PHYE 281 - Applied Kinesiology
Lecture 2
Neuromuscular Fundamentals

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Objectives

Identify the types, characteristics and function of muscle tissue

Understand how muscles are named

Describe the connective tissue organization and fiber arrangement of skeletal muscle

Become familiar with the Sliding Filament Theory of muscle contraction

Identify the structure of a representative neuron

Define the Neuromuscular Junction, the Motor Unit and the concept of Recruitment

Define the All or None Theory

Understand the concepts of mechanisms for Kinesthesis and Proprioception

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Types of Muscle Tissue

Cardiac - tissue of the heart

Striated and involuntary

Smooth - lines hollow organs

Non-striated and involuntary

Skeletal - attached to bone

Striated and voluntary

This type of muscle will be our focus

Characteristics of Muscle

Excitability

Receive and respond to nervous system stimuli

Contractility

Actively generate force to shorten

Extensibility

Ability to passively stretch by antagonist

Elasticity

Ability to return to original shape

Skeletal Muscle Functions

Produce movement of skeleton

Maintain posture

Support soft tissues

Guard openings into body

Maintain body temperature

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Muscle Nomenclature

Attachments to bone

- Origin - stationary end
- Insertion - moveable end

Actions

- Agonist (prime mover)
- Antagonist - opposes agonist

Tendon

- Fibrous connection of muscle to bone

Innervation

- Nerve stimulating muscle

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Naming of Muscles

Location

Rectus femoris

Fiber organization

External oblique

Bony attachment

Coracobrachialis

Action

Supinator

Shape

Deltoid

Size

Gluteus maximus

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Connective Tissue Organization

Epimysium

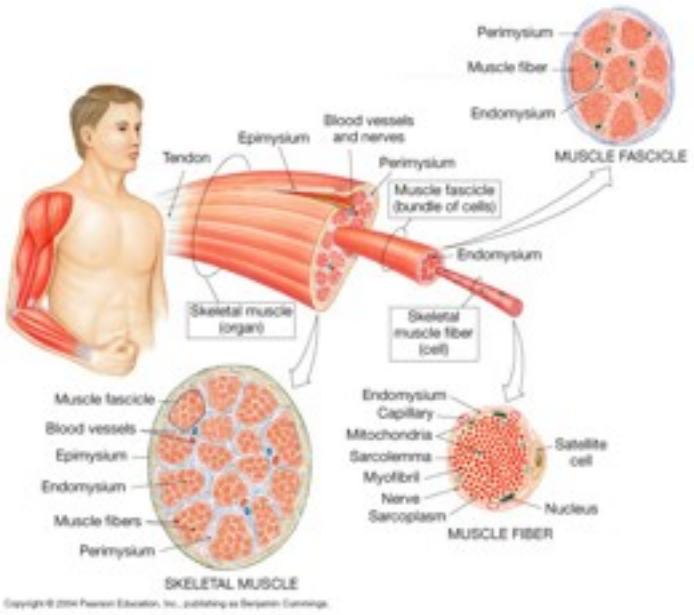
Surrounds Muscle

Perimysium

Surrounds bundles of fibers called fascicles

Endomysium

Covers individual fibers



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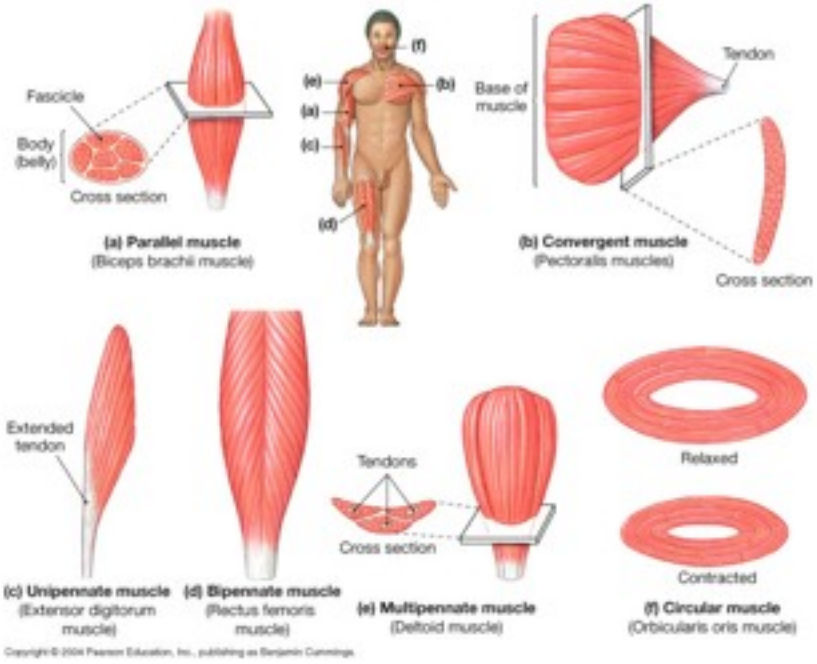
Fiber Arrangement

Parallel

Convergent

Pennate

Circular



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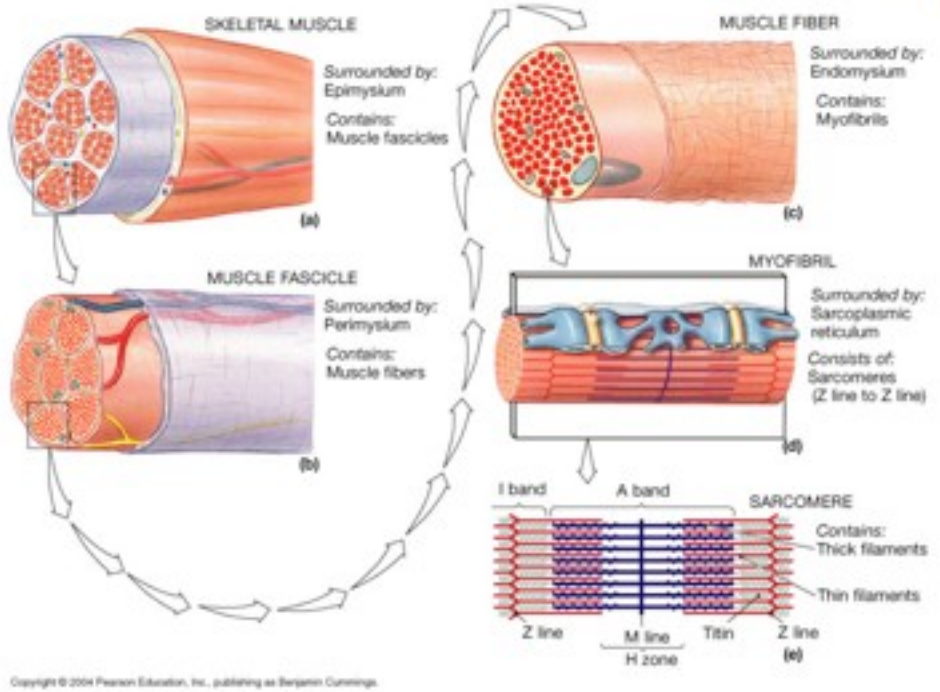
Skeletal Muscle Morphology



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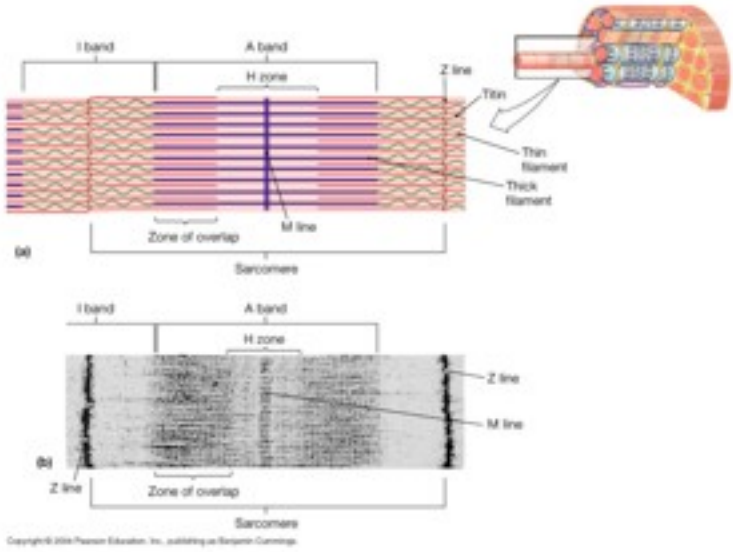
Sliding Filament Theory

Contraction is via thick and thin filaments sliding past each other

The basic unit of contraction is the sarcomere



Skeletal Muscle Structure and Function

Types of Muscle Contraction

Isometric

Muscle tension with no change in joint angle

Isotonic

Concentric - tension resulting in shortening overcoming gravity

Eccentric - tension resulting in lengthening lowering to ground

Which type of contraction causes greater stress on muscle?

How would this influence resistance training?

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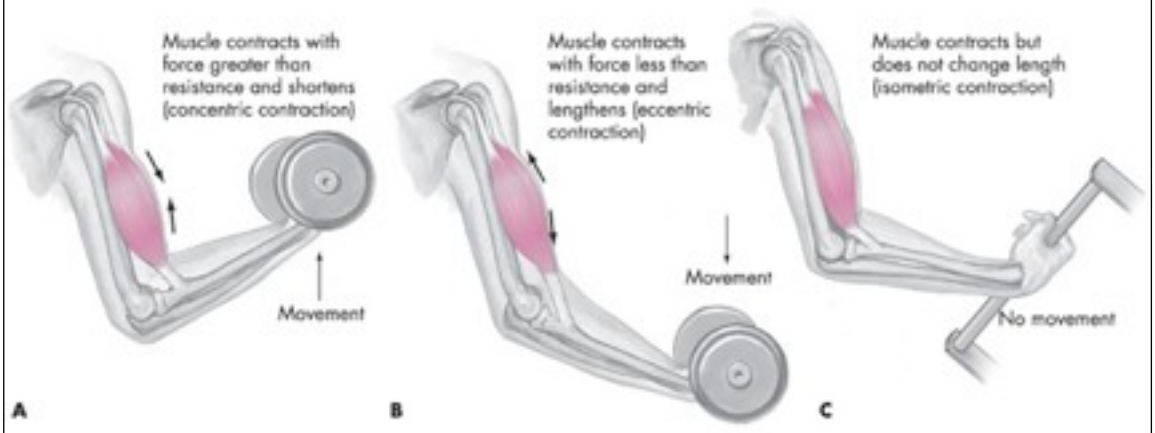
Types of Muscle Contraction



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Neural Control of Skeletal Muscle

Skeletal muscle is innervated by Central Nervous System (CNS) stimulation

Action potentials travel away from the CNS along Somatic Motor Neurons of the Peripheral Nervous System (PNS)

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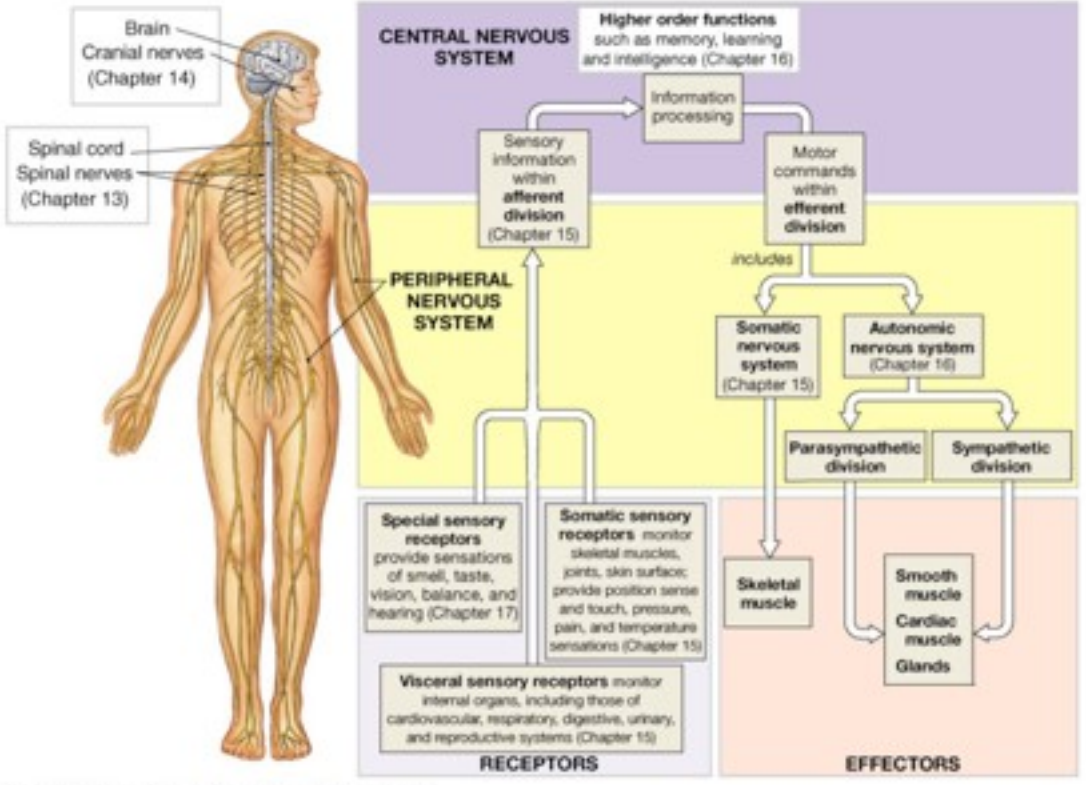

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Neuron Structure

Basic functional unit of nervous system is the neuron

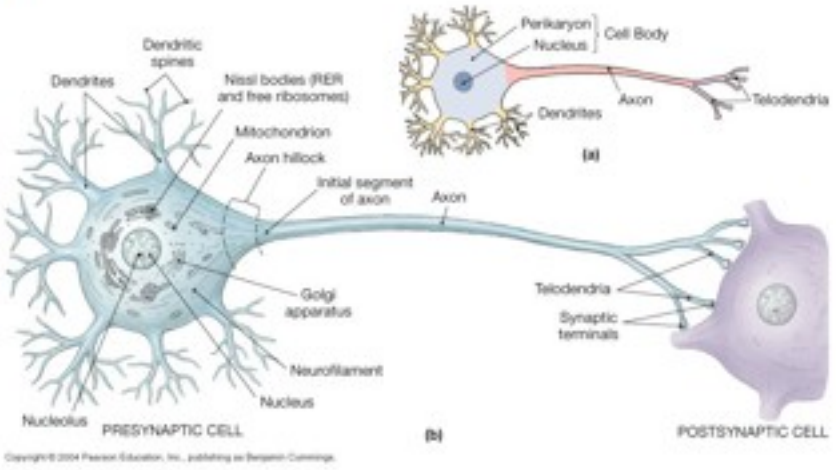
Generates impulses called action potentials (AP)

Neurons contain:

Cell body

Dendrites – conduct AP towards cell body

Axons – conduct AP away from cell body

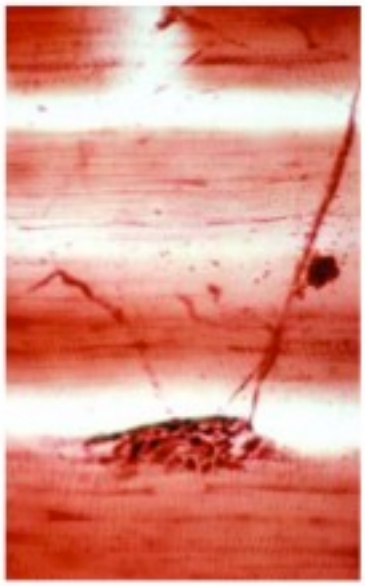


Neuromuscular Junction (NMJ)

Motor neurons originate in the CNS and synapse with skeletal muscle at the NMJ

A motor neuron can innervate just a few skeletal muscle fibers, or a few thousand

A single motor neuron and the skeletal muscle fibers it innervates are called a motor unit



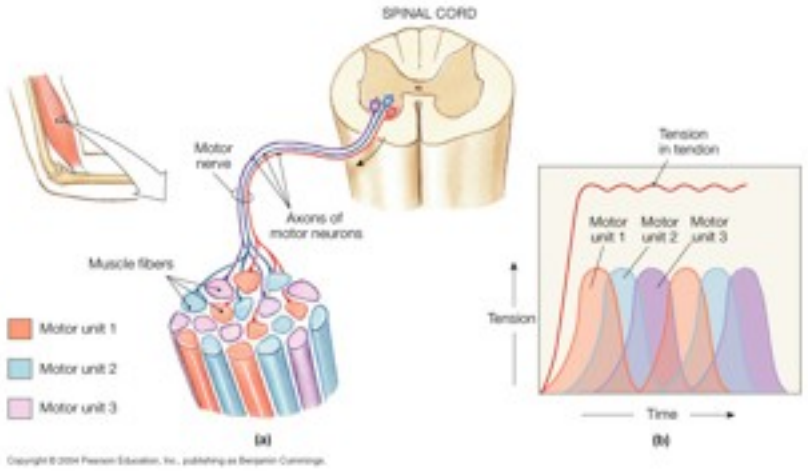
Recruitment and Motor Units

Movement is achieved via the recruitment of motor units

Tension is progressively increased by smooth and steady recruitment

Fine movements of the eye are via motor units of 4-6 muscle fibers

Gross movements of legs involve motor units of 1-2K fibers



All or None Principle

A single muscle fiber is either at rest, or contracting fully - Fibers contract All or None

Increases in tension are not from an individual fiber contracting more forcefully

Increases in tension, therefore, are achieved by increasing the number of motor units involved during contraction

Kinesthesis and Proprioception

Human performance is dependent upon neurologic feedback

Kinesthesis is the awareness of the position and movement of the body in space

The mechanism for this awareness is via stimuli originating in the Proprioceptors of the muscles, tendons, joints and inner ear.

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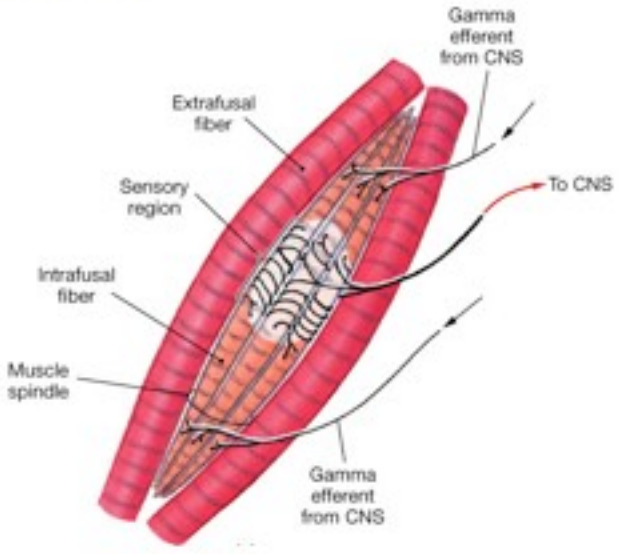
Proprioception

Proprioceptors specific to skeletal muscle:

Muscle spindles: specialized skeletal muscle fibers and sensory neurons that detect muscle stretch - involved in the stretch reflex

Golgi tendon organs (GTO): specialized sensory neurons in tendon that detect excessive tension - protects muscle from excessive stretch by inhibiting agonist



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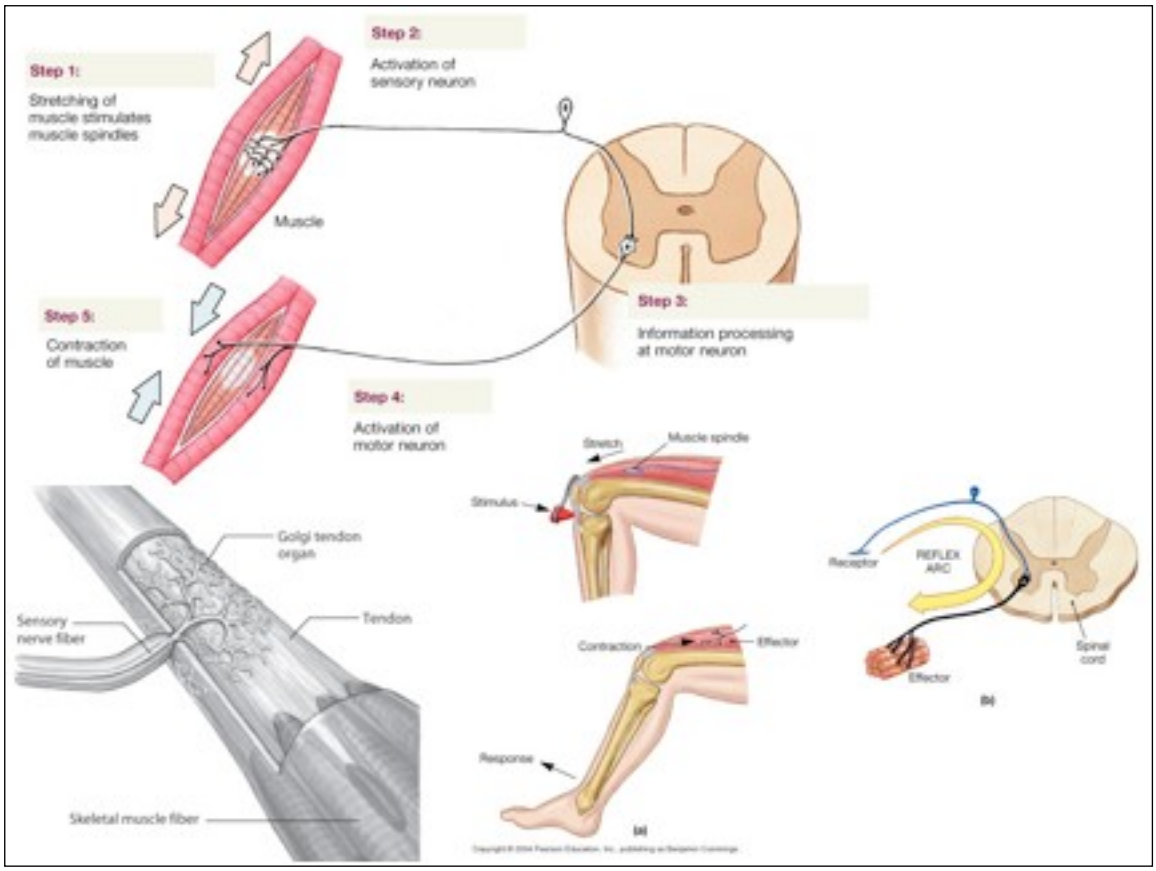

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