

A microscopic image of skeletal muscle tissue, showing multiple parallel muscle fibers with visible striations and nuclei. The fibers are arranged in a regular, repeating pattern, characteristic of striated muscle. The nuclei are located at the periphery of the fibers. The overall appearance is that of a highly organized, contractile tissue.

MUSCULAR SYSTEM

Reading: Chapter 8

MUSCULAR SYSTEM

A. INTRODUCTION

Muscle tissue is:

- 1) Contractile - unlike other tissue**
- 2) Irritable - responds to stimuli**
- 3) Extensible - can be stretched**
- 4) Elastic - returns to original shape**

B. FUNCTION

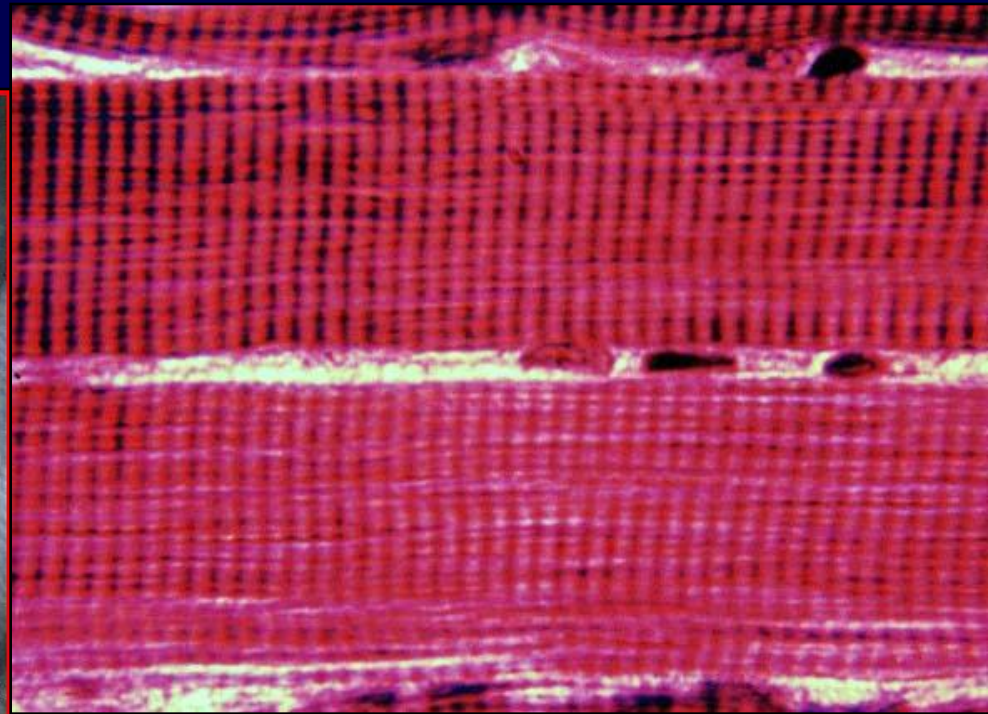
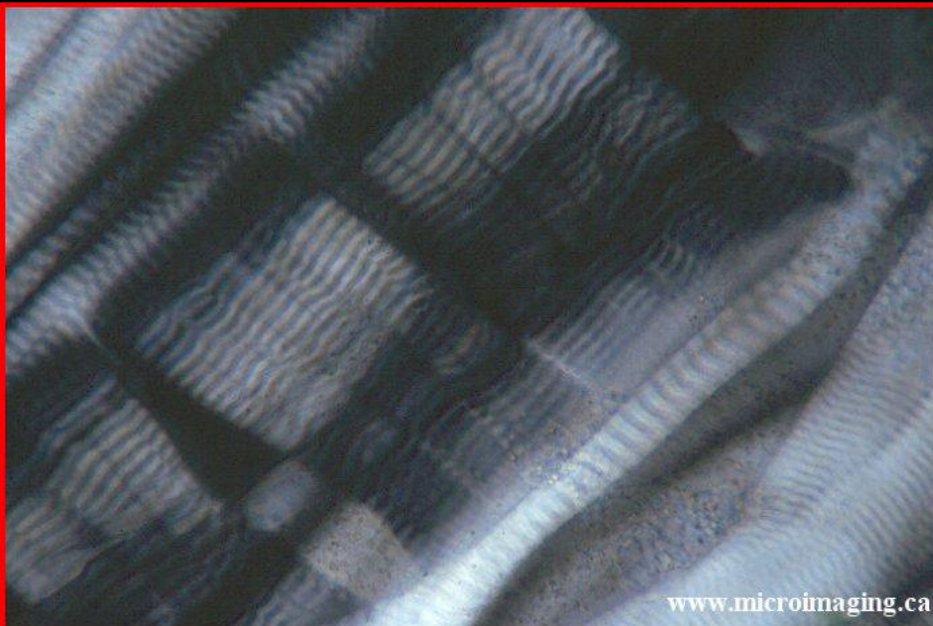
- 1) Movement
 - a) movement & locomotion
 - b) propulsion
 - c) peristalsis

- 2) Temperature regulation

- 3) Maintenance of posture

C. TYPES OF MUSCLE TISSUE

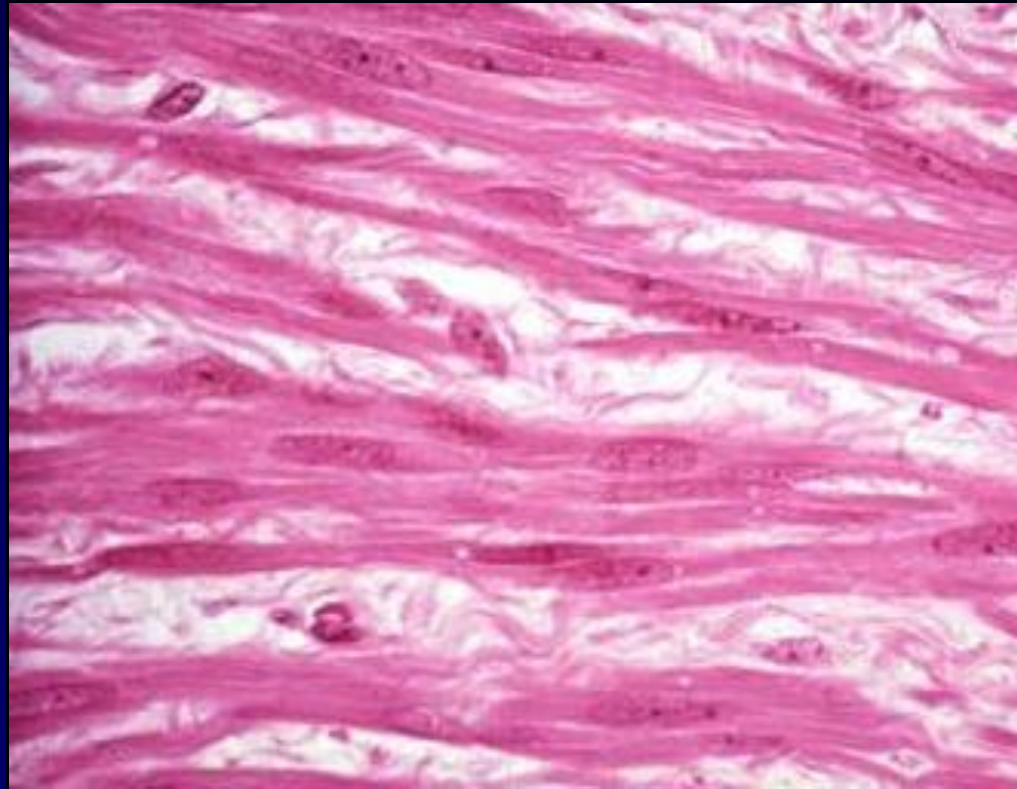
- 1) Skeletal - striated
 - a) multinucleated
 - b) nuclei = peripheral
 - c) voluntary



C. TYPES OF MUSCLE TISSUE

2) Smooth

- a) non-striated
- b) spindle shaped cells
- c) central nuclei
- d) involuntary



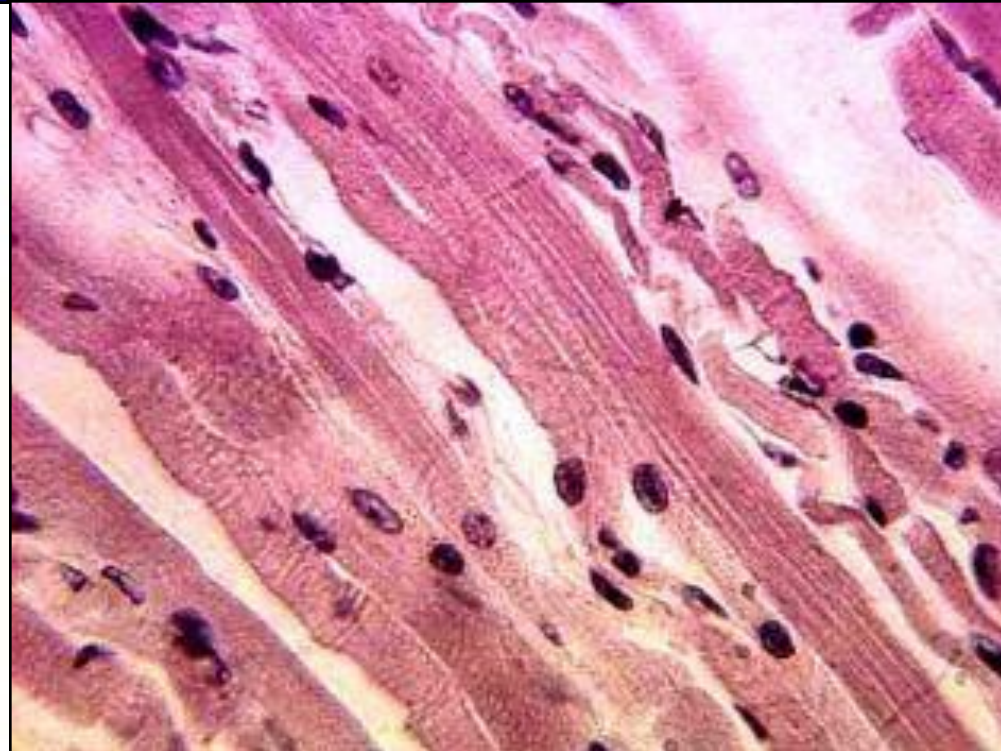
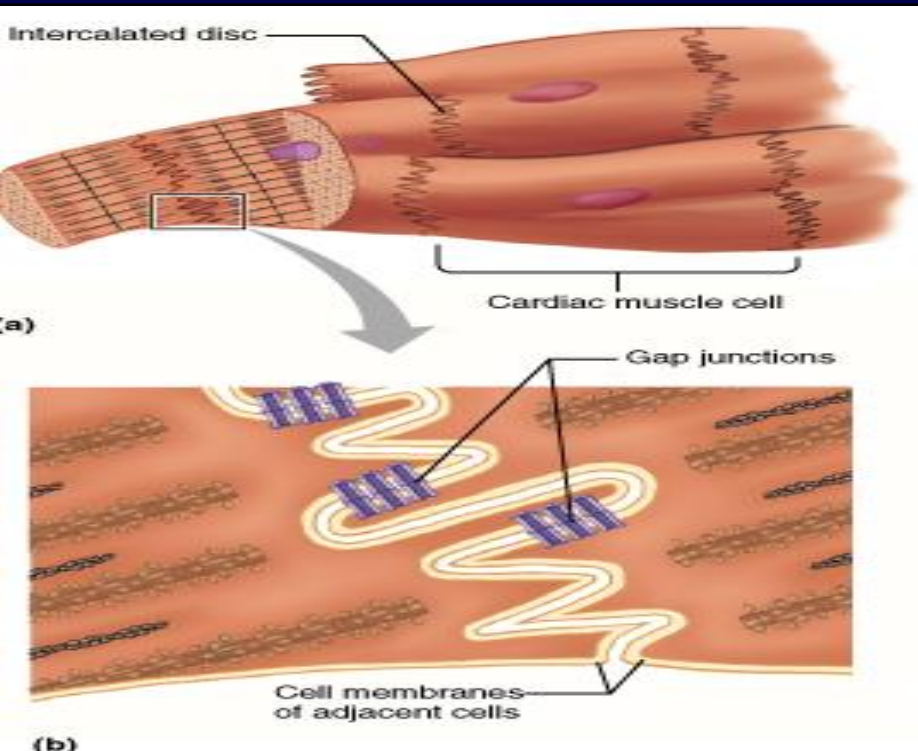
C. TYPES OF MUSCLE TISSUE

3) Cardiac

a) striated

b) single nuclei that are centrally located

c) intercalated disks



D. NAMING MUSCLES

There are over 800 muscles in the body...some of the ways they are named include:

- 1) Direction of fibers -
 - a) rectus - straight
 - b) transverse - across
 - c) oblique - at an angle



D. NAMING MUSCLES (con't)

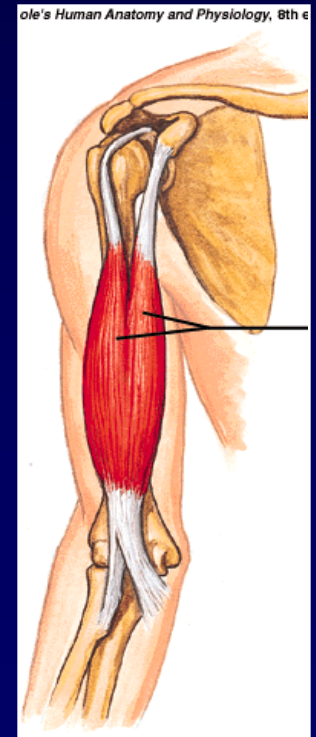
2) Location - Anterior or Posterior surface of a bone

3) Size: a) maximus or major =
b) minimus or minor =
c) longus =
d) brevis =


4) Number of origins

a) biceps: "bi" = 2

b) triceps: "tri" = 3



D. NAMING MUSCLES (con't)

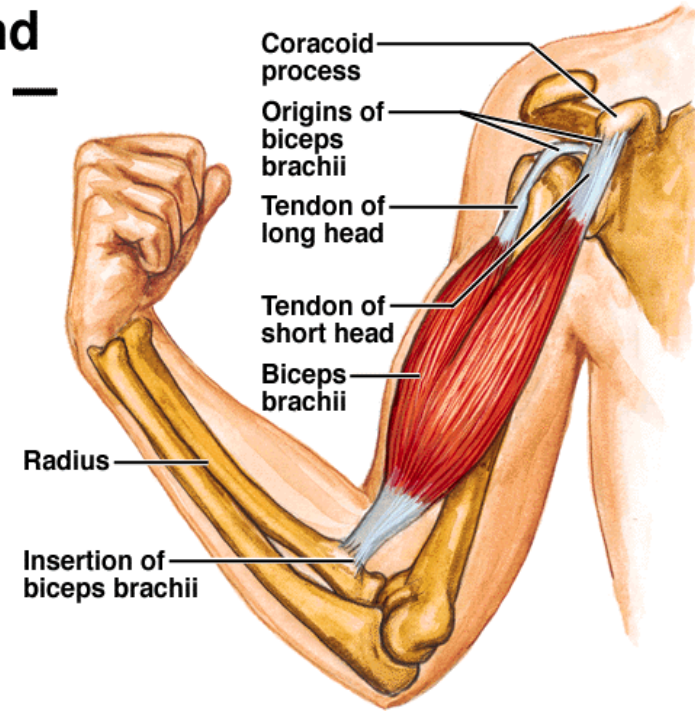
- 5) Origin and insertion - sternocleidomastoid
- 6) Action - flexors and extensors
- 7) Shape - rhomboideus major & minor 
- 8) Other methods with no rhyme or reason (sorry)

E. MUSCLE ATTACHMENTS

- 1) Origin – point of muscle attachment that doesn't move during contraction
- 2) Insertion - muscle attachment that moves the most

Action – at contraction, the insertion moves toward the origin

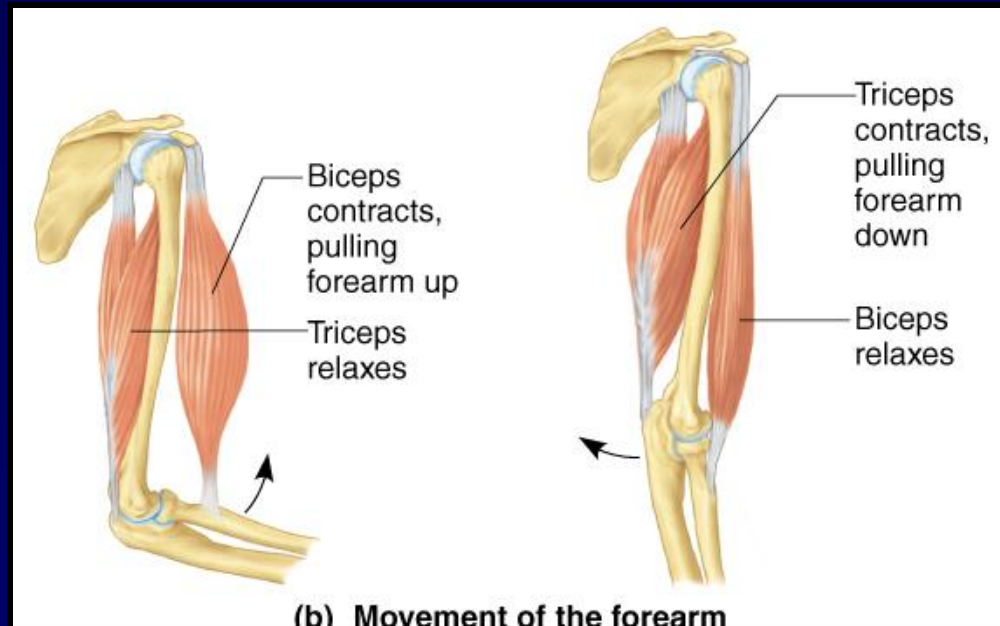
Origin and Insertion — Biceps Brachii



F. MUSCLE GROUPS

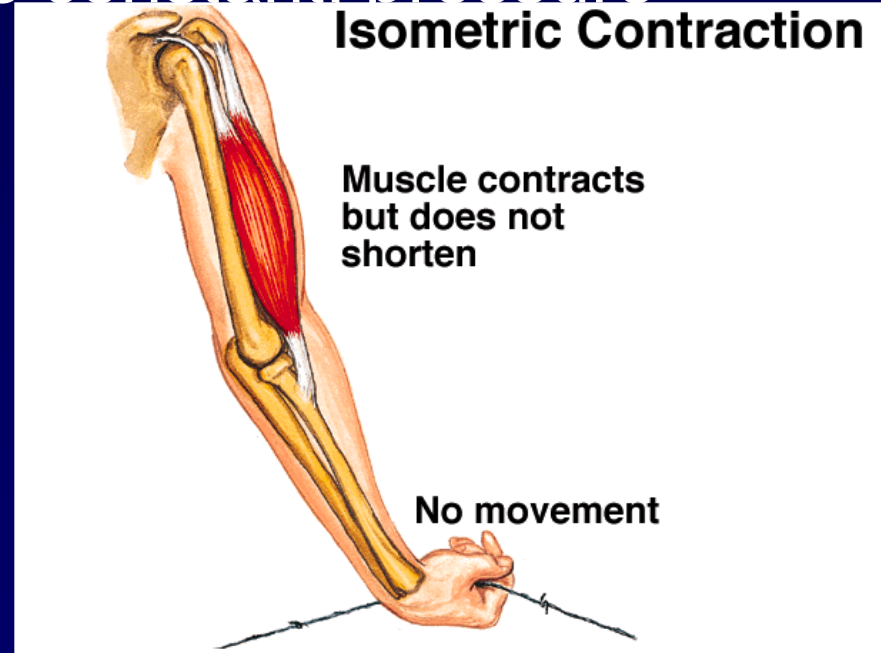
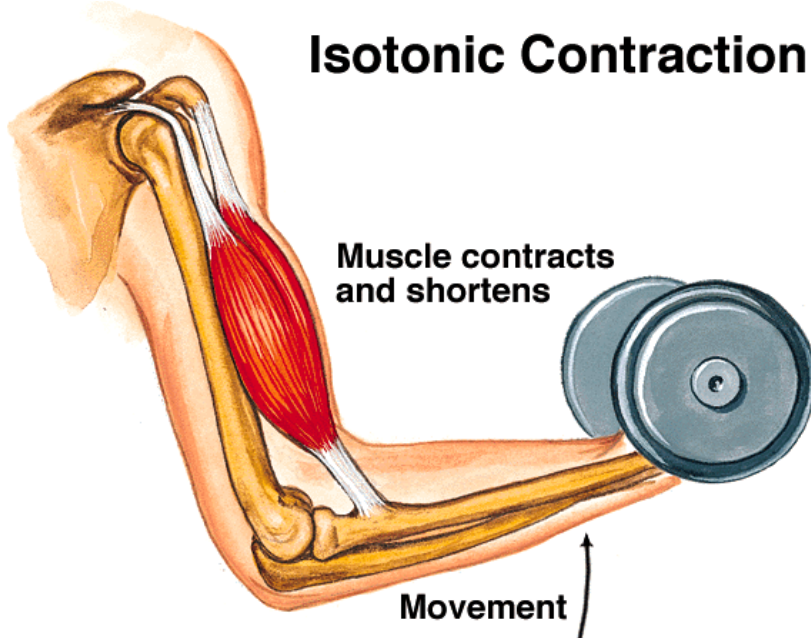
- Muscles can only contract actively
- So, most muscles work in pairs

- 1) **Prime mover** - causes the action you want
- 2) **Antagonist** - opposes this action
- 3) **Synergists** - helps the prime mover by “fixing” the joint



G. TYPES OF CONTRACTIONS (2 TYPES)

- 1) Isotonic - *iso* = “equal”; *tonic* = “pressure”
 - muscle shortens, pressure stays the same
- 2) Isometric - *iso* = “equal”; *metric* = “length”
 - length stays constant, pressure





MUSCULAR SYSTEM

Part 2 of 2

Reading: Chapter 8

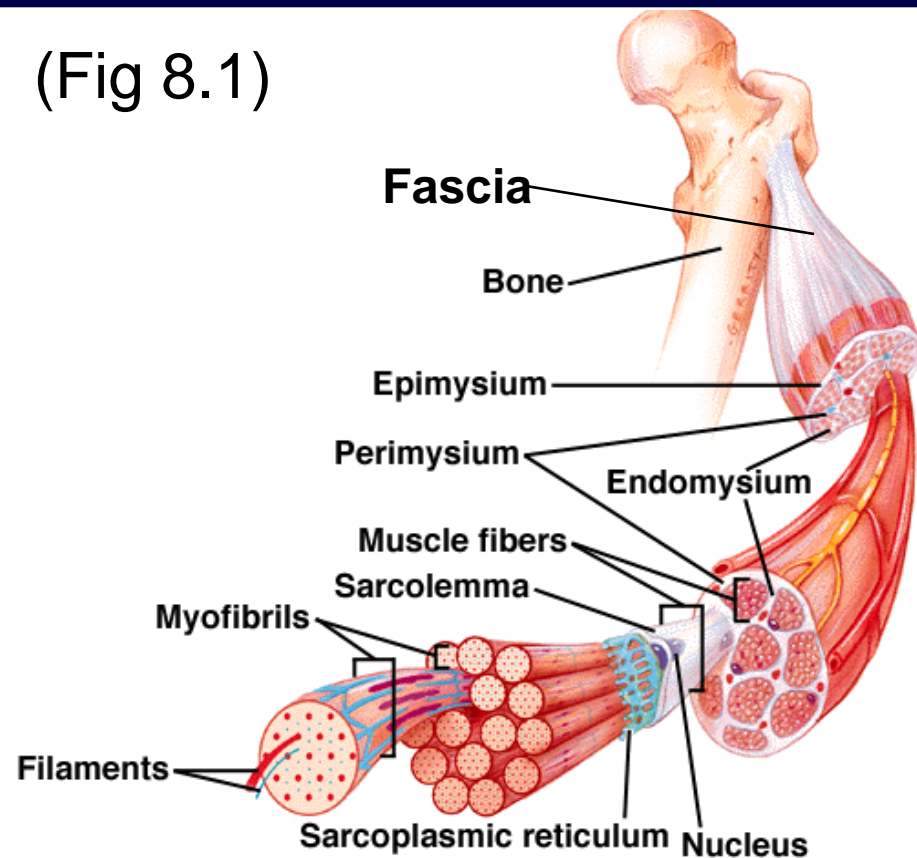
H. STRUCTURE OF SKELETAL MUSCLE

1) Connective Tissue Layers

All muscles = covered by white fibrous CT in various layers

a) **FASCIA** = “saran wrap”

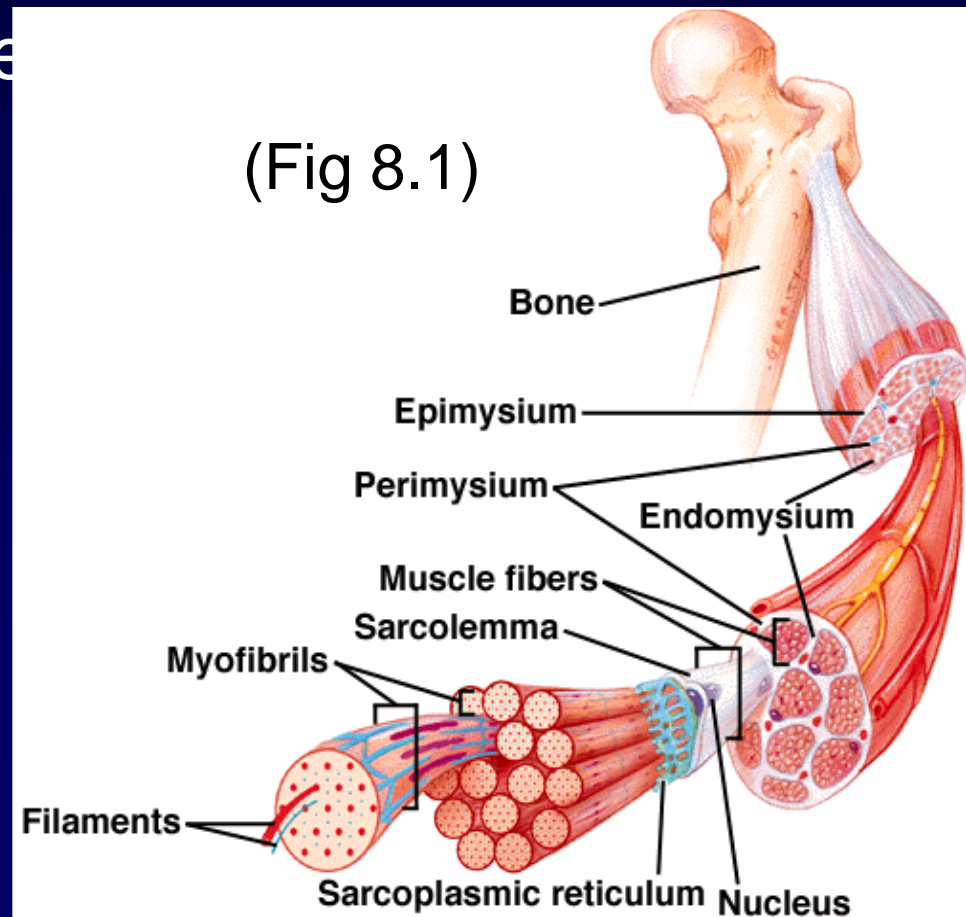
(Fig 8.1)



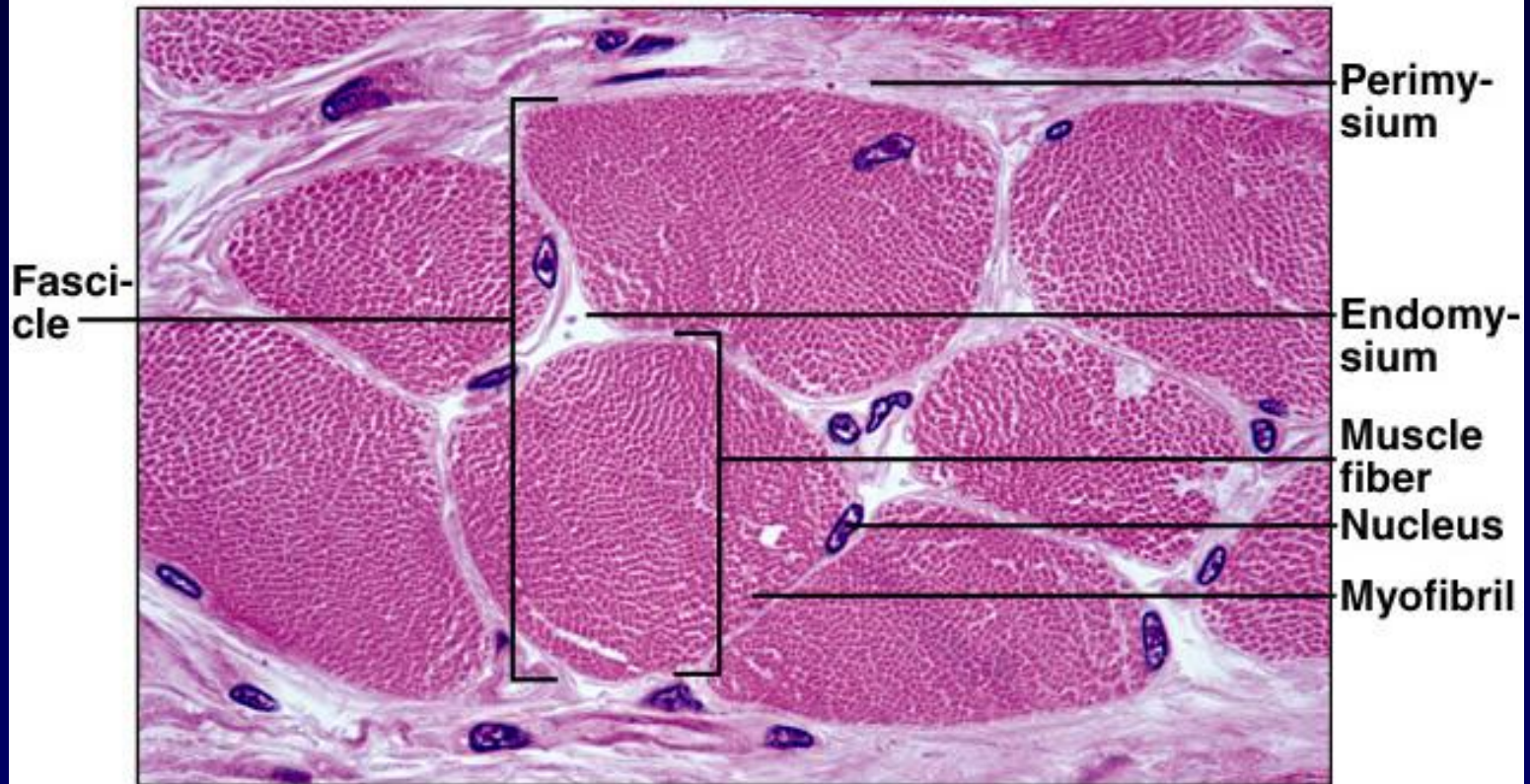
b) Epimysium: - surrounds each individual muscle

c) Perimysium:
-surrounds each fascicle
(bundle of muscle cells)

d) Endomysium
-surrounds individual
muscle cells/fibers



Fascicle and Perimysium



2) Muscle Cell (= muscle fiber) Structure

a) sarcolemma - muscle cell membrane (remember plasmalemma?)

b) sarcoplasm - cytoplasm of muscle cells

c) **sarcoplasmic reticulum** - modified S.E.R.
- inside sarcoplasm
- store Ca^{++}

d) transverse tubules – continuous with cell membrane

e) **mitochondria**
– *what do they do?*

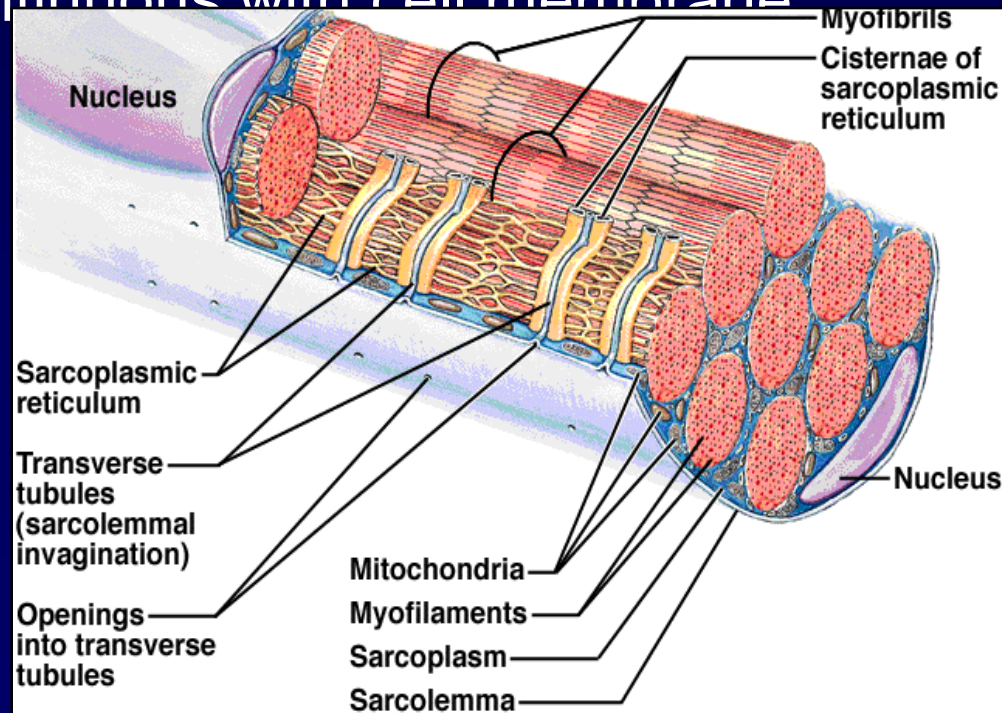
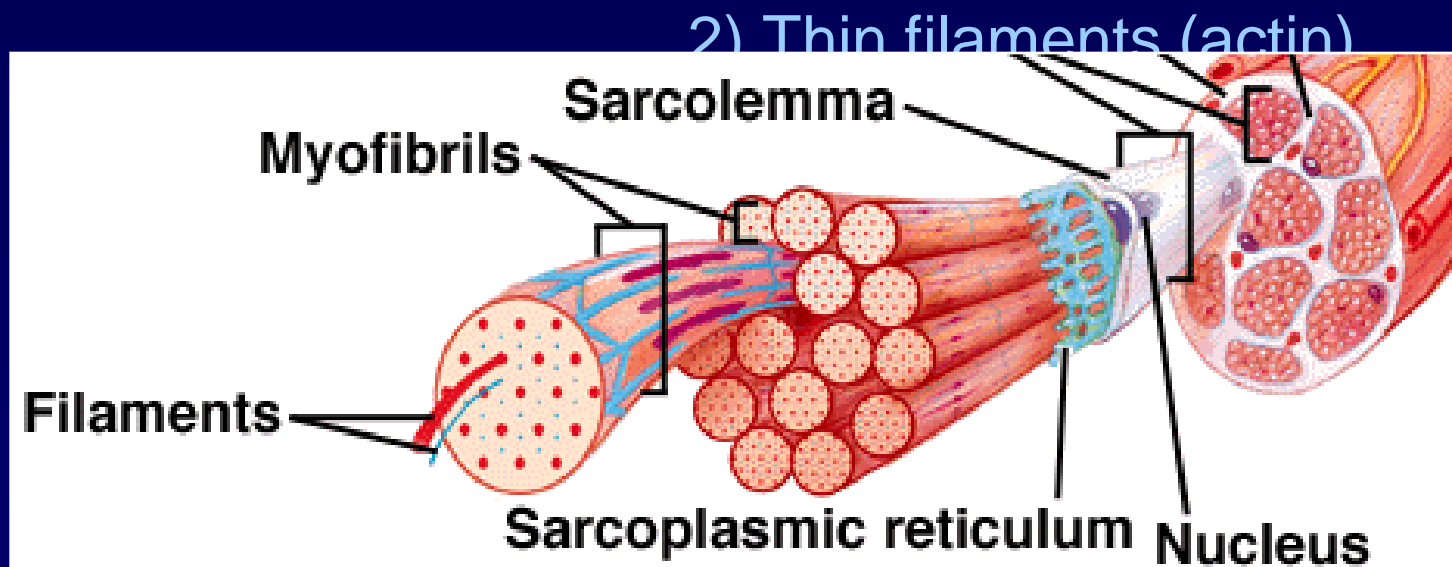


Fig 8.4 (muscle fiber = 1 cell)

f) MYOFIBRILS -each cell (fiber) has many myofibrils
-myofibrils shorten during contraction
-allows the _____ to move toward the _____

g) MYOFILAMENTS -smaller units within myofibrils
-Two Types: 1) Thick filaments
(myosin)



3) Nerve Supply

Every muscle cell is connected to a neuron (nerve cell)

a) synaptic knob = the end of the neuron

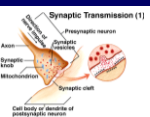
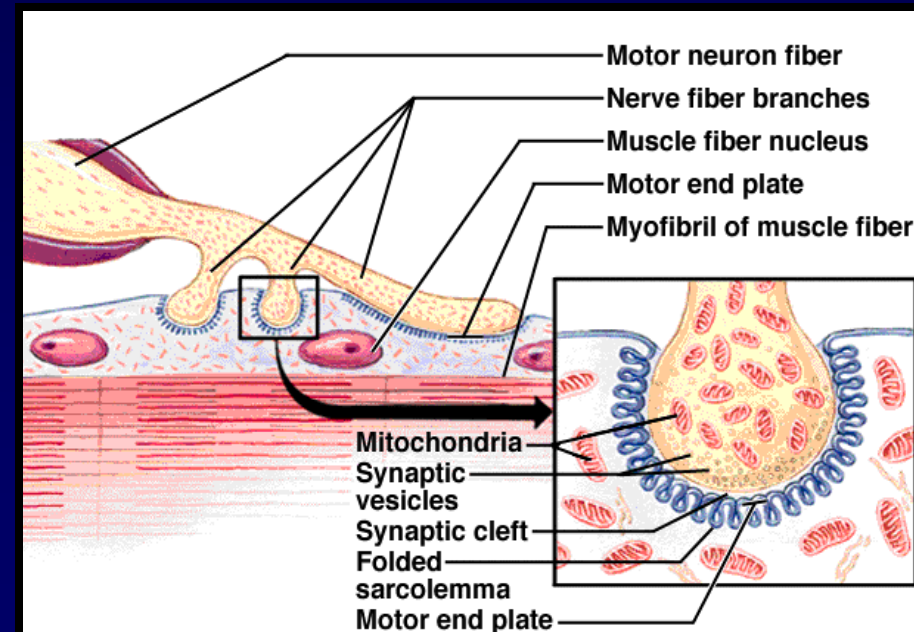
b) motor end plate = modified area on sarcolemma where muscle cell meets nerve ending

c) synaptic cleft = space b/w motor end plate & synaptic knob

Electrical Impulses— travel down neuron

Neurotransmitters— released to synaptic cleft

- *Ex: acetylcholine*

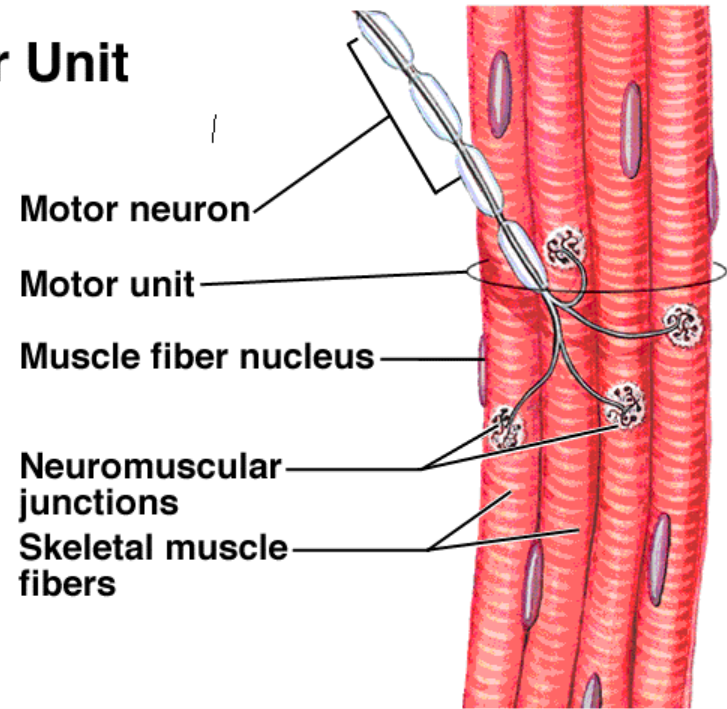


4) Motor Unit = 1 neuron + all the muscle cells it controls

-A motor unit may be 1 neuron + a few muscle cells

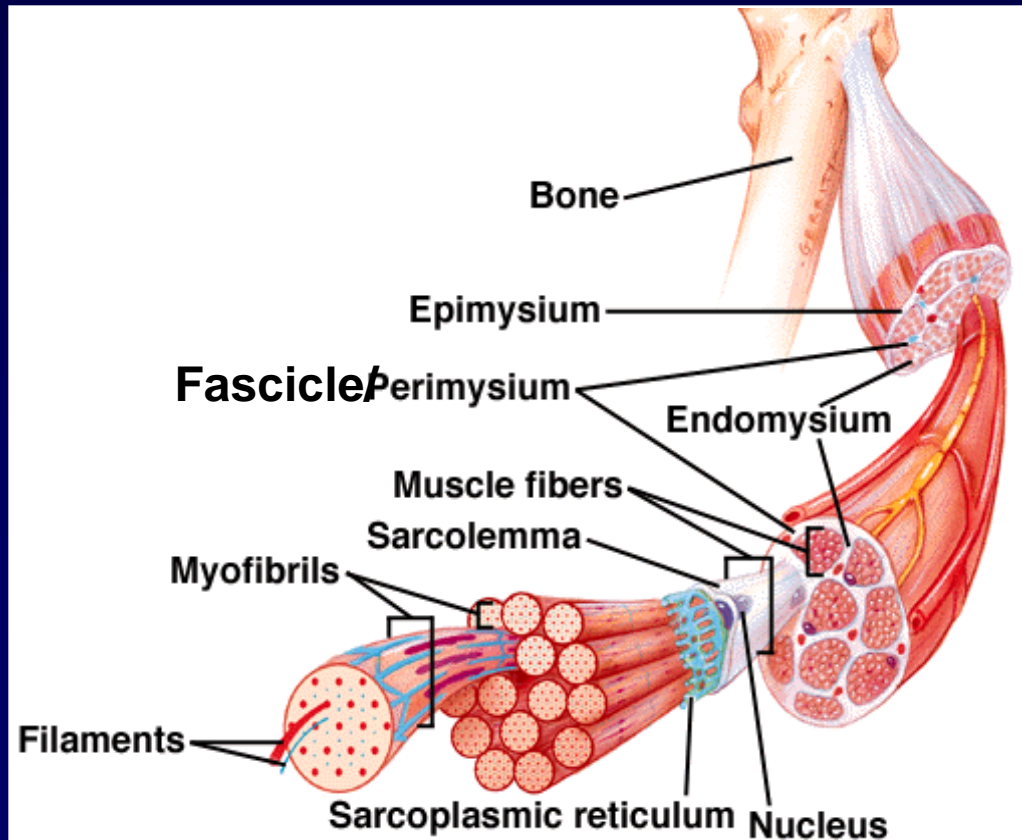
-A motor unit may be 1 neuron + up to 400 muscle cells

Motor Unit

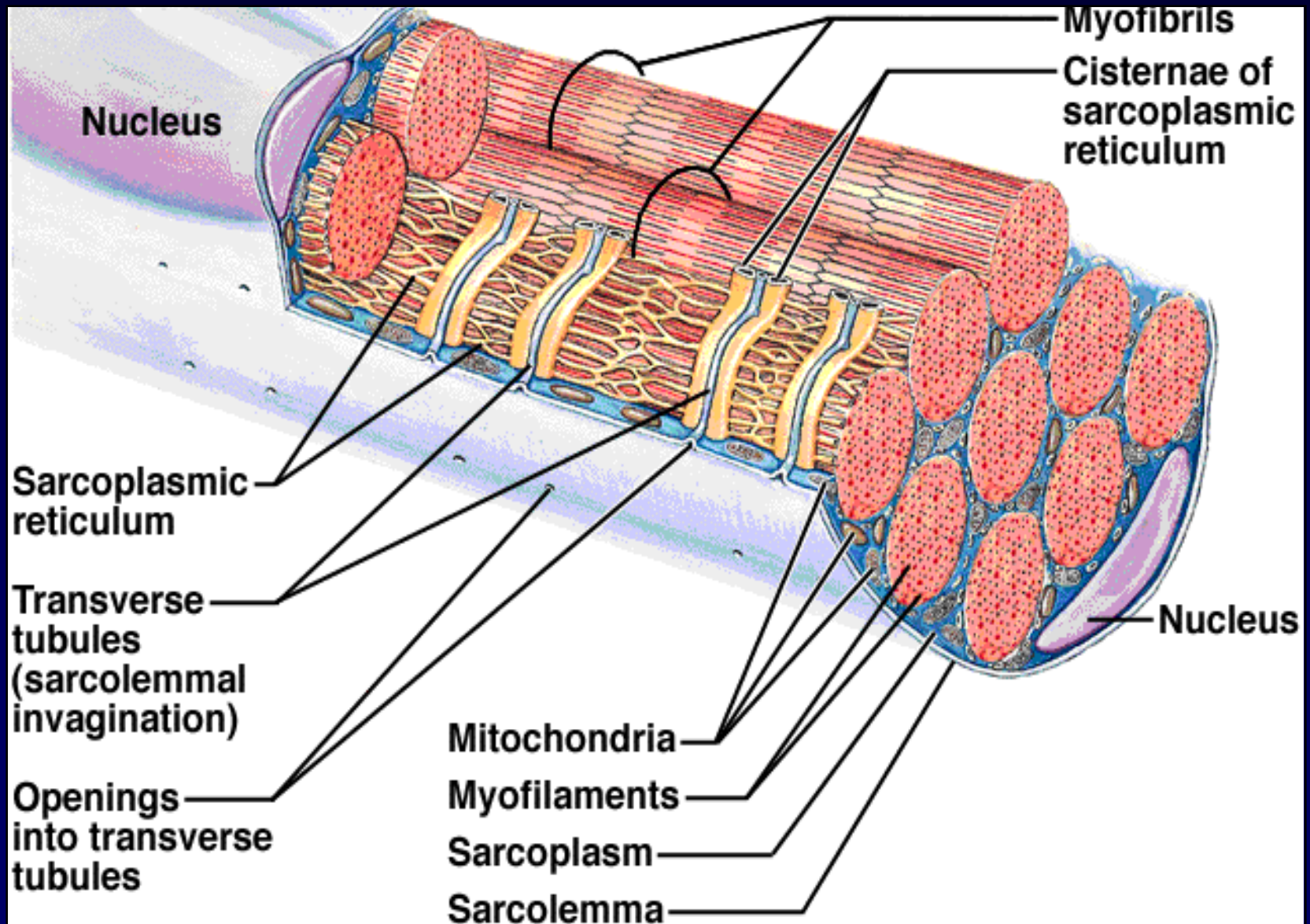


I. Skeletal Muscle Contraction

In order to understand how muscle contracts, we need to know exactly how it is

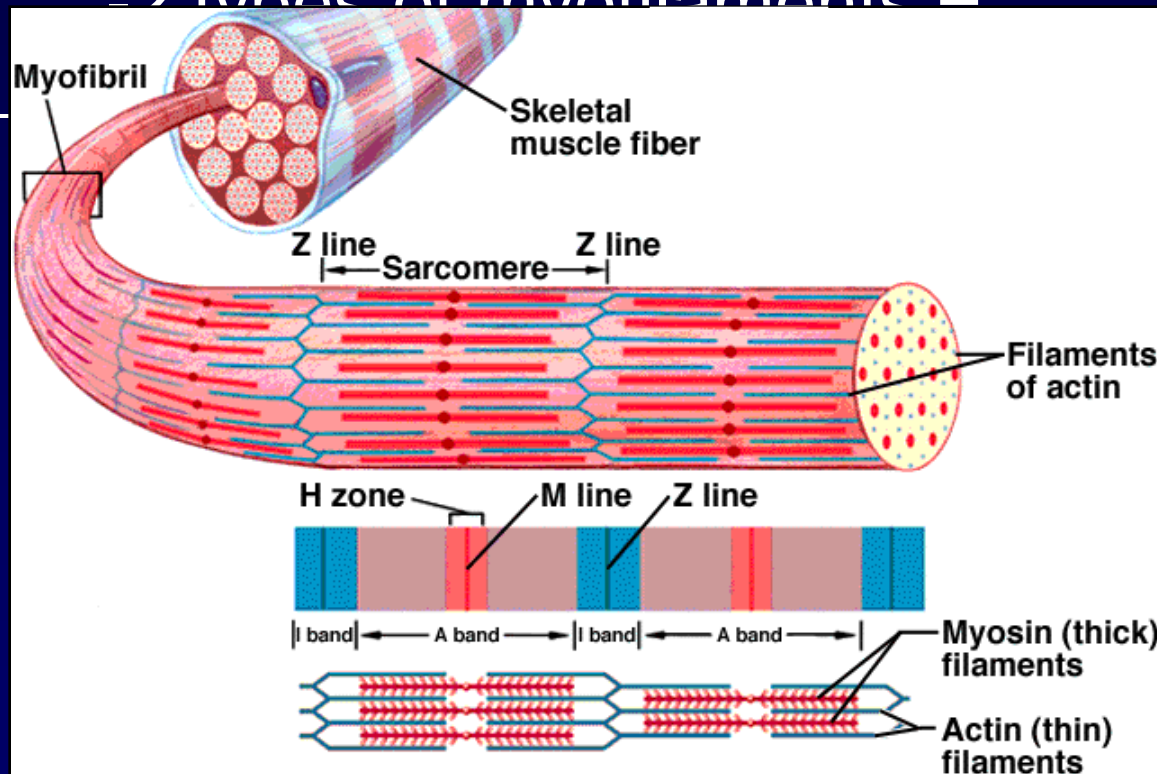


2) Muscle Cell (= muscle fiber) Structure



- Myofibril** =
- the part that contracts
 - repeating pattern of light & dark bands
 - the functional unit in a myofibril = **sarcomere**
 - filled with smaller myofilaments
 - 2 types of myofilaments =

&



(o1)

Sarcomere (Fig 8.3)

- M line = middle of sarcomere
- Z lines = outer borders (lined up w/ adjacent sarcomeres)
- Thin filaments (actin) attach at Z lines
- Thick filaments (myosin) line up at M line
- At rest, the thin and thick filaments do NOT overlap
- Pale areas = actin only = I bands
- A bands = area encompassing whole myosin band (looks dark)
- H zone = pale area at the middle of A band (myosin only)

(o1)

Sliding Filament Theory (Fig 8.9)

- Imagine an isotonic contraction
- Individual muscle fibers are getting shorter
- The **sarcomeres** are **getting shorter**
- The **actin & myosin** fibers **stay the same length!**
- The actin & myosin fibers slide past each other
- A bands = stay the same (but get closer together)
- I bands = get smaller
- H band = gets smaller and disappears

(o2)

Go to overhead

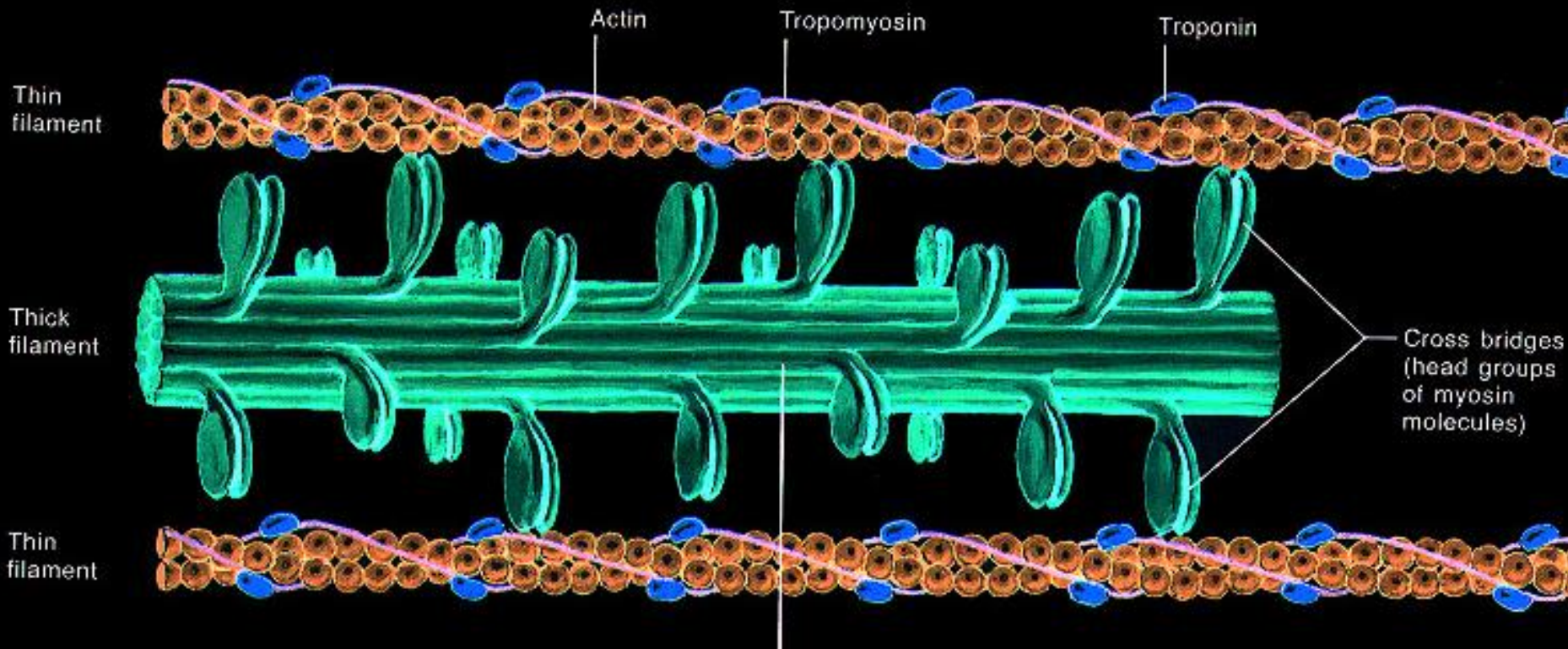
(03)

Filaments slide due to cross-bridge formation (Fig 8.7)

- Myosin = many tails stick together (thick)
round heads stick up
heads have actin binding site
- Actin = thin chains have myosin binding sites

(03)

Filaments slide due to cross-bridge formation (Fig 8.7)



Where are these “cross-bridges” formed?

(o4)

CONTROLLING MUSCLE CONTRACTION

Regulatory proteins on actin: troponin & tropomyosin

(05)

Interaction Between Myosin and Actin During Muscle Contraction

SLIDING FILAMENT THEORY

1) Contraction

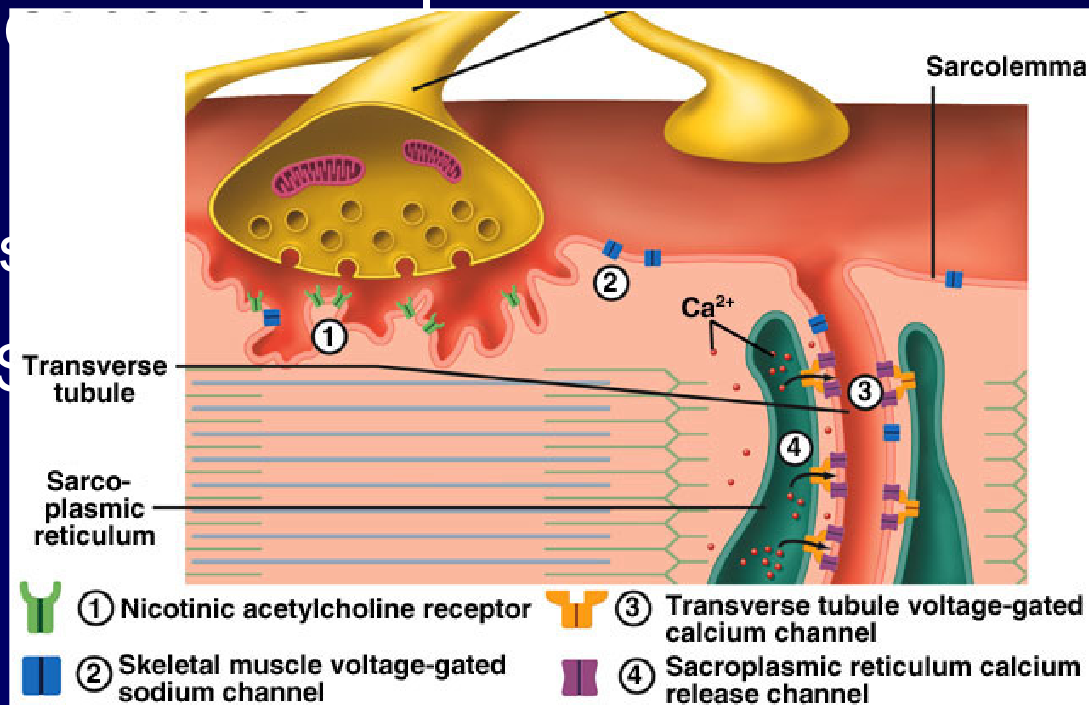
a) Nerve impulse → ACH released into synaptic cleft

b) ACH stimulates motor end plate

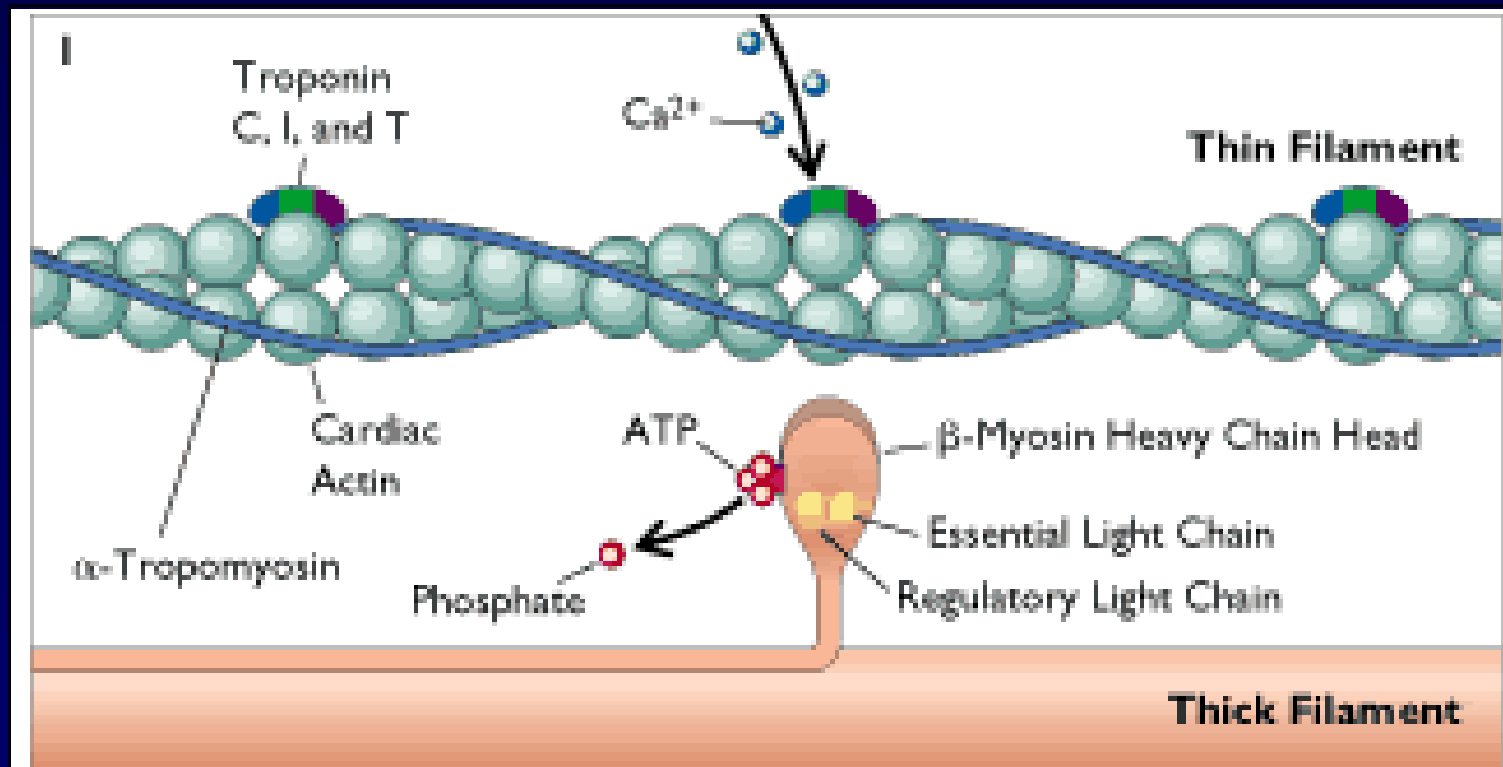
c) Electrical impulse

d) Electrical impulse travels into T tubules

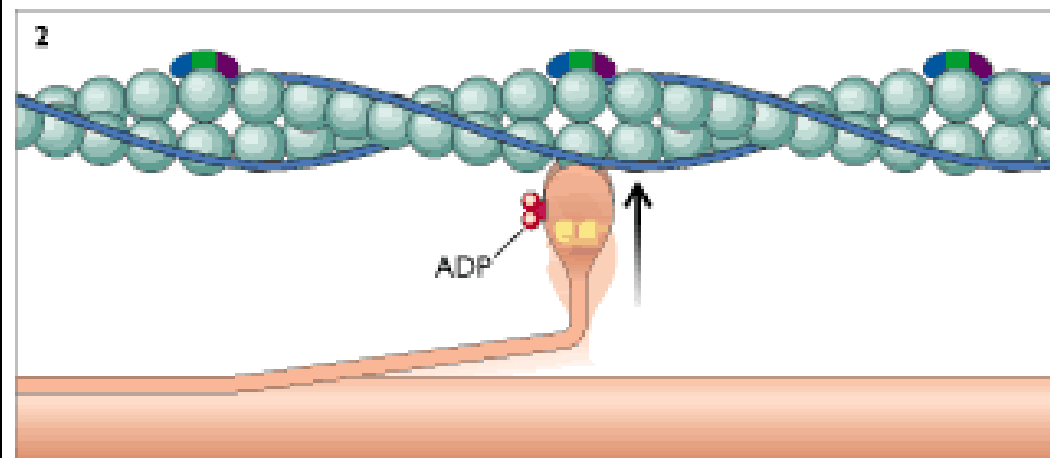
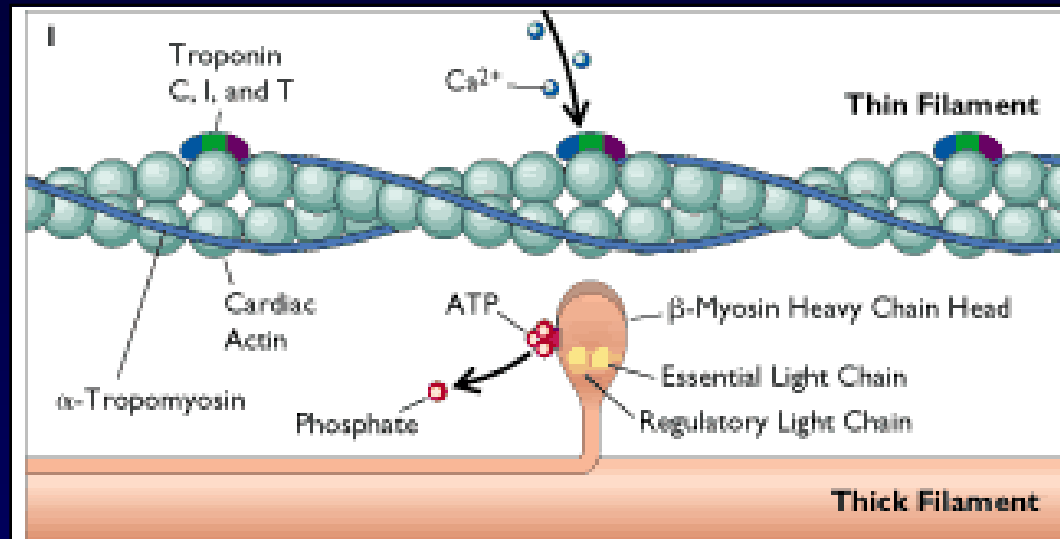
e) Ca^{++} released from SR into sarcoplasm



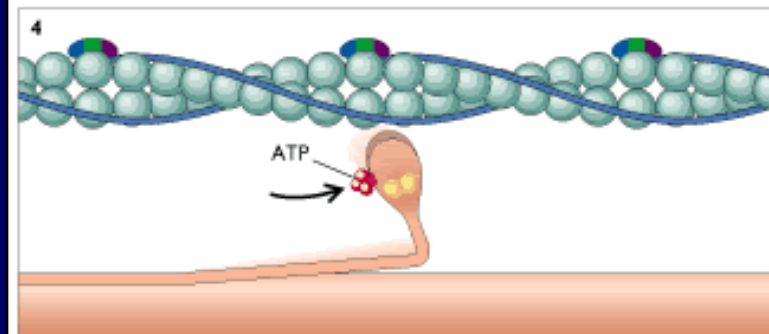
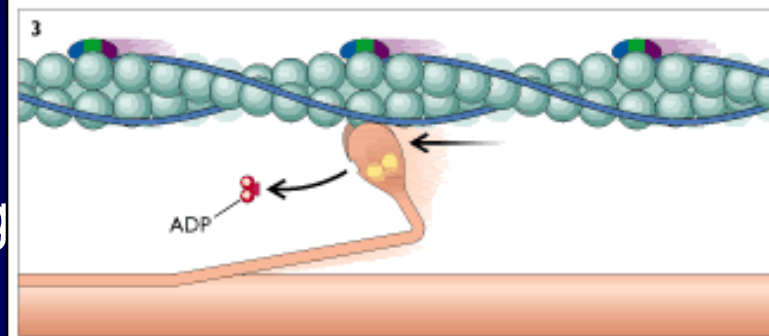
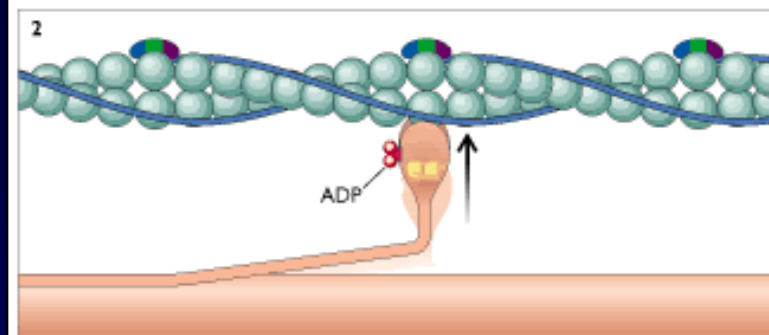
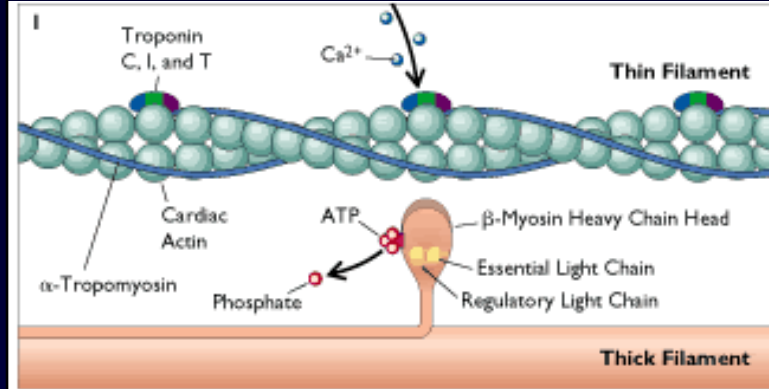
- f) Ca^{++} binds with troponin
- g) Tropomyosin moves to expose myosin binding site
- h) Myosin cross-bridges may now bind with actin



- i) Initially, the myosin head is in a low energy state. When the ATP molecule splits, the myosin head enters a high energy state that can bind to actin.



- j) When the ADP molecule is released, the myosin head rotates towards the H band -“Power Stroke” occurs
- k) A new ATP binds w/ myosin x-bridge → separation
- l) The x-bridge cocks back & grabs actin again
- m) The process continues as long as Ca^{++} & ATP are present



Relaxation

- a) nerve impulse is turned off
- b) ACH removed
- c) Ca^{++} pumped back into SR
- d) troponin-tropomyosin complex blocks cross-bridges

NOTE: -The return of Ca^{++} back to SR requires ATP
-ATP is needed for both contraction & relaxation!
- Ca^{++} is also needed for contraction (not just ATP)

Medical Note: Rigor Mortis

- ATP must bind to myosin for cross-bridges to detach
- *Do you think dead muscle makes ATP?*
- Once ATP runs out...cross-bridges are bound
- These “rigor-complexes” b/w actin & myosin cannot be broken
- After ~ 72 hours proteins movement is restored...*why?*

J. HOW DOES A MUSCLE CHANGE IN SIZE?

- 1) **Hypertrophy** -muscle gets bigger
-adding more myofibrils
-no new cells are formed

Stimulated by:

- a) resistance training
- b) testosterone
- c) anabolic steroids



MUSCLE SIZE CHANGES (con't)

2) Atrophy - decrease in muscle size
-due to loss of myofibrils or muscle cells.

Caused by:

- a) lack of use
- b) lack of nervous stimulation
- c) age

3) Misconceptions

K. MUSCLE ABNORMALITIES

- 1. Muscular Dystrophy: Autosomal dominant_____**
- 2. Myasthenia gravis: the body's immune system____**
- 3. Fibromyalgia: Chronic _____**

END