

# MUSCULAR SYSTEM

# Introduction

- ▣ Approximately 700 muscles
- ▣ Most attached by tendons to bones
- ▣ Myo-, mys-, and sarco- are words for muscle
- ▣ 40% of body mass

# Characteristics

- ▣ Excitable/irritable
- ▣ Contractable
- ▣ elasticity

# Types

- ▣ Smooth
  - Non-striated
  - Glands/organs
- ▣ Cardiac
  - Striated
  - Heart only
- ▣ Skeletal
  - Striated
  - Gross muscles – you can see them

# Functions

- ▣ Movement
- ▣ Maintain posture
- ▣ Stabilizes joints
- ▣ Generates heat

# Attachment

- ▣ Origin = inserted on stationary bone
- ▣ Insertion = inserted on bone that moves
  - Ex. Biceps radius = insertion/humerus=origin
- ▣ Direct attachment
  - Directly to the periosteum - most
- ▣ Indirect attachment
  - Tendons
  - Aponeurosis
    - ▣ Forearms, palms, soles

# General Rules

- ▣ Antagonists
  - Functionally oppositional
  - Examples:
- ▣ Synergists
  - Muscles with the same functions
  - Prime mover
  
- Flexors are front
- Extensors are back – these muscles weaken first

# How skeletal muscles are named

- ▣ Location
- ▣ Size
- ▣ Shape
- ▣ Direction in which fibers run
- ▣ Number of heads for attachment
- ▣ Action of the muscle



# Skeletal Muscle Movement Mechanics

- ▣ Lever
  - Bone – rigid bar moving around fixed point
- ▣ Fulcrum
  - Joint – fixed pivot point
- ▣ Force
  - Applied by the muscle

# Muscle Tone

- ▣ State of slight contraction
- ▣ Needed for posture
- ▣ Alternate fibers contract to prevent fatigue
- ▣ Exercise improves muscle tone
  - Isometric
    - ▣ Muscle tone tension remains same but muscle contracts
    - ▣ Lifting weights, walking, running
  - Isotonic
    - ▣ No muscle contraction but increase in tone/tension
    - ▣ Pushing palms against one another

# Muscle coverings

- ▣ Endomysium
  - Around each fiber
- ▣ Perimysium
  - Around bundles of fibers (fascicles)
- ▣ Epimysium
  - Around all fascicles

# Myofilaments

- ▣ Actin
  - Thin filaments
- ▣ Myosin
  - Thick filaments

# Skeletal Muscle Cell

- ▣ Sarcoplasm
  - Muscle cell membrane
- ▣ Sarcoplasmic reticulum
  - Endoplasmic reticulum of the muscle cell
- ▣ Myofibrils
  - Actin and myosin
- ▣ Sarcomere
  - Structural contractile unit

# Action Potential

- ▣ Normal cell is negative inside when resting
- ▣ Sodium (Na) enters the cell causing the polarity to reverse
- ▣ Sodium stimulates the sarcoplasmic reticulum to release calcium
- ▣ Calcium attaches to the actin and allows myosin to grab and pull – shortening the sarcomere

# Important terms

- ▣ Depolarization – changing inside cell to +
- ▣ Repolarization – changing cell back to –
- ▣ Neurotransmitter responsible is acetylcholine
- ▣ All or none response – muscle fully contracts when depolarized

# Repolarization

- ▣ Sodium is pumped out of the cell
  - ▣ Calcium is reabsorbed into sarcoplasmic reticulum
  - ▣ Myosin lets go
  - ▣ Acetylcholine is destroyed by acetylcholine esterase
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- ▣ Rigor Mortis – dying cells release Calcium
  - ▣ Charlie Horse – the muscle has to run out of calcium to stop contracting



# Energy source for muscle contraction

- ▣ Direct energy source = ATP
- ▣ Additional oxygen is stored as myoglobin
- ▣ Additional glucose is stored as glycogen
- ▣ Additional energy stored as creatine phosphate
  
- ▣ When oxygen runs out anaerobic process begins
- ▣ Glucose is converted to lactic acid – muscle cramps occur

# Oxygen debt must be repaid

- ▣ Respiratory rate will remain elevated until enough oxygen is inhaled to remove the lactic acid

# Disease/Disorders

- ▣ Atrophy
  - Progressive loss of muscle mass
- ▣ Muscular Dystrophy
  - Prevalent in males – hereditary
  - Life expectancy – 20 years
- ▣ Myasthenia Gravis
  - Autoimmune disorder
  - Weakness with chewing, seeing, talking
- ▣ Fibromyalgia
  - Chronic widespread muscle pain and fatigue

# Types of muscle fibers

## RED FIBERS

- ▣ Slow twitch
- ▣ Slow contracting
- ▣ Slow to fatigue
- ▣ Burn fat
- ▣ Aerobic
- ▣ More mitochondria
- ▣ Endurance sports

## WHITE FIBERS

- ▣ Fast twitch
- ▣ Designed for strength
- ▣ Anaerobic
- ▣ Not designed for endurance
- ▣ Fatigue easily
- ▣ Build up of lactic acid

# Benefits of exercise

- ▣ Strengthens heart muscle
  - ▣ Decreases blood pressure
  - ▣ Increases respiratory efficiency
  - ▣ Delays development of oxygen debt
  - ▣ Improves muscle tone
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- ▣ Long term exercise – increases blood supply, increases mitochondria, and reserve energy sources