

Chapter 8

Skeletal Muscle

Objectives

- Draw & label the microstructure of skeletal muscle
- Outline the steps leading to muscle shortening
- Define the concentric & isometric
- Discuss: twitch, summation & tetanus
- Discuss the major biochemical & mechanical properties of skeletal muscle fiber types

Objectives

- Discuss the relationship b/n skeletal muscle fibers types & performance
- List & discuss those factors that regulate the amount of force exerted during muscular contraction
- Graph the relationship b/n movement velocity & the amount of force exerted during muscular contraction
- Discuss structure & function of muscle spindle
- Describe the function of a Golgi tendon organ

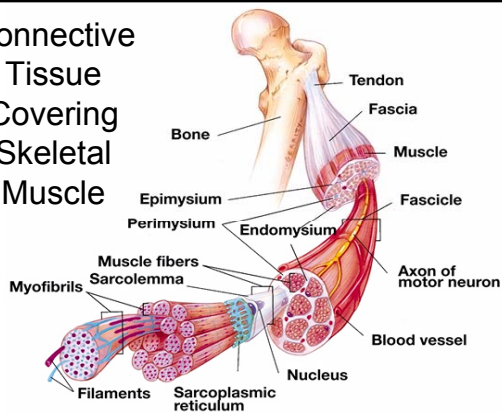
Skeletal Muscle

- Human body contains over 400 skeletal muscles
- Facts of skeletal muscle

Structure of Skeletal Muscle: *Connective Tissue Covering*

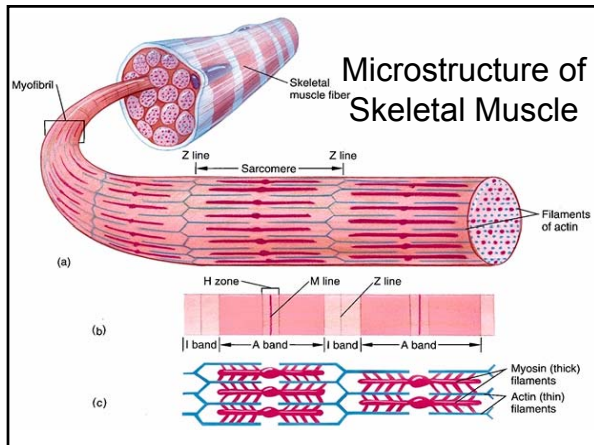
- Epimysium
- Perimysium
- Endomysium

Connective Tissue Covering Skeletal Muscle



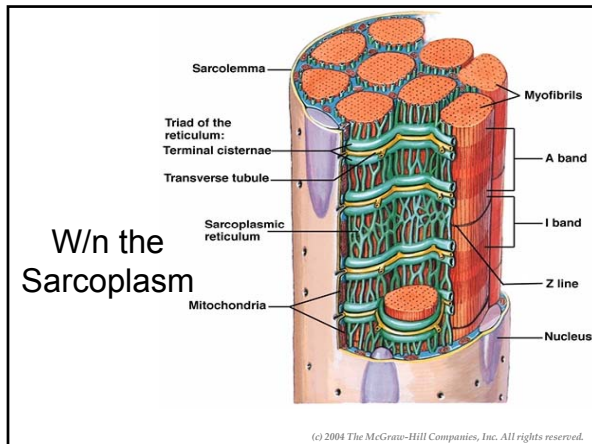
Microstructure of Skeletal Muscle

- Sarcolemma
- Myofibrils



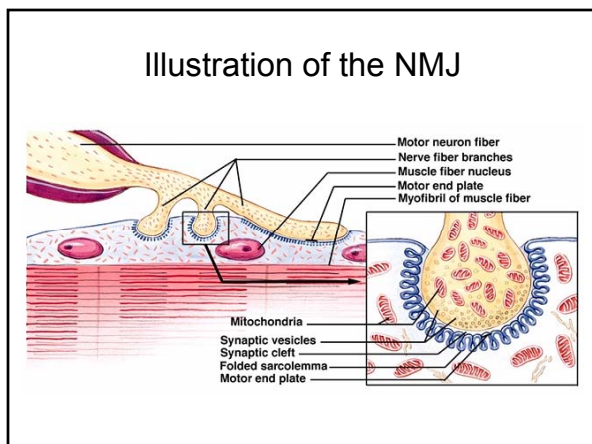
Microstructure of Skeletal Muscle

- W/n the sarcoplasm



The Neuromuscular Junction (NMJ)

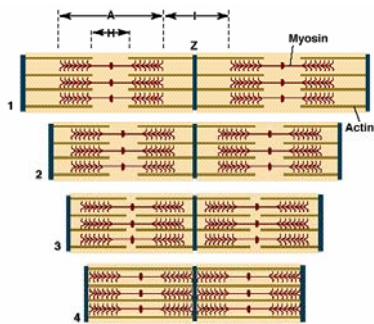
- Site where motor neuron (MN) meets the muscle fiber
- Motor end plate (MEP)
- Acetylcholine (ACh) is released from the MN



Muscular Contraction

- The sliding filament model

The Sliding Filament Model of Muscle Contraction

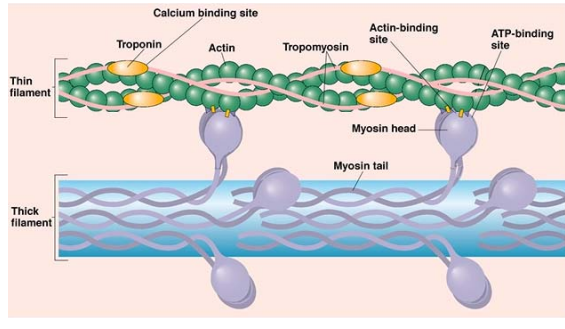


Actin & Myosin Relationship

- Actin

- Myosin

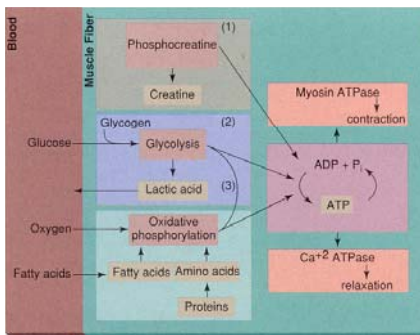
Actin & Myosin Relationship



Energy for Muscle Contraction

- ATP is required for muscle contraction
- Sources of ATP

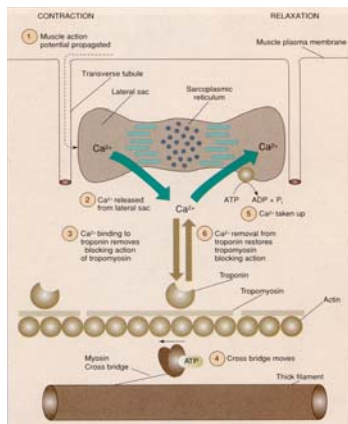
Sources of ATP for Muscle Contraction

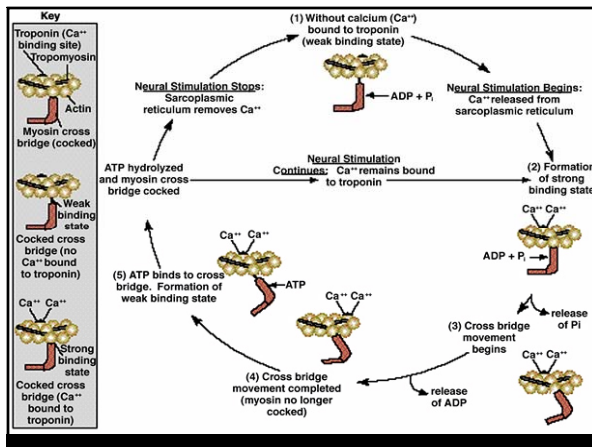


Excitation-Contraction Coupling

- Depolarization of MEP (excitation) is coupled to muscular contraction

Excitation-Contraction Coupling





Properties of Muscle Fibers

- Biochemical properties
- Contractile properties

Individual Fiber Types

Fast fibers

- Type IIx fibers

Slow fibers

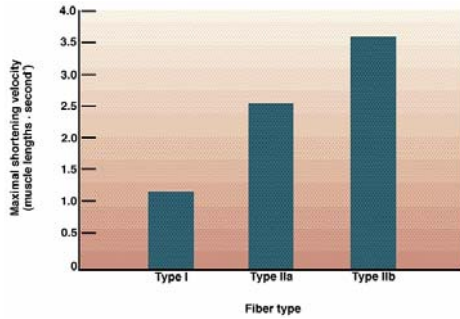
- Type I fibers

- Type IIa fibers

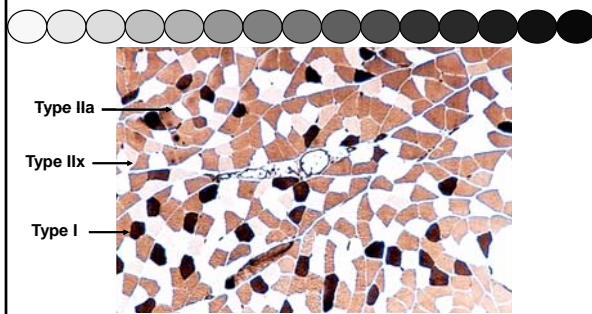
Muscle Fiber Types

Characteristic	Fast Fibers		Slow fibers
	Type IIx	Type IIa	Type I
Number of mitochondria	Low	High/mod	High
Resistance to fatigue	Low	High/mod	High
Predominant energy system	Anaerobic	Combination	Aerobic
ATPase	Highest	High	Low
V_{max} (speed of shortening)	Highest	Intermediate	Low
Efficiency	Low	Moderate	High
Specific tension	High	High	Moderate

Comparison of Maximal Shortening Velocities b/n Fiber Types



Histochemical Staining of Fiber Type



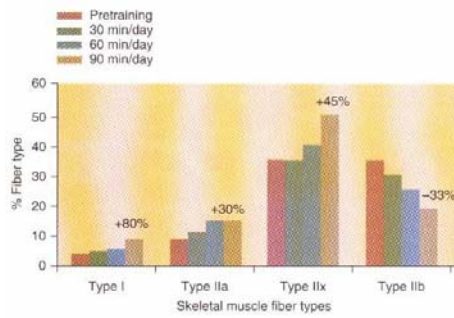
Fiber Types & Performance

- Power athletes
- Endurance athletes
- Others

Alteration of Fiber Type by Training

- Endurance & resistance training

Training-Induced Δ s in Muscle Fiber Type



Age-Related Δ s in Skeletal Muscle

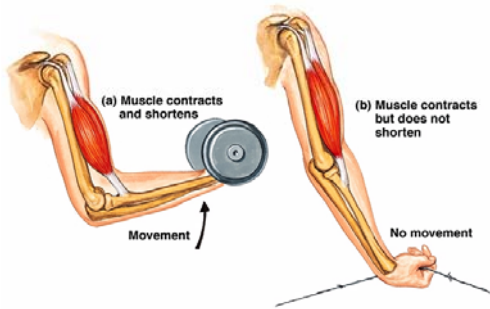
- Aging is associated w/ a loss of muscle mass
- Regular exercise training can improve strength & endurance

Types of Muscle Contraction

- Isometric

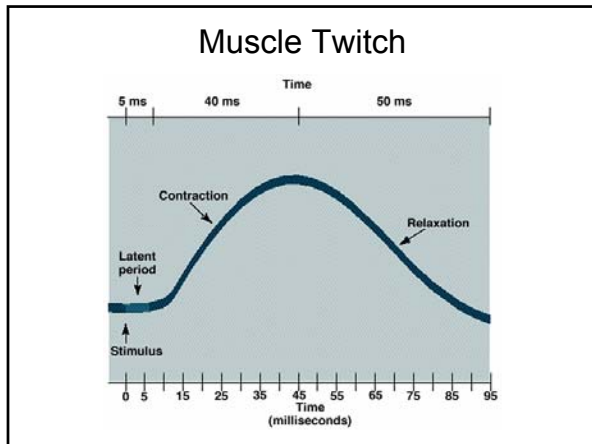
- Isotonic (dynamic)

Isotonic & Isometric Contractions

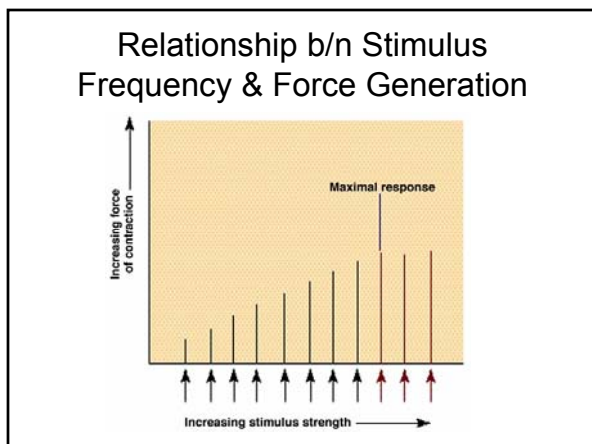


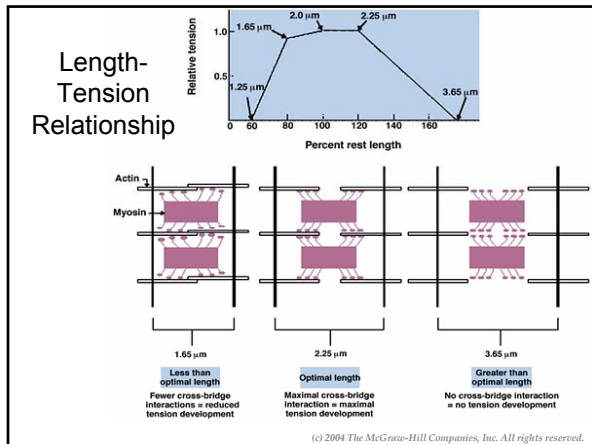
Speed of Muscle Contraction & Relaxation

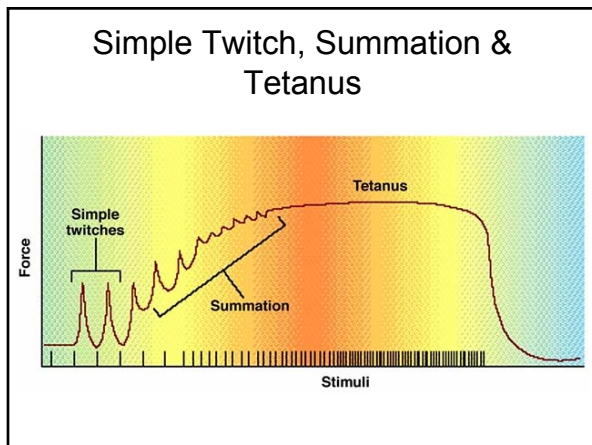
- Muscle twitch
 - Contraction as the result of a single stimulus
 - Latent period
 - Lasting only ~5 ms
 - Contraction
 - Tension is developed
 - 40 ms
 - Relaxation
 - 50 ms



- ### Force Regulation in Muscle
- Types and number of motor units recruited
 - More motor units = greater force
 - Fast motor units = greater force
 - Increasing stimulus strength recruits more & faster/stronger motor units
 - Initial muscle length
 - “Ideal” length for force generation
 - Nature of the motor units neural stimulation
 - Frequency of stimulation
 - Simple twitch, summation, and tetanus



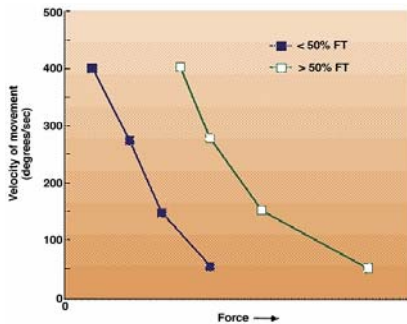




Force-Velocity Relationship

- At any absolute force the speed of mvt is greater in muscle w/ higher percent of fast-twitch fibers
- The maximum velocity of shortening is greatest at the lowest force
 - True for both slow & fast-twitch fibers

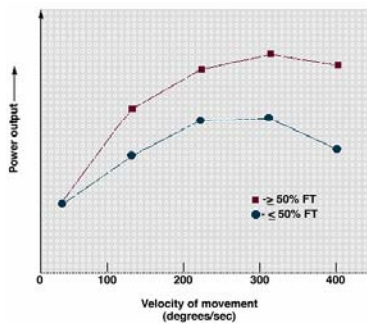
Force-Velocity Relationship



Force-Power Relationship

- At any given velocity of mvt the power generated is greater in a muscle w/ a higher % of fast-twitch fibers
- The peak power ↑s w/ velocity up to mvt speed of 200-300 degrees•second⁻¹
 - Force ↓s w/ ↑ing mvt speed beyond this velocity

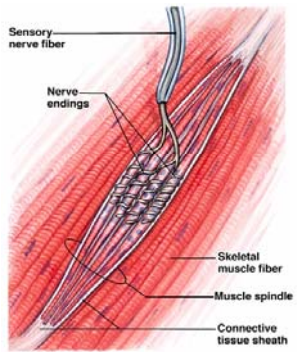
Force-Power Relationship



Receptors in Muscle

- Muscle spindle
 - Δ s in muscle length
 - Rate of Δ in muscle length
 - Intrafusal fiber contains actin & myosin & therefore has the ability to shorten
 - Gamma motor neuron stimulate muscle spindle to shorten
- Stretch reflex
 - Stretch on muscle causes reflex contraction

Muscle Spindle



Receptors in Muscle

- Golgi tendon organ (GTO)
 - Monitor tension developed in muscle
 - Prevents damage during excessive force generation
 - Stimulation results in reflex relaxation of muscle

Golgi Tendon Organ

