

**Aim: SWBAT to define what
is in a muscle.**

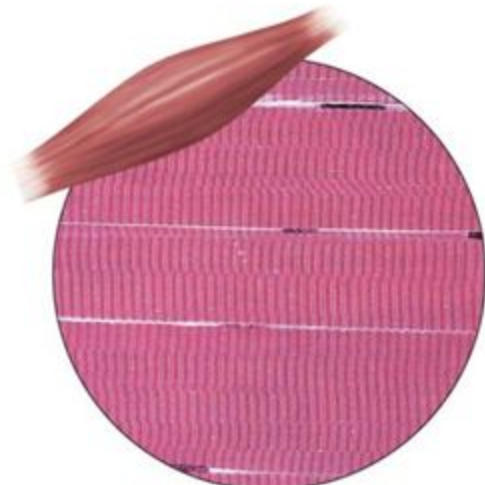
Do Now: Become a stronger student by studying for
the muscles quiz.

Participation Rubric

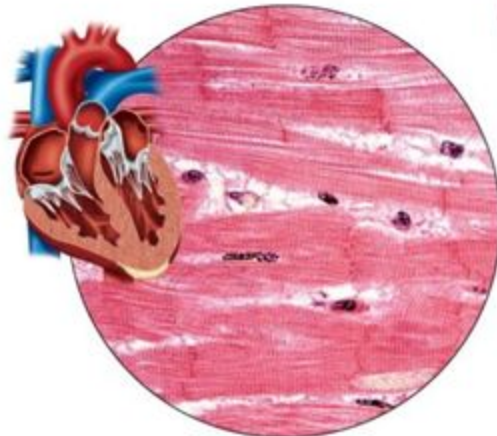
- 5 (100)- Students answers referenced notes, previous readings, or personal life experience that is relevant to topic.
- 4.5 (90)- Students asked a relevant question that helped clarify for self or for the class
- 4 (80)- Students answer was correct but did not reference any outside source or experience.
- 3.5 (70)- Students answers were not correct but were on topic and was an attempt at the correct answer
- 0 (0)-Disruptive in class, off task, on cellphone or made an inappropriate comment

Three Types of Muscle Tissue

- Smooth muscle: involuntary, hollow organs**
- Cardiac muscle: involuntary, heart**
- Skeletal muscle: voluntary, skeleton**



a Skeletal muscle



b Cardiac muscle



c Smooth muscle

Skeletal Muscle Anatomy

- **Entire muscle**

- Surrounded by epimysium
- Consists of many bundles (fasciculi)

- **Fasciculi**

- Surrounded by perimysium
- Consists of individual muscle cells (muscle fibers)

- **Muscle fiber**

- Surrounded by endomysium
- Consists of myofibrils divided into sarcomeres

Structure of Muscle Fibers

- **Plasmalemma (cell membrane)**

- Fuses with tendon
- Conducts action potential
- Maintains pH, transports nutrients

- **Satellite cells**

- Muscle growth, development
- Response to injury, immobilization, training

Structure of Muscle Fibers

- **Sarcoplasm**

- Cytoplasm of muscle cell

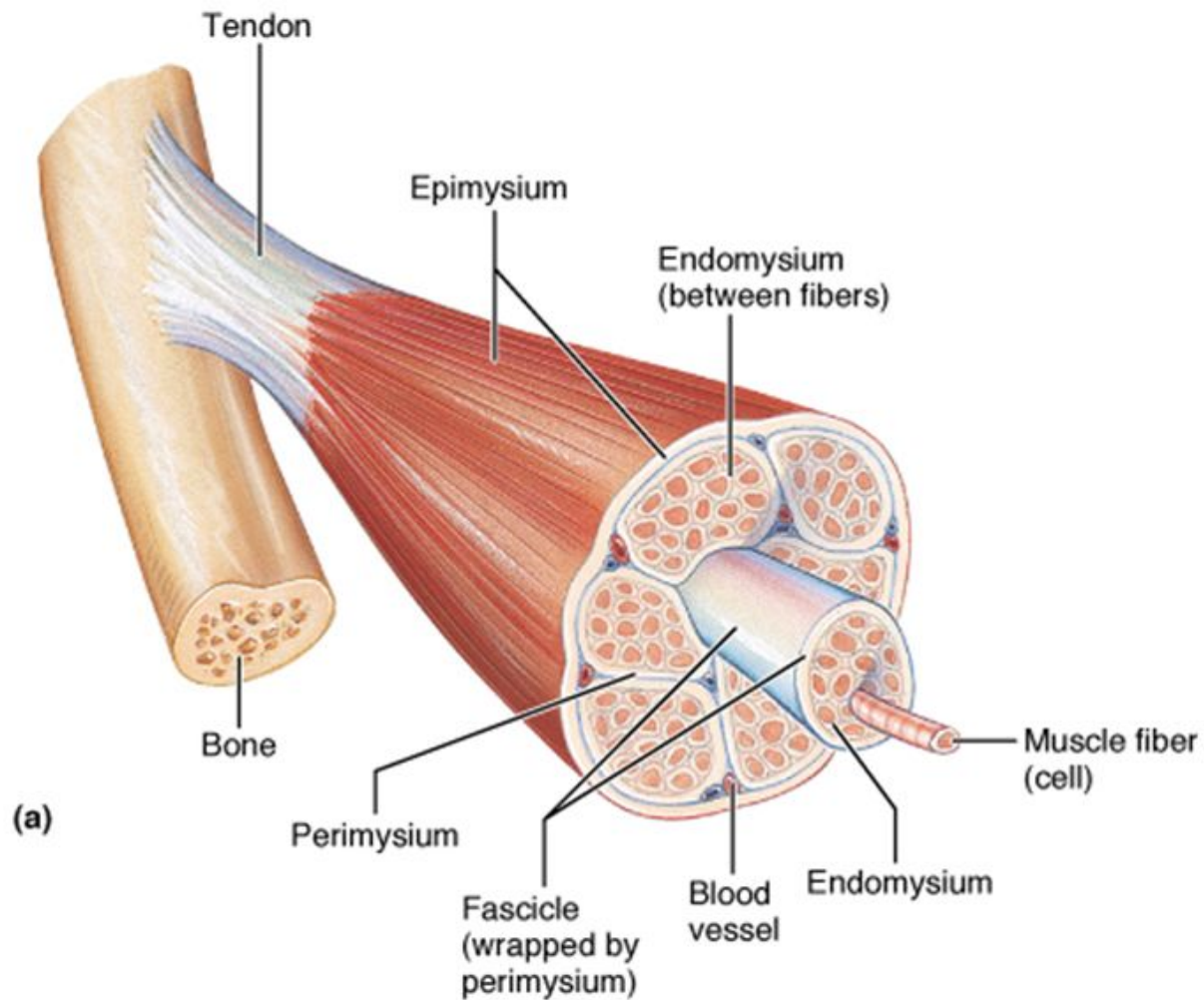
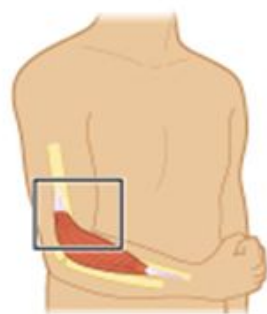
- Unique features: glycogen storage, myoglobin

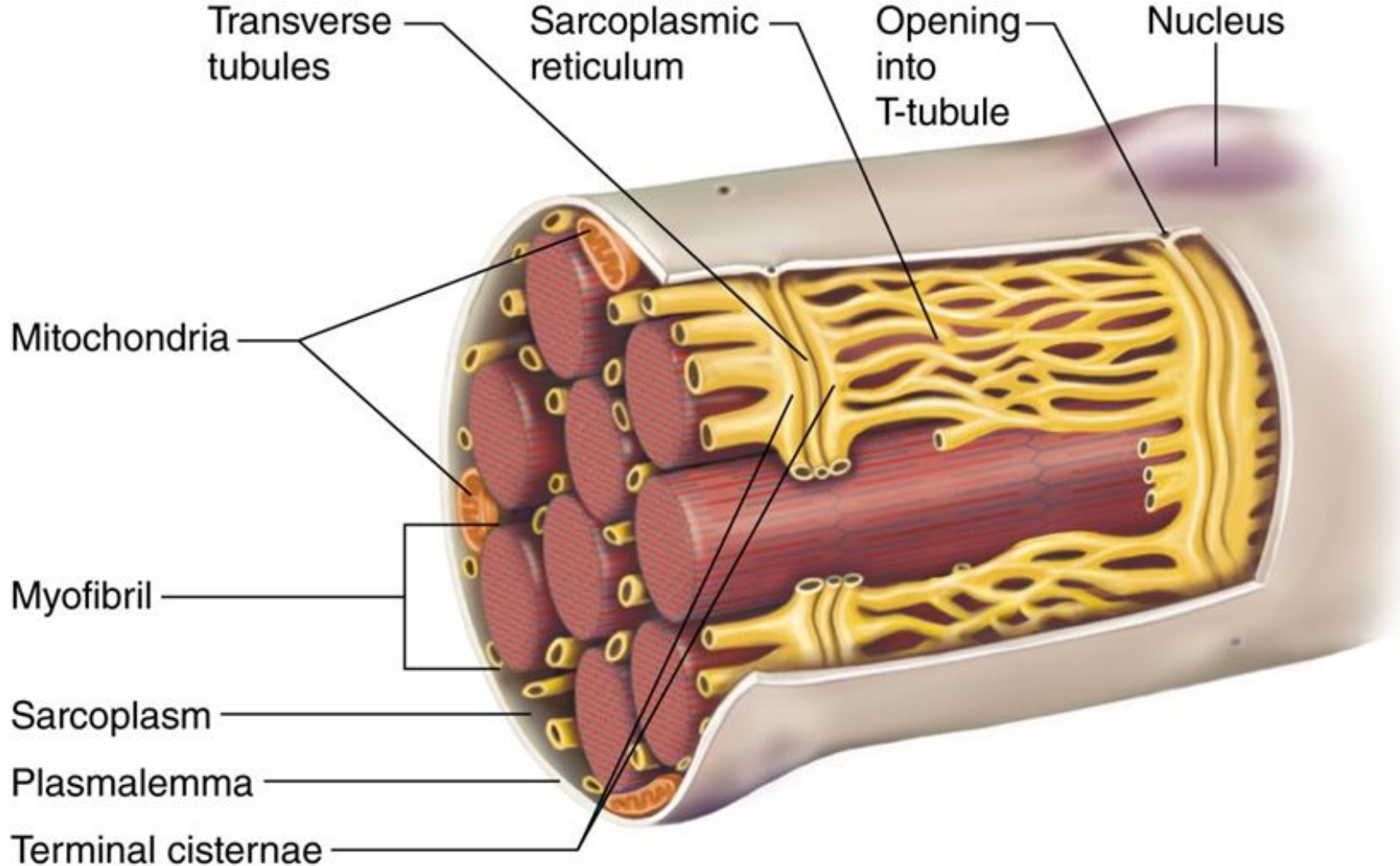
- **Transverse tubules (T-tubules)**

- Extensions of plasmalemma

- Carry action potential deep into muscle fiber

- **Sarcoplasmic reticulum (SR): Ca^{2+} storage**





Myofibrils and Sarcomeres

- **Myofibrils**

- Hundreds to thousands per muscle fiber

- **Sarcomeres**

- Basic contractile element of skeletal muscle

- End to end for full myofibril length

Sarcomere: Protein Filaments

- **Used for muscle contraction**

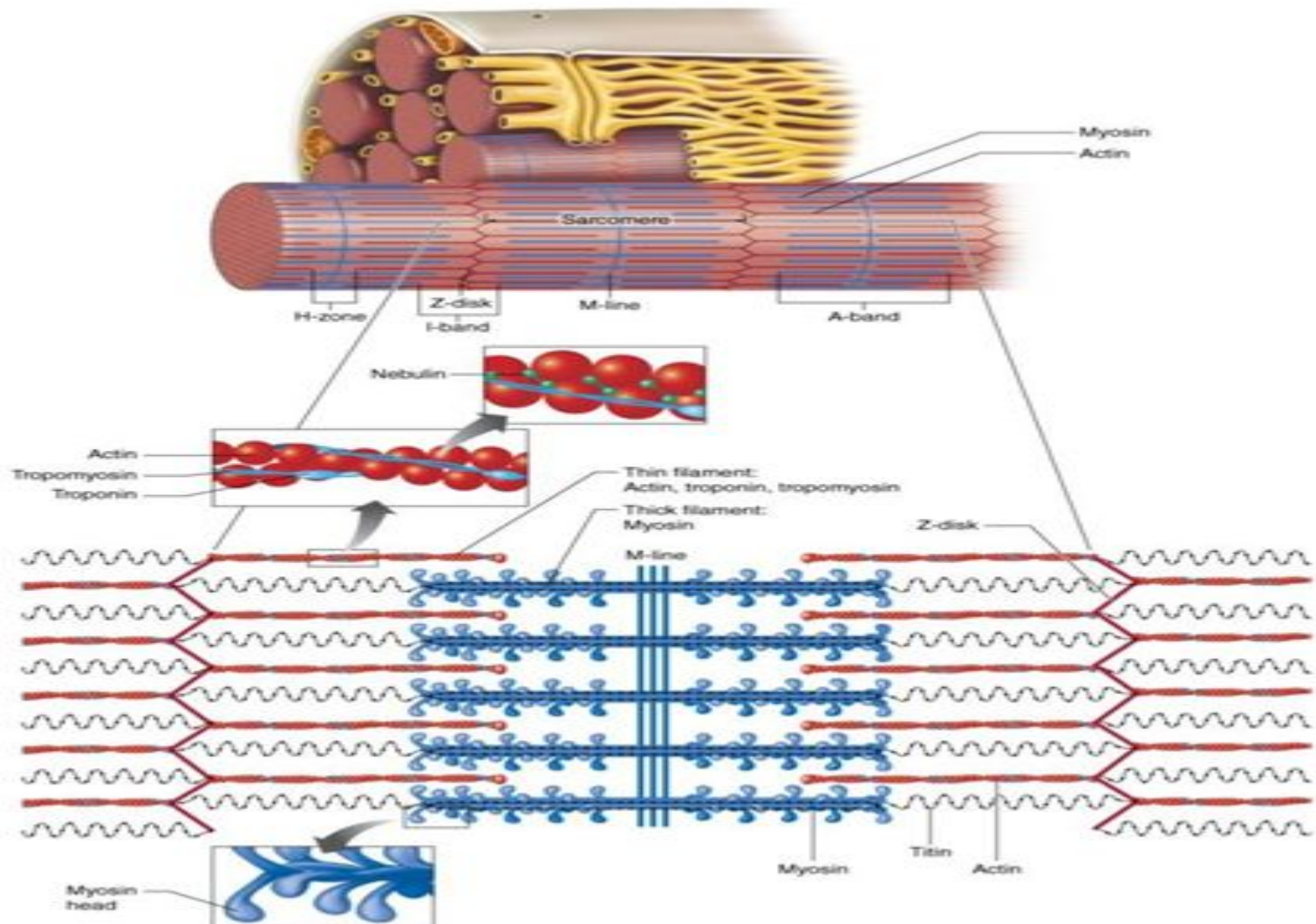
- **Actin (thin filaments)**

 - I-band contains only actin filaments

- **Myosin (thick filaments)**

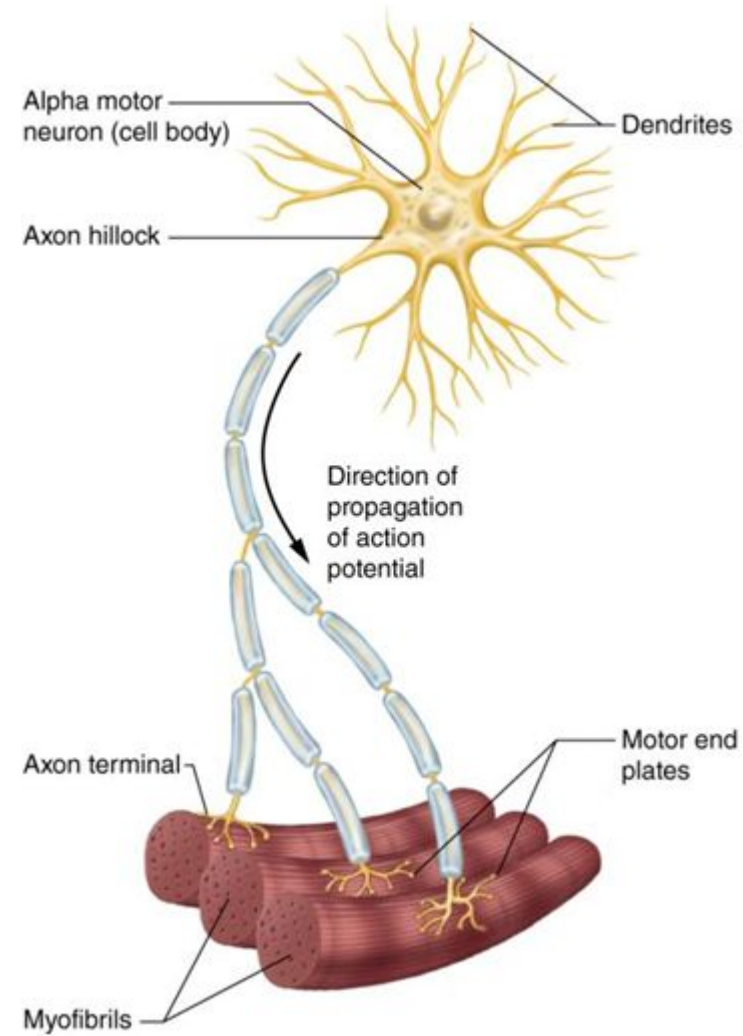
 - A-band contains both actin and myosin filaments

 - H-zone contains only myosin filaments



Muscle Contraction (Excitation-Contraction Coupling) The Long Version

1. Action potential (AP) starts in brain
2. AP arrives at axon terminal, releases acetylcholine (ACh)
3. ACh crosses synapse, binds to ACh receptors on plasmalemma
4. AP travels down plasmalemma, T-tubules
5. Triggers Ca^{2+} release from sarcoplasmic reticulum (SR)
6. Ca^{2+} enables actin-myosin contraction



Sliding Filament Theory: How Muscles Create Movement (What you need to know)

- **Process of actin-myosin contraction**

- **Relaxed state**

- No actin-myosin interaction at binding site

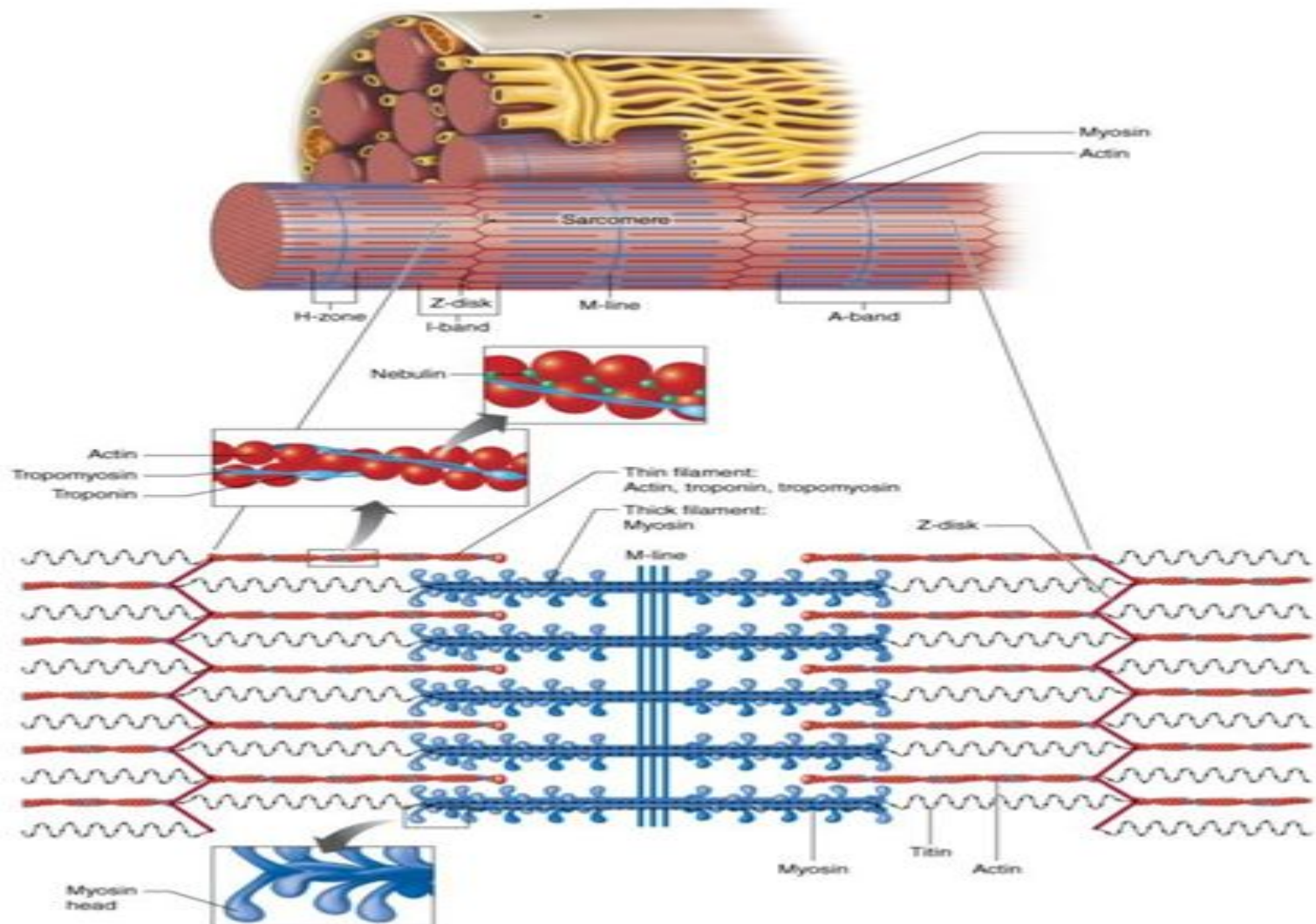
- Myofilaments overlap a little

- **Contracted state**

- Myosin head pulls actin toward sarcomere center (power stroke)

- Filaments slide past each other

- Sarcomeres, myofibrils, muscle fiber all shorten



What you really need to know?

- A muscle is a bunch of muscle fibers wrapped by the perimysium.
- The bunch of wrapped cells is then wrapped again by an epimysium.
- Each muscle cell is a bunch of myofibrils.
- These myofibrils contain thick (myosin) and thin (Actin) filaments which bind and release to cause the sarcomere to contract and release.
- Calcium and energy is involved in this process.
- A lot more is involved as this is not a simple process but this is the limit I am expecting you to know.

Muscle Fiber Types

•Type I

- ~50% of fibers in an average muscle
- Peak tension in 110 ms (slow twitch)

•Type II

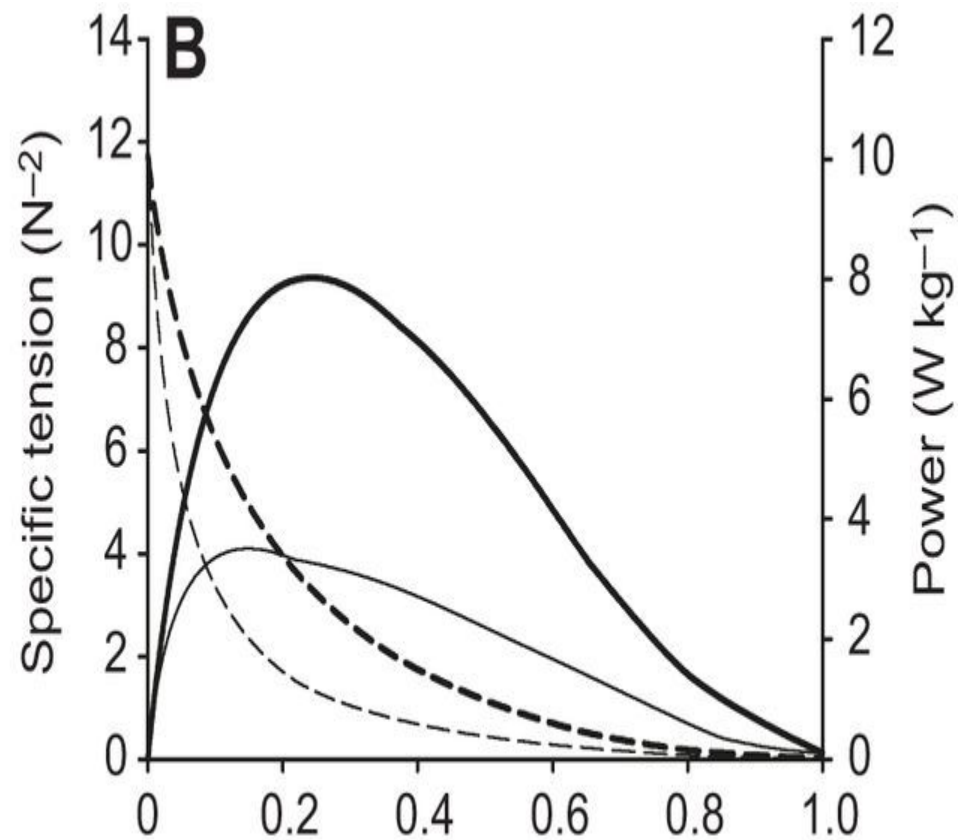
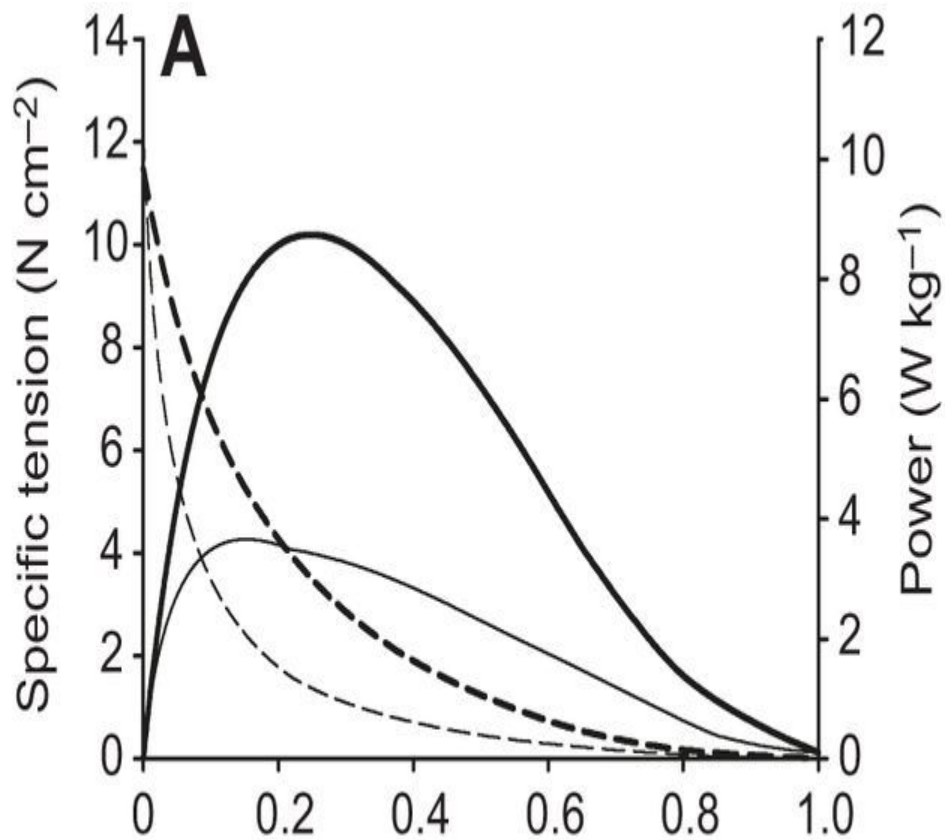
- Peak tension in 50 ms (fast twitch)
- Type IIa (~25% of fibers in an average muscle)
- Type IIx (~25% of fibers in an average muscle)

•Sarcoplasmic reticulum

- Fast twitch fibers have a more highly developed SR
- Faster Ca^{2+} release, 3 to 5 times faster V_0

•Motor units

- Slow Twitch motor unit: smaller neuron, <300 fibers
- Fast Twitch motor unit: larger neuron, >300 fibers



Slow Twitch

- **High aerobic endurance**

- Can maintain exercise for prolonged periods
- Require oxygen for ATP production
- Low-intensity aerobic exercise, daily activities

- **Efficiently produce ATP from fat, carbohydrate**

Fast Twitch

- **Type II fibers in general**

- Poor aerobic endurance, fatigue quickly
- Produce ATP anaerobically

- **Type IIa**

- More force, faster fatigue than type I
- Short, high-intensity endurance events (1,600 m run)

- **Type IIx**

- Seldom used for everyday activities
- Short, explosive sprints (100 m)

Fiber Type and Athletic Success

- **Endurance athletes—type I predominates**
- **Sprinters—type II predominates**
- **Fiber type *not* sole predictor of success**
 - Cardiovascular function
 - Motivation
 - Training habits
 - Muscle size

