

# Exercise Science (Muscle Anatomy and Physiology)

PPL10

Date: May 11<sup>th</sup>, 2015

# Examples of Strength and Physique Athletes



# The Principle of Muscles

- The most important principle for muscles is the “**use it or lose it**” principle.
- Every person born has the same amount or number of muscles. The difference lies in how big you make those muscles in regards to training.
- Thus, women and men have the same number of muscles though men have an advantage in building muscle and strength.

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**Question:** Do we turn on and off our muscles when we are walking or sitting vs running or lifting weights?

# Major Muscles of the Body

## Frontal Muscle Anatomy

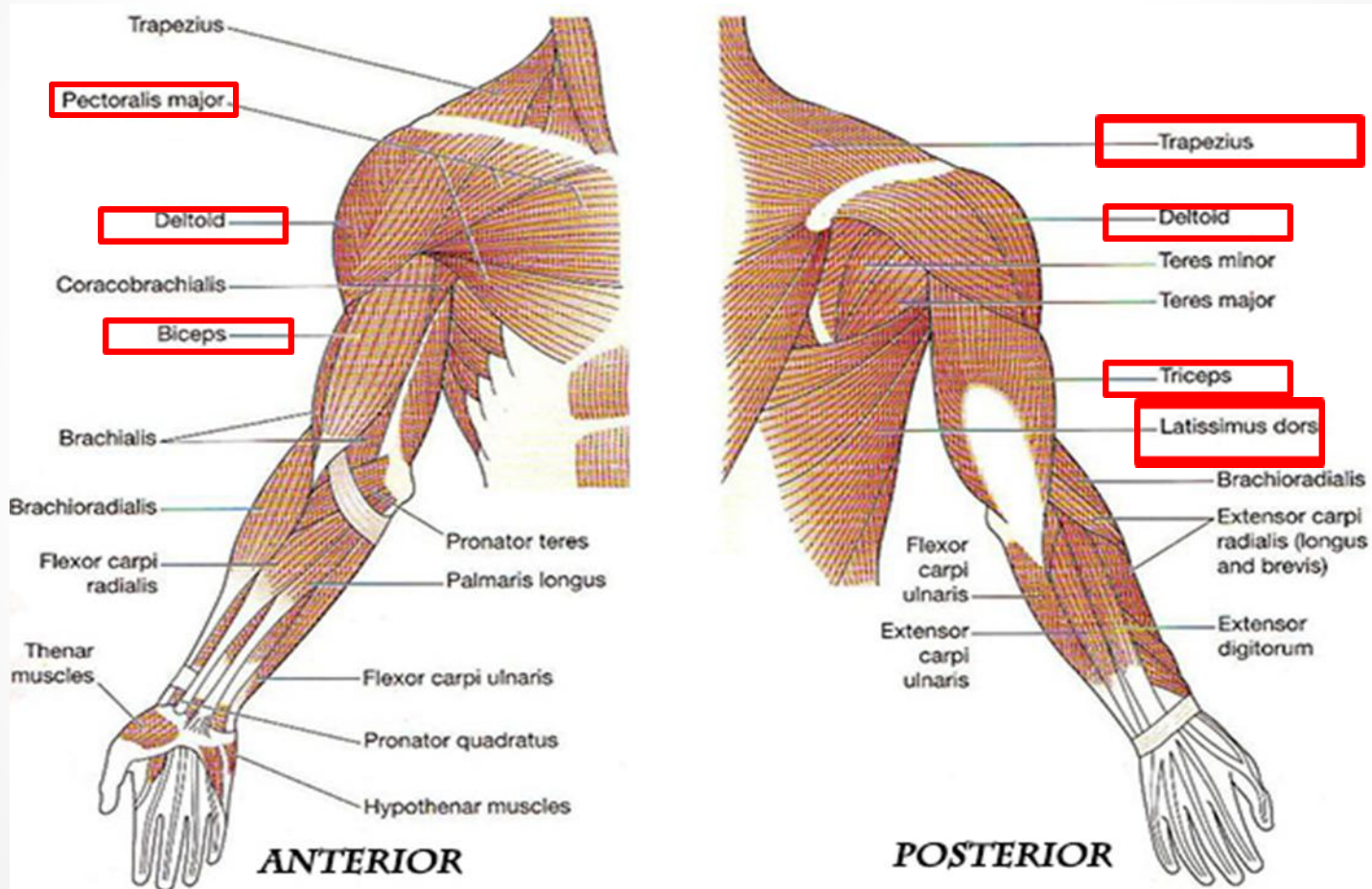


## Back Muscle Anatomy





# Major Muscles of the Upper Body



# Major Muscles of the Lower Body



**Hip Flexors**  
**Glutes**

**Adductors**  
**Abductors**

**Quadriceps**  
**Hamstrings**

**Gastrocnemius**  
**Soleus**



# Lower body orientation

- Front thigh: Quadriceps
- Back of the Thigh: Hamstrings
- Bum: Gluteus Maximus and Medius
- Front Lower Leg: Tibialis Anterior
- Calves: Gastrocnemius and Soleus
- Adductors: Inside the thigh (Medial)
- Abductors: Outside the thigh (Lateral)



# The Muscular System

- Skeletal muscle (the muscle that surrounds your skeletal system and attaches to it) is the single largest organ in your body.
- **40%** of your mass comes from muscle alone.
- They also play a role in protecting your vital organs, particularly your abdominal muscles (because you can brace them)

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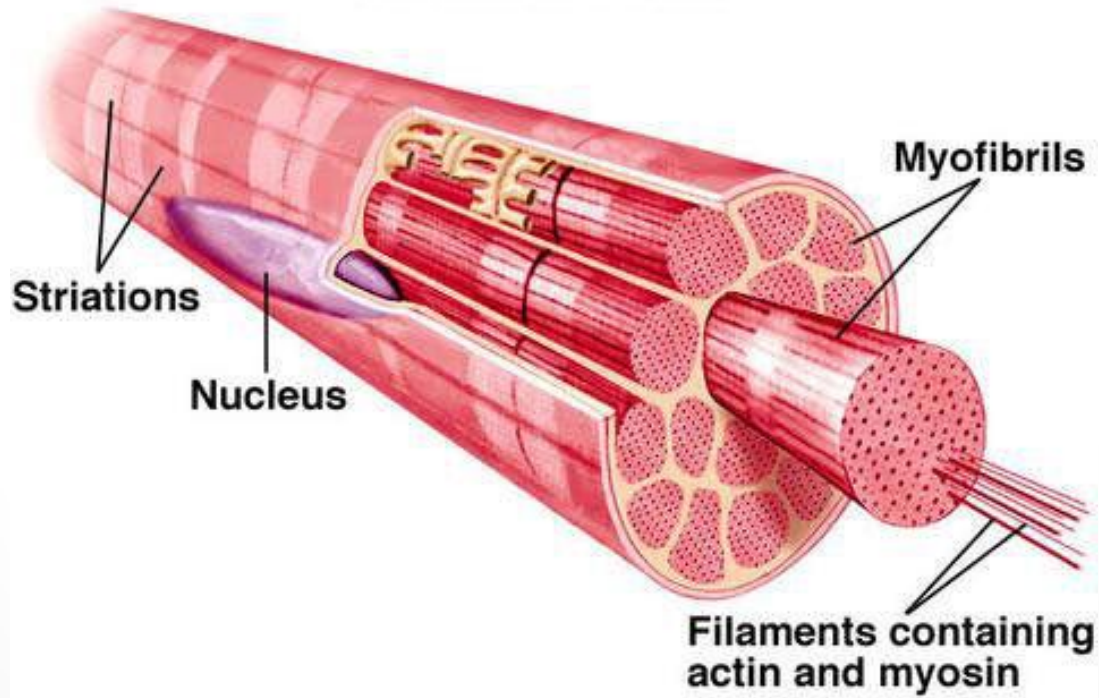
# What is a Muscle?

- A band or bundle of fibrous tissue in a human or animal body that has the ability to contract, producing movement in or maintaining the position of parts of the body.
- When you think of muscles, you think of them as one whole tissue. However, muscles are made up of many muscle fibers,



# Enter the Fiber

**Muscle Fiber**



# What is aerobic and anaerobic?

- **Aerobic:** Refers to an activity that requires oxygen to be present (i.e. long distance running)
- **Anaerobic:** Does not require oxygen or at the very least, very minimum levels (i.e. 100m sprint)
- Certain fiber types will be better suited for aerobic or anaerobic activities

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# Muscle Fiber Composition

- All different types of skeletal muscle fibers perform the same function (i.e. produce a contraction in order to exert force)
- The differences between the three main fiber types are in their size, fatigue capacity, and amount of force produced.



# The three fiber types

<u>Type 1 a</u>	<u>Type 2a</u>	<u>Type 2b</u>
Slow twitch Oxidative	Fast Twitch Oxidative	Fast Twitch Glycolytic
Efficient Oxygen Use (Purely Aerobic)	Combination of Aerobic and Anaerobic Metabolism	Primarily Anaerobic
Marathon	800m dash	100m sprint
Low but frequent force production	Moderate force production	High force production

**2<sup>nd</sup> question:** Does genetics influence how individuals develop muscle or respond to strength training?

# Figure 10.6 Levels of Functional Organization in Skeletal Muscle Fiber

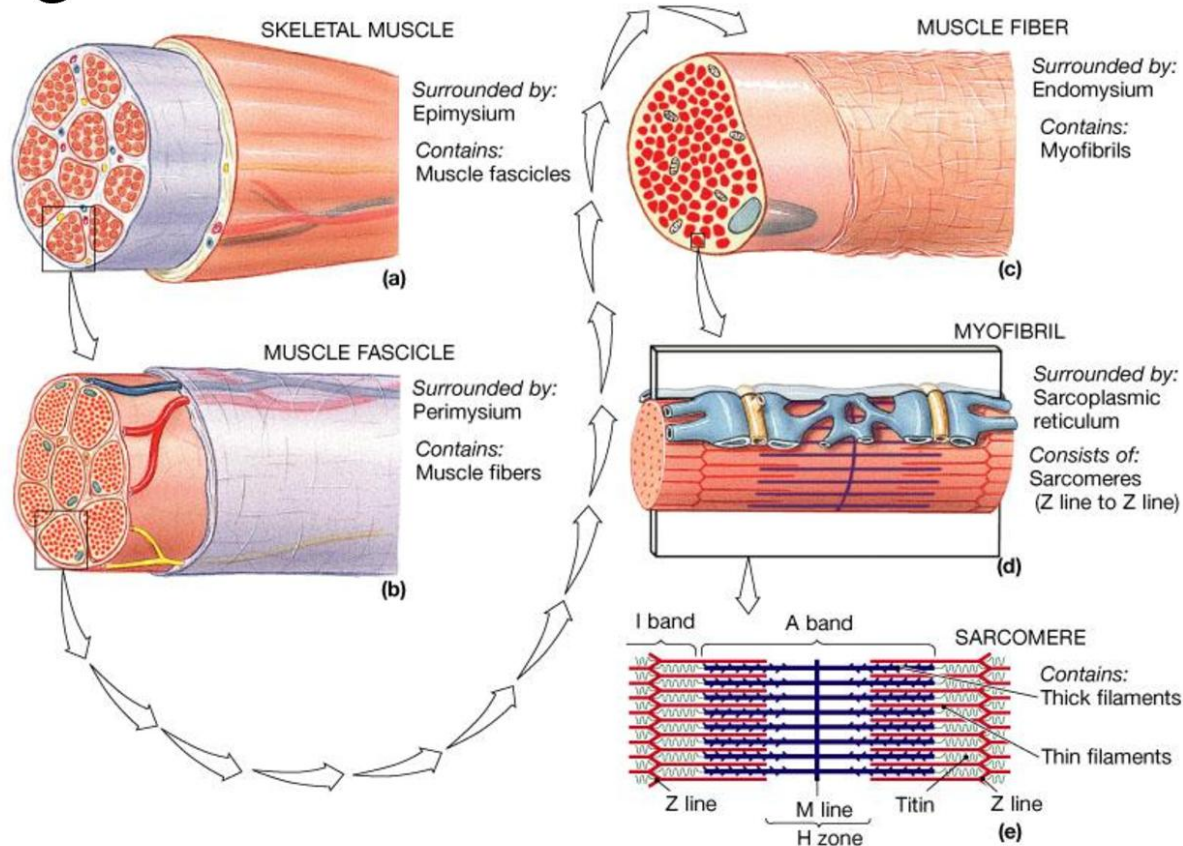


Figure 10.6

# The Role of ATP (Adenosine Tri-Phosphate)

- **ATP** is the molecule responsible for all energy being produced in the body (organs need ATP to do their own functions)
- The calories you consume will form the building blocks of ATP production.
- If you have no ATP, or you depleted them during extremely stressful training, you will not be able to use your muscles any further!



# Sliding Filament Theory

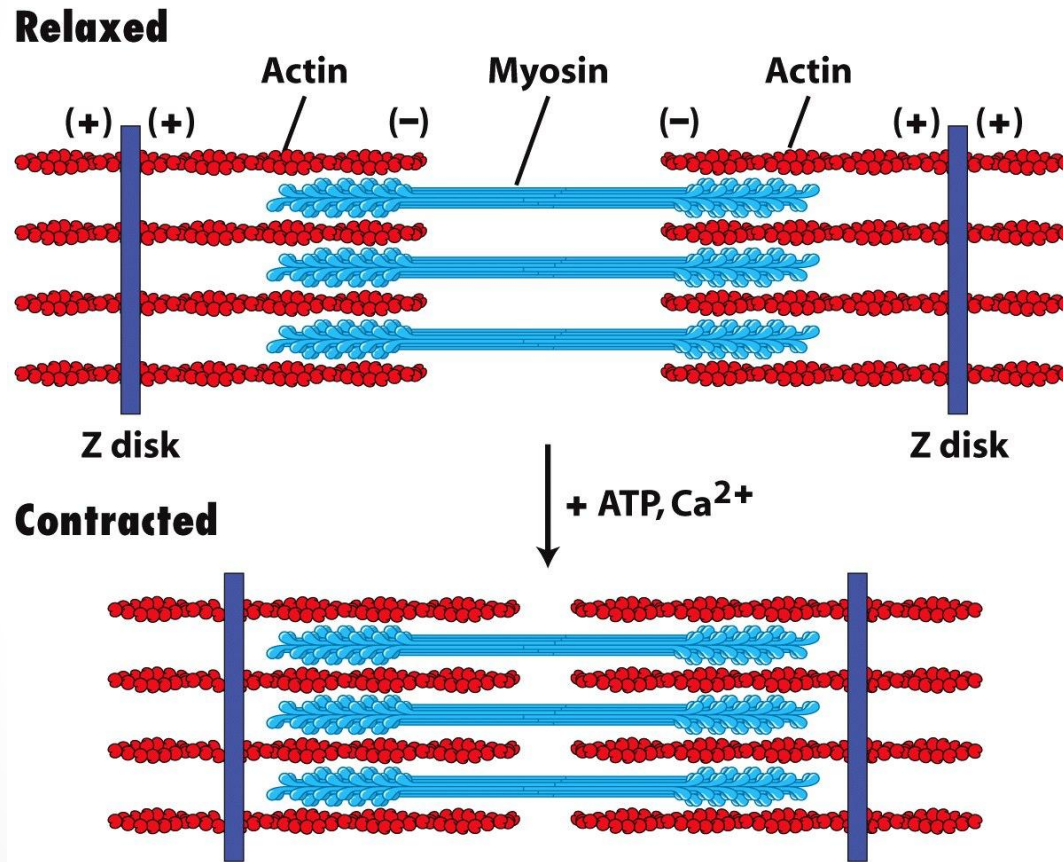


Figure 17-30  
*Molecular Cell Biology, Sixth Edition*  
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# What is it?

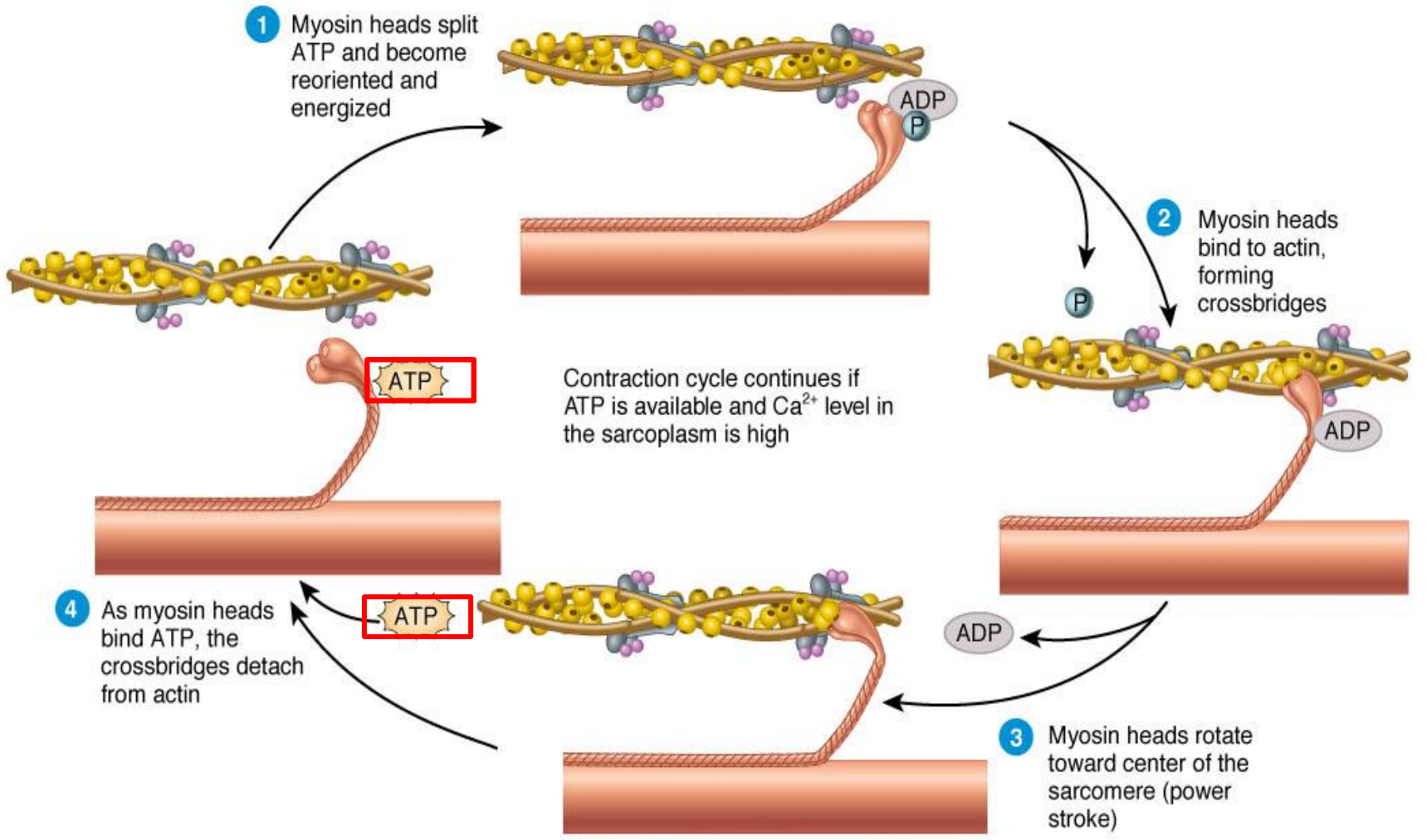
- The sliding filament theory is the theory that explains how muscle contraction works.
- Two filaments comprised of actin and myosin slide towards each other, thus producing force.
- When you contract your bicep (flex your elbow up) your muscle shortens and this is exactly what is happening on the molecular level.
- When they separate from one another, the muscle relaxes.



# Intro Video to Muscle Contractions

- [https://www.youtube.com/watch?v=Ct8AbZn\\_A8A](https://www.youtube.com/watch?v=Ct8AbZn_A8A)

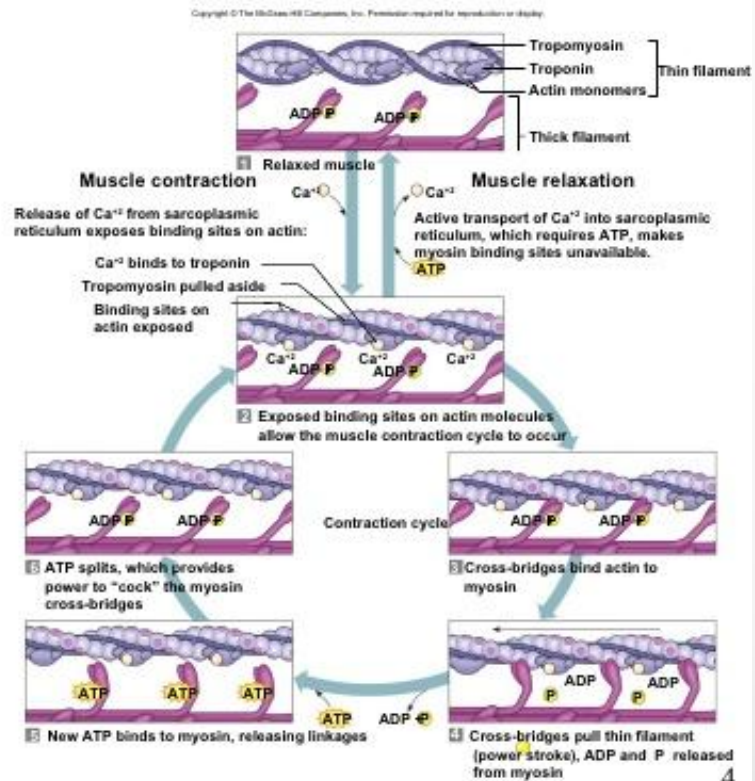
# Cross Bridge Cycle



# Cross Bridge Cycle

## Cross Bridge Cycling

- Myosin cross-bridge attaches to actin binding site
- Myosin cross-bridge pulls thin filament
- ADP and phosphate released from myosin
- New ATP binds to myosin
- Linkage between actin and myosin cross-bridge break
- ATP splits
- Myosin cross-bridge goes back to original position



# Troponin and Tropomyosin

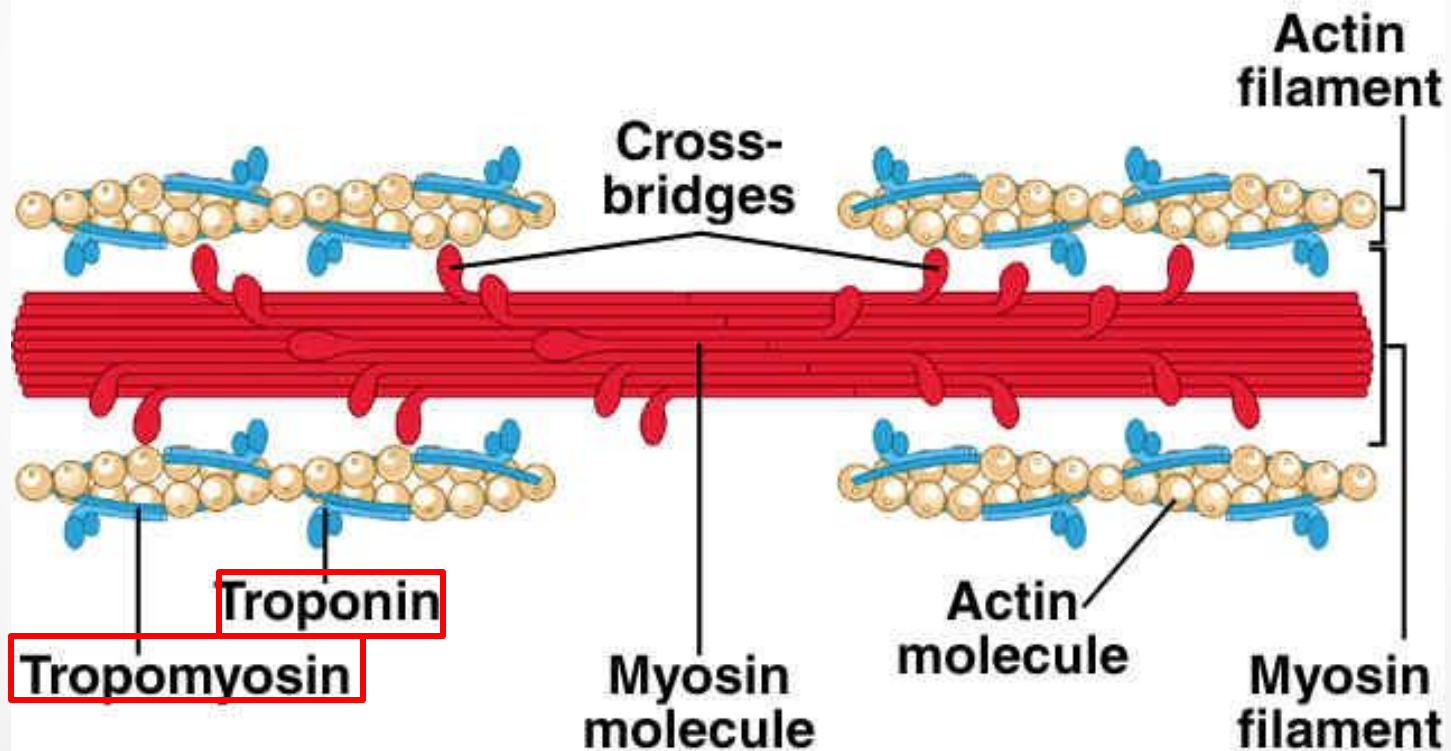
- Two proteins on the actin filament that act as gatekeepers or locks for calcium to open it.
- When calcium ( $\text{Ca}^+$ ) binds to troponin, it lifts the tropomyosin off to allow the myosin heads to bind to the actin heads, allowing for the cross bridge to occur.
- ATP is formed from myosin, the myosin head detaches from actin and then ATP is split again into ADP + P.



# Troponin and Tropomyosin

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## Thick Filaments



# Three types of muscle contractions

- Concentric muscle contraction:  
“Shortening”
- Eccentric muscle contraction:  
“Lengthening”
- Isometric muscle contraction: “Staying Still”



# Muscle Contractions

## Types of Muscle Contraction

### Concentric contraction

- Length of muscle shortens
- Muscle force is greater than the resistance

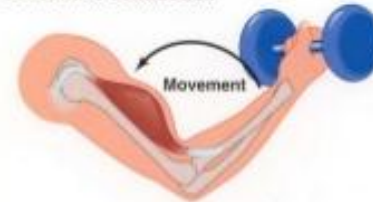
### Static or Isometric contraction

- No change in muscle length
- Muscle force is equal to the resistance

### Eccentric contraction

- Muscle lengthens
- Muscle force is less than the resistance

Concentric contraction



Isometric contraction  
Muscle contracts  
but does not shorten



Eccentric contraction



So how do you  
get bigger  
muscles?

Note: This transformation does not represent everyone's potential

