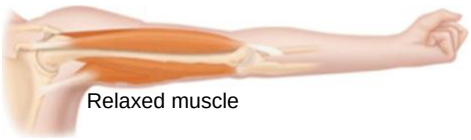
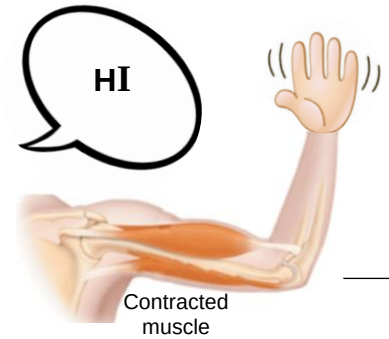
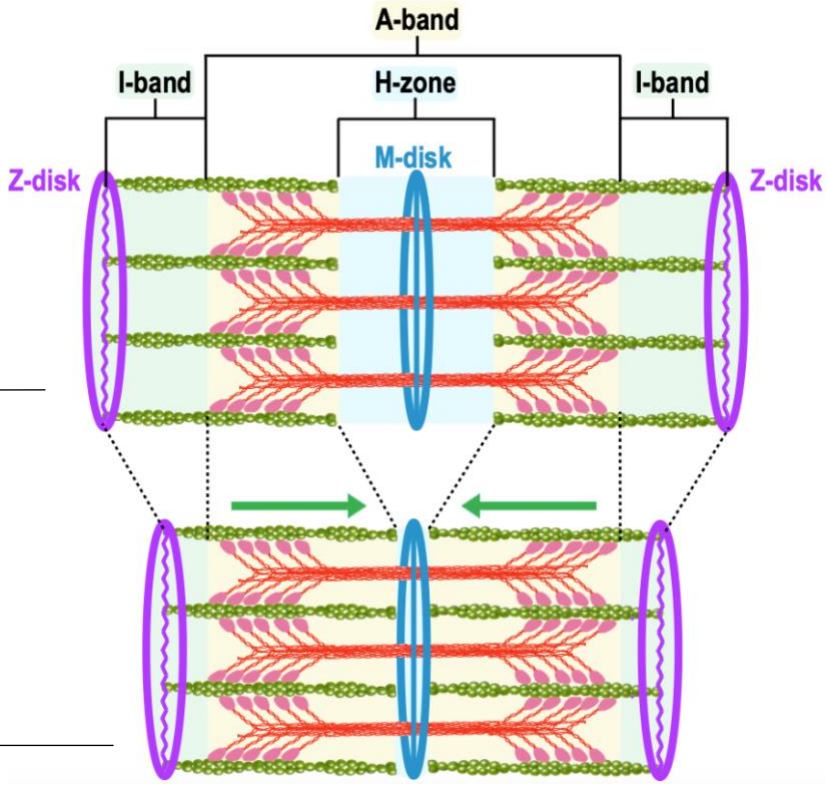
CONCEPT: SKELETAL MUSCLE CONTRACTION

Sliding Filament Model

●*Sliding Filament Model*: describes the nature of a contracting sarcomere (_____ zone & _____ bands *reduce* in size).







□ Thick myosin filaments *pull* thin actin microfilaments towards ____ disk during contraction to _____ muscle.

□ ____ band (length of myosin filaments) does NOT reduce in size, but ___ disks are *pulled closer* to the ____ disk.

□ *Volume* of the muscle is _____, but the muscle becomes shorter upon contraction.

PRACTICE: Which statement best describes the sliding filament model of a sarcomere contraction?

a) The A band and the H zone both become smaller.

b) The I bands gets smaller but the H zone remains the same.

c) The I bands gets smaller while the A band gets larger.

d) The I bands and H zone get smaller while the A band remains the same size.

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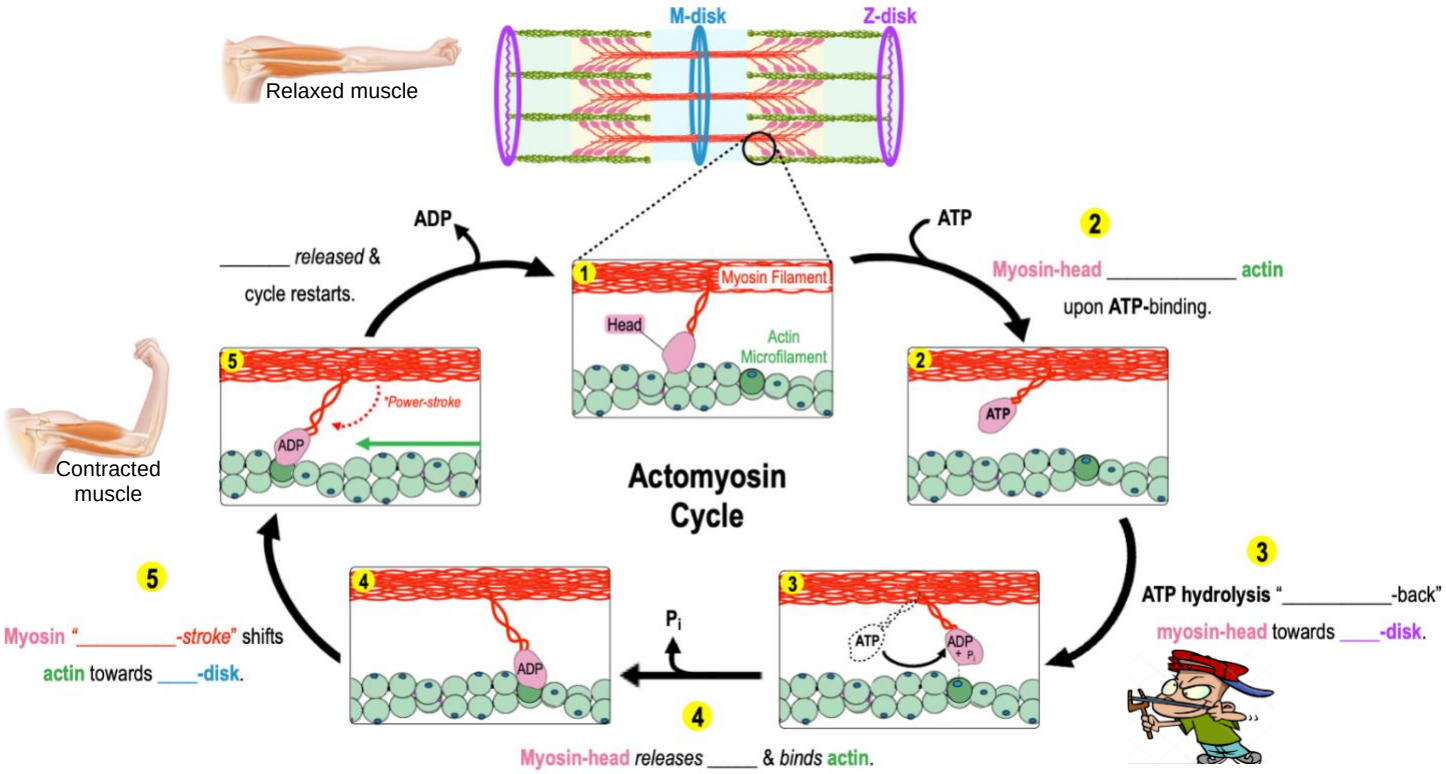
Actomyosin Cycle Leads to Muscle Contraction

●Actomyosin Cycle: a _____-step cycle of biochemical events that results in only the contraction of a sarcomere.

1. _____ ATP, myosin heads bind *tightly* to the actin microfilaments.
2. ATP binding to myosin head _____ the actin-myosin interaction, causing myosin to *release* actin.
3. Upon ATP hydrolyzation to ADP + P_i, the myosin head *changes conformation* to a "_____ energy" state.
   - □ This causes myosin head to "*cock-back*" & *weakly* interact with actin closer to the ____ disk.
4. *Release* of P_i causes myosin to _____ its actin binding.
5. Myosin "power-stroke" *pulls* actin towards the ____ disk, returns myosin to its original state.
   - □ ADP is *released* & cycle is repeated until myosin-binding-sites on actin are _____.

EXAMPLE: Actomyosin Cycle.



Summary of Actomyosin Cycle

Step #	Details
1	No **ATP** = "You bind to me".
2	**ATP** binds & myosin is *released*.
3	**ATP** hydrolysis *cocks-back* myosin.
4	P_i released.
5	*Power-stroke* & **ADP** *released*.

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PRACTICE: Fill-in the blanks with numbers (1-7) to put the events of the actomyosin cycle in order from beginning to end:

a) _____: Myosin releases P_i.
b) 1 : Myosin binds ATP.
c) _____: Myosin head bonds tightly to thin actin filament.
d) _____: Myosin power stroke occurs.
e) _____: Myosin-actin interaction is broken.
f) _____: Myosin head pivots to a high-energy state.
g) _____: Myosin hydrolyzes ATP to ADP and P_i.

Muscle Relaxation via Troponin & Tropomyosin Regulation

●Myosin & actin together make up about 80% of the protein mass in a muscle fiber cell.

□ Remaining 20% consists mainly of _____ other types of thin filaments: 1) *Troponin*. & 2) *Tropomyosin*.

□ Troponin-tropomyosin-complex: *binds* actin & _____ myosin-binding-sites for *muscle relaxation*.

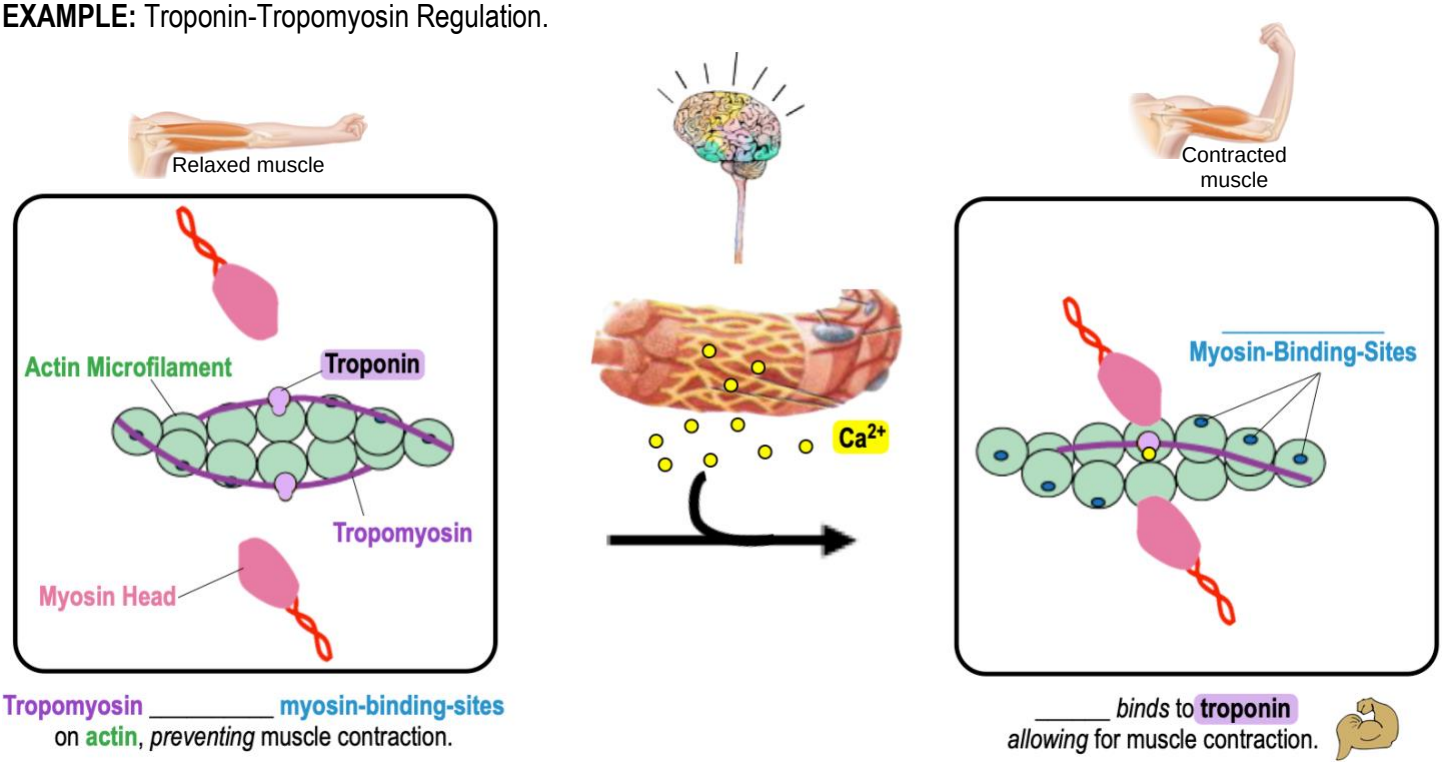
●Troponin-tropomyosin-complex _____ muscle contractions so they ONLY occur with *nervous system signals*.

●Upon receiving a *nervous system signal*, a myofibril's *sarcoplasmic reticulum* is stimulated to release _____.

□ _____: binds to released Ca^{2+} & causes a *conformational change* in the troponin-tropomyosin-complex.

□ Tropomyosin's change _____ myosin-binding-sites on actin, allowing the *actomyosin cycle* to initiate.

EXAMPLE: Troponin-Tropomyosin Regulation.



Tropomyosin _____ myosin-binding-sites on actin, *preventing* muscle contraction.

_____ *binds* to troponin *allowing* for muscle contraction.

●Over time, the released Ca^{2+} is *returned* to the sarcoplasmic reticulum, _____ the $[Ca^{2+}]$.

□ *Low* $[Ca^{2+}]$ allows troponin-tropomyosin-complex to _____ actin's myosin-binding-sites for *muscle relaxation*.

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PRACTICE: Muscle contraction is directly caused by:

a) Conformational changes in actin.
b) Conformational changes in myosin.
c) Conformational changes in the A band.
d) Conformational changes in the Z disk.

PRACTICE: Which of the following does not occur during a muscle contraction?

a) "Power stroke"; the thick filament pulls the actin thin filament towards the M line.
b) ATP is hydrolyzed; the heads of myosin shift into a high energy state.
c) ATP binds to myosin heads; increases the affinity of the myosin head for actin.
d) The myosin head rebinds to the actin closer to the Z disk prior to the power-stroke.
e) All the above occur.

PRACTICE: Which of the following is false concerning the sliding-filament model of muscle contraction?

a) The myosin head hydrolyzes ATP causing a conformational shift of the myosin head.
b) When a muscle shortens or lengthens, the H zones and I bands of sarcomeres change in size.
c) Neither the thick or thin filaments change in length during a muscle contraction.
d) After ATP hydrolyzation, the myosin head first releases P_i before it releases the ADP.
e) Actin detaches from the myosin head with energy from ATP hydrolysis.

PRACTICE: Which of the following statements correctly describes the relationship between cytosolic [Ca^{2+}] and the corresponding sarcomere response?

a) Increasing [Ca^{2+}] causes troponin to bind to tropomyosin.
b) Increasing [Ca^{2+}] causes movement of tropomyosin, exposing myosin-binding-sites on actin.
c) Decreasing [Ca^{2+}] promotes interactions between actin and myosin.
d) Increasing [Ca^{2+}] causes troponin and tropomyosin to bind to actin.
e) Increasing [Ca^{2+}] causes dissociation of Ca^{2+} from troponin.