Neuromuscular Function

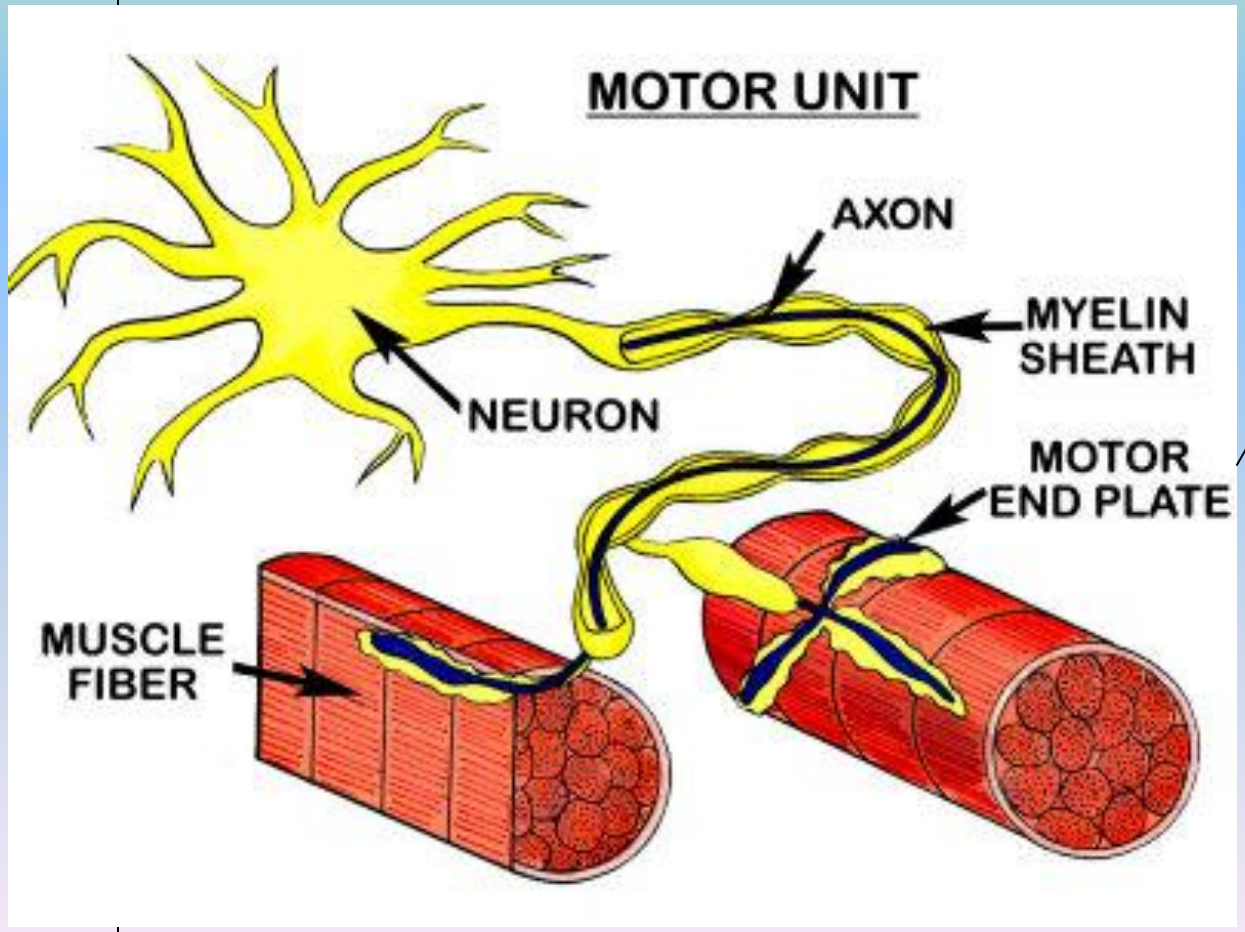
Draw and label a diagram of a motor unit.

Terms to know:

- dendrite
- cell body (soma)
- nucleus
- axon
- motor end plate
- synapse

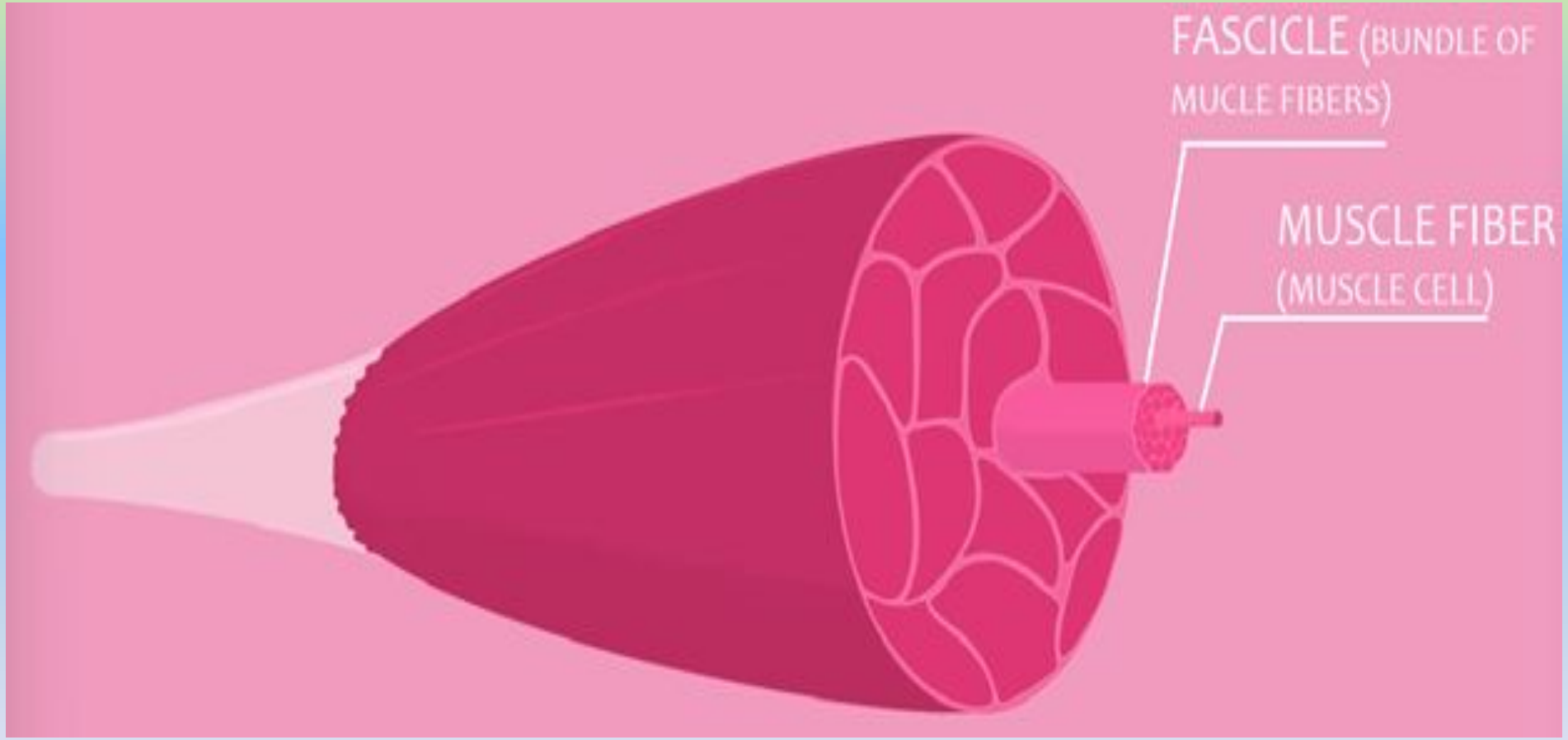
Neuromuscular Function

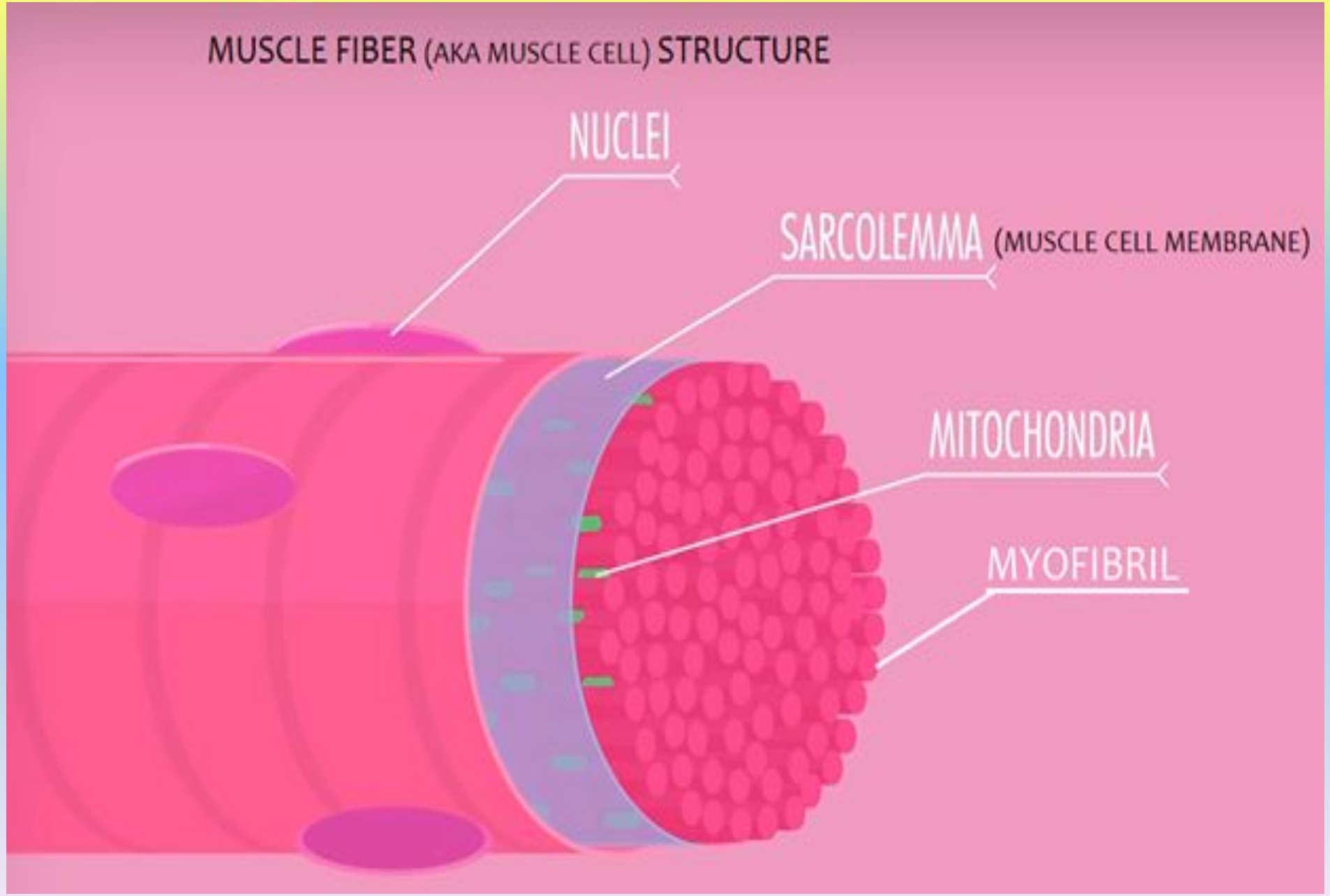
Draw and label a diagram of a motor unit.



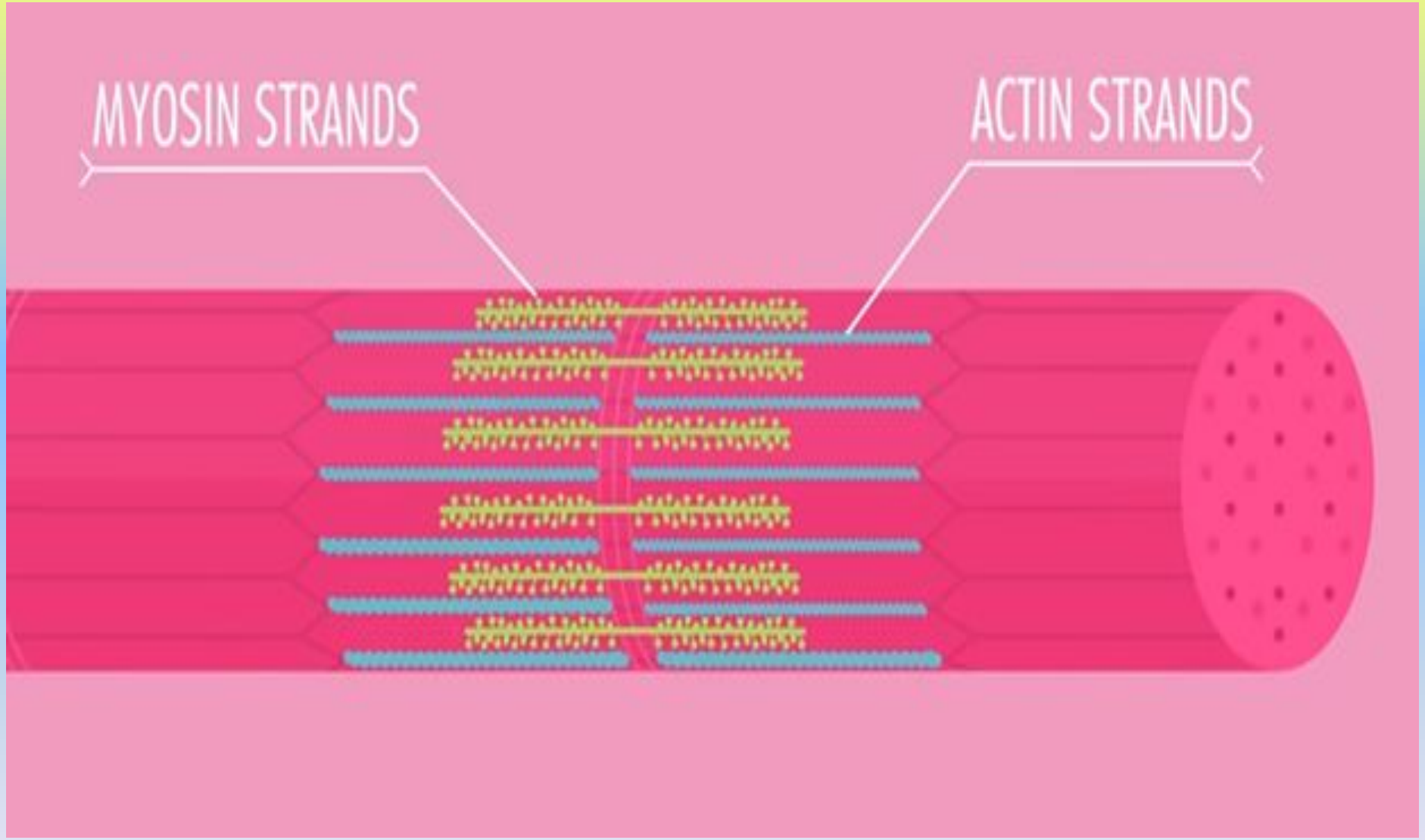
AKA neuromuscular junction

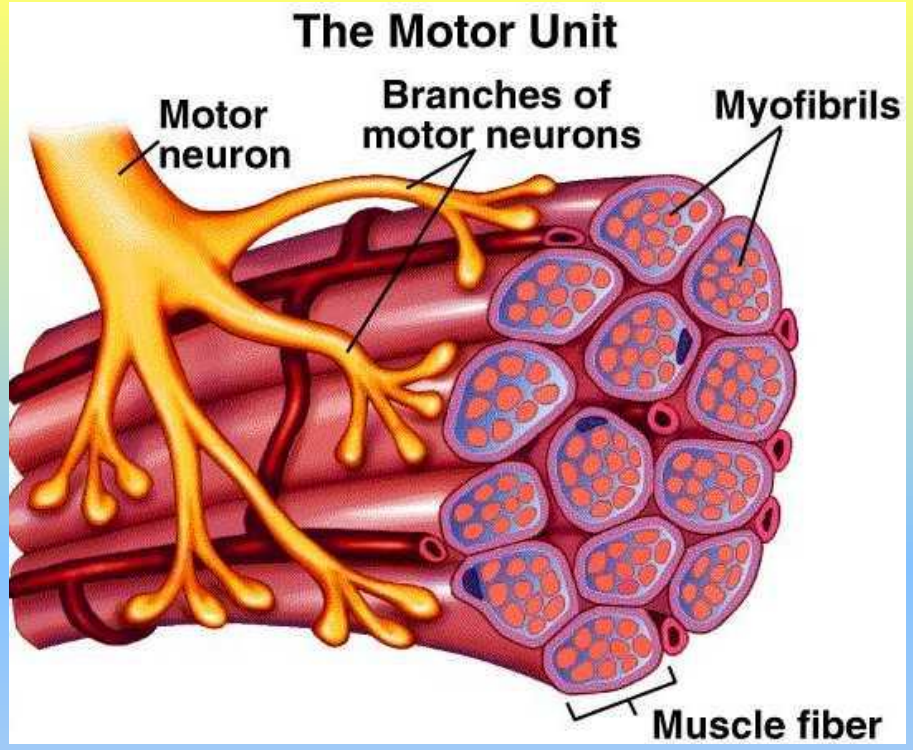
Quick Muscle Structure Review

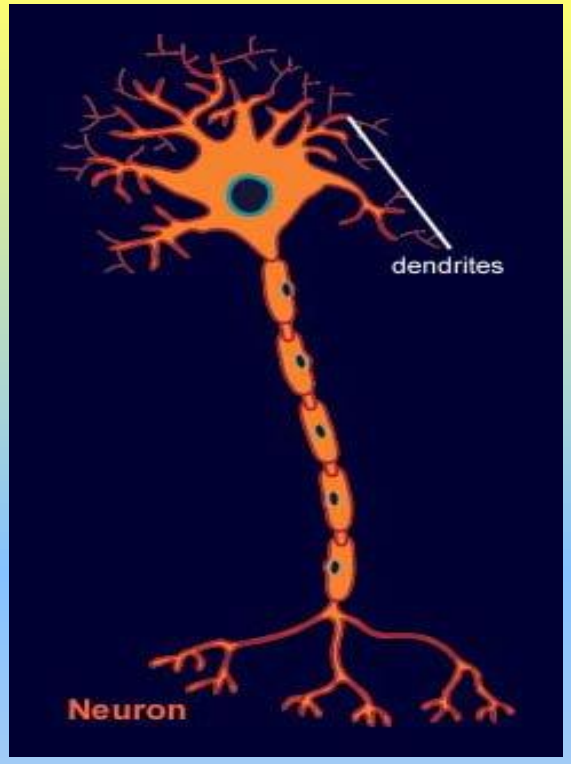



MUSCLE FIBER (AKA MUSCLE CELL) STRUCTURE
NUCLEI
SARCOLEMMA (MUSCLE CELL MEMBRANE)
MITOCHONDRIA
MYOFIBRIL

MYOFIBRIL


MYOSIN STRANDS
ACTIN STRANDS





A motor unit, the functional unit of muscle contraction, is a single motor nerve and the associated muscle fibers that are innervated upon stimulation from the nerve.

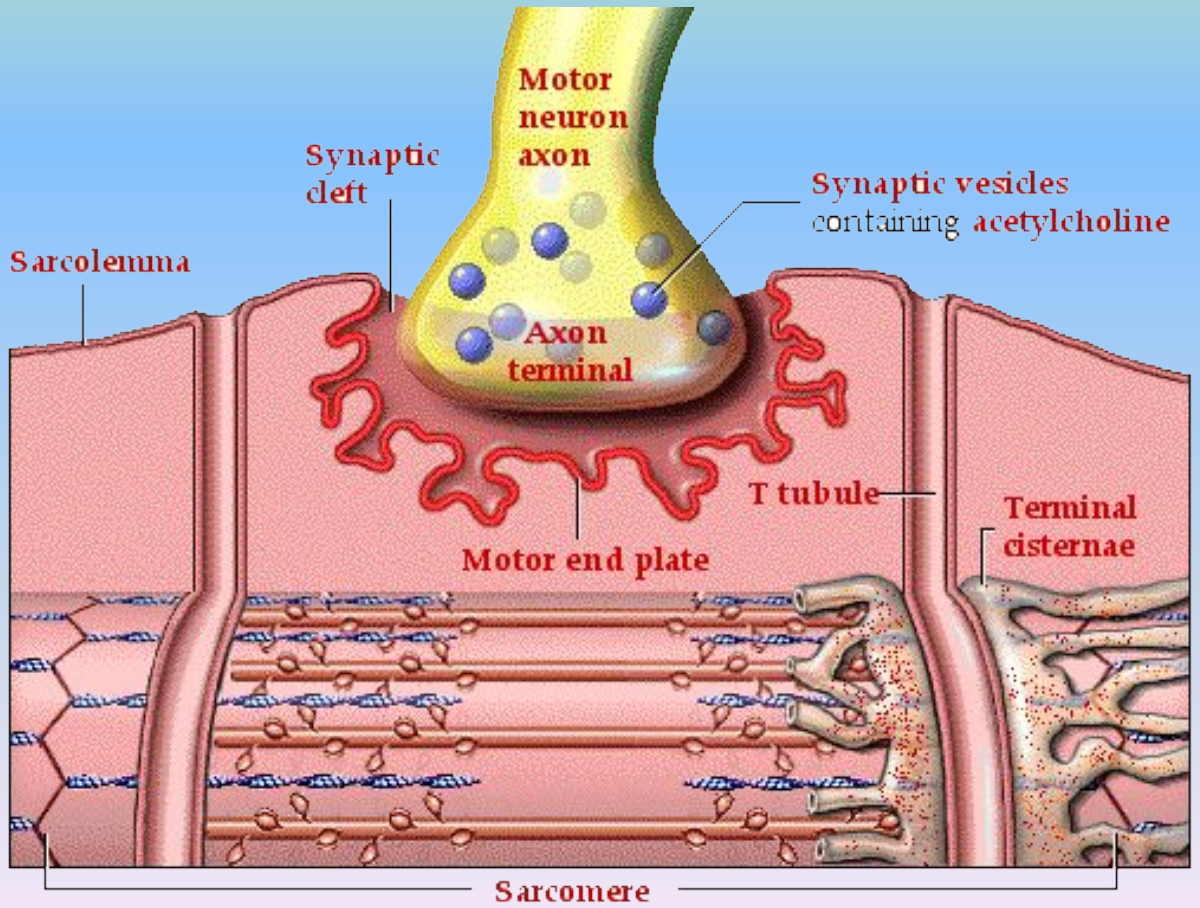
A collection of motor units is referred to as a **motor pool.**

- The number of muscle fibers within each unit can vary within a particular muscle, which impacts precision and force generation.
- Differential activation of single or multiple motor units within a motor pool can therefore control precision and force of movement

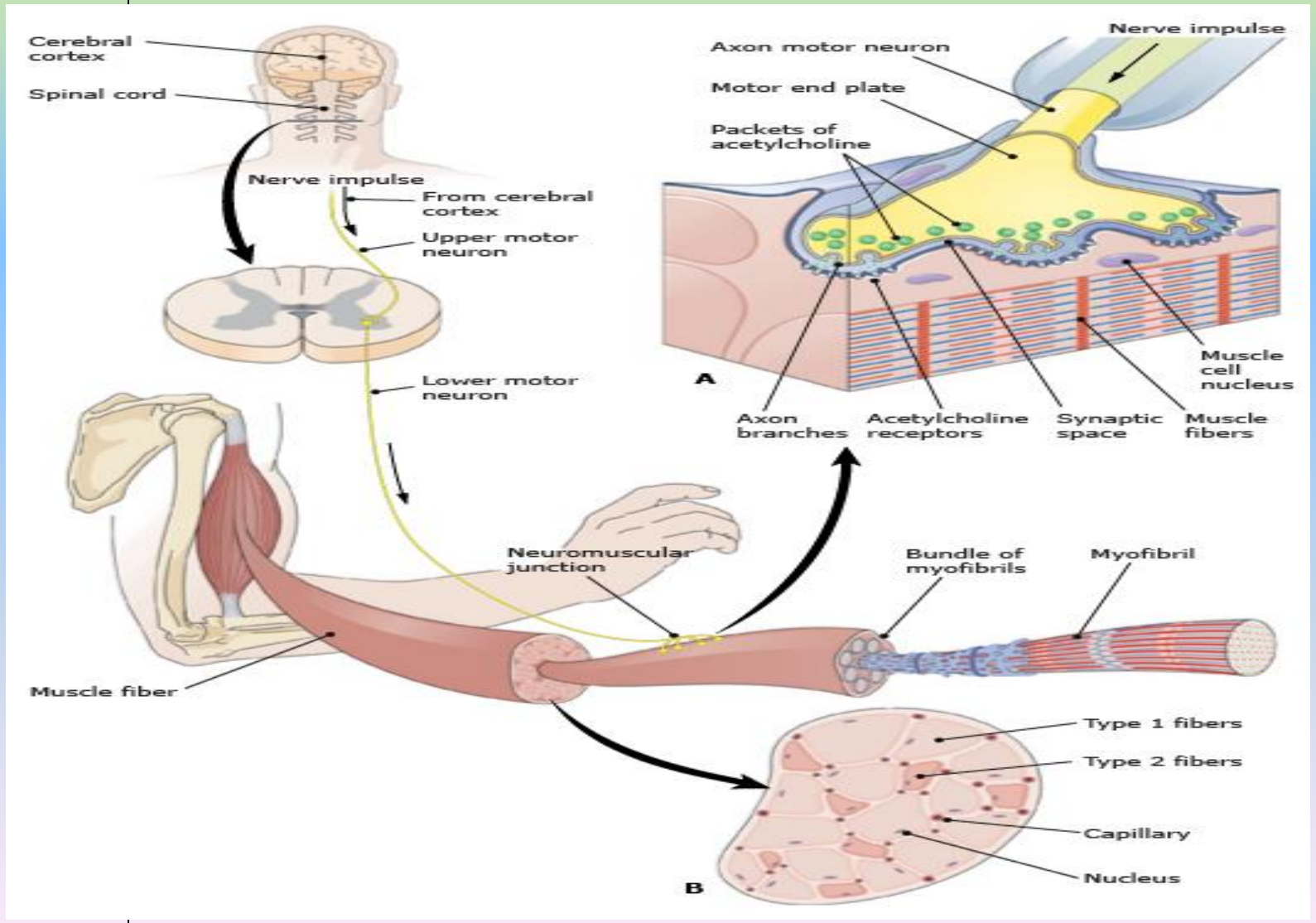
Source: Boundless. “Motor Units.” Boundless Anatomy and Physiology. Boundless, 27 Sep. 2016. Retrieved 10 Oct. 2016 from https://www.boundless.com/physiology/textbooks/boundless-anatomy-and-physiology-textbook/muscular-system-10/control-of-muscle-tension-97/motor-units-544-6159/

Neuromuscular Function

Draw and label a diagram of a motor unit.



Neuromuscular Function



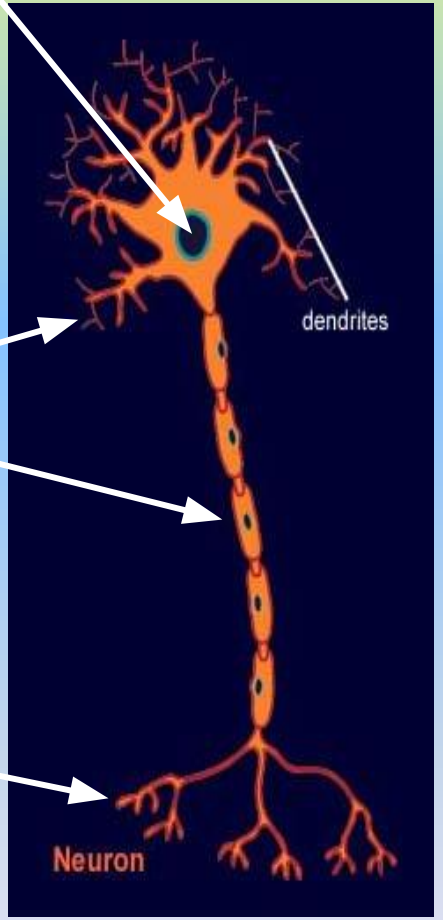
Nucleus – a membrane enclosed organelle that contains most of the cells genetic material

Axon - A long fibre of a nerve cell (a neuron) that acts somewhat like a fiber-optic cable carrying outgoing (efferent) messages. The neuron sends electrical impulses from its cell body through the axon to target cells. Each nerve cell has one axon. An axon can be over 20 cm (a foot) in length, which for the human body is remarkably long.

Dendrites - bring information to the cell body

Motor end plate – or A **neuromuscular junction** (**NMJ**) is the synapse or junction of the axon terminal where a neural cell (neuron) communicates with a target cell.

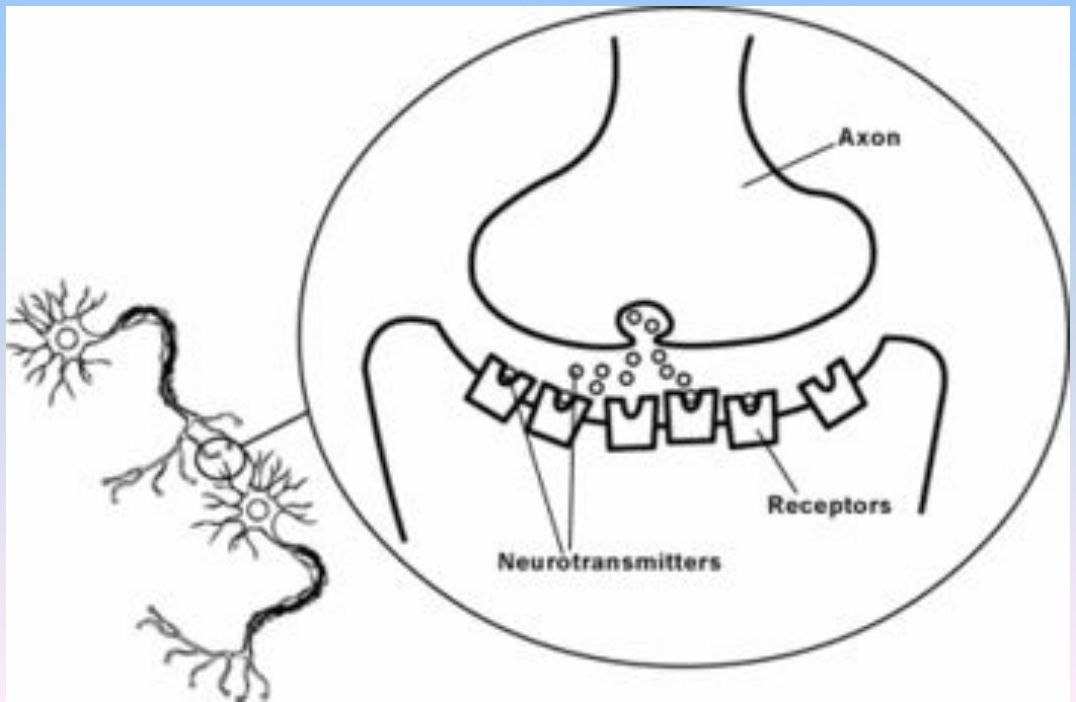
Synapse - The small junction across which a nerve impulse passes from one cell to another



Neuromuscular Function

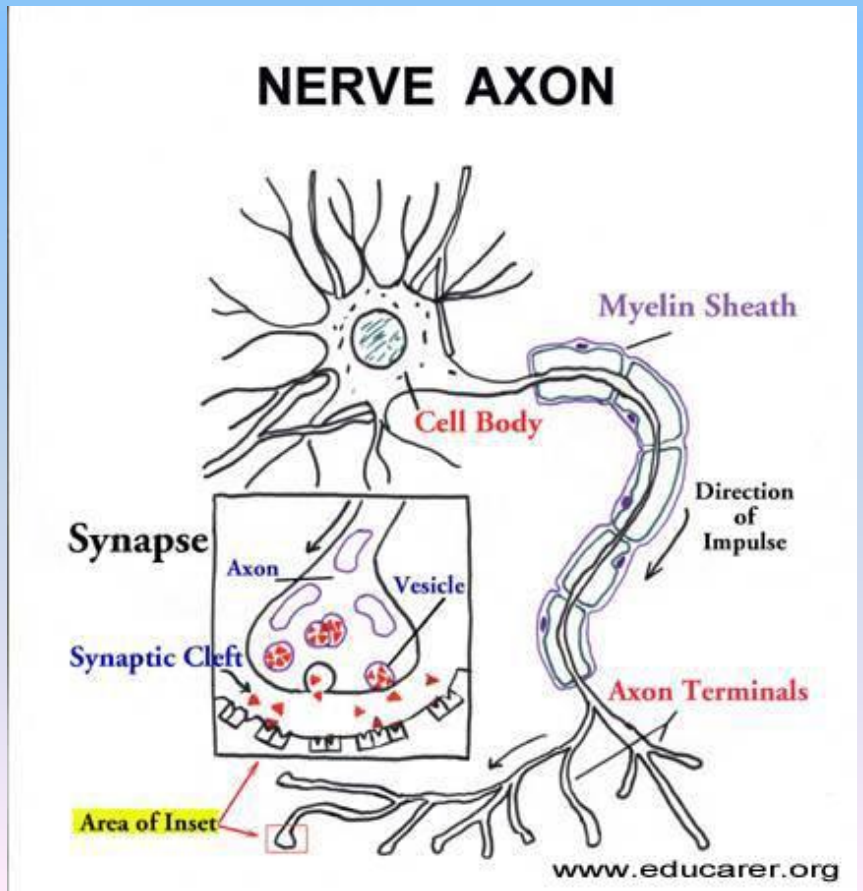
Role of neurotransmitters in stimulating muscle contraction.

- Neurotransmitters are chemicals that are used for communication between a neuron at the synapse and another cell.



Neuromuscular Function

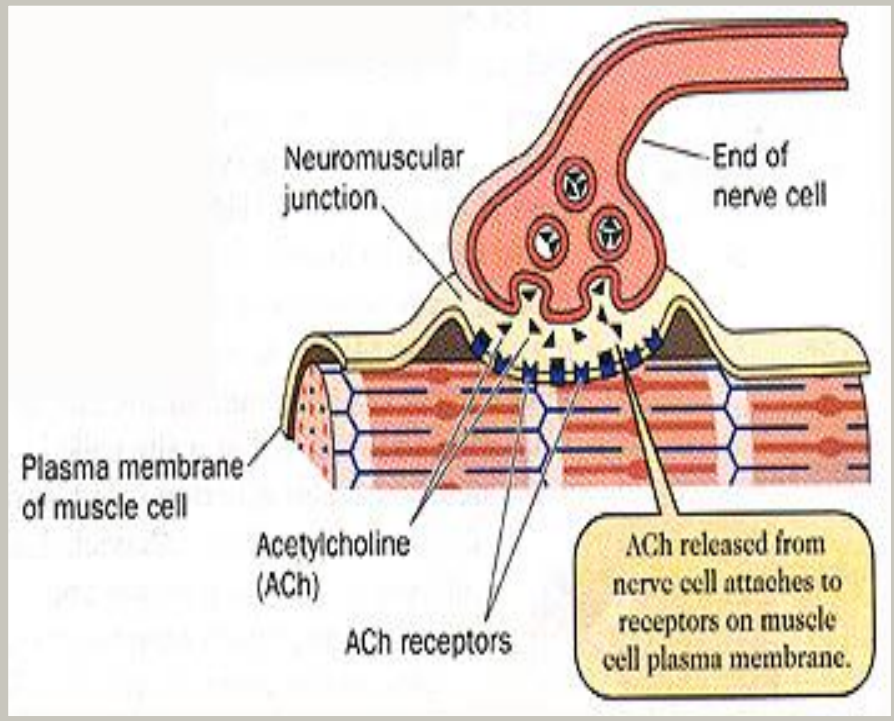
Role of neurotransmitters in stimulating muscle contraction.



Neuromuscular Function

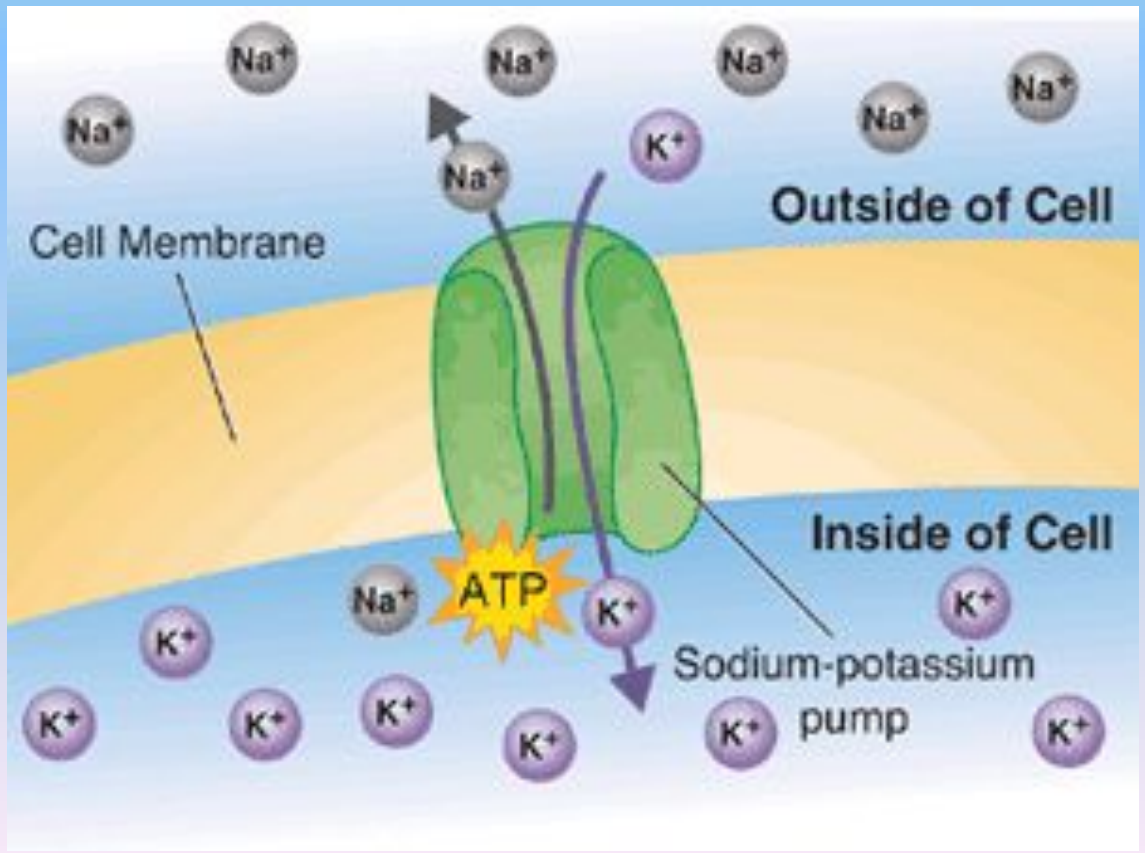
Role of neurotransmitters in stimulating muscle contraction.

Acetylcholine (Ach): Acetylcholine is the primary neurotransmitter for the motor neurons that innervate skeletal muscle and for most parasympathetic neurons. It is generally an excitatory neurotransmitter, but it can have inhibitory effects at some parasympathetic nerve endings, such as the heart.



Neuromuscular Function

Role of neurotransmitters in stimulating muscle contraction.

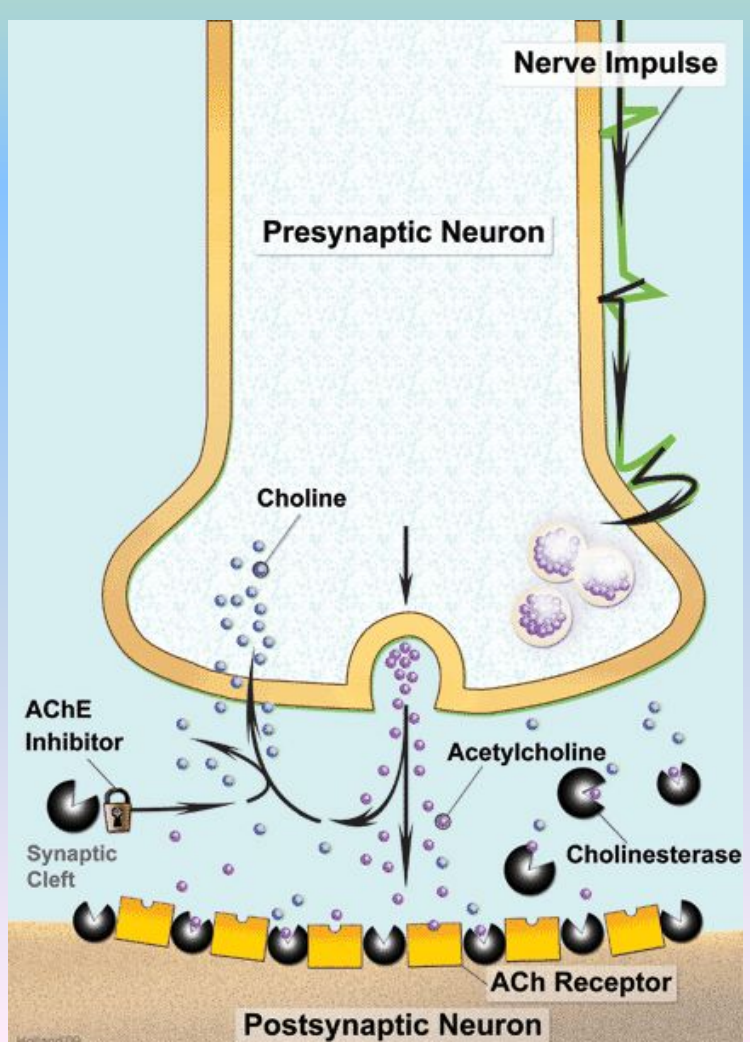


Neuromuscular Function

Role of neurotransmitters in stimulating muscle contraction.

Cholinesterase is an enzyme that catalyzes the hydrolysis of the neurotransmitter acetylcholine into choline and acetic acid, a reaction necessary to allow a neuron to return

to its resting state after activation.



Neuromuscular Function

Sliding Filament Theory

Terms to know:

myofibril
myofilament
sarcomere
actin/myosin
H zone
A band
Z line
tropomyosin
troponin
sarcoplasmic reticulum
sarcoplasm
sarcolemma
calcium ions
ATP

Neuromuscular Function

Sliding Filament Theory

Tropomyosin is an actin-binding protein that regulates actin mechanics. (found on the actin protein)

Troponin (a protein) is attached to the protein tropomyosin and lies within the groove between actin filaments in muscle tissue. In a relaxed muscle, tropomyosin blocks the attachment site for the myosin crossbridge, thus preventing contraction. I.E. It blocks myosin from bonding.

Neuromuscular Function

Sliding Filament Theory

- When the muscle cell is stimulated to contract by a nerve, calcium channels open in the sarcoplasmic reticulum and release calcium into the sarcoplasm (cytoplasm of a striated muscle cell). Some of this calcium attaches to troponin, causing a conformational change that moves tropomyosin out of the way so that the cross bridges can attach to actin and produce muscle contraction.
- Difference between Smooth ER and sarcoplasmic ER is the smooth ER synthesizes molecules and the sarcoplasmic reticulum stores and pumps calcium ions. The sarcoplasmic reticulum contains large stores of calcium, which it stores and then releases when the muscle is innervated. This has the effect of triggering muscle contraction.

Neuromuscular Function

Sliding Filament Theory

- Explains how muscle fibers shorten during a contraction.
- When the myosin cross-bridges are activated, they bind with actin, resulting in a conformational change in the cross-bridge, which causes the myosin to tilt and to drag the thin filament toward the center of the sarcomere.

Actin - Myosin Crossbridge Video

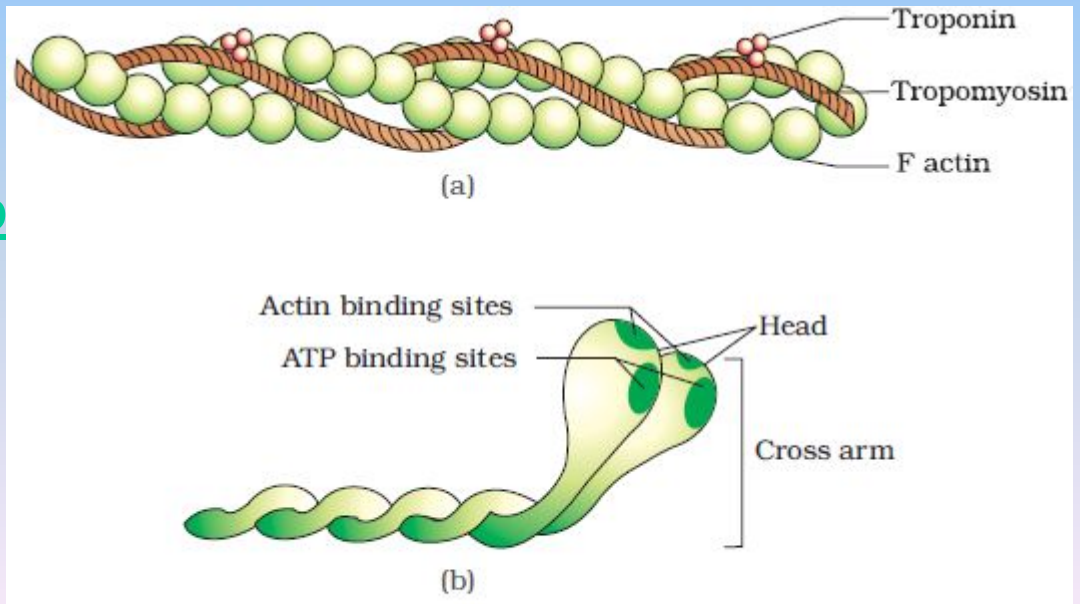


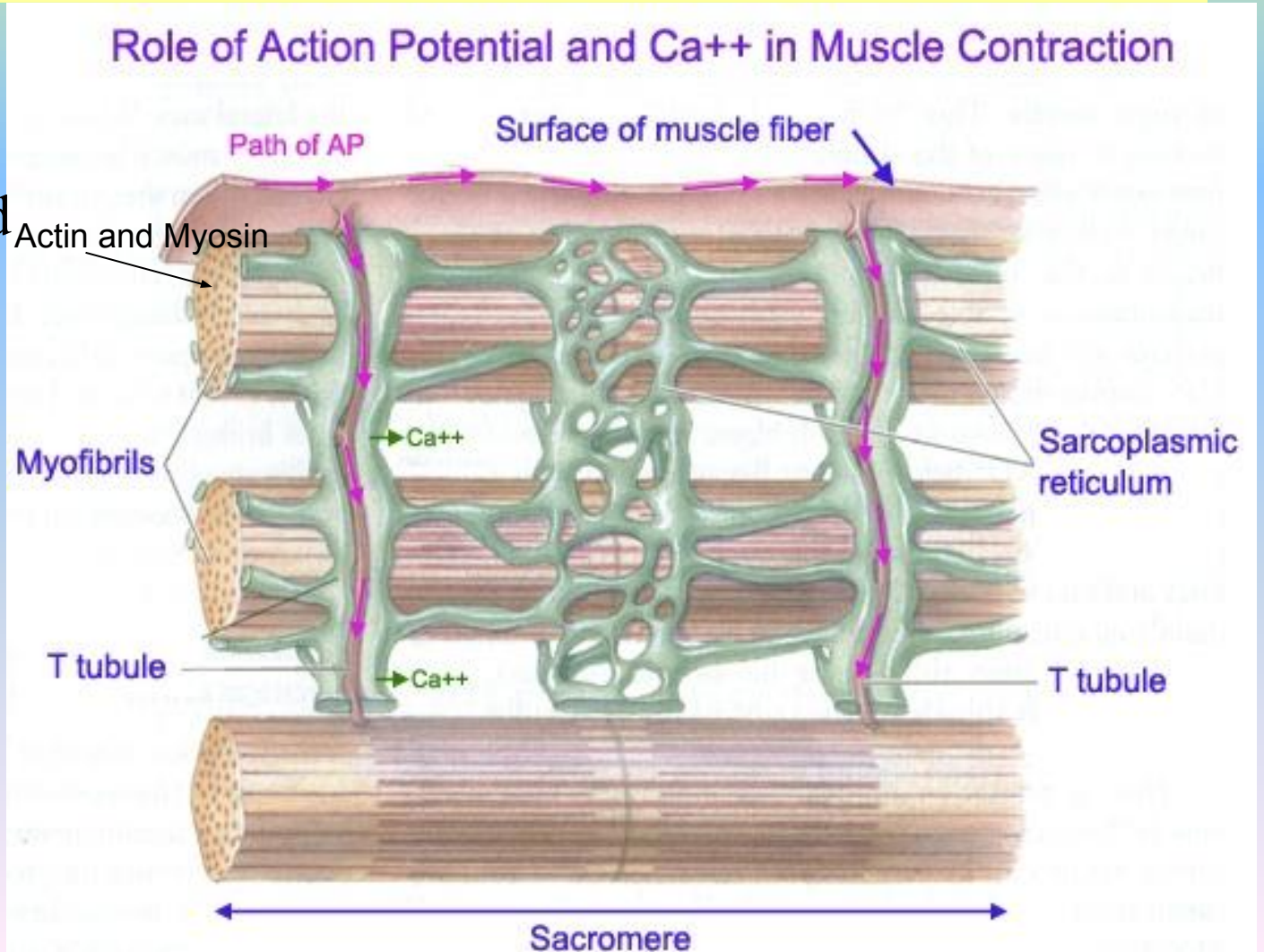
Figure 20.3 (a) An actin (thin) filament (b) Myosin monomer (Meromyosin)

Neuromuscular Function

Sliding Filament Theory

Steps of a muscle contraction:

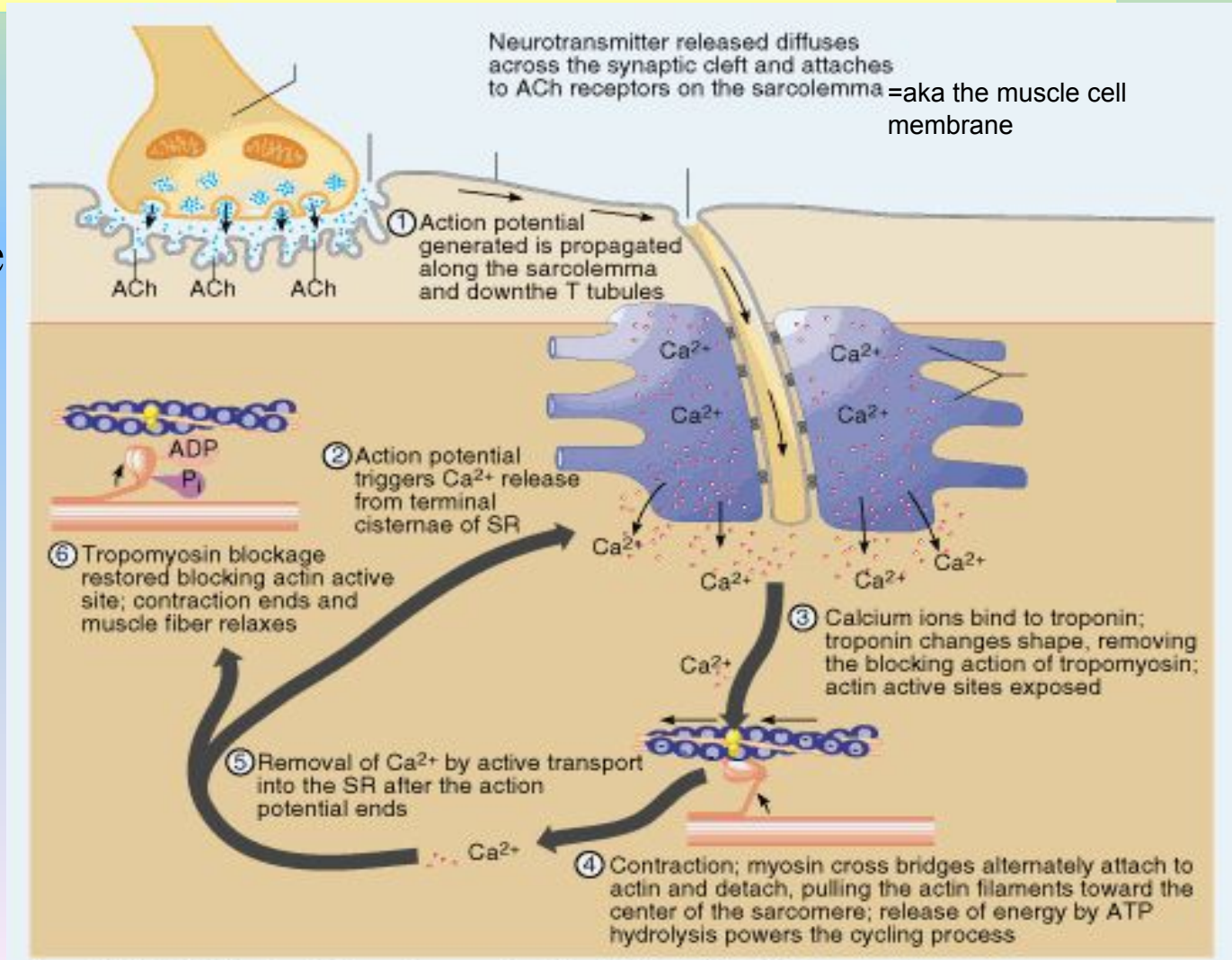
1. Ca^{++} are released by the sarcoplasmic reticulum.
2. Ca^{++} binds to troponin preventing the blocking action of tropomyosin.



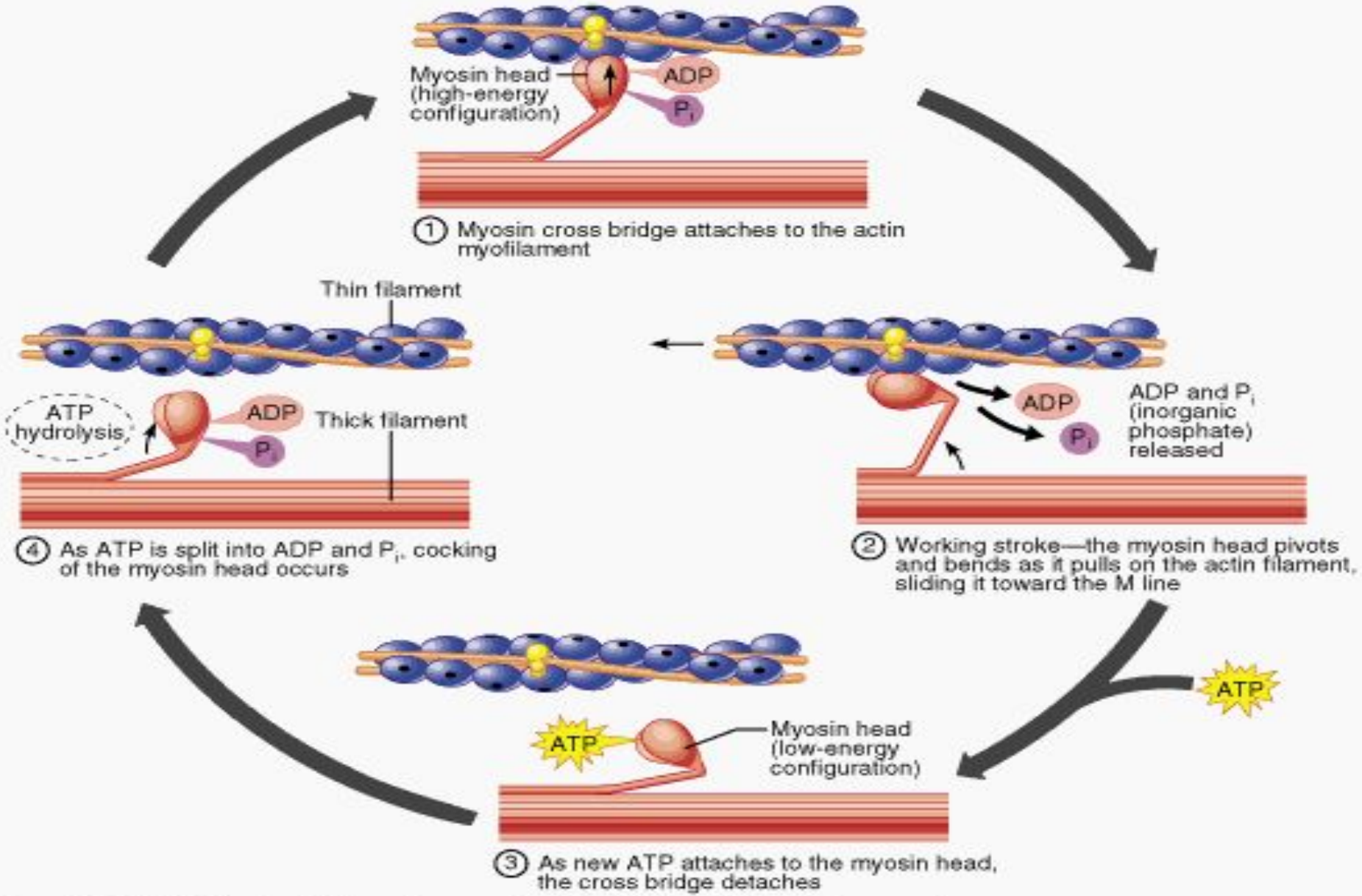
Neuromuscular Function

Sliding Filament Theory

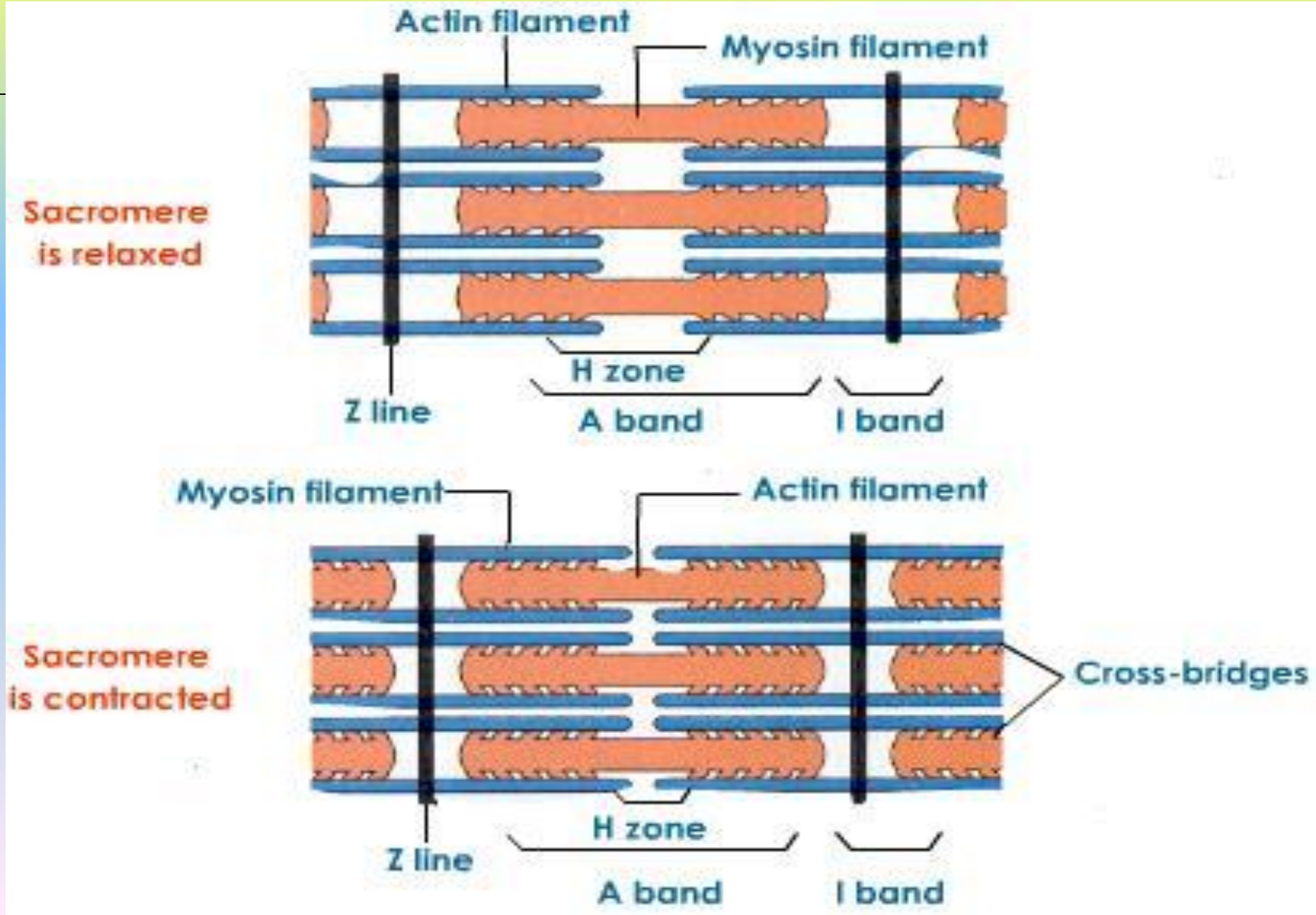
3. myosin heads can now attach to active sites on the actin filament.
4. using ATP, the myosin heads pulls on the actin filament.
5. myosin head releases the actin when a new ATP is formed.



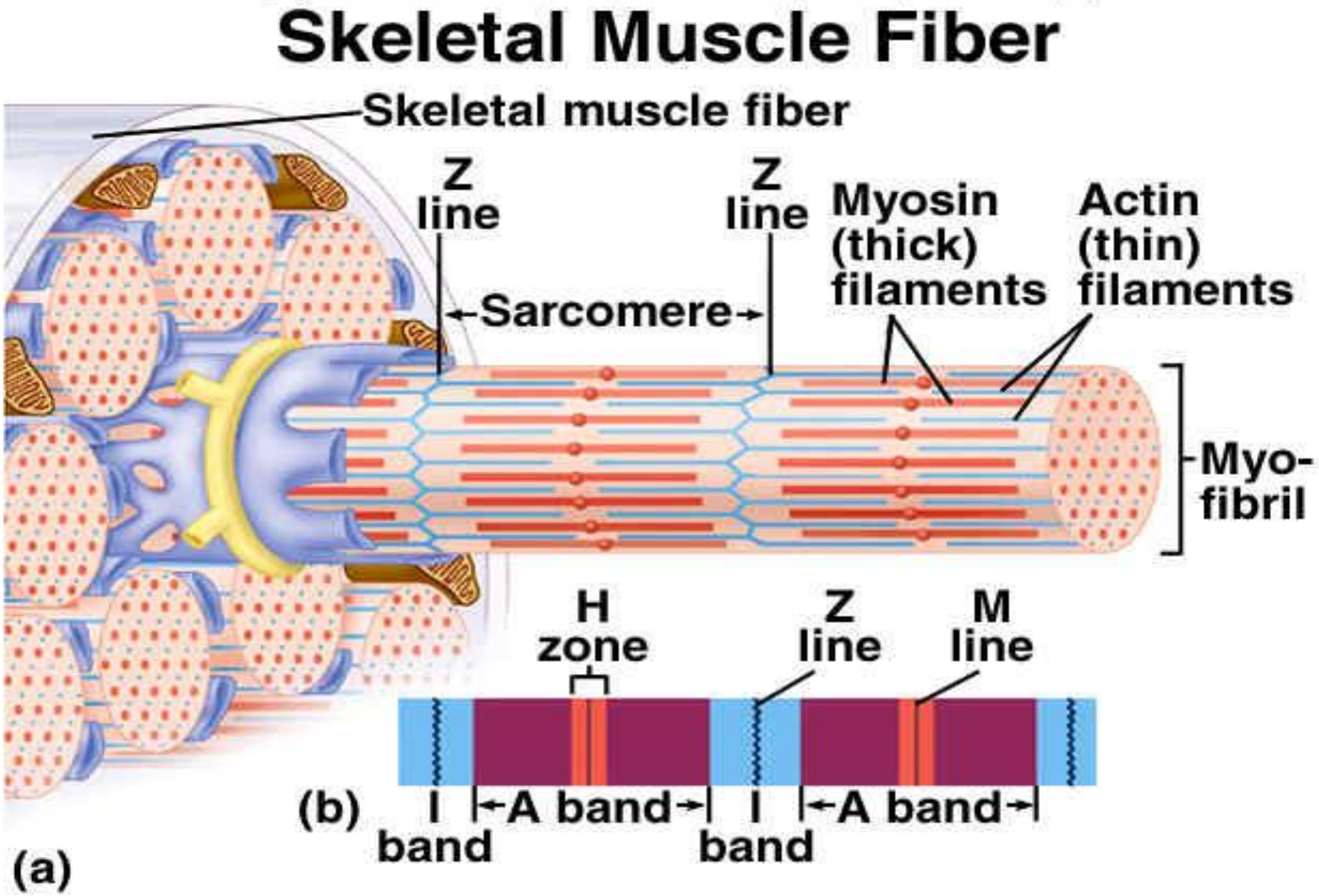
Sliding Filament Theory



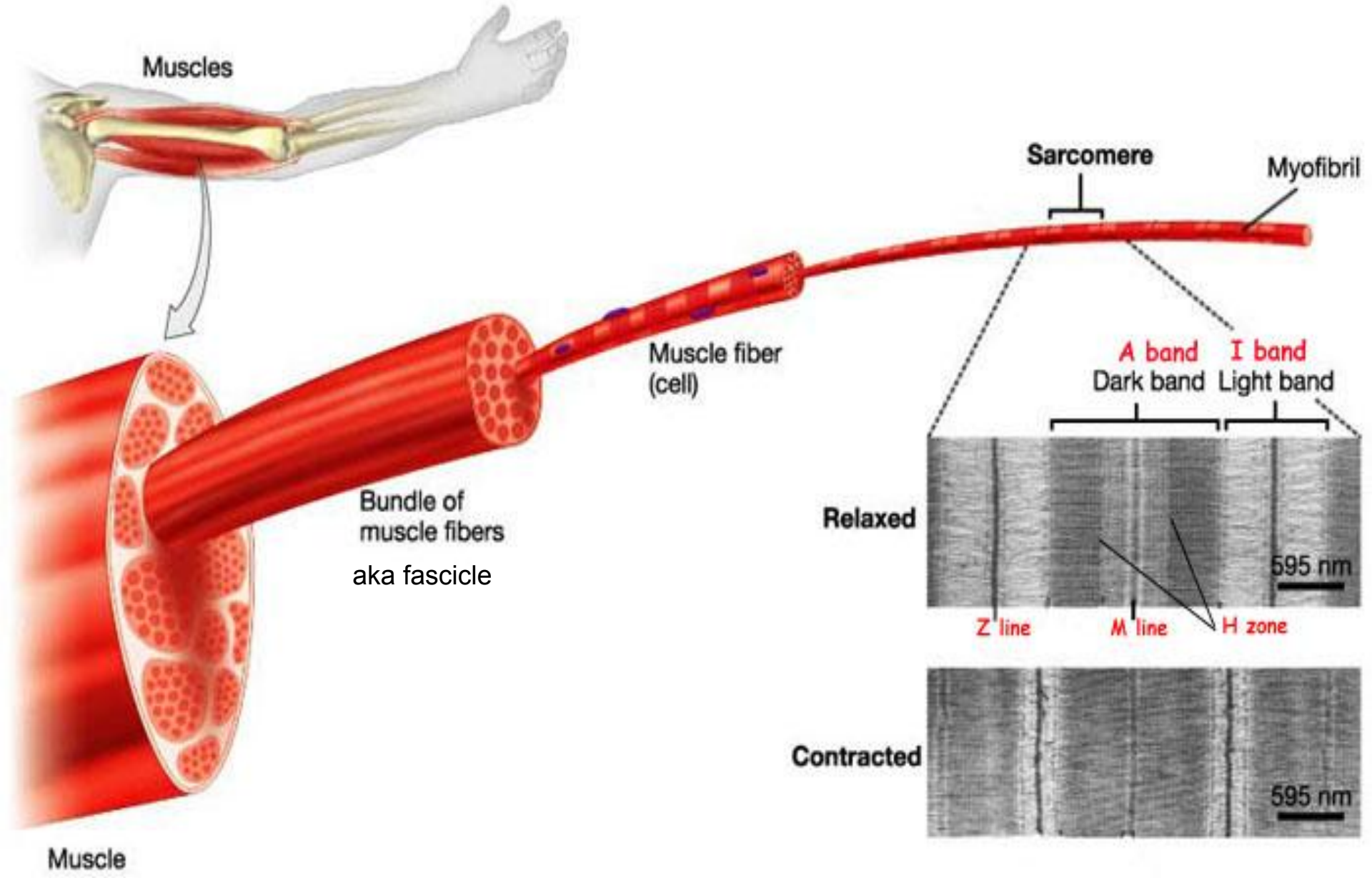
Sliding Filament Theory



Sliding Filament Theory



Sliding Filament Theory



Neuromuscular Function

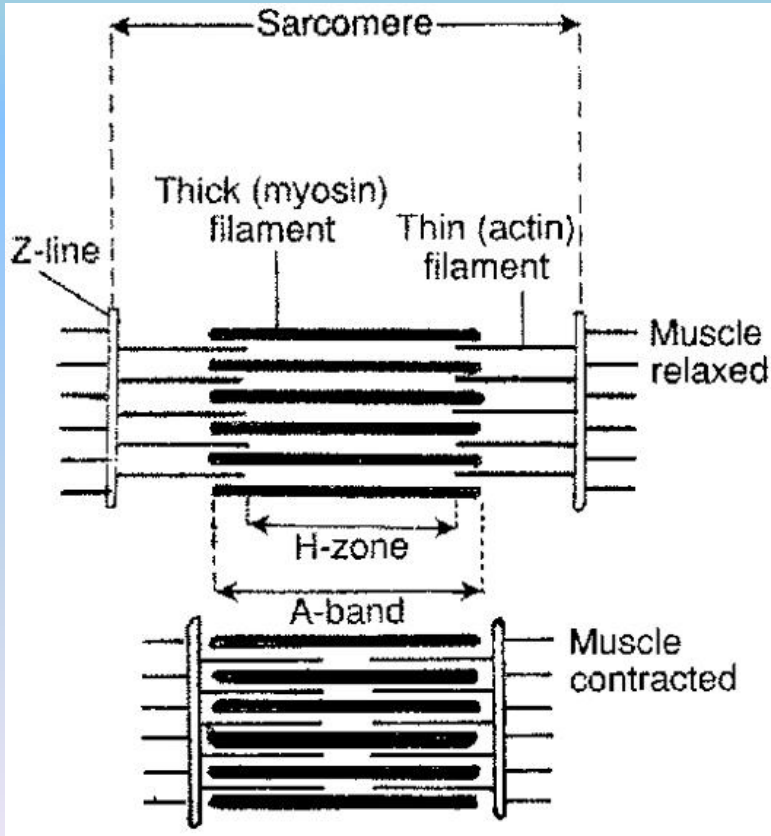
Sliding Filament Theory

- Immediately after the myosin head tilts, it breaks away from the active site, rotates back to its original position, and attaches to a new active site farther along the actin filament. Repeated attachments and power strokes cause the filaments to slide past one another, giving rise to the term *sliding filament theory*. This process continues until the ends of the myosin filaments reaches the Z-disks, or until the Calcium is pumped back into the sarcoplasmic reticulum.

Neuromuscular Function

Sliding Filament Theory

- During this sliding (contraction), the thin filaments move toward the centre of the sarcomere and protrude into the H-zone, ultimately overlapping. When this occurs, the H zone is no longer visible.



Slow & Fast Twitch Fibers

Slow Twitch: (type 1)

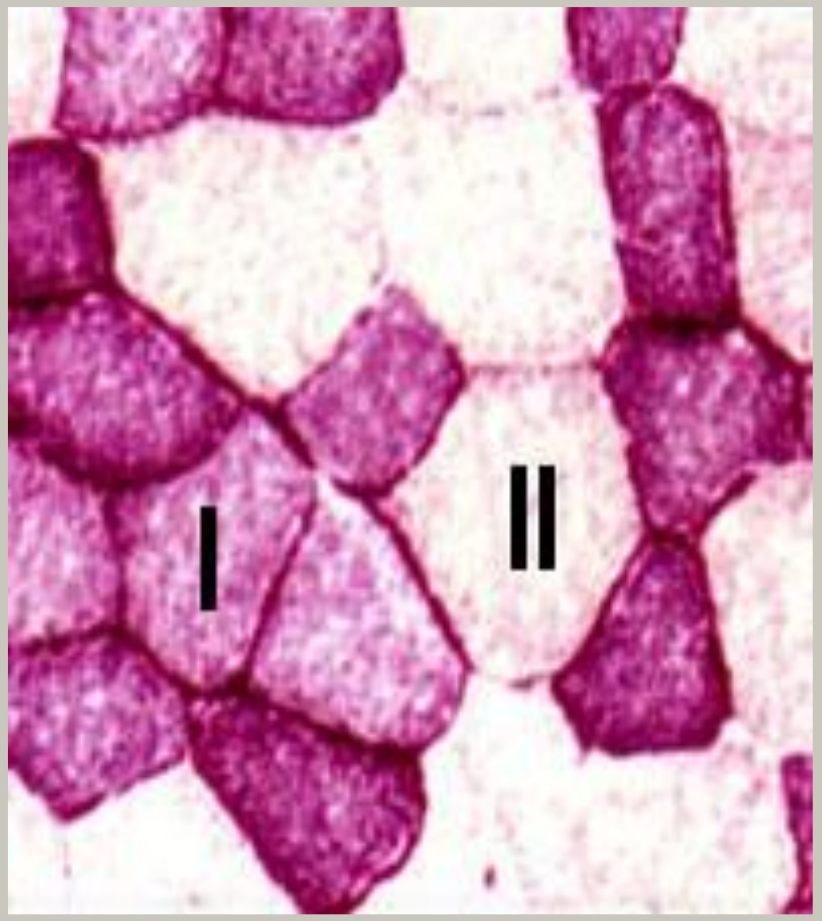
*smaller in diameter

*reddish color

*use aerobic resp. for ATP supply

*contain more mitochondria

*fire slowly, but take long to fatigue.



Neuromuscular Function

Slow & Fast Twitch Fibers

Fast Twitch: used for short explosive movements, stop and go sports.

Type IIA:

*large diameter

*white in color

*less mitochondria

*uses both anaerobic and aerobic energy transfer

Type IIB:

*similar physical characteristics as Type IIA, but strictly uses the glycolytic anaerobic system.

- less mitochondria

3 Muscle Fiber Types

Fiber type	**Slow Twitch (Type I)**	**Fast twitch A (Type IIA)**	**Fast twitch B (Type IIB)**
Contraction time	slow	fast	Very fast
Fatigue resistance	high	intermediate	Low
Used for:	Aerobic activity	Long term anaerobic	Short term anaerobic
Capillary density	High	Intermediate	Low
Mitochondria density	High	Medium	Low

Slow & Fast Twitch Fibers

Fast-twitch, or type II, fibers (sometimes referred to as "White") have fewer mitochondria, are capable of more powerful (but shorter) contractions, metabolize ATP more quickly, have a lower capillary to volume ratio, and are more likely to accumulate lactic acid. Weightlifters and sprinters tend to have more type II fibers. Type II fibers are distinguished by their primary sub-types

TABLE 8.2 Typical Muscle Fiber Composition in Elite Athletes

Sport	% Slow Fibers (Type I)	% Fast Fibers (Types IIb and IIa)
Distance runners	70–80	20–30
Track sprinters	25–30	70–75
Nonathletes	47–53	47–53

Muscle fiber composition

How do we determine our muscle fiber type?

1. Muscle biopsy (best method)
2. Testing an athlete's **muscle groups** for different muscle fiber properties.

Example:
establish an RM (repetition maximum) of any exercise.
lift 80% of 1RM as many times as possible.

7 or less reps most likely more than 50%FT fibers
12 or more reps most likely more than 50% ST fibers

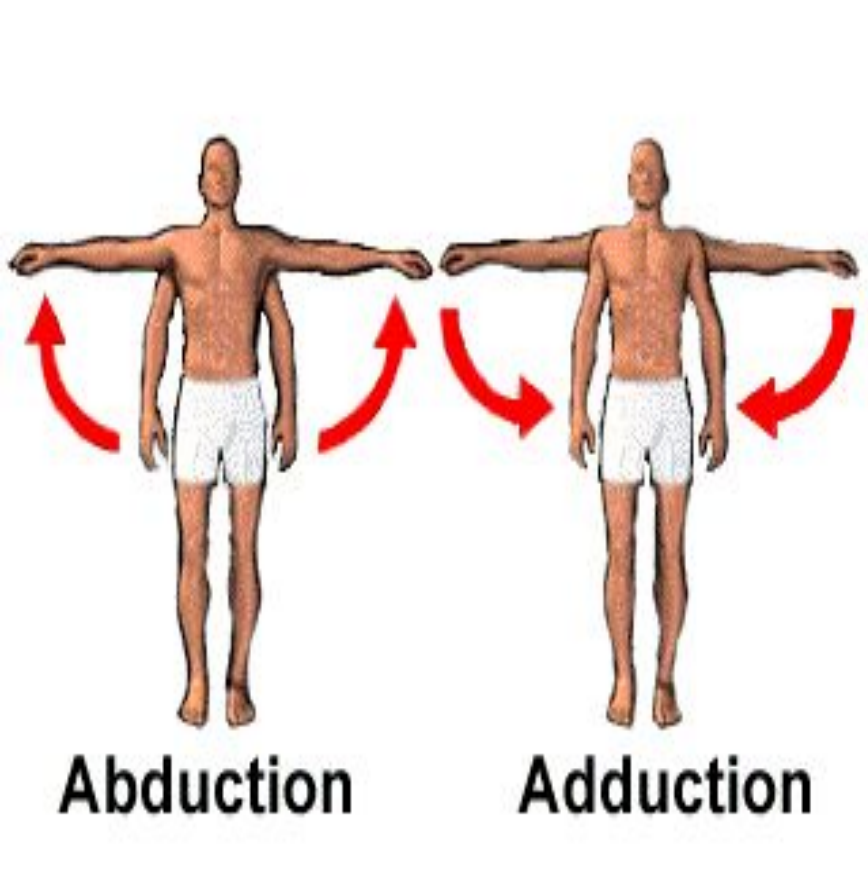
4.2 Joint and Movement Type

Synovial Joint Movements

Types of Joint Movement:

Abduction: movement away from the body's center.

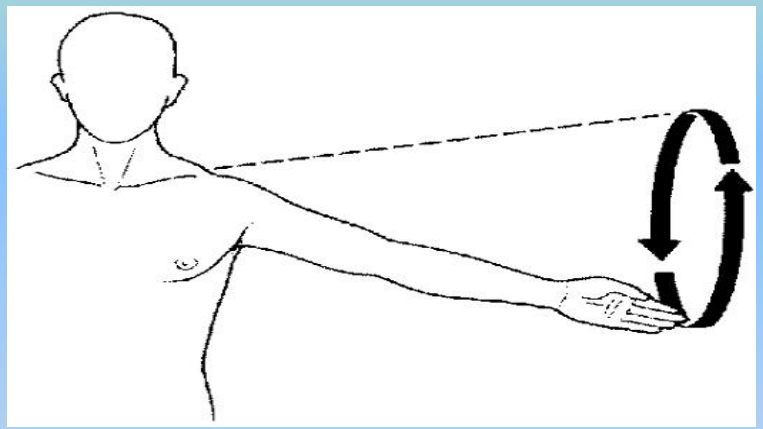
Adduction: movement towards the body's center.



4.2 Joint and Movement Type

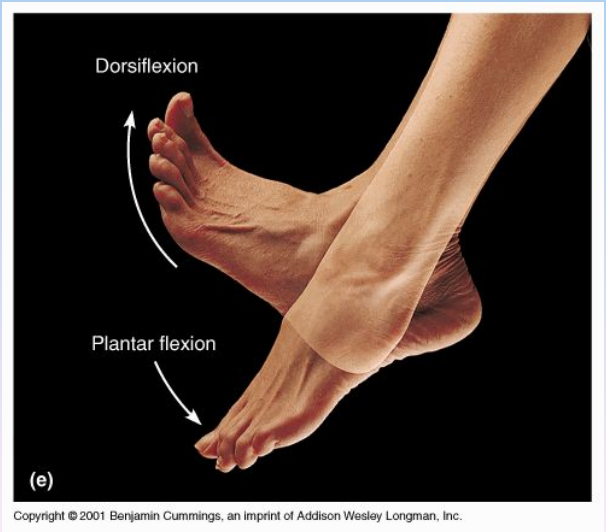
Synovial Joint Movements

Circumduction: making circular movements.



Dorsiflexion: movement of the ankle elevating the sole. (digging in the heel)

Plantar flexion: extending the ankle and elevating the heel. (standing on tiptoes)



Synovial Joint Movements

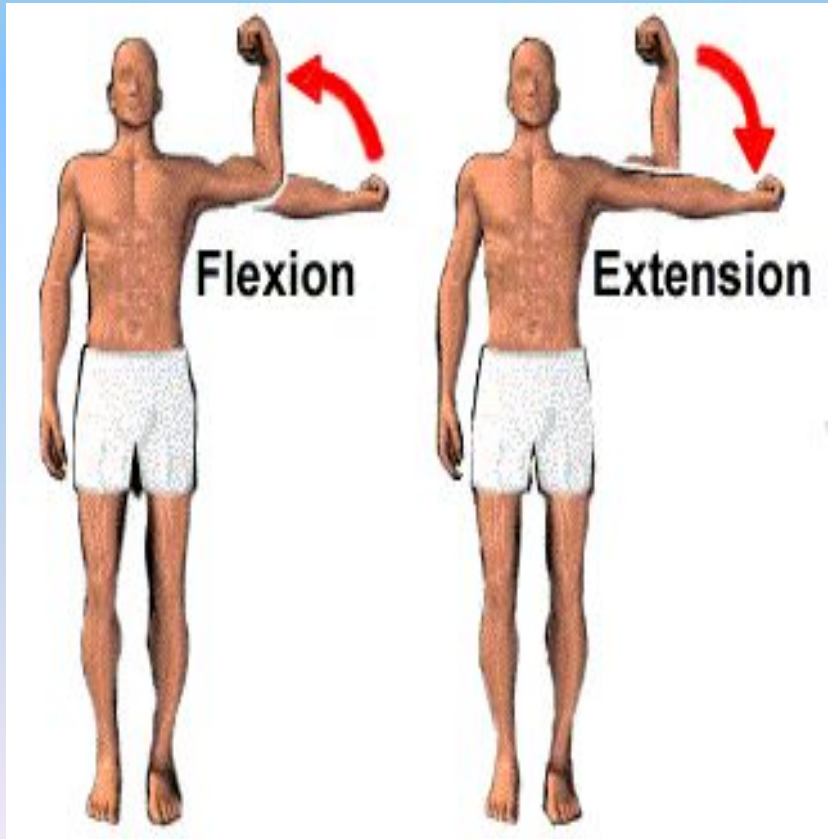
Elevation: occurs when a structure moves in a superior (towards head) manner. Ex. Closing your mouth/elevating the shoulders.

Depression: movement is inferior (towards feet). Ex. opening your mouth/lowering the shoulders

Synovial Joint Movements

Extension: movement that increases the angle between articulating elements opening the joint.

Flexion: decreases the angle between articulating elements and closes the joint.

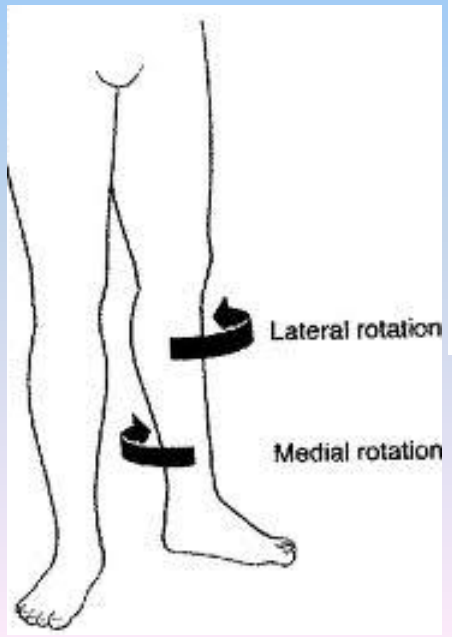


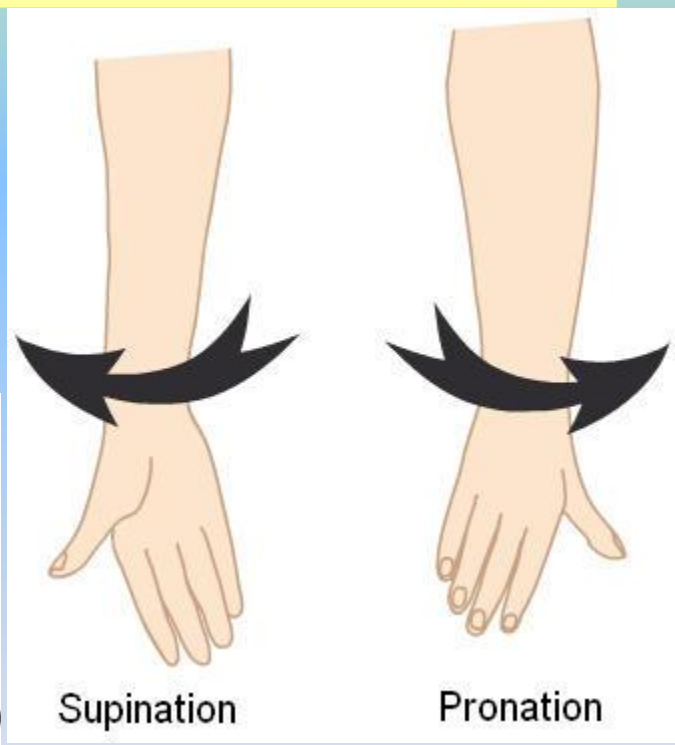
Synovial Joint Movements

Pronation: rotating the palm down.

Supination: rotating the palm up.

Rotation: turning the body around a longitudinal axis.

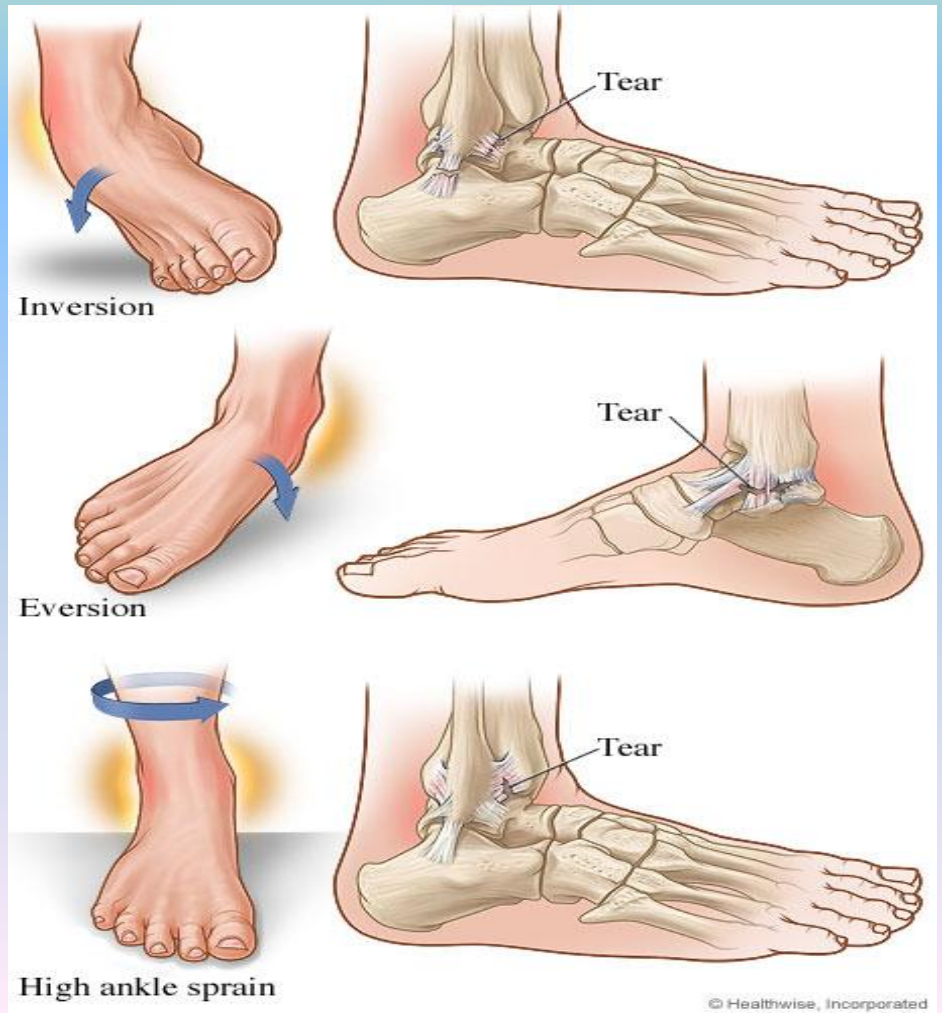




Synovial Joint Movements

Inversion: when the ankle rolls outward.

Eversion: ankle roles inward.

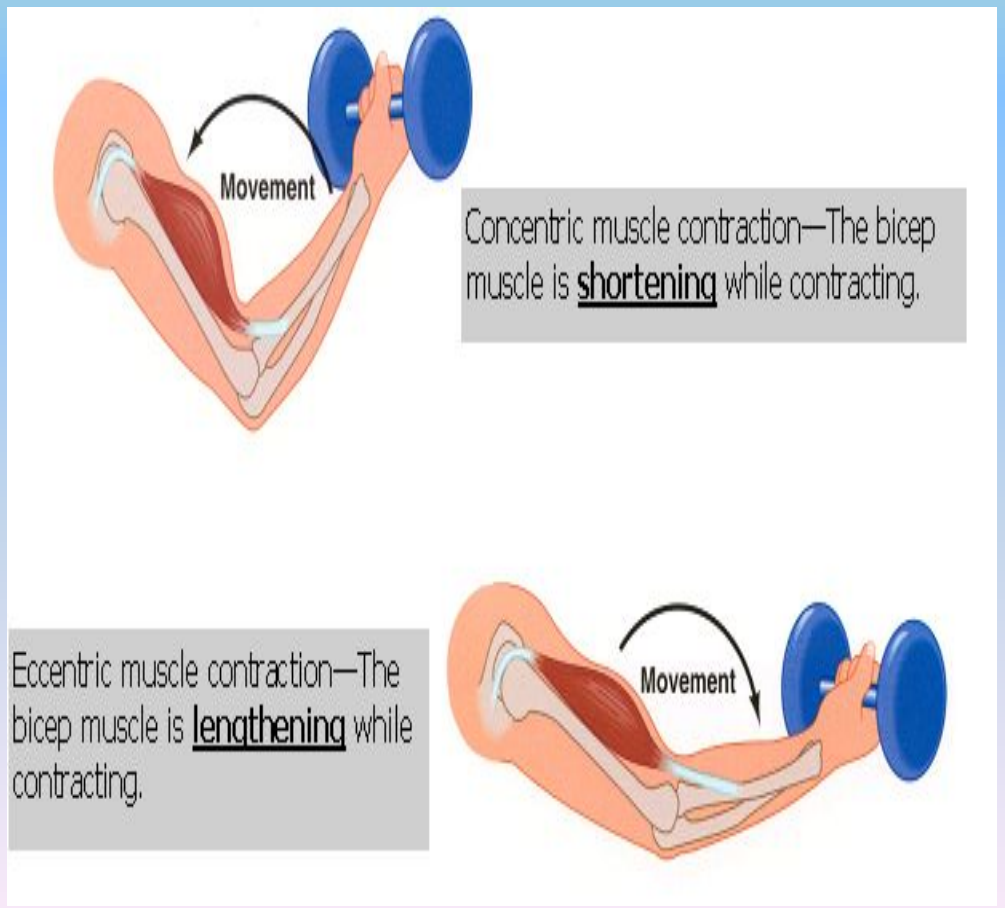


Types of muscle contraction

Isotonic: Increase in loads on muscles. (concentric and eccentric muscle actions.)

Concentric: muscle is shortened during contraction.

Eccentric: muscle is contracting while lengthening. Ex: lengthening resist- you quadriceps do this when running downhill.



Types of muscle contraction

Isometric: muscle generates force without changing length. Ex. Hand grip, plank position, trying to lift a building

Isokinetic: the speed of movement is fixed and the resistance varies with the force exerted.

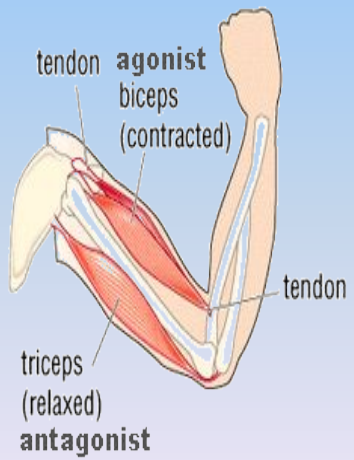
*requires special equipment!

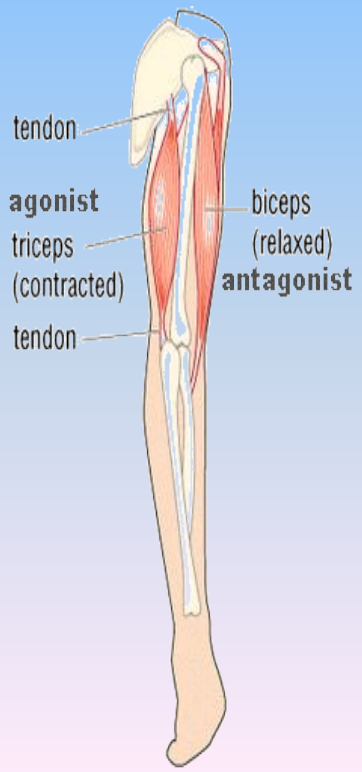
Reciprocal Inhibition

Describes muscles on one side of a joint relaxing while the other side is contracting. (antagonistic pairs)

Agonist: muscle that causes the movement.

Antagonist: muscle that works opposite the agonist to return the joint to its initial position.





Movement Analysis

Describe movement considering the following terms:

Abduction
Adduction
Circumduction
Dorsiflexion
Plantar flexion
Elevation
Depression
Extension
Flexion
Pronation
Supination
Rotation
Inversion
Eversion

Isotonic
Concentric
Eccentric
Isometric
Isokinetic

Delayed onset muscle soreness (DOMS)

The pain and stiffness felt in muscles several hours to days after unaccustomed or strenuous exercise.

*brought on by eccentric contractions of the muscle causing pressure at the nerve endings.

Read the article and summarize

http://sportsmedicine.about.com/cs/injuries/a/doms.htm