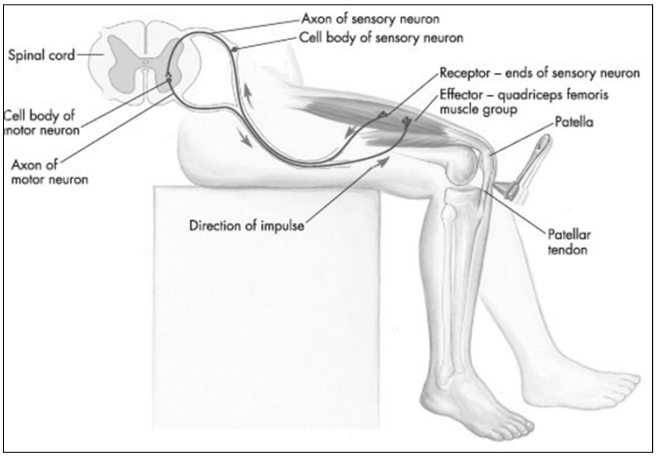
Golgi tendon organs
- Near muscle-tendon junction: monitor tension within tendons

Joint kinesthetic receptors
- Monitor stretch in synovial joints
- Send info to cerebellum and spinal reflex arcs



Proprioception & Kinesthesis

- Ex. Knee jerk or patella tendon reflex



All or None Principle

- *All or None Principle* - regardless of number, individual muscle fibers within a given motor unit will either fire & contract maximally or not at all
- difference between lifting a minimal vs. maximal resistance is the number of muscle fibers recruited

All or None Principle

- When muscle contracts, contraction occurs at the muscle fiber level within a particular motor unit
- Motor unit
  - Single motor neuron & all muscle fibers it innervates
  - Function as a single unit