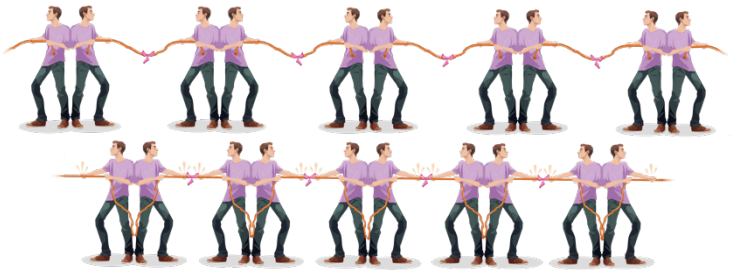
TOPIC: SLIDING FILAMENT THEORY AND THE SARCOMERE

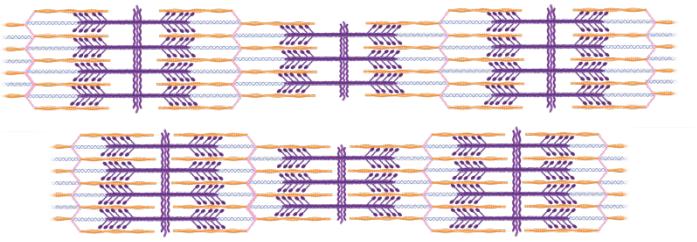
Sliding Filament Theory

- How do muscles get shorter?
  - **Myosin (_____ filament):** anchored to the center of the sarcomere.
    - *Protein that wants to pull on a rope.*
  - **Actin (_____ filament):** anchored to the ends of the sarcomere.
    - *Protein that is the _____.*

Analogy



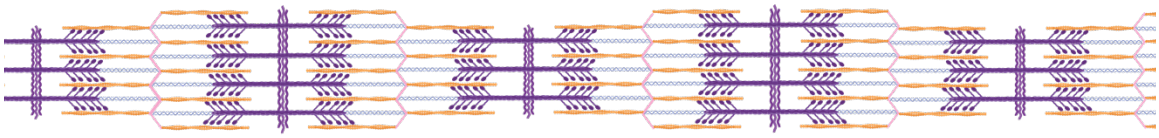
Sarcomeres



- During contraction:
  - Filaments (actin & myosin) stay the _____ length; overlap of actin & myosin _____.

EXAMPLE: The image below shows multiple sarcomeres.

1. Draw arrows to label at least two myosin filaments.
2. Draw arrows to label at least two actin filaments.



3. When the muscle contracts, which filament gets closer to the center of the sarcomere?

   _____

PRACTICE: During a muscle contraction, the _____ pulls on the _____, shortening the muscle.

a) Actin: Myosin.
c) Sarcomere: Actin.
b) Myosin: Sarcomere.
d) Myosin: Actin.

PRACTICE: During a muscle contraction, what gets shorter?

a) Actin.
b) Sarcomere.
c) The thick and thin filaments.
d) Myosin.

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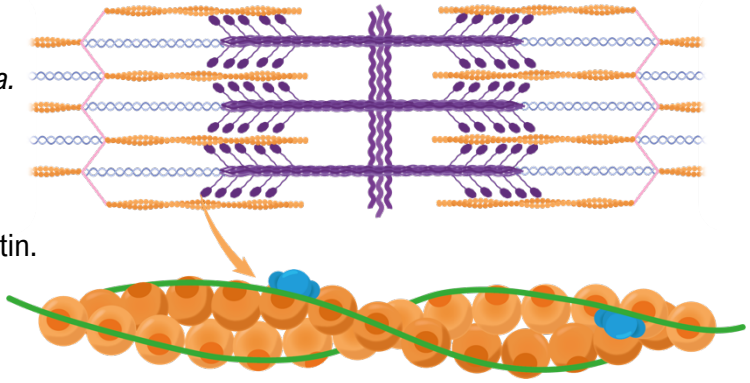
Proteins of the Sarcomere

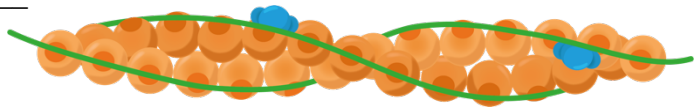
- *Recall:* Sarcomere is the contractile unit: _____ pulls on _____.
- Contractile Proteins:
  - **Myosin**: _____ filament: *many headed Medusa.*
  - **Actin**: _____ filament: *ac**TIN** is **THIN**.*
- Regulatory Proteins:
  - **Tropomyosin**: _____ - like protein, wraps actin.
    - _____ the myosin binding sites on actin.
  - **Troponin**: _____ protein.
    - Binds to Ca^{+2}: _____ the binding sites on actin by moving tropomyosin.
  - *Tropomyosin says "No" to the myosin.*
  - *Tr**OPON**in OPENs the binding site*
- Structural Proteins:
  - **Elastic Filament** (Titin): helps sarcomere retain _____.



EXAMPLE: Imagine whether the myosin binding sites on the actin will be more likely to be exposed or blocked in the following two scenarios. Likewise, predict whether you would expect overall myosin binding to increase or decrease in each scenario. An image is shown for reference.

a) There is no tropomyosin present on the actin filament.

- **Myosin binding sites:** _____
- **Binding increase or decrease:** _____



b) The calcium binding sites on the troponin molecules are non-functional.

- **Myosin binding sites:** _____
- **Binding increase or decrease:** _____

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PRACTICE: Myosin storage myopathy is a rare congenital condition where some of the myosin folds incorrectly in certain skeletal muscles creating clumps. Individuals with this condition exhibit muscle weakness and may be delayed in learning to walk as infants. What changes would you expect to see if you were to examine the sarcomere of an individual with this condition?

a) The thick filament would form protein clumps.

b) The thin filament would form protein clumps.

c) The titin would form protein clumps.

d) The fascicle proteins would form clumps.

PRACTICE: The contractile proteins of the sarcomere include which of the following?

a) Troponin.

b) Tropomyosin.

c) Titin.

d) None of the above.

PRACTICE: Which protein contributes to the structural integrity of the sarcomere?

a) Troponin.

b) Tropomyosin.

c) Titin.

d) Actin.

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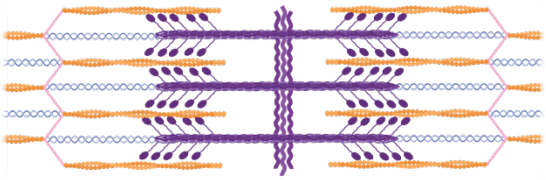
Structure of the Sarcomere: Bands, Zones, Discs & Lines

- The regions of the sarcomere were named for how they _____ on a TEM microscope.

1. **Discs and Lines:**

   - _____ Disc: end of sarcomere.
     - *Z is at the end of the alphabet.*
   - _____ Line: Myomesin protein that _____ myosin.
     - *M = Middle.*



2. **Bands and Zones:**
   - **I** band (_____ Band): area with just _____.
   - **A** band (_____ Band): area with _____ actin & myosin.
     - _____ Zone: center region with just _____.
     - *Helle* = bright.

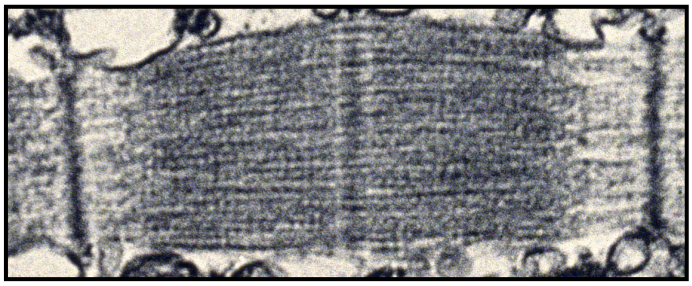
EXAMPLE: In the following image:

a) Mark the **A Band**, **I Band** and **H Zone** with brackets and label each.

b) Mark the **Z Disc** and **M Line** with arrows and label each.

c) Draw a line to represent the length of one **Actin** filament.

Then, in the table, describe if and how each component changes in size during a muscle contraction.



A Band	
I Band	
H Zone	
Z Disc	
M Line	

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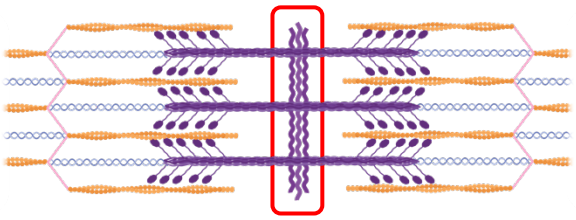
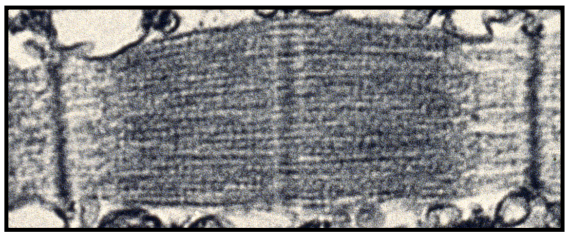
PRACTICE: The box in the image below surrounds what structure?

a) A Band.
b) I Band.
c) Z Disc.
d) M Line.



PRACTICE: Which region is the same length as the actin filament? An image is shown for reference.

a) A Band.
b) I Band.
c) From the edge of the H zone to the Z disc.
d) From the Z disc to the M line.



PRACTICE: What of the following is NOT found in the A band?

a) M Line.
b) H Zone.
c) Z Disc.
d) Areas with both actin and myosin.