

Nerve-muscle relationship

- I. Motor neurons
 - A. somatic nerves – voluntary (skeletal)
 - B. motor unit
 - i. nerve fiber
 - ii. all fibers (interspersed) it affects
 - 1. result – weak universal contraction
 - 2. “work in shifts”
 - 3. all or none response
 - C. neuromuscular junction
 - i. axon terminal
 - ii. synapse/synaptic cleft
 - iii. motor end plate – depression in sarcolemma
 - iv. muscle fiber nucleus
- II. Sliding filament theory
 - Firing a muscle fiber:
 - A. electrical signal sent from brain
 - B. calcium ions (Ca^{2+}) cause release of acetylcholine (ACh)
 - C. ACh goes into synapse
 - D. muscle fiber receptors cause ion imbalance (Na^+ , K^+) through T-tubules
 - E. Ca^{2+} allowed in, binds to troponin; slides to expose tropomyosin
 - F. myosin forms cross-bridges with active sites
 - G. ATP causes myosin heads to contract, “power stroke”
 - H. more ATP causes heads to release “recovery stroke”
 - I. process continues
 - To relax muscle:
 - J. nerve impulse stops
 - K. ACh broken down by acetylcholinesterase (AChE)
 - L. Ca^{2+} reabsorbed by reticulum from tropomyosin – stored in vesicles with calsequestrin
 - M. troponin moves to cover up tropomyosin again
 - N. myosin heads no longer attracted, cross bridge eliminated
 - O. muscle relaxes

- III. Stages of contraction
 - A. Threshold – amount of voltage req'd to release Ca
 - B. Latent period – delay for tropomyosin, etc (2 msec)
 - C. Contraction phase
 - D. Relaxation phase (7 – 10 msec)
- IV. Twitch strength
 - A. Twitch – low stimulation, full relaxation between
 - B. Treppe – moderate stim, full relaxation, stronger twitches
 - C. Incomplete tetanus – wave summation stimulation (adding on to last before relaxation can occur), stronger twitches
 - D. complete tetanus – 40/50 stimuli per second, twitches fuse into prolonged contraction
- V. Types of contraction
 - A. Isometric – no length change
 - B. Isotonic – muscle shortens
 - i. Concentric – maintains tension throughout contraction
 - ii. Eccentric – muscle lengthens as it maintains tension
- VI. Oxygen Debt
 - A. oxygen used to make ATP from glycogen
 - B. oxidizing lactic acid if not enough O₂
 - C. fast-twitch muscles
 - i. fast processing, low endurance
 - D. slow-twitch muscles
 - i. slow processing, high endurance
 - E. intermediates
- VII. Muscle disorders
 - A. Cramps
 - B. Fibromyalgia – general disorder causing pain/tenderness, also caused by physical/emotional trauma or medications
 - C. Atrophy – inactivity causing muscle loss – 3% per day if bed rest
 - D. Hypertrophy – building muscles due to use
 - E. Myositis – muscle inflammation due to infection
 - F. Muscular dystrophy – genetic, muscles break down and replaced by fat
 - G. Myasthenia gravis – ACh receptors attacked, muscles become less sensitive, cause drooping (face)

VIII. Muscle structures

Fascia – outer covering

Muscle

Epimysium – surrounds all bundles

Perimysium – surrounds individual bundles

Fascicle – bundles making up muscle

Endomysium – surrounds all fibers w/i fascicle; like epimysium

Fibers – bundles making up fascicle

Sarcolemma – surrounds individual fibers; like perimysium

Sarcoplasmic reticulum – canal system over fibers

Myofibrils – bundles making up fibers

Filaments – bundles making up myofibrils; actin & myosin

Filaments actin & myosin → myofibril → fibers → fascicle → muscle

Sarcomere – Z line to Z line, functional unit; I band (actin), A band (actin & myosin) with H zone (myosin contracting zone) and M line (myosin only)