

Muscular system



**MOVE
ME!**

MUSCLES

Day 1 Nov 13 and 16

**TYPES OF MUSCLES, STRUCTURE AND
FUNCTIONS.**

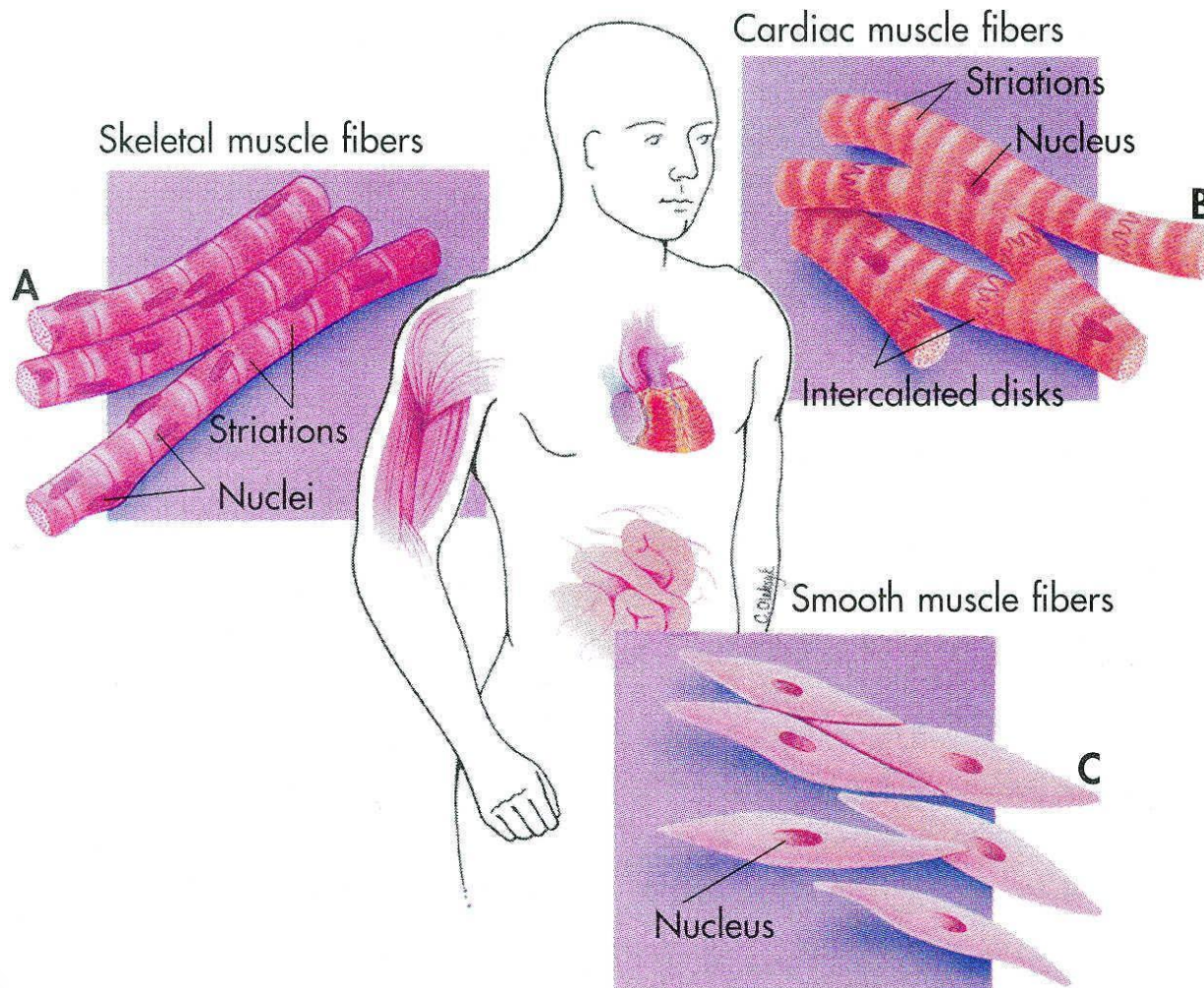
FUNCTIONS of MUSCLE

- Movement
- Maintains posture
- Stabilize joints
- Generates heat
 - Byproduct of muscular contraction

Three Types of Muscle

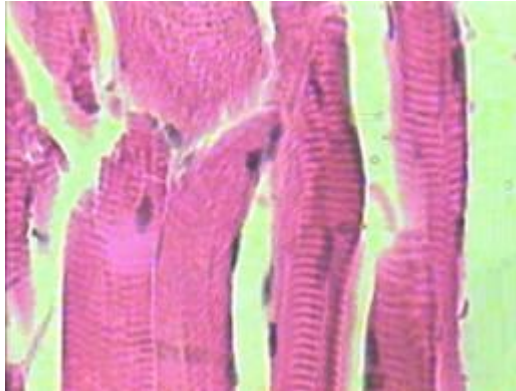
- Skeletal
 - Associated with bones
- Cardiac
 - Makes your heart
- Smooth
 - Tubular, common in intestines, blood vessels

Three muscle types

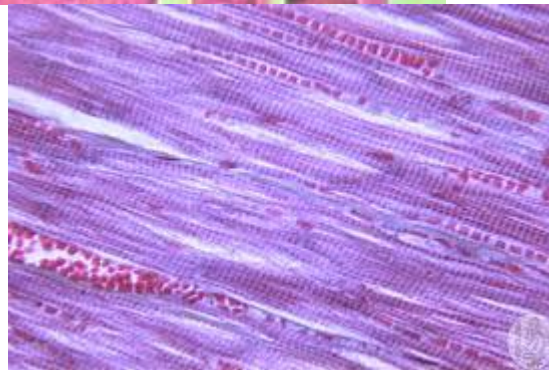


Three types at the cellular level

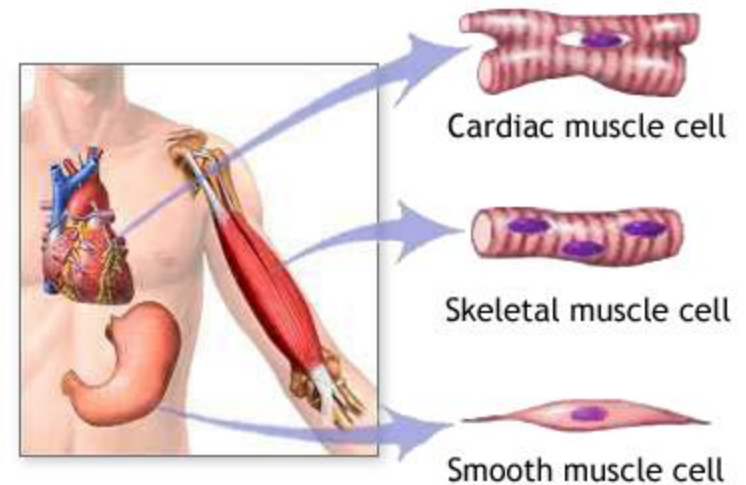
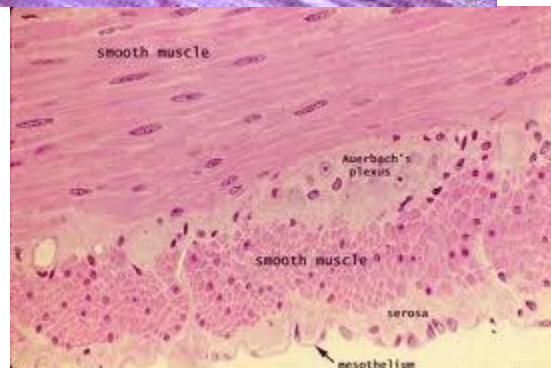
- SKELETAL



- CARDIAC



- SMOOTH



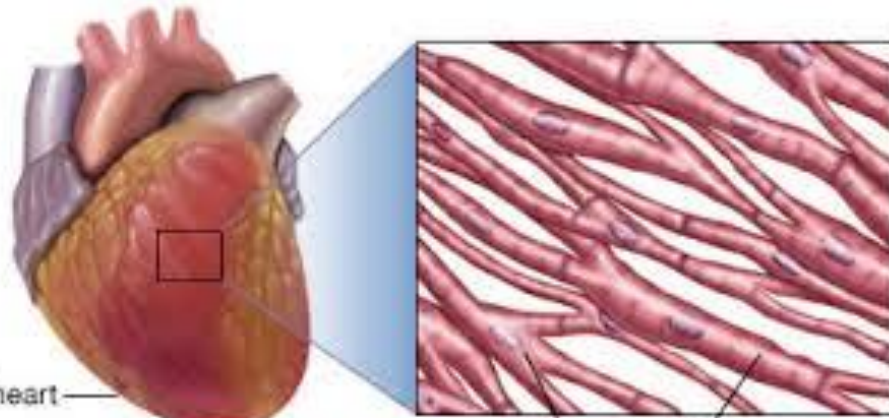
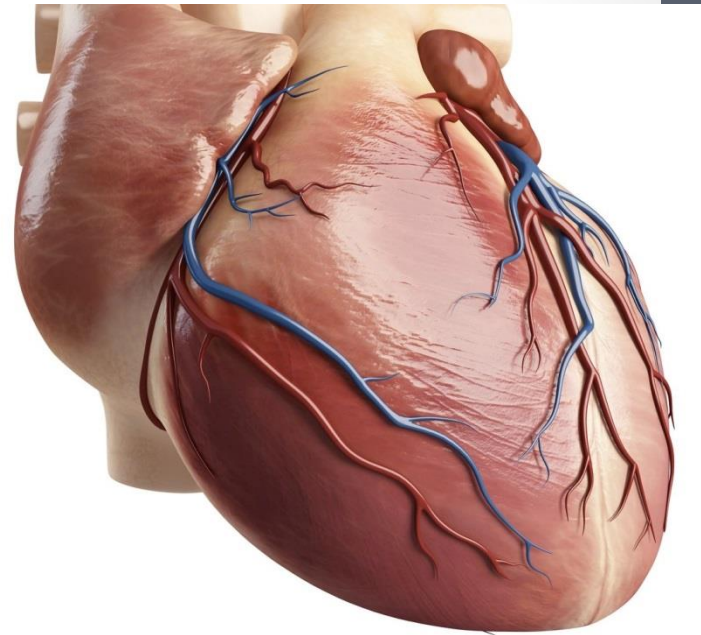
CARDIAC MUSCLE



- Only found in your heart
- Striated (striped)
- Involuntary (can't control it)
- Multinucleated



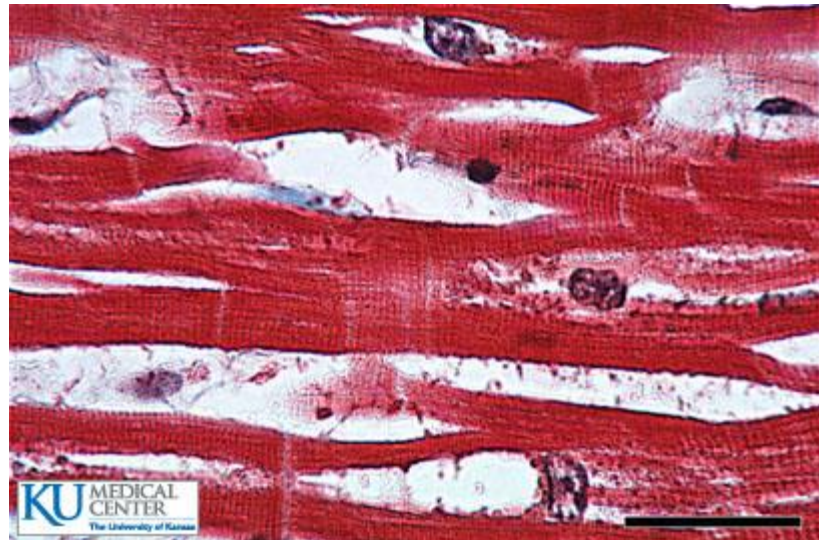
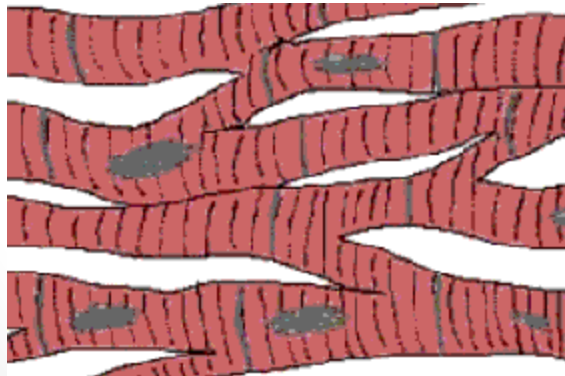
Cardiac Muscle



heart

cardiac muscle cells

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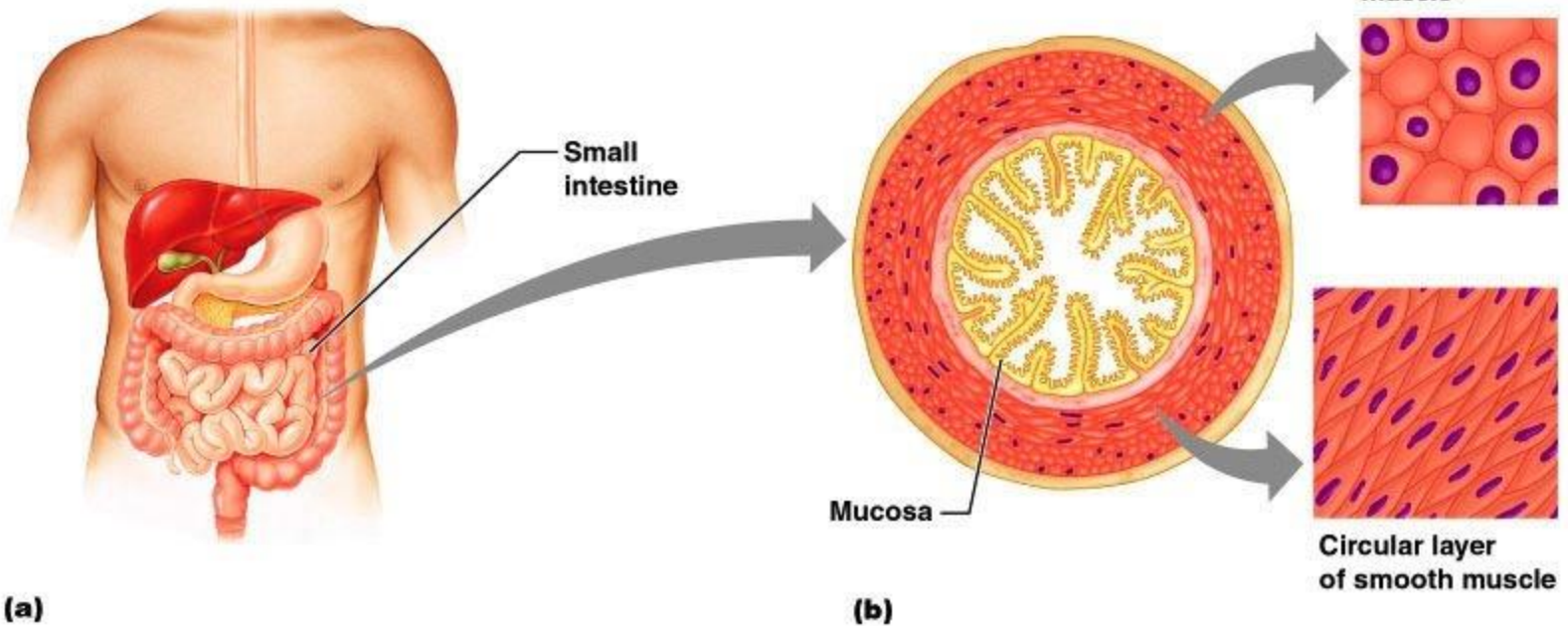


KU MEDICAL CENTER
The University of Kansas

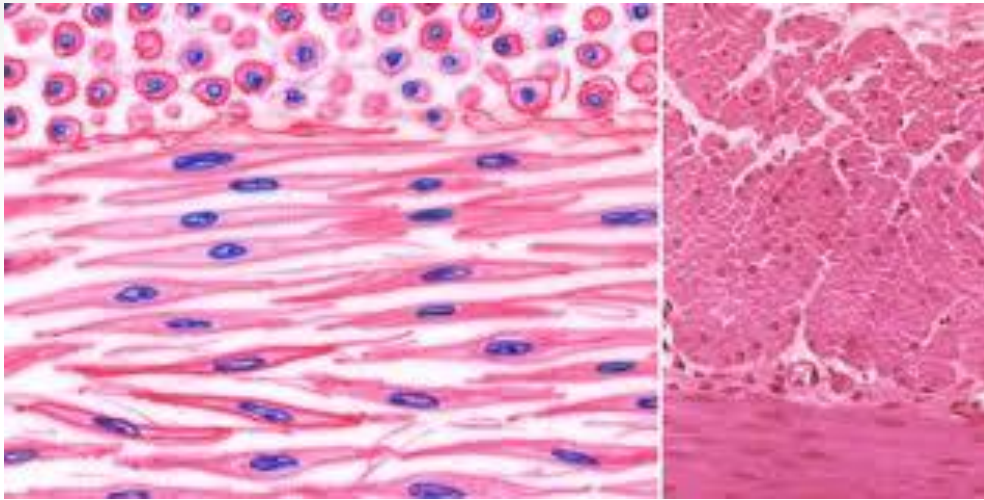
SMOOTH MUSCLE

- Involuntary and
- Not striated (striped)
- Not multinucleated
- Makes up vessels, intestines, bladder, stomach
 - Moves “stuff” through the body
- Slow smooth contractions

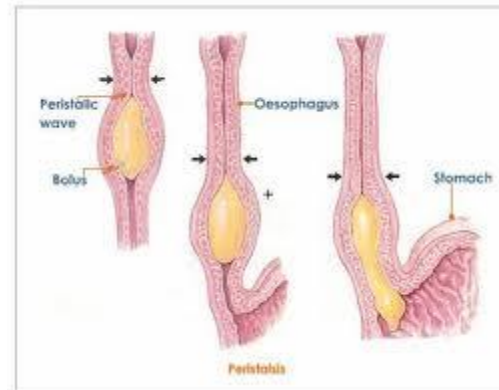
Smooth muscle



Smooth muscle cells



Single smooth muscle cell

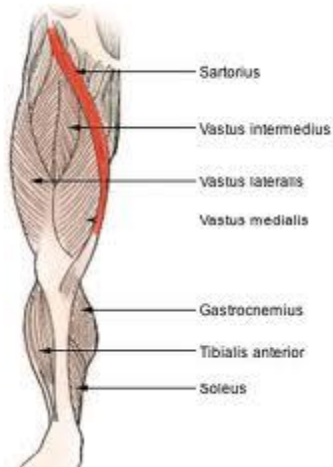


SKELETAL MUSCLE

- Voluntary
 - Striated (striped)
 - Multinucleated
 - Fast strong contractions
-
- Human body contains over 400 skeletal muscles
 - 40-50% of total body weight



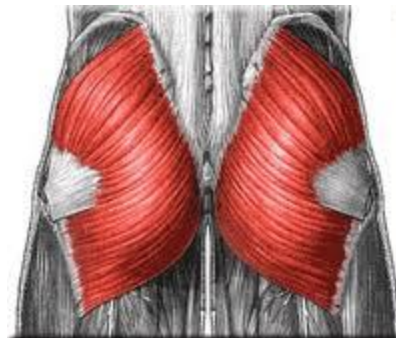
Longest muscle - sartorius

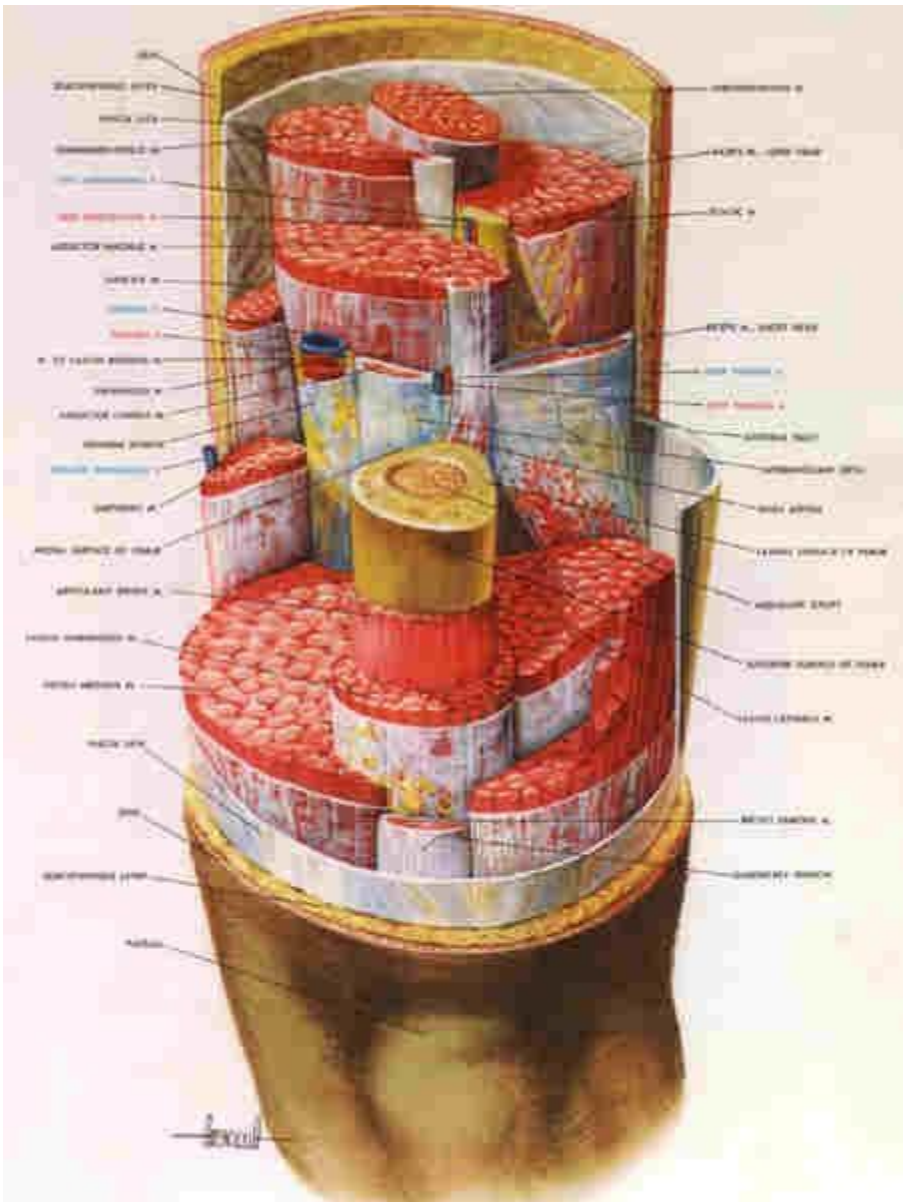


Strongest muscle

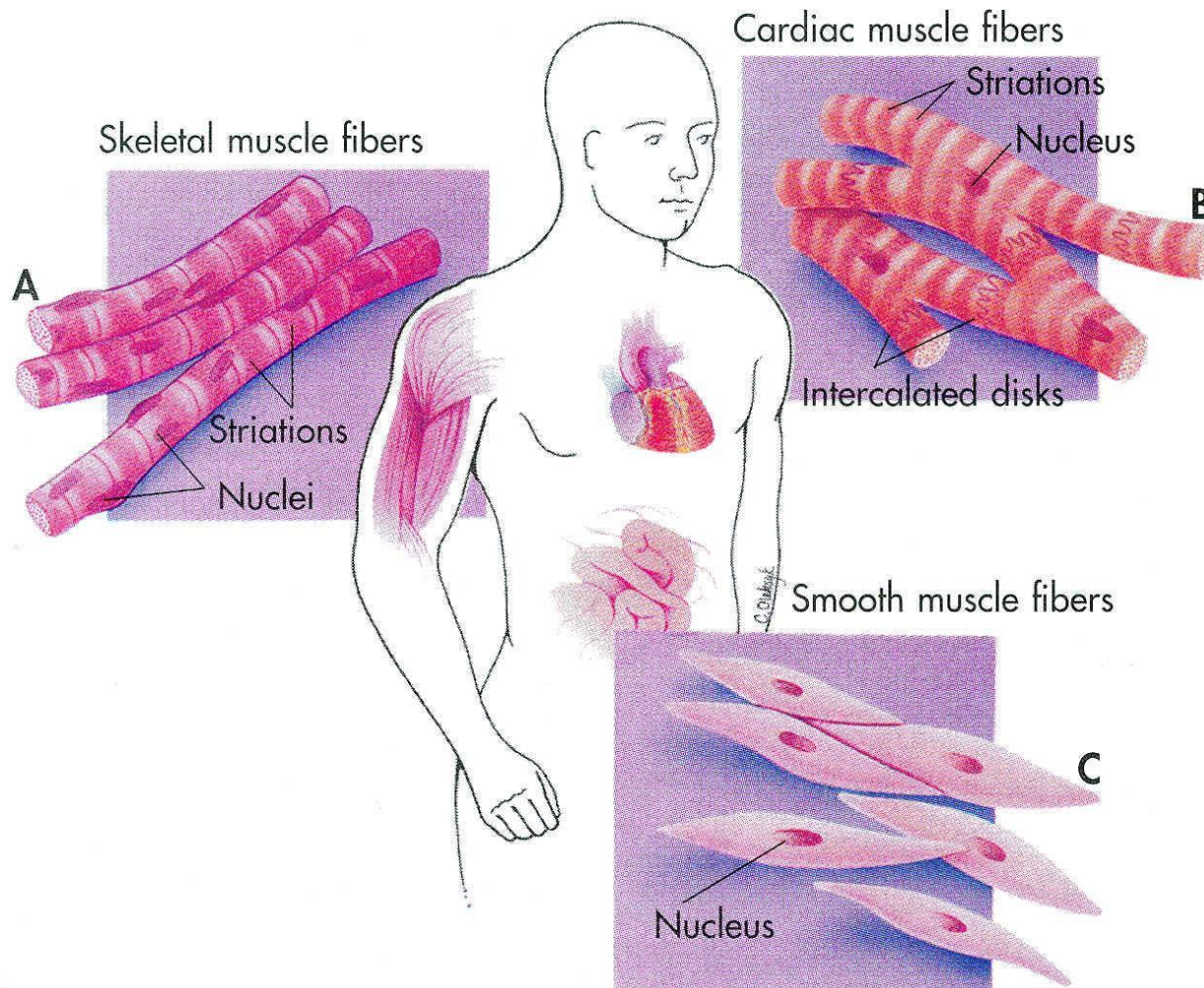


Largest muscle – gluteus maximus





Three muscle types



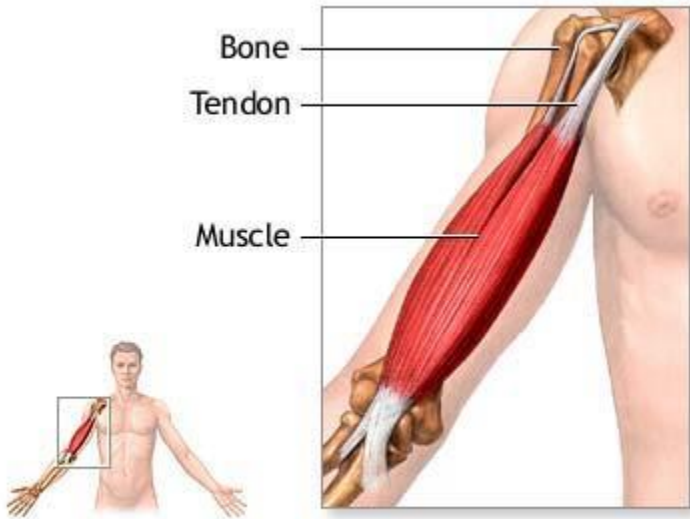
MUSCLES

Day 2 Nov 17 and 18

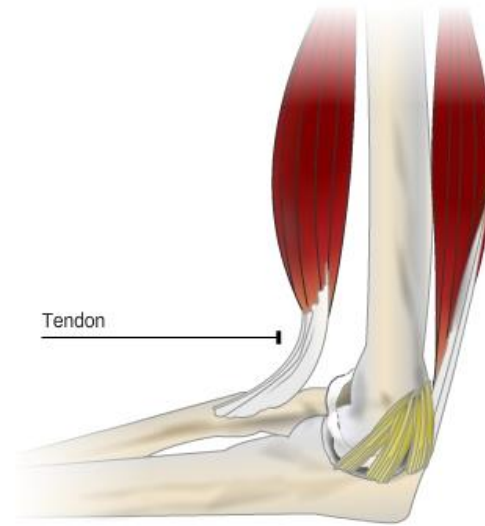
**NAMING MUSCLES AND HOW THEY
MOVE YOU**

Structure of Skeletal Muscle

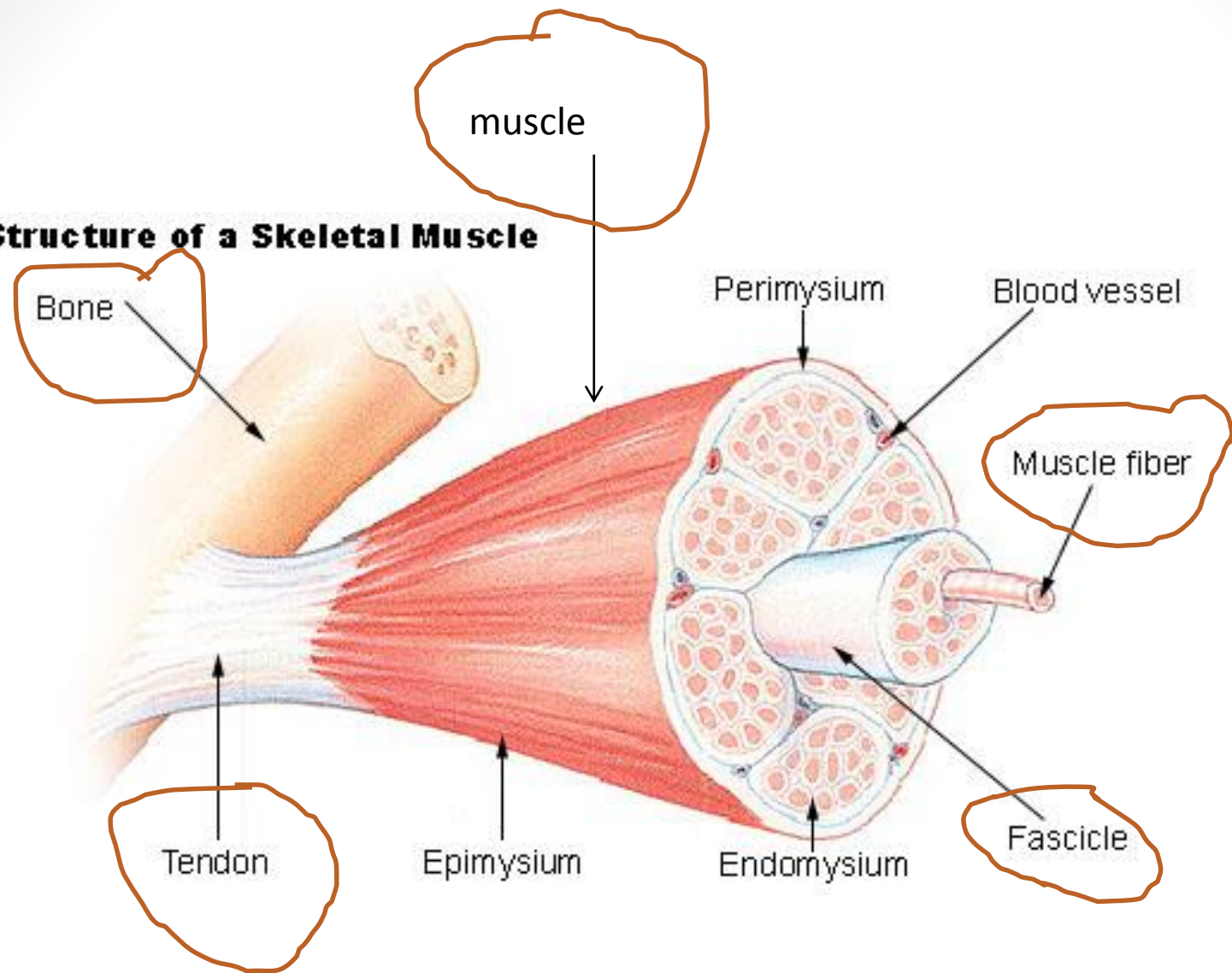
- Muscle Fiber is a muscle cell
- Fibers up to a foot long
- Strong due to connective tissue that surrounds groups of muscle fibers and becomes tendons



ADAM.



Structure of a Skeletal Muscle



Structure of skeletal muscle

- Muscle – many fascicles
 - Fascicle – many muscle fibers/cells
- **BIG TO SMALL**
 1. Muscle
 2. Fascicles
 3. Muscle fibers/cells
 4. Myofibrils
 5. (Sarcomeres)
discuss later

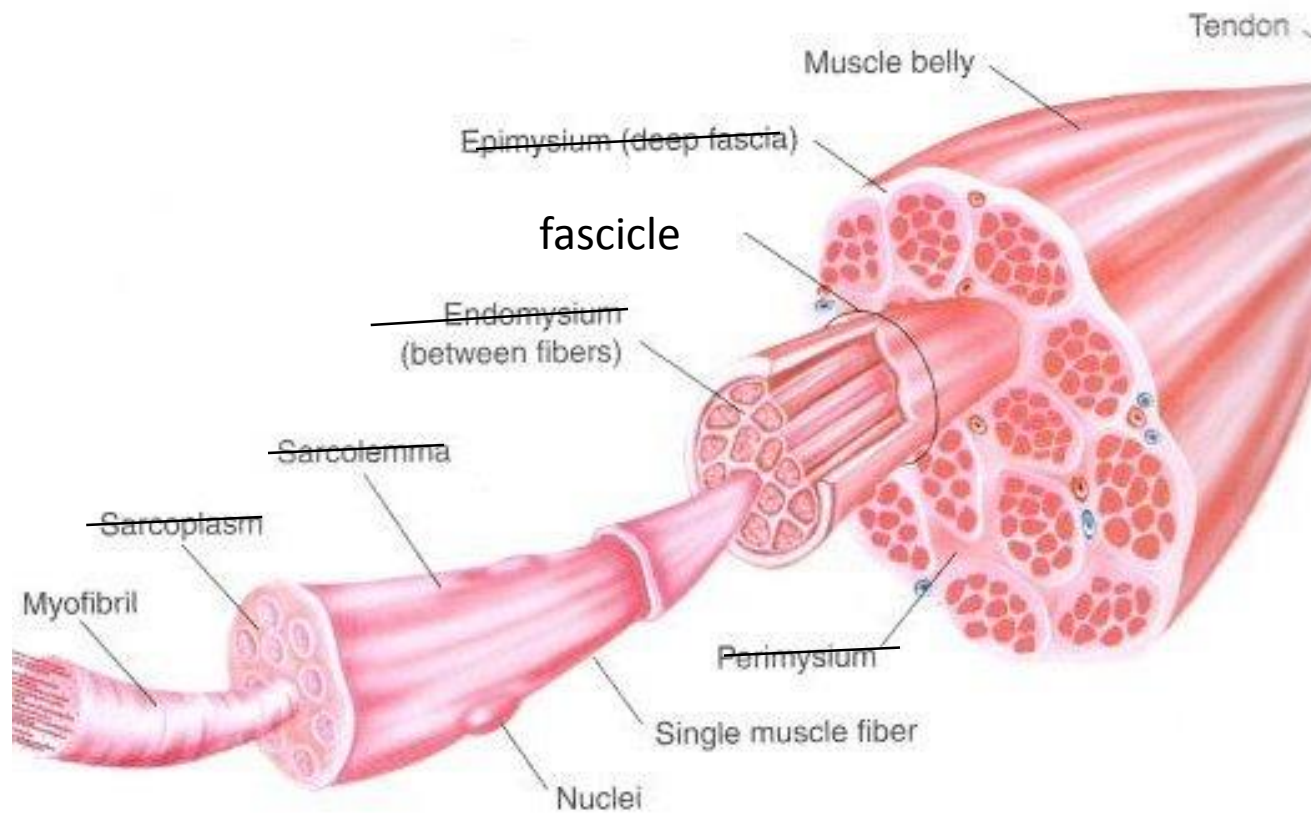
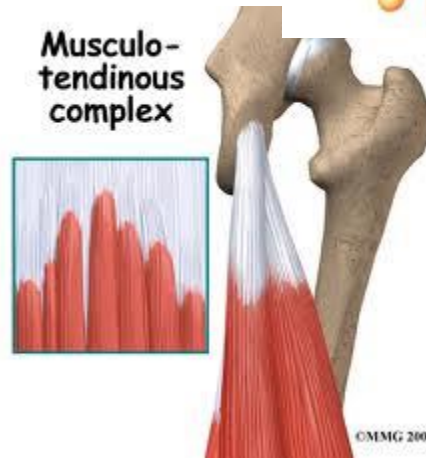
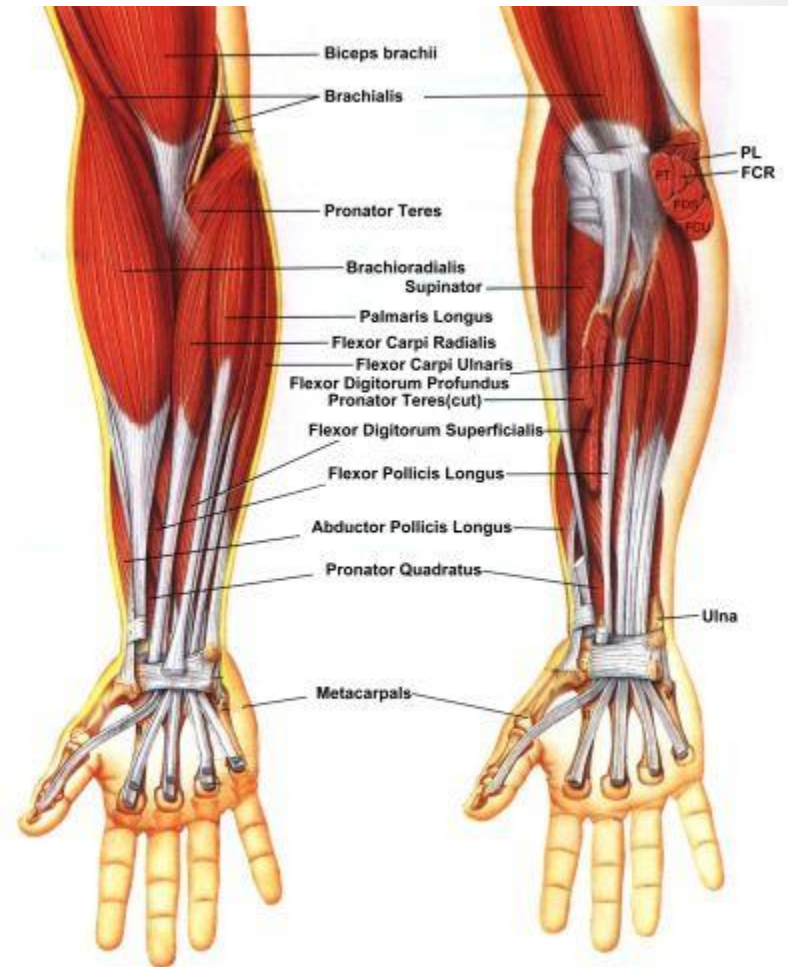


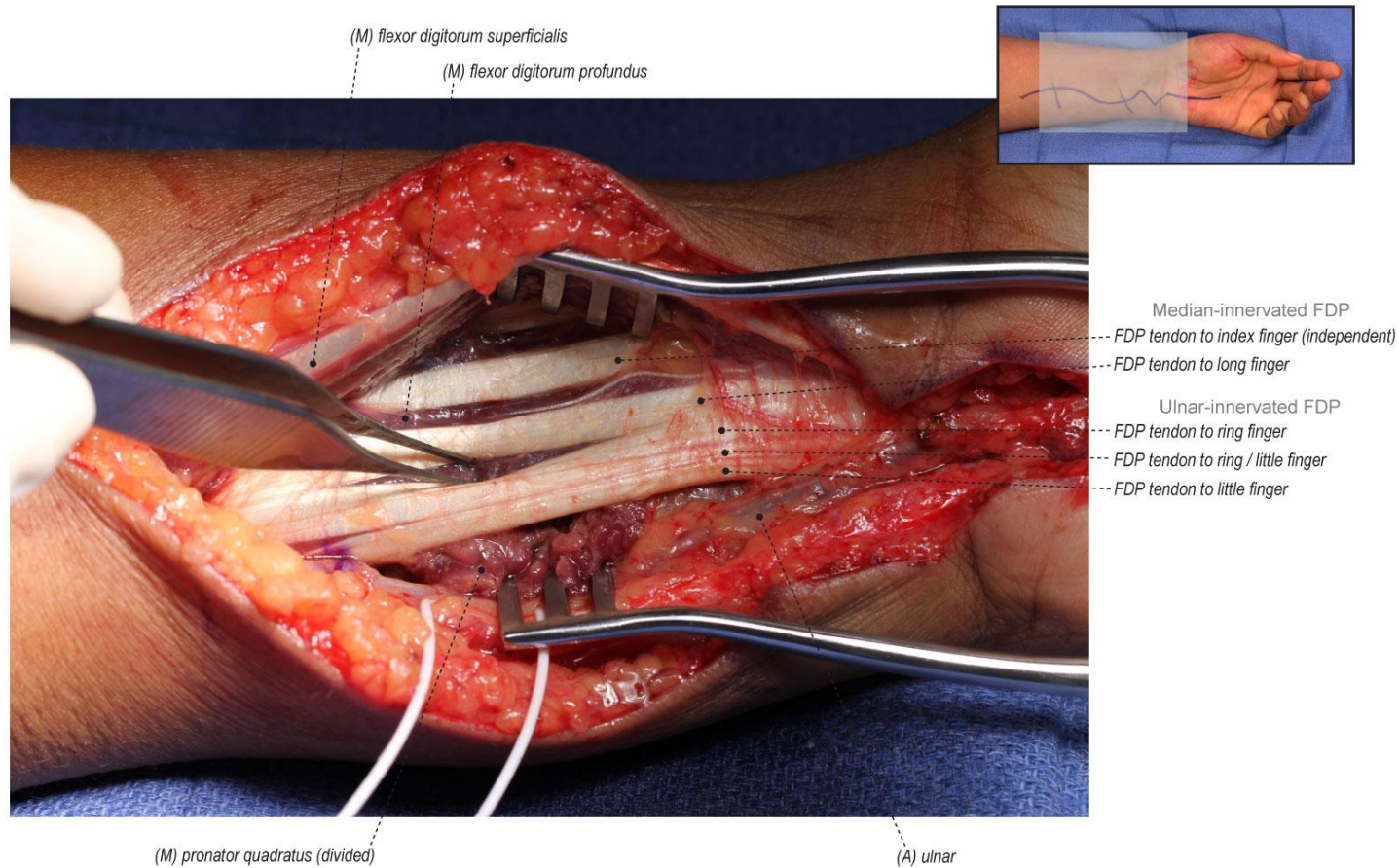
Figure 1: Muscle belly split into various component parts (from Essentials of Strength Training & Conditioning, National Strength & Conditioning Association)

TENDONS

- CONNECT MUSCLE TO BONE
- THE (FASCICLE) MEMBRANE AROUND THE BUNDLES OF MUSCLE FIBERS/CELLS COME TOGETHER TO FORM TENDONS

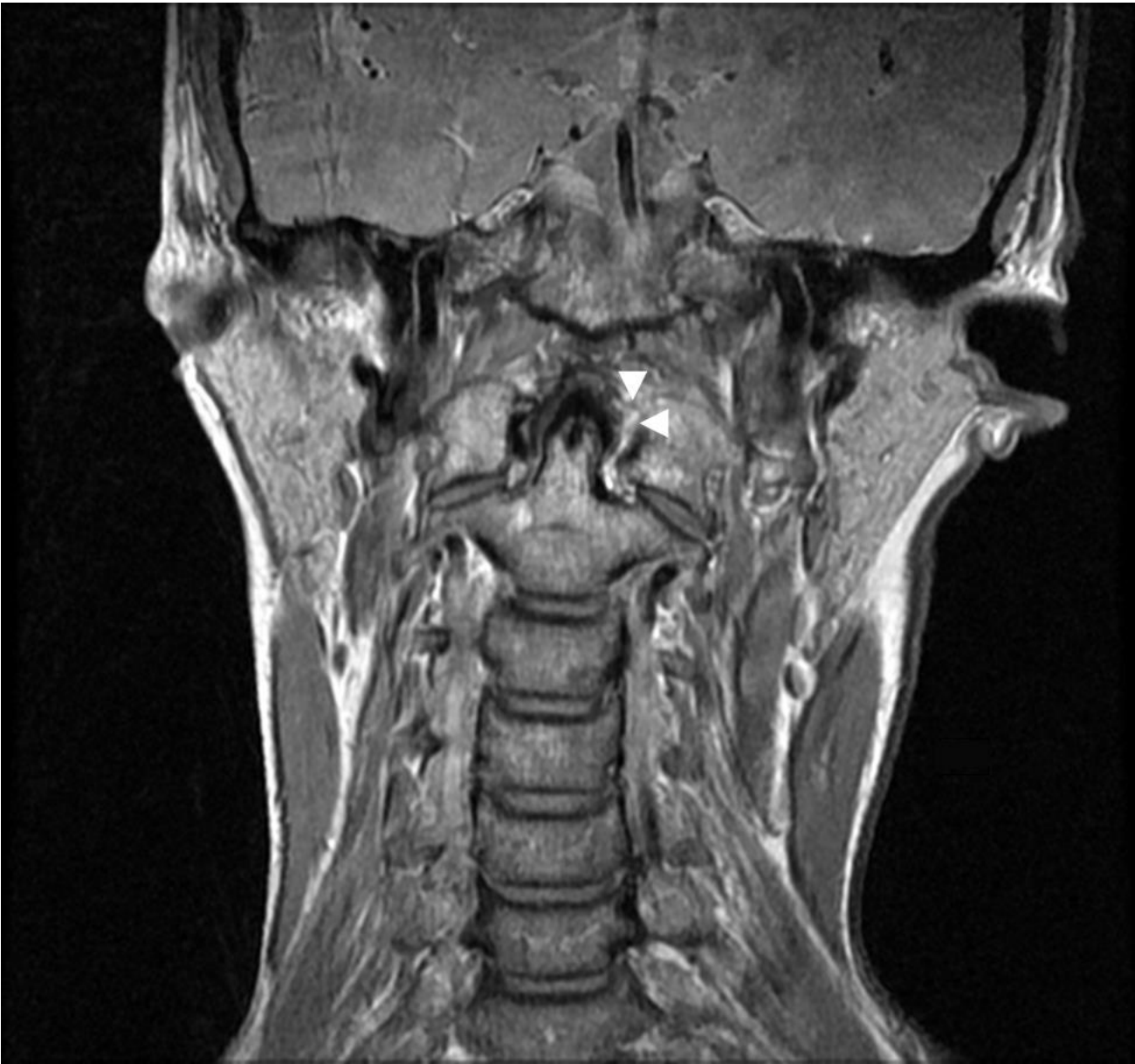


The real thing – a bit gross







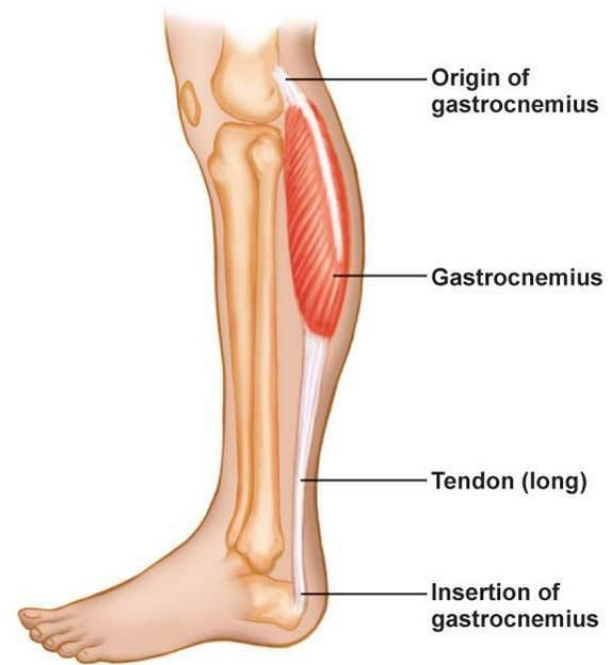
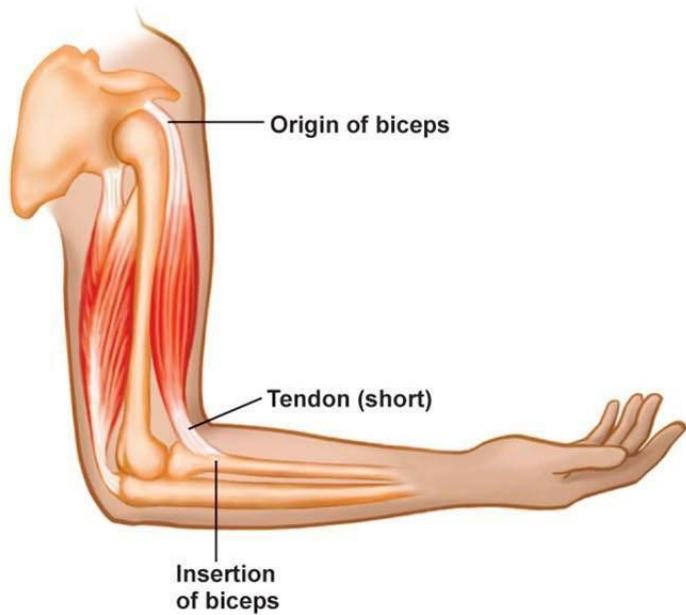


HOW MUSCLES CONNECT TO BONES

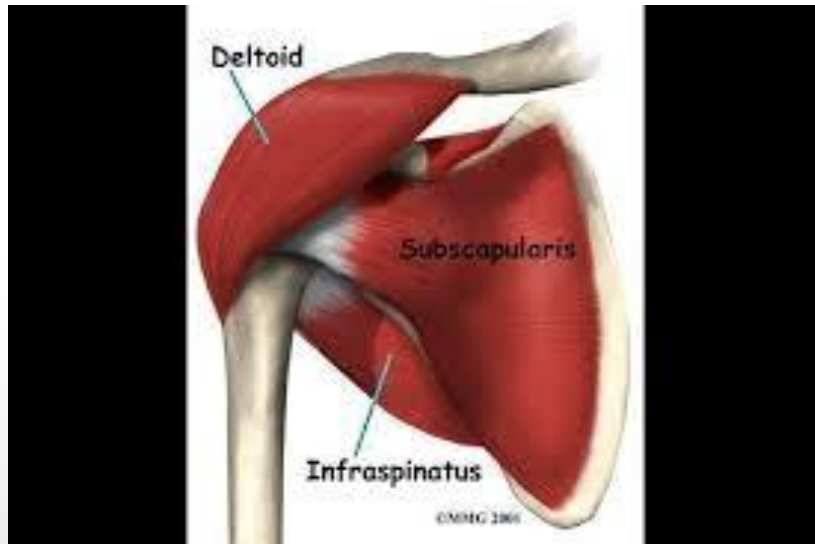
- All muscles connect to bones at a minimum of TWO places
 1. Point of origin
 2. Point of insertion

WHEN A MUSCLE CONTRACTS THE
ORIGIN GETS CLOSER TO THE
INSERTION

Muscles only PULL, they never PUSH



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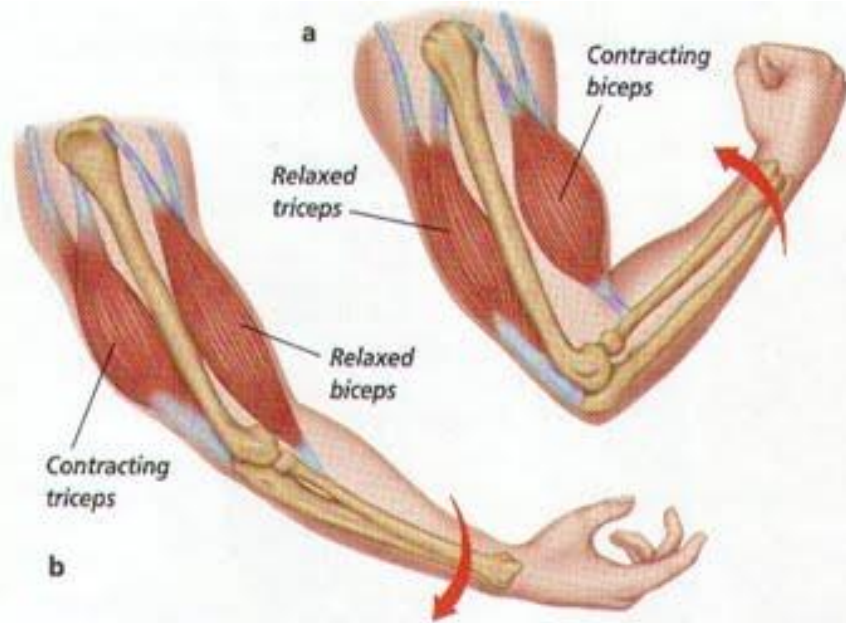


Point of Origin and Insertion

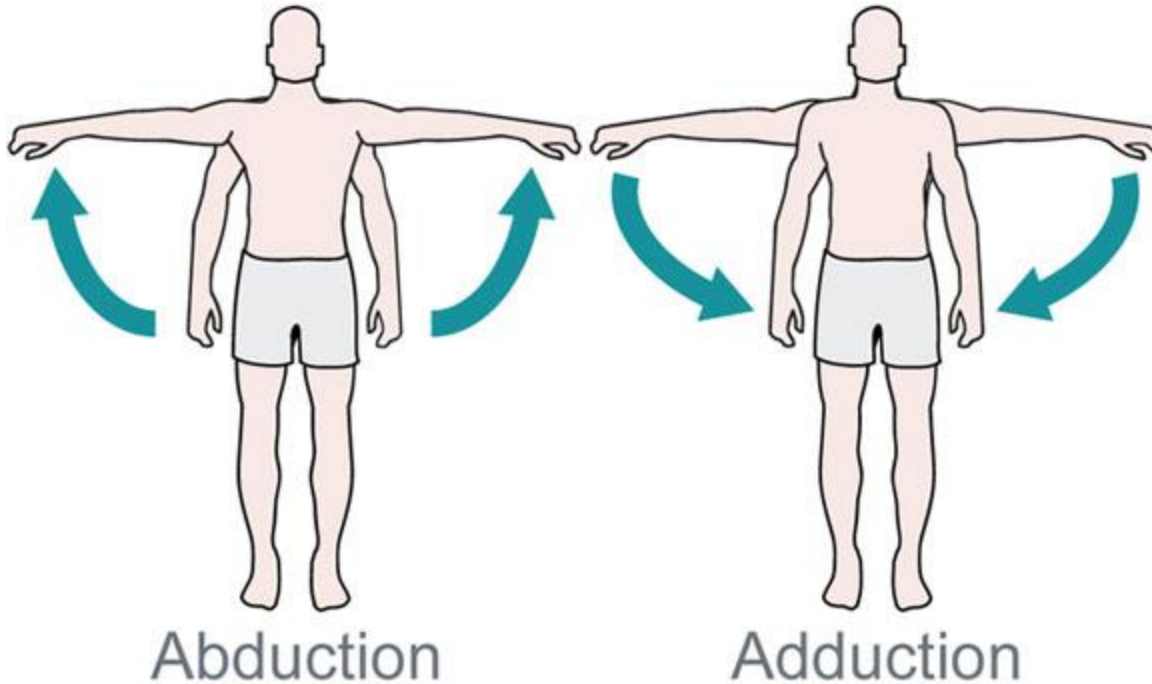
Some ways that muscles can move

- **Flexion**
 - Decreases the angle of the joint
- **Abduction**
 - Away from the midline
- **Rotation**
 - In a circular motion
- **Extension**
 - Increases the angle of the joint
- **Adduction**
 - Towards the body

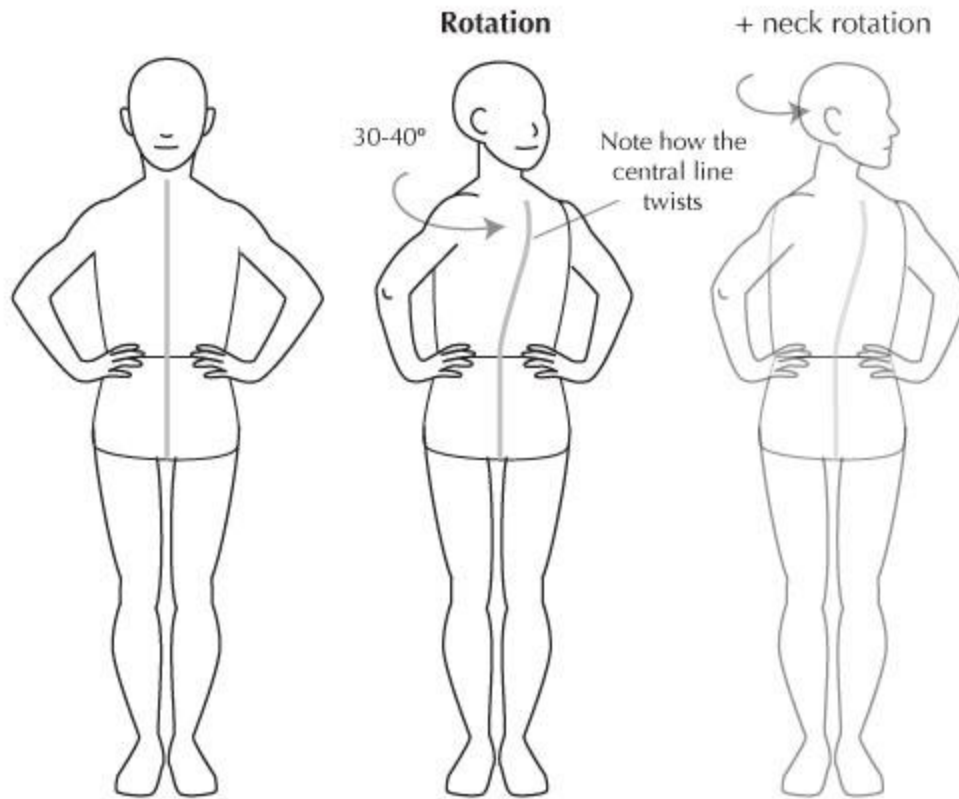
Extension and Flexion



Abduction and Adduction



Rotation



MUSCLES

Day 3 NOV 19 AND 20

No Notes (Finish posters, steroid article)

MUSCLES

Day 4 Nov 23 and 24

Muscles at the cellular level

Structure of skeletal muscle

- Muscle – many fascicles
 - Fascicle – many muscle fibers/cells
 - Muscle fibers/cells – many myofibrils
 - Myofibrils – many sarcomeres
- **BIG TO SMALL**
 1. Muscle
 2. Fascicles
 3. Muscle fibers/cells
 4. Myofibrils
 5. Sarcomeres

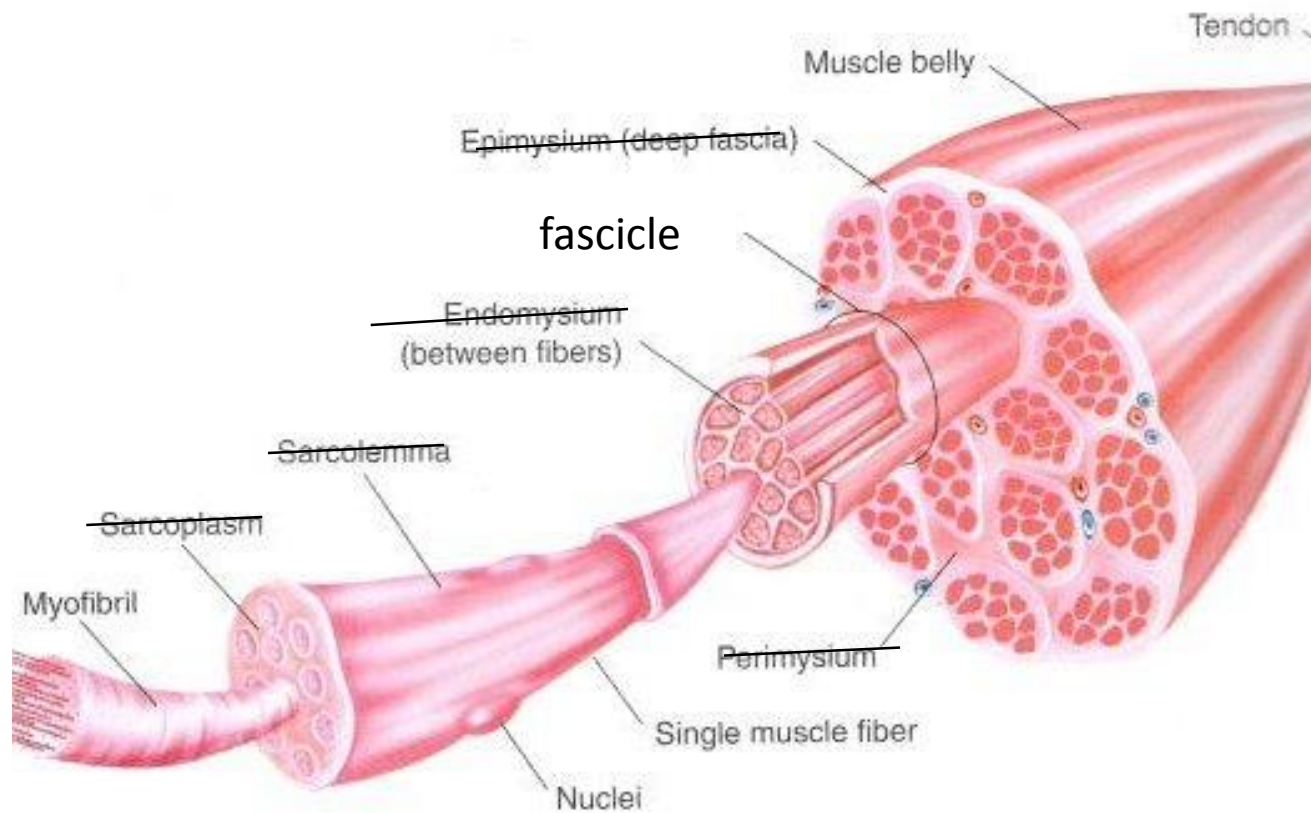
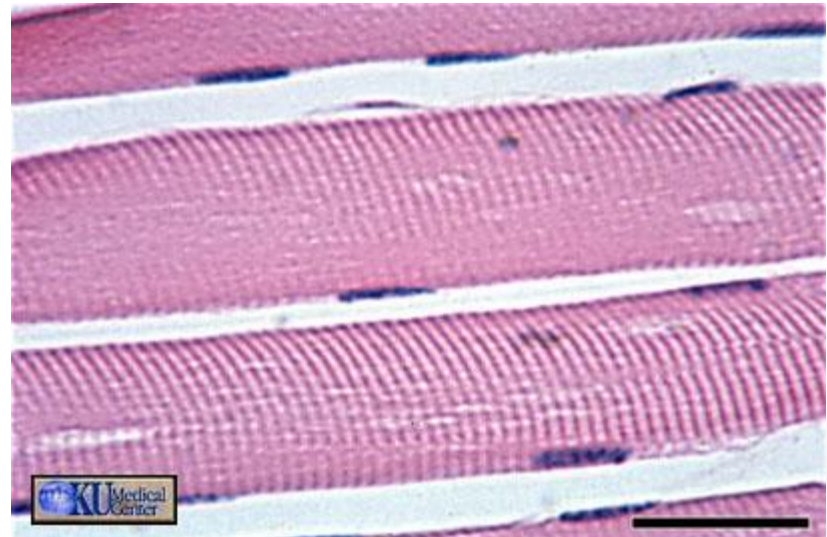
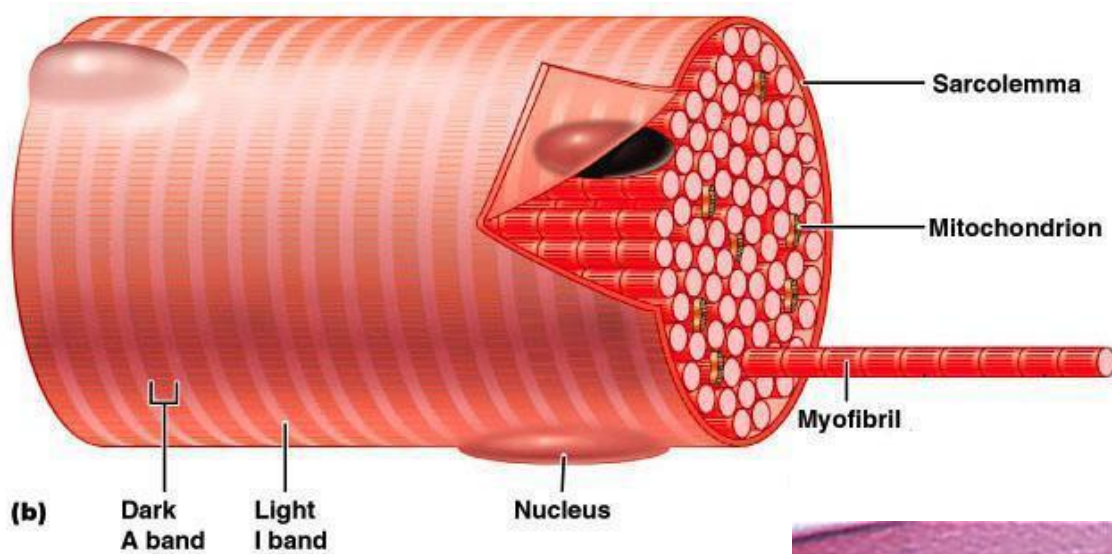
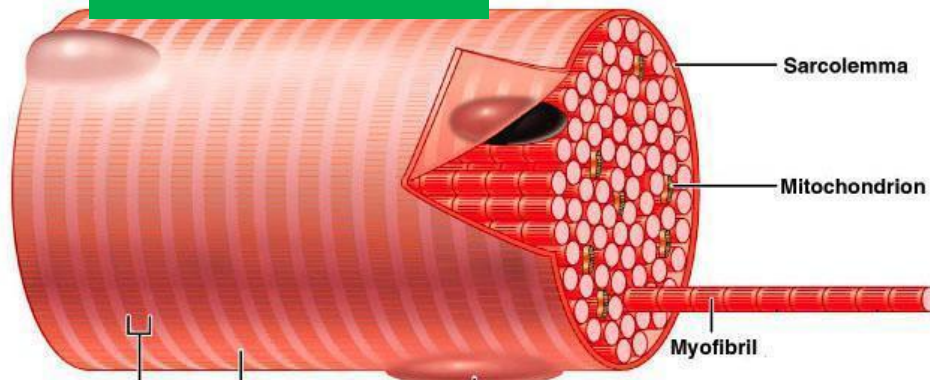


Figure 1: Muscle belly split into various component parts (from Essentials of Strength Training & Conditioning, National Strength & Conditioning Association)

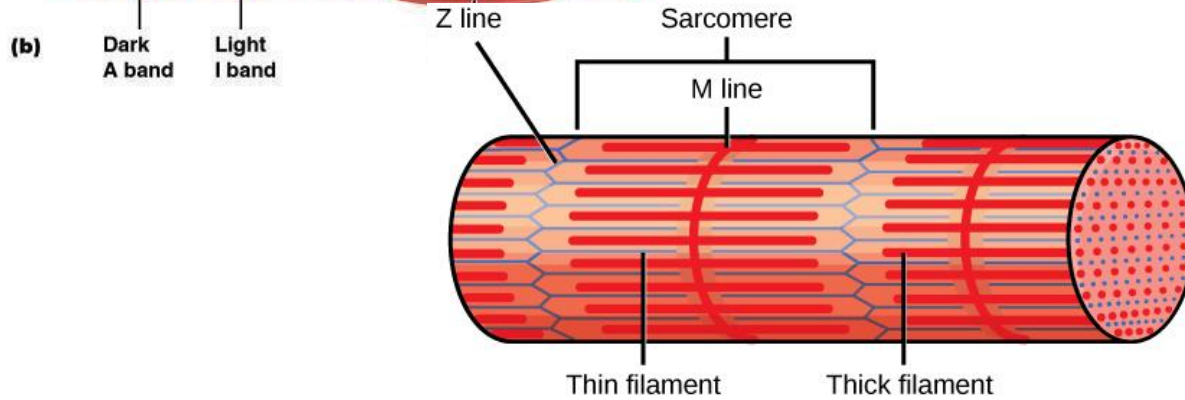
Inside a SINGLE muscle fiber/cell



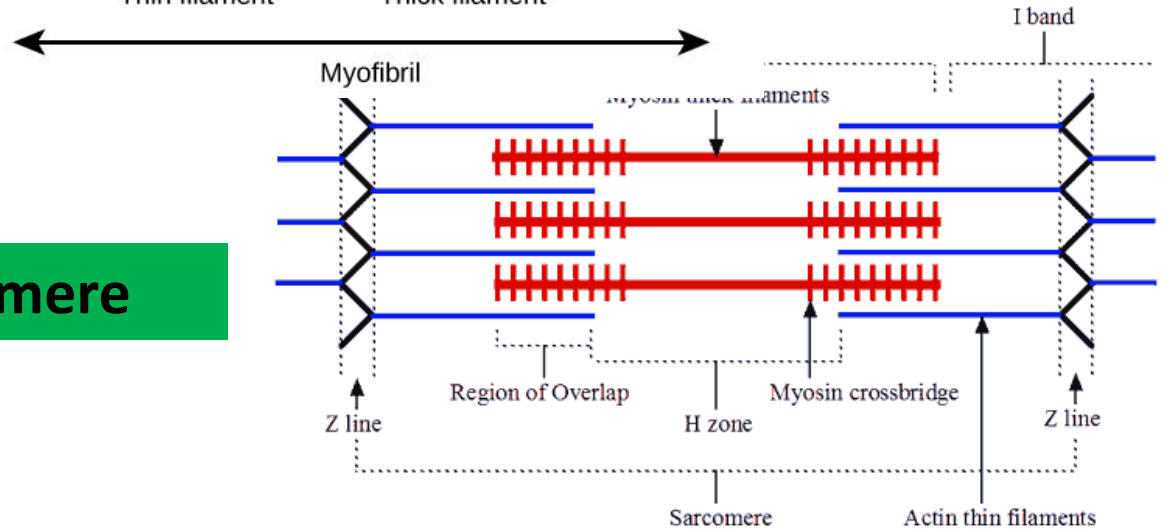
Muscle fiber



Myofibril

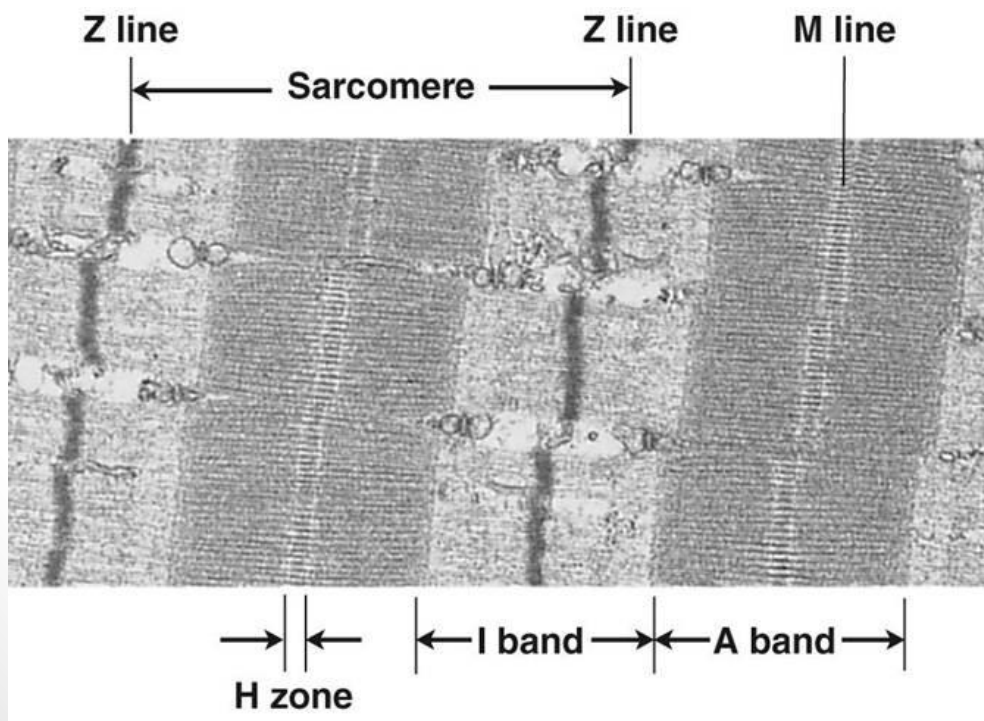
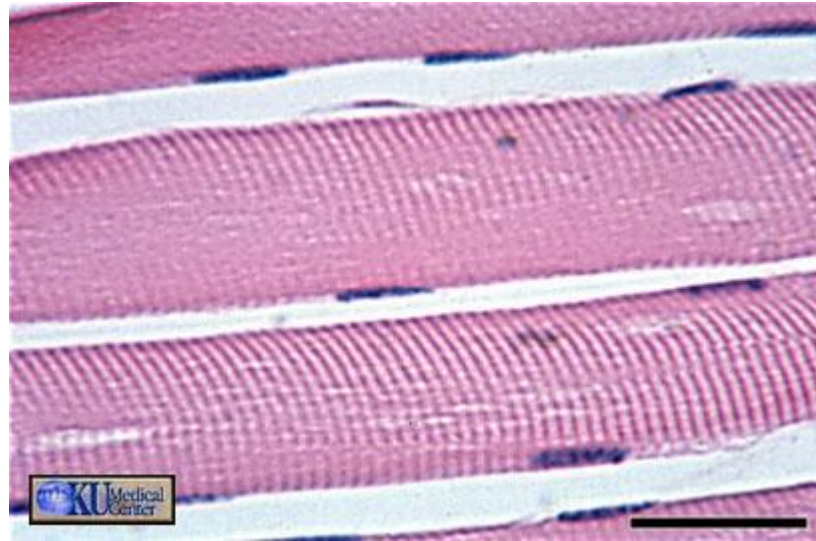


Myofibril – detail



Sarcomere

Histology

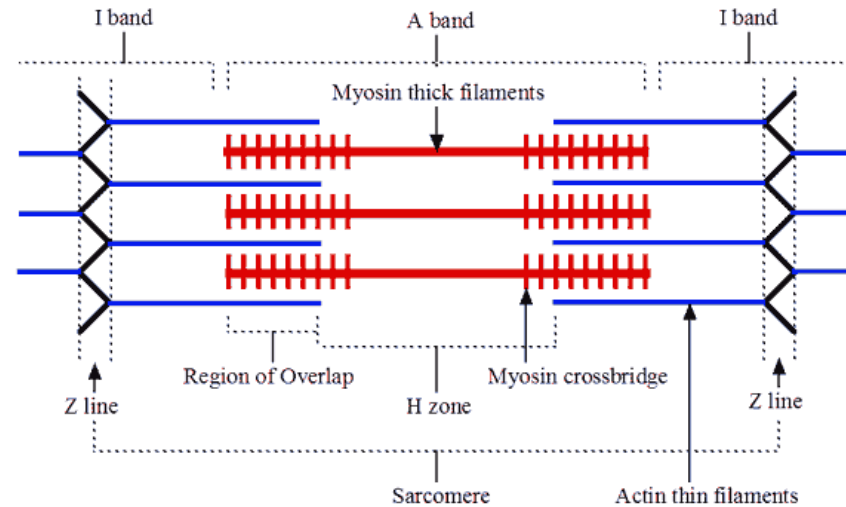


How contraction occurs

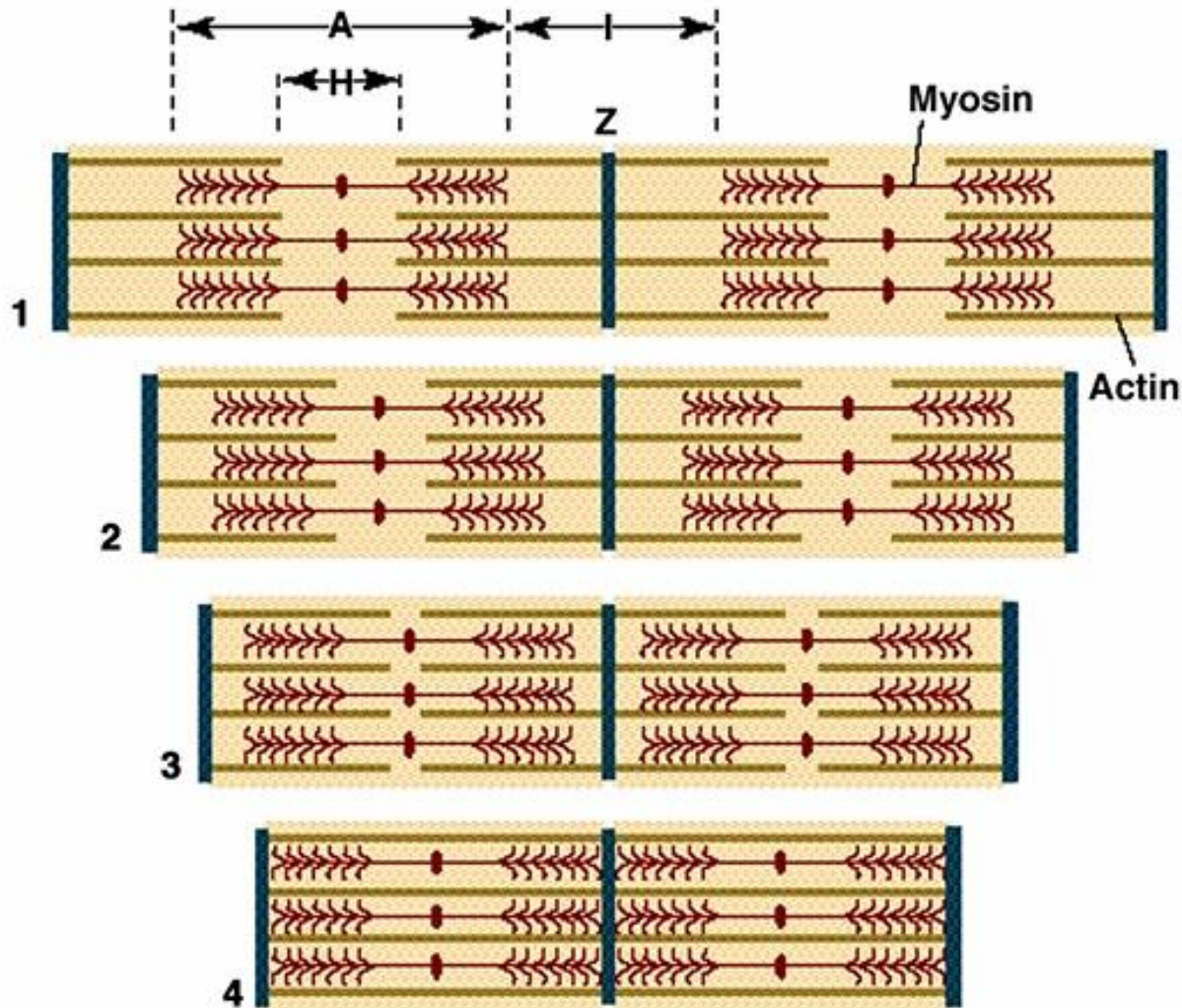
- Myofibrils
 - The dark and light bands of the myofibrils move together when a skeletal muscle contracts.
- **REMEMBER!** Muscles always pull, never push

SLIDING FILAMENT THEORY

- THE RED PROTEINS GRAB THE BLUE PROTEINS AND PULL THEM TOGETHER.
- WHOLE MUSCLE GETS SHORTER



The Sliding Filament Model of Muscle Contraction



IN SUMMARY

1. Muscles are made of many muscle fibers/cells
2. Inside each muscle cell are myofibrils
3. The myofibrils are striated (striped) with light and dark bands
4. One set of light and dark bands is a sarcomere
5. When the proteins in the bands pull on each other each sarcomere gets shorter.
6. When hundreds of sarcomeres in a myofibril get shorter, the whole muscle gets shorter.
7. The muscle pulls on the bone and you move

MUSCLES

Day 5 Dec 1 and 2

How nerves move muscles

IN SUMMARY

1. Muscles are made of many muscle fibers/cells
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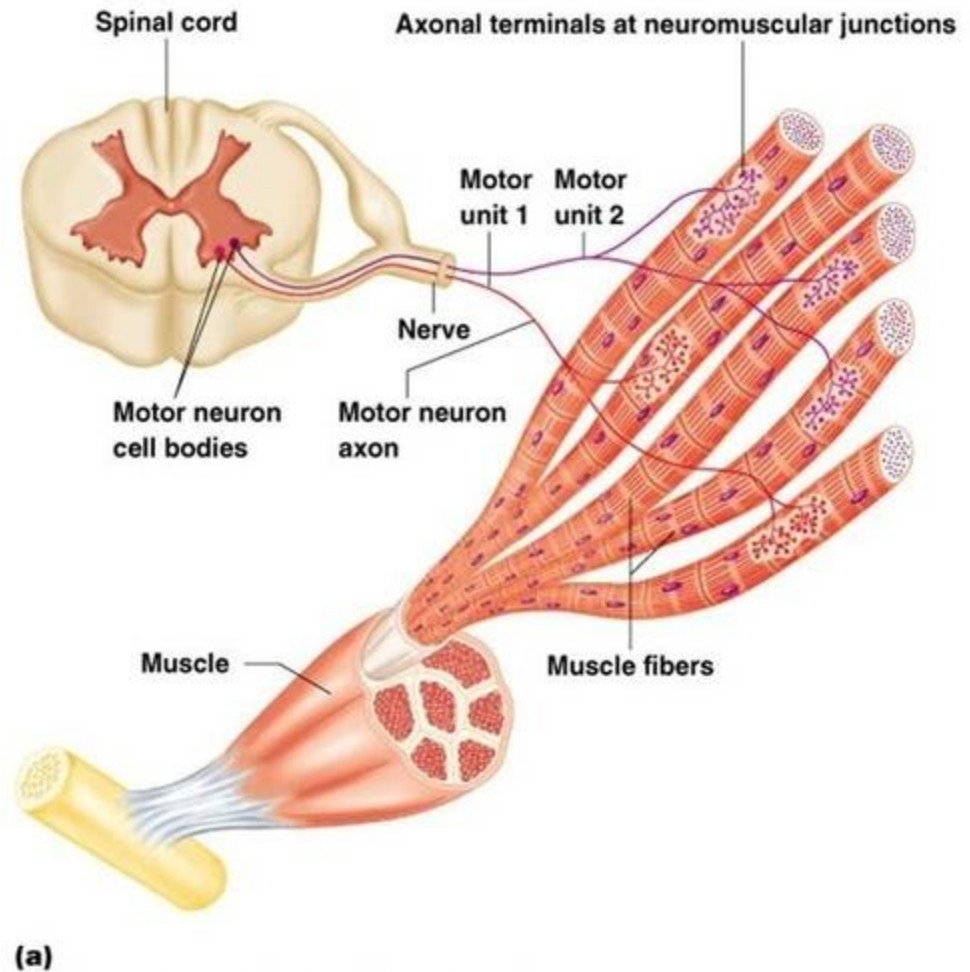
What causes muscles to move?

- You think (or instinctively just do it) I want to move a muscle
- Your brain sends a signal to the muscle
- The muscle responds to that signal by contracting
- You move

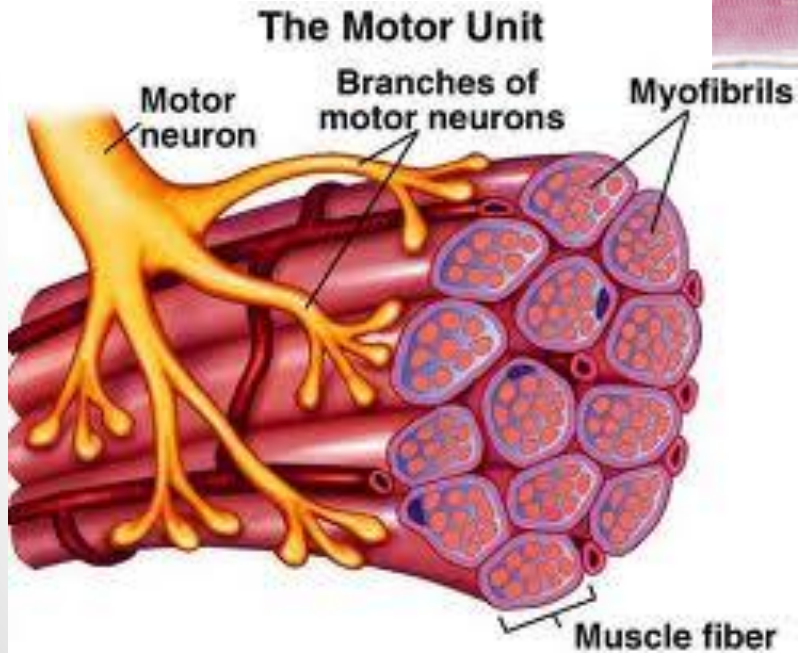
- But how does that signal work?

Spinal cord to muscle

1. A nerve in the spinal cord sends a message to a bunch of muscle fibers (this is a **motor unit**)
2. Where the nerve reaches the muscle is called the **neuromuscular junction**.



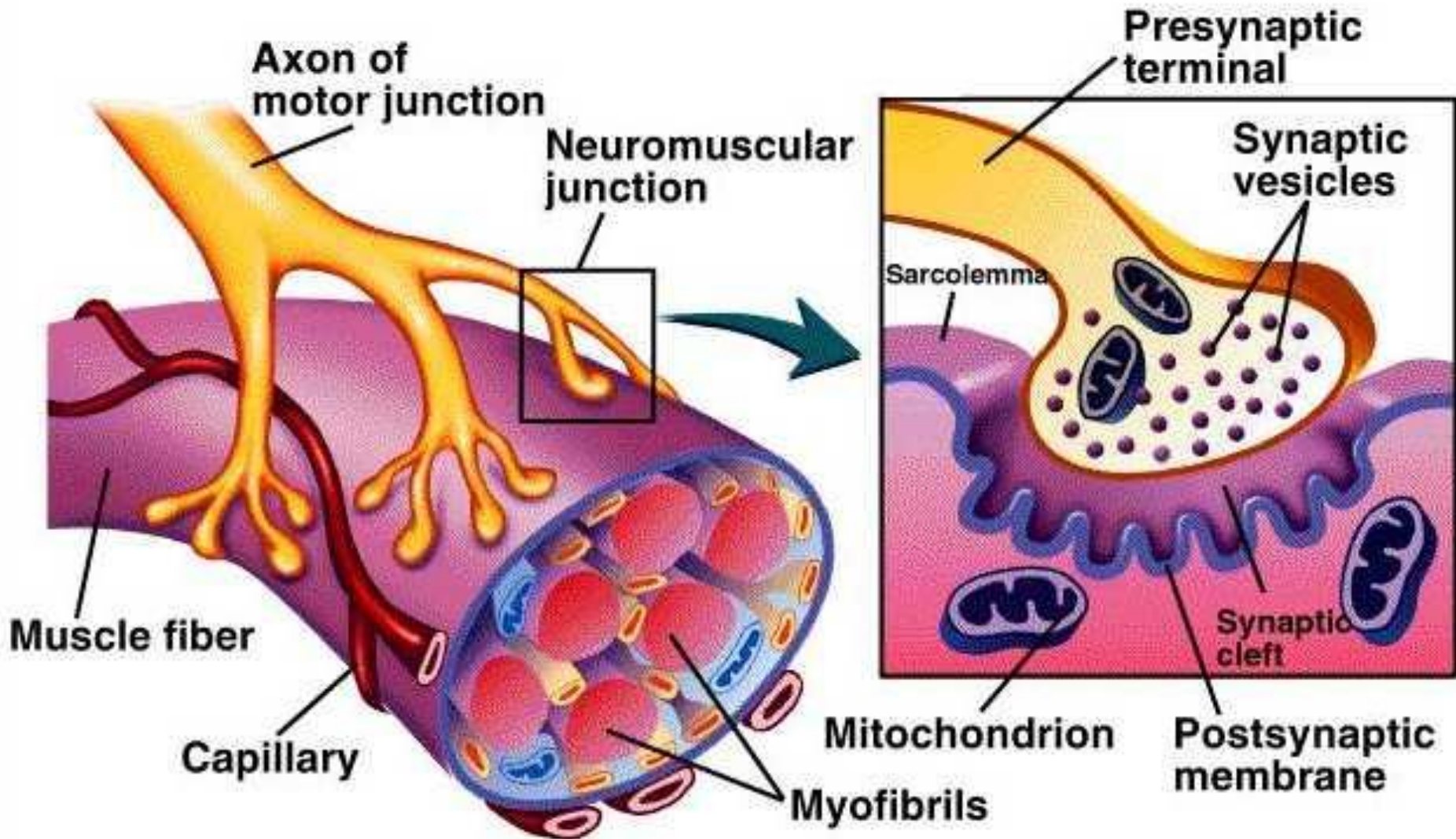
Motor Unit



Motor Unit - examples

- Single motor neuron & muscle fibers it stimulates
- Eye muscles – 1:1 muscle fiber/nerve ratio
- Hamstrings – 300:1 muscle fiber/nerve ratio

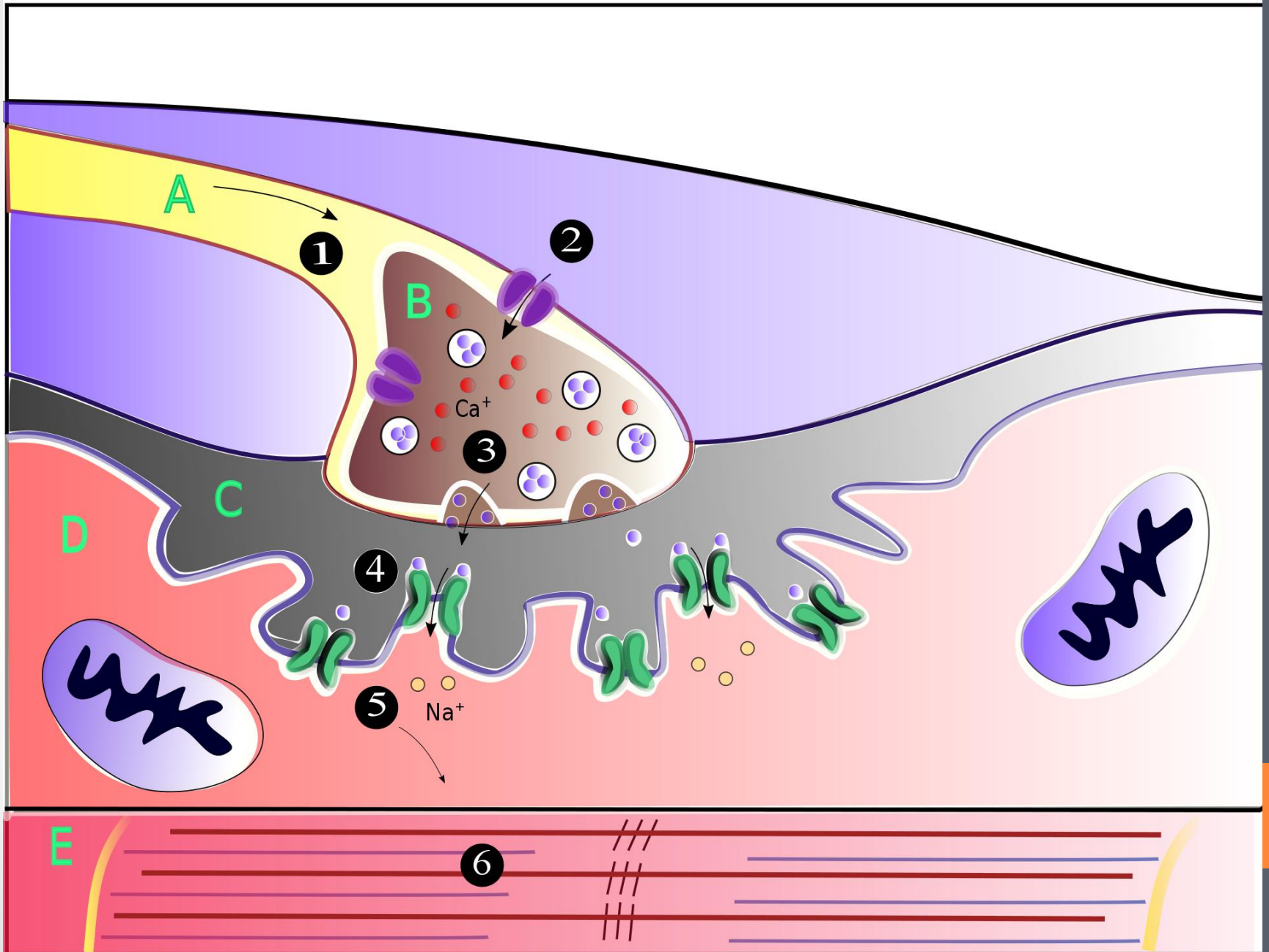
Neuromuscular Junction



The Neuromuscular Junction

Site where motor neuron meets the muscle fiber/cell

1. A chemical signal is released by the neuron. (neurotransmitter/ acetylcholine)
2. The muscle receives this signal, causing the muscle to contract.



MUSCLES

Day 6 Dec 3 and 4

Exercise, Oxygen Debt and Fatigue

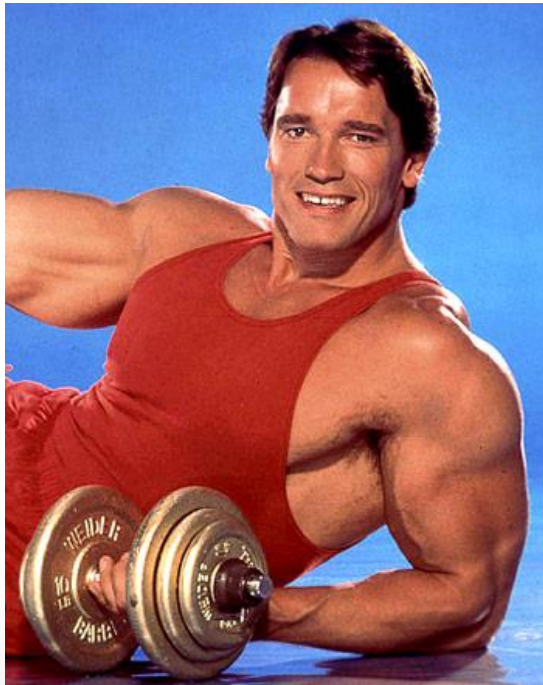
A few random things

- A muscle fiber/cell contraction is all or nothing.
- A stronger contraction is caused by using more muscle fibers/cells

Hypertrophy and Hyperplasia

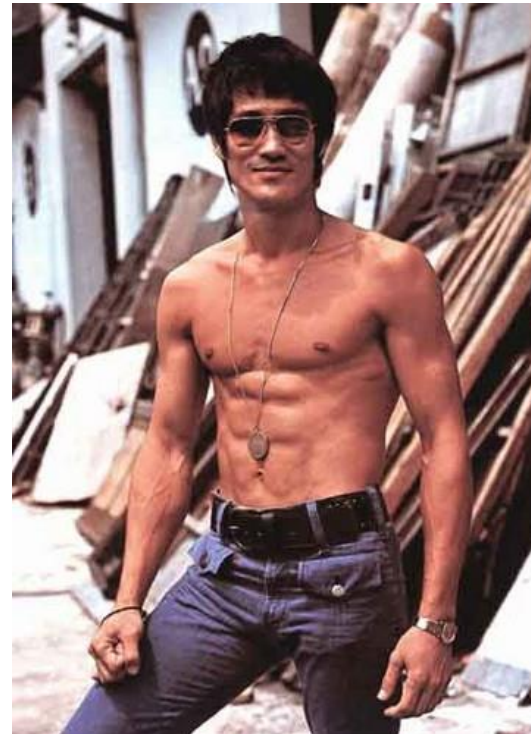
Arnold Schwarzenegger

- Increase in size of each muscle fiber/cell



Bruce Lee

- Increase in number of muscle fibers/cells



Muscle Fatigue

- Fatigue means tired
 - Muscle fatigue is when a muscle won't contract even though a nerve is telling it to
 - Not enough oxygen is main factor
- Not enough oxygen means your body has trouble making ATP

Making ATP

Aerobic respiration

- Requires Oxygen
- Makes a LOT of ATP per glucose
- Better way to power muscles

Normally occurs

Anaerobic respiration

- Doesn't require oxygen
- Makes less ATP for every glucose.
- Produces Lactic Acid (muscle burn)

Necessary with low Oxygen

MUSCLES

Day 7 Dec 7 and 8

Case study about muscle fatigue and disease

slides I'm not using

Types of Muscle Contraction

- Isometric
 - Muscle exerts force without changing length
 - Pulling against immovable object
 - Postural muscles
- Isotonic (dynamic)
 - Concentric
 - Muscle shortens during force production
 - Eccentric
 - Muscle produces force but length increases

Age-Related Changes in Skeletal Muscle

- Aging is associated with a loss of muscle mass
 - Rate increases after 50 years of age
- Regular exercise training can improve strength and endurance
 - Cannot completely eliminate the age-related loss in muscle mass

Alteration of Fiber Type by Training

- Endurance and resistance training
 - Cannot change fast fibers to slow fibers
 - Can result in shift how efficiently they use oxygen

Force Regulation in Muscle

- Types and number of motor units recruited
 - More motor units = greater force
 - Fast motor units = greater force

Fiber Types and Performance

- Power athletes
 - Sprinters
 - Possess high percentage of fast fibers
- Endurance athletes
 - Distance runners
 - Have high percentage of slow fibers
- Others
 - Weight lifters and non-athletes
 - Have about 50% slow and 50% fast fibers

The Neuromuscular Junction

- Site where motor neuron meets the muscle fiber
 - Separated by gap called the neuromuscular gap
- Acetylcholine is released from the motor neuron
 - Causes depolarization (electrical change) of the muscle fiber
 - Runs down the sarcolemma – almost instantaneous because it is just one membrane.

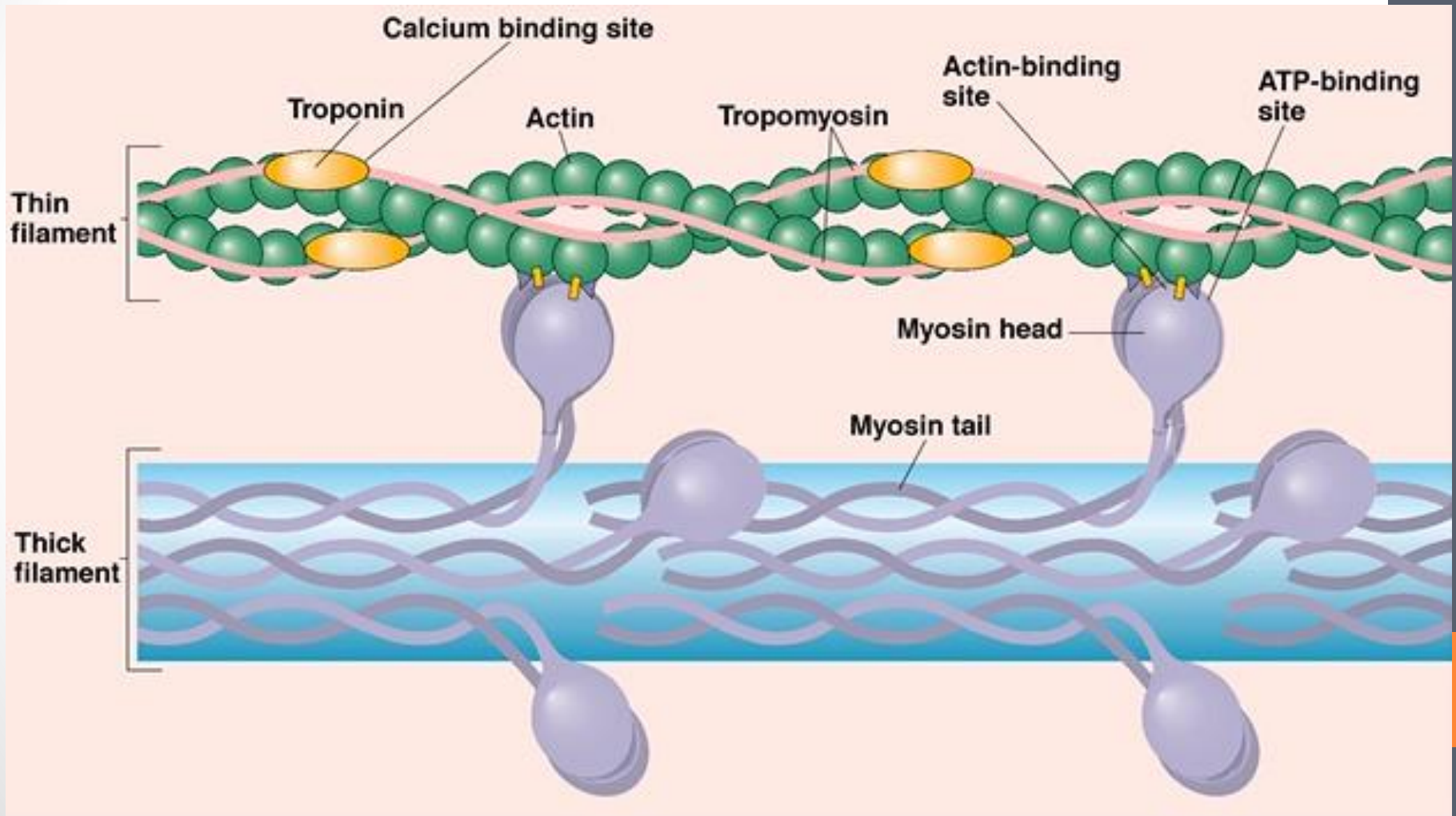
Some vocabulary

- Muscle – a bunch or bundle of muscle fibers.
- Muscle fiber or muscle cell –
 - Multinucleated - many - nuclei
 - Long and skinny
- Myo and sarco-
 - Prefixes that mean muscle

Structure of Skeletal Muscle

- Further divisions of myofibrils
 - Z-line
 - Actin
 - Myosin
- Within the Muscle fiber
 - Sarcoplasm
 - Sarcoplasmic reticulum
 - Storage sites for calcium
 - Sarcomere

Cross-Bridge Formation in Muscle Contraction



Isotonic and Isometric Contractions

