EXAM 3 REVIEW SHEET

Do your best to answer the questions below. The more completely you answer them, the better your study material will be and the better you will do on the exam.

Muscle Physiology

- What are the key features of skeletal, cardiac, and smooth muscle? What are the two types of smooth muscle? Where would you find them?

Muscle Type	Appearance	Control	Location/Function	Key Features
Skeletal Muscle	Striated (striped)	Voluntary	Attached to bones, skin (facial expressions), fascia	Multinucleated, cylindrical cells
Cardiac Muscle	Striated	Involuntary	Heart muscle	Autorhythmic, branched cells with one nucleus
Smooth Muscle	Non-striated	Involuntary	Walls of blood vessels, gastrointestinal tract, hair follicles (erector pili muscles)	Spindle-shaped, single nucleus

- What are the 5 functions of muscles?
  - Produce body movement by pulling on bones
  - Stabilize body posture (e.g., keeping the head upright)
  - Regulate organ volume (e.g., blood vessels constrict or dilate)
  - Move substances through the body (e.g., blood by the heart, urine through ureters, food through intestines, sperm through reproductive ducts)
  - Generate heat during contraction (e.g., shivering to maintain body temperature)

- What are the 5 properties of muscle tissue?
  - Excitability: respond to chemical signals from nerves
  - Conductivity: transmit electrical signals along the cell membrane

- Contractility: shorten to generate force
- Extensibility: can be stretched without damage
- Elasticity: return to original shape after stretching

- Where would you will find epimysium, perimysium, endomysium?

Connective tissue components of the muscle include

– epimysium = surrounds the whole muscle

– perimysium = surrounds bundles (fascicles)

– endomysium = separates individual muscle cells

- How is the sarcoplasm of a skeletal muscle cell different from a typical cell?

Highly specialized for contraction and energy storage

- What do the structural proteins do? What are the four structural proteins? What does each do?

Four structural proteins: titin, myomesin, nebulin and dystrophin

What they do: provide proper alignment, elasticity and extensibility

• **Titan** anchors thick filament to the M line and the Z disc.

– Titan can stretch to 4 times its resting length and spring back unharmed playing an important role in recovery of the muscle from being stretched.

• **Myomesin** (M line) connects to titin and adjacent thick filaments.

• **Nebulin**, an inelastic protein wrapped around the thin filaments that helps align the thin filaments and anchors them to Z disc.

• **Dystrophin** links thin filaments to sarcolemma and transmits the tension generated to the tendon

- What does troponin do? What does tropomyosin do?

regulatory proteins which turn contraction on & off

Tropomyosin covers the actin binding sites, preventing their union with myosin cross bridges.

• Troponin has three binding sites: one binds to tropomyosin, one to actin, and one to Ca

– When calcium combines with troponin, tropomyosin slips away from its blocking position between actin and myosin.

– With this change actin and myosin can interact and muscle contraction can occur.

- Go through all of the steps of the sliding filament theory. Start at the release of acetylcholine from the synaptic end bulb of a motor neuron all the way through contraction to relaxation

1. Arrival of nerve impulse at nerve terminal causes release of acetylcholine (ACh) from synaptic vesicles

2. ACh binds to receptors on muscle motor end plate opening the gated ion channels so that Na+ can rush into the muscle cell

3. Inside of muscle cell becomes more positive, triggering a muscleaction potential that travels over the cell and down the T tubules

4. The release of Ca2+ from the SR is triggered and the muscle cell will shorten & generate force

5. Acetylcholinesterase breaks down the ACh attached to the receptors on the motor end plate so the muscle action potential will cease and the muscle cell will relax

- Know the 3 sources of ATP production within muscle and how long they provide ATP for:
  creatine phosphate: 15 seconds

  anaerobic cellular respiration, 30-40 seconds
  aerobic cellular respiration: more than 10 minutes

- What contributes to muscle fatigue?

central fatigue is feeling of tiredness and a desire to stop (protective mechanism)

– insufficient release of acetylcholine from motor neurons

– depletion of creatine phosphate

– decline of Ca2+ within the sarcoplasm

– insufficient oxygen or glycogen

– buildup of lactic acid and ADP

– heat

- What is a motor unit? How are motor units recruited?

one somatic motor neuron & all the skeletal muscle cells (fibers) it stimulates (10 cells to 2,000 cells)

Motor units in a whole muscle fire asynchronously

– some fibers are active others are relaxed

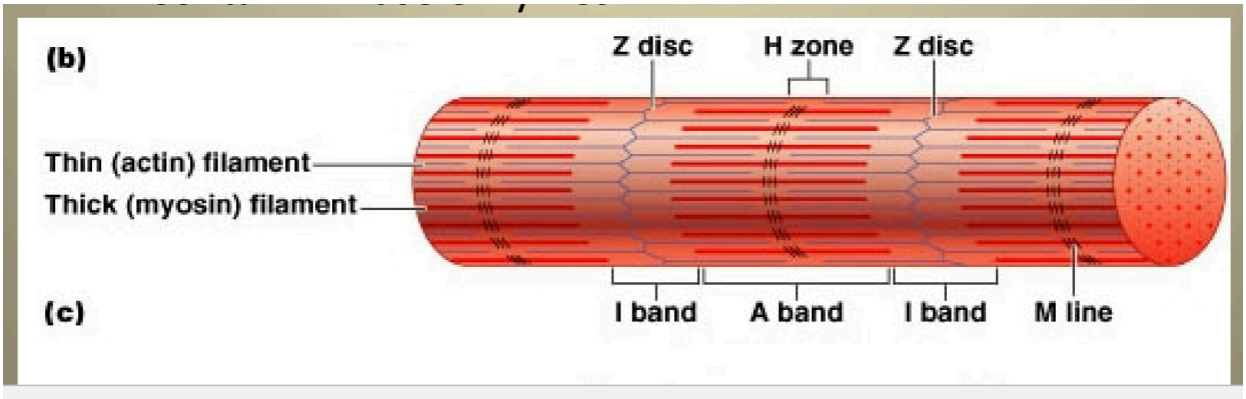
– delays muscle fatigue so contraction can be sustained

Definitions:
Myology: scientific study of muscles
Myogram: graph of a twitch contraction

Intercalated disc: Cells connected by intercalated discs with gap junctions

Sarcolemma: Muscle cell membrane (specialized for electrical conduction)
Sarcomere: Functional contractile unit within myofibrils
Sarcoplasm: Cytoplasm of a muscle cell

Myofiber: Muscle cell, composed of many myofibrils
Sarcoplasmic reticulum: Specialized ER storing calcium ions for contraction



Z disc: boundaries of each sarcomere
A Band: The length of the thick filament, including overlapping thin filaments; appears dark under a microscope.

I Band: Region with only thin filaments; appears lighter.

H Zone: Central part of the A band where only thick filaments are present (no thin filament overlap).

M Line: The middle line in the H zone that stabilizes thick filaments structurally.

Neuromuscular junction: The synapse between a motor neuron and a skeletal muscle fiber where the neuron communicates with the muscle using the neurotransmitter acetylcholine to trigger contraction.

Synaptic cleft

The small gap between the motor neuron's synaptic end bulb and the muscle fiber's motor end plate where neurotransmitters diffuse across to transmit the signal.

Motor end plate

The specialized region of the muscle fiber's sarcolemma that contains acetylcholine receptors; it receives the signal from the motor neuron.

Acetylcholinesterase

The enzyme located in the synaptic cleft that breaks down acetylcholine, stopping the signal and allowing the muscle to relax.

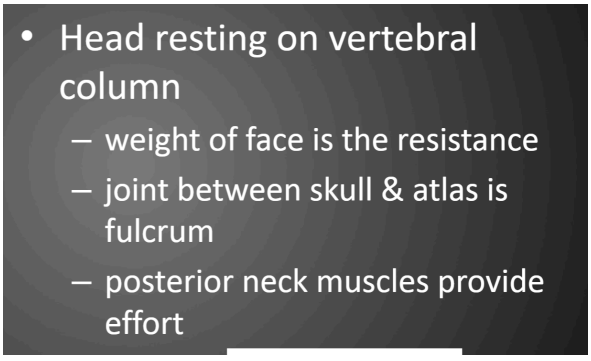
Motor unit

A single motor neuron and all of the muscle fibers it innervates; smaller motor units allow fine control, and larger motor units provide stronger force.

Muscle System Continued

You will need to understand how muscles are named, including location, shape, size, number of origins, and function.

Know the difference between the three classes of levers, how they are arranged.

First: 

Second:

- Similar to a wheelbarrow
- Raising up on your toes
  - resistance is body weight
  - fulcrum is ball of foot
  - effort is contraction of calf muscles which pull heel up off of floor

Third:

- Most common levers in the body
- Favors speed and range of motion over force
- Flexor muscles at the elbow
  - resistance is weight in hand
  - fulcrum is elbow joint
  - effort is contraction of biceps brachii muscle

Know the purpose of IM injections and the common sites where they may occur.

IM injection

- Intramuscular injection penetrates the skin, subcutaneous tissue and enters the muscle.
- They are given when rapid absorption is necessary, for large doses, or when a drug is irritating to subcutaneous tissue.
- Common sites of injection are the **gluteus medius, vastus lateralis, and deltoid.**
- Intramuscular injections are faster than oral medications, but slower than IV.

Definitions:
Origin: the bone that does not move when muscle shortens (normally proximal)
Insertion: is the movable bone (some 2 joint muscles)
Belly: Fleshy portion of the muscle in between attachment sites

Nervous System

What is the difference between the central and peripheral nervous system?

Central Nervous System (CNS): Brain and spinal cord.

Peripheral Nervous System (PNS): All nerves outside the CNS, including cranial nerves (I–XII), spinal nerves, ganglia, and extensive networks like those in the intestines (sometimes called the “second brain”).

Know the different parts of the neuron and what they do:
Cell body (soma or perikaryon): Contains organelles such as rough and smooth endoplasmic reticulum, mitochondria, Golgi apparatus, lysosomes, and Nissl bodies (clusters of ribosomes and rough ER specialized for protein synthesis, especially neurotransmitters).

Dendrites: Multiple short, branching projections that receive incoming signals and transmit them to the cell body.

Axon: A single long projection that transmits outgoing signals to other neurons, muscles, or tissues.

What are the structural and functional classification of neurons?

Classification Type	Categories	Description
Structural	Unipolar	One process from cell body that splits into axon and dendrite.
	Bipolar	Two processes from cell body: one dendritic, one axonal.
	Multipolar	One axon, many dendrites from cell body (most common type).
Functional	Sensory neurons	Transmit sensory information from environment to CNS.
	Interneurons (association neurons)	Connect sensory input to motor output within CNS.
	Motor neurons	Transmit commands from CNS to muscles or glands.

What are the functions of the different neuroglia of the central nervous system?

- **Astrocytes:**
  - Star-shaped, regulate nutrient transfer from blood to neurons.
  - Maintain blood-brain barrier, regulate ion transport, uptake excess neurotransmitters, and support neuron growth.
- **Oligodendrocytes:**
  - Wrap axons with **myelin sheath** in CNS to insulate and increase signal speed.
- **Microglia:**
  - Phagocytic cells that clean up debris and pathogens.
- **Ependymal cells:**
  - Line brain ventricles and spinal cord, produce and circulate cerebrospinal fluid (CSF).
  - Help maintain optimal chemical environment for neurons.

What are the functions of the different neuroglia of the peripheral nervous system?

- **Schwann cells:**
  - Analogous to oligodendrocytes; form myelin sheath around peripheral axons.
  - The outer layer of the Schwann cell wrapping is called the **neurilemma**.
- **Satellite cells:**
  - Support and protect neuron cell bodies in the PNS.

How is voltage generated?

Potential energy due to separated charges, measured in millivolts in neurons

How is the resting membrane potential created? What is the resting membrane potential?

Mechanism of Charge Separation in Neurons

- The **cell membrane** of the neuron acts as a barrier separating the inside from the outside environment.
- The **sodium-potassium pump** actively maintains high potassium (K^+) concentration inside and high sodium (Na^+) concentration outside the cell.
- **Potassium leakage channels** allow K^+ to slowly leak out of the neuron, creating an imbalance.
- As K^+ (positive ions) leave, **negatively charged ions inside the cell remain**, lining the inside of the membrane (since they cannot pass through the membrane).
- Positive charges outside the membrane are attracted back to the negative charges inside, but cannot re-enter due to lack of channels.
- This creates a **separation of charge**: positive outside, negative inside.
- The result is a **resting membrane potential of approximately -70 mV** inside relative to outside the cell.

What is the difference between a graded potential and an action potential?

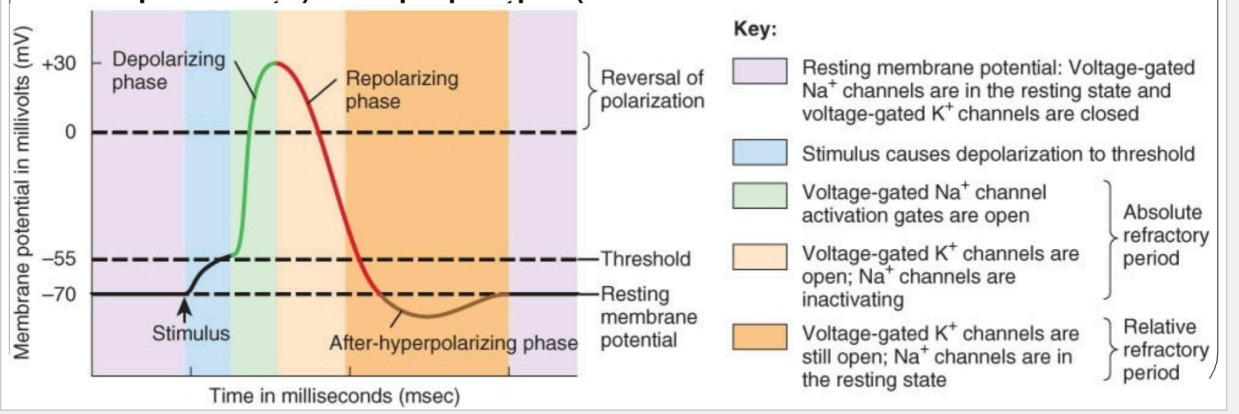
Graded Potential – short-lived local change in the membrane potential

Action Potential – a rapid sequence of changes in the voltage across a membrane. It travels (spreads) over surface of cell without dying out = propagation

What is occurring at each step of an action potential? What channels are open and what channels are closed?

- Series of rapidly occurring events that change and then restore the membrane potential of a cell to its resting state

- Ion channels open, Na+ rushes in (depolarization), K+



What factors affect the speed of propagation?

1. Myelination
2. Axon diameter
   - Larger is faster
3. Temperature
   - Hotter is faster
   - Colder is slower – one of the reasons why you ice painful regions

What is the difference between electrical and chemical synapses?

Electrical Synapses send signals very fast by letting ions pass directly through gap junctions.

• Fast communication

• Found in the heart and visceral smooth muscle

Chemical Synapses are slower. They use neurotransmitters to cross the synaptic cleft.

Definitions:

Term	Location	Definition/Description
Ganglion	Peripheral nervous system	Cluster of neuron cell bodies outside CNS.
Nucleus	Central nervous system	Cluster of neuron cell bodies inside CNS (not to be confused with individual cell nucleus).
Nerves	PNS	Bundles of axons in the peripheral nervous system.
Tracts	CNS	Bundles of axons in the central nervous system.
Myelinated axons	Both CNS & PNS	Axons wrapped in fatty myelin sheath appear white (white matter).
Gray matter	Both CNS & PNS	Areas with unmyelinated structures (cell bodies, dendrites).

Voltage: Potential energy due to separated charges, measured in millivolts in neurons

Current: Flow of electrical charges caused by voltage difference

Action Potential: rapid sequence of changes in the voltage across a membrane. It travels (spreads) over surface of cell without dying out = propagation

Neurotransmitter: a molecule (chemical messenger) stored in the axon terminal of a neuron that is released into the synaptic cleft when a nerve impulse arrives.