

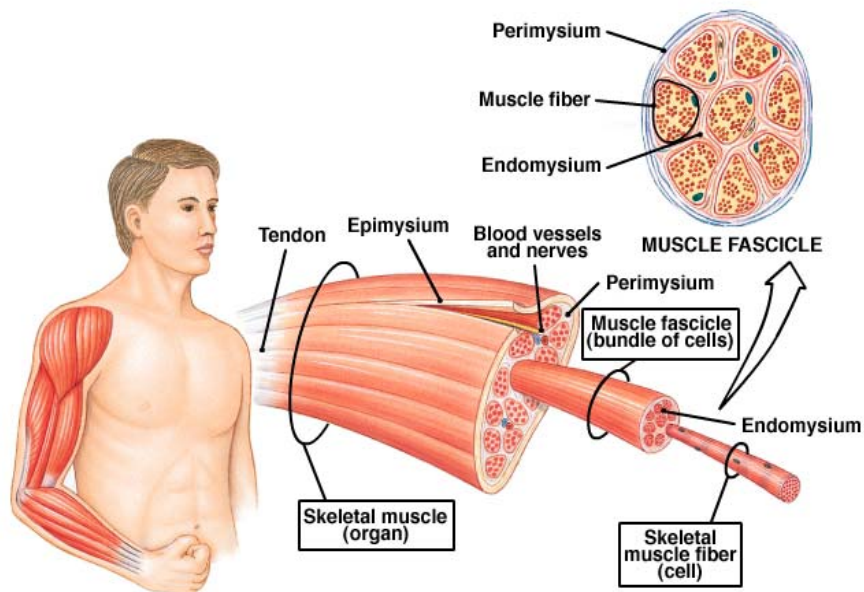
CHAPTER 10: MUSCLE TISSUE

Read: Chapter 10, pages 283-320. Use your CD-ROM Interactive Physiology to visualize function at the neuromuscular junction, sliding filament theory, control of motor units and whole muscle.

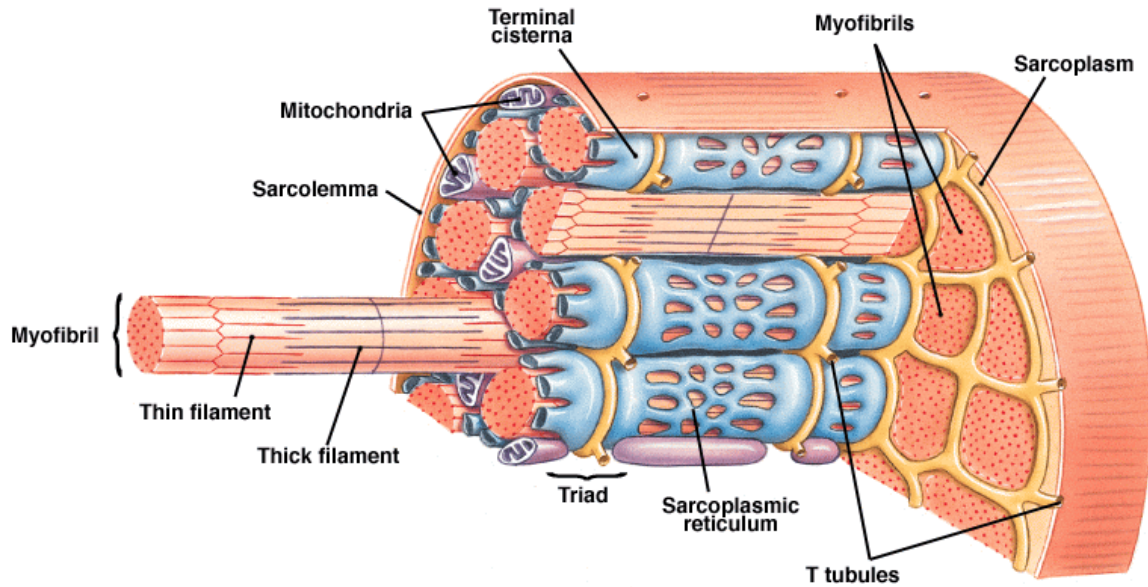
I. Organization of Skeletal Muscle Tissue (Overview)

A. Connective Tissues -

- 1) Epimysium -
- 2) Perimysium -
fascicle -
- 3) Endomysium -



B. Muscle Fiber (= myofiber = “muscle cell”) Anatomy



1) Sarcolemma -

2) Sarcoplasm -

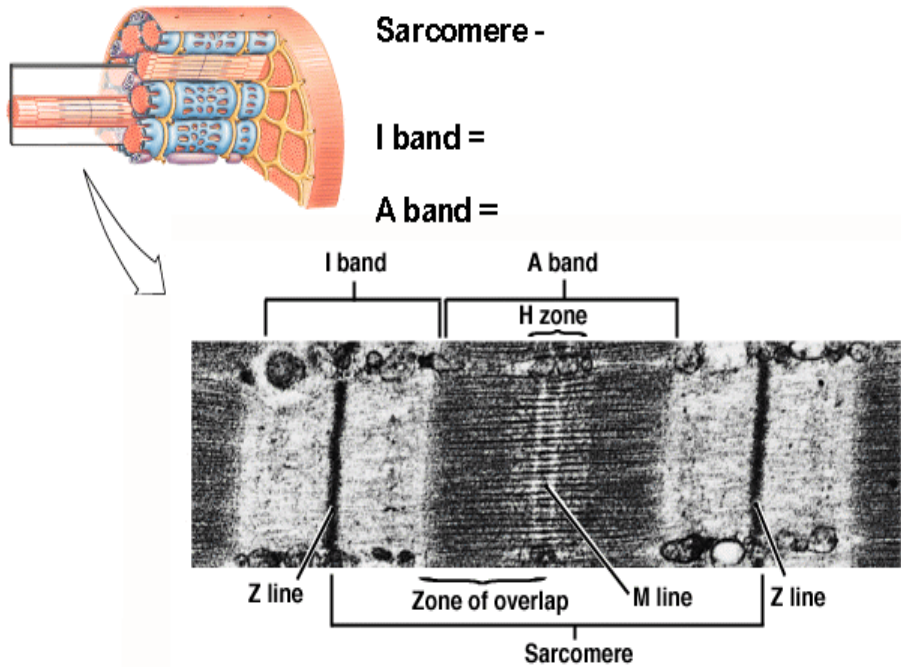
3) Transverse (T) tubules -

4) Sarcoplasmic reticulum -

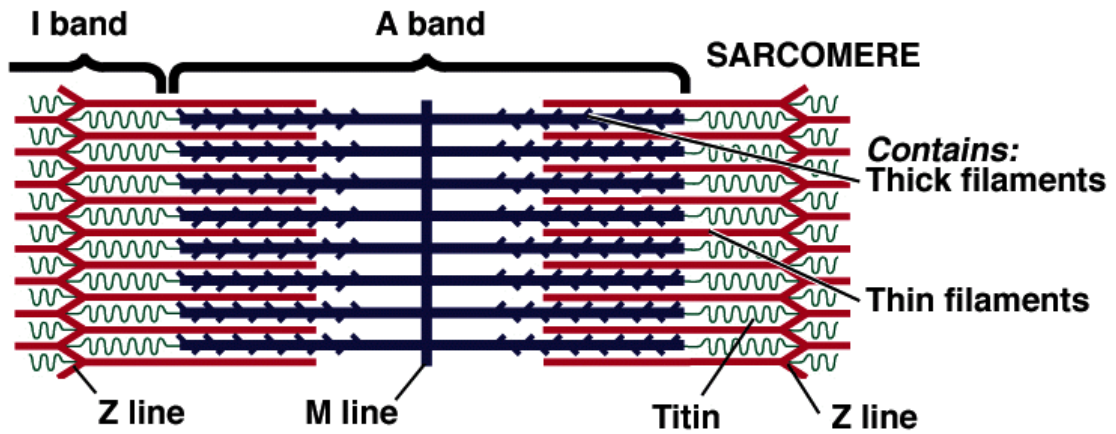
5) Mitochondria -

6) Myofibrils -

C. Myofibril Structure -

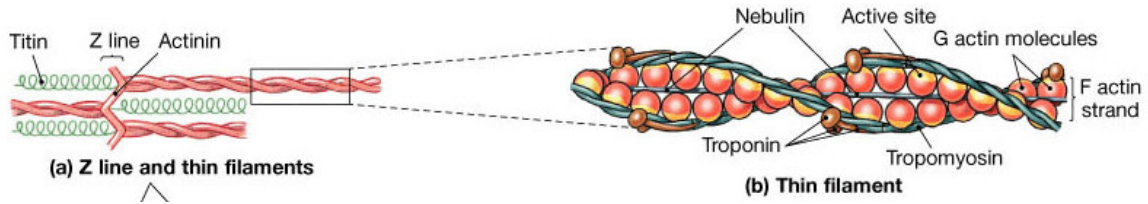


D. Sarcomere Structure -

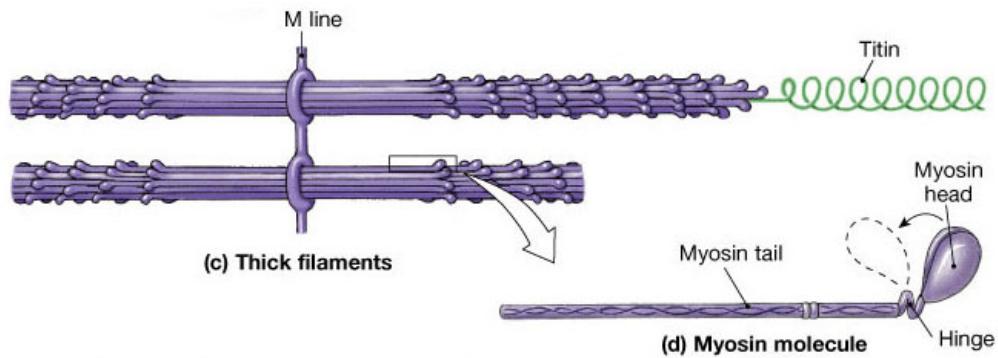


E. Biochemistry of the Myofiber

1) Thin Myofilament -



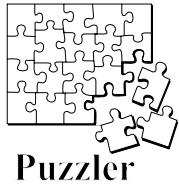
2) Thick Myofilament



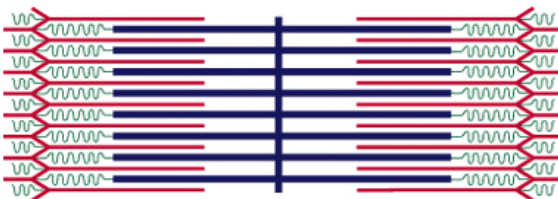
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3) Other important molecules

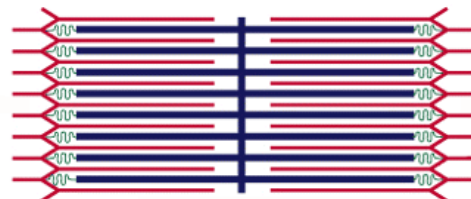
II. Muscle Function: Contraction



When a skeletal muscle contracts, a pulling force is generated on the insertion. The pulling force can be explained by the shortening of the muscle. The picture below shows the results of the microscopic examination of relaxed and fully contracted muscle; what is happening to the sarcomeres of a muscle?



Sarcomere of relaxed muscle



Sarcomere of contracted muscle

Label both diagrams above with the A band and the I band.

Which part(s) of the sarcomere decrease in size?

(Circle one)

A band / I band

At one time, two different theories were suggested to explain the disappearance of the above band.

Theory A: The myofilaments of the sarcomere are broken down to shorten the sarcomere.

Theory B: The myofilaments in the sarcomere slide across each other to shorten the sarcomere.

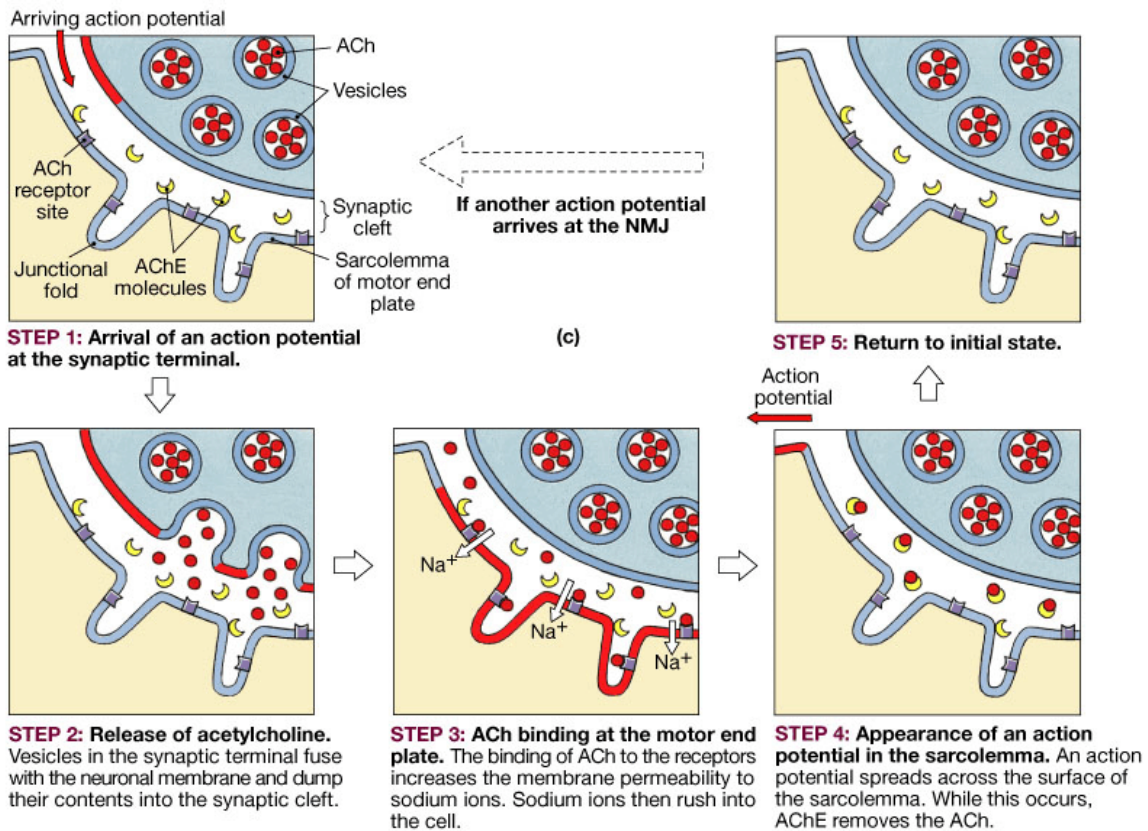
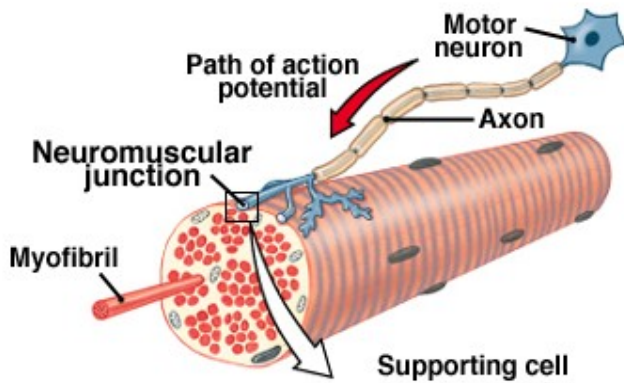
Based on the picture above, which theory is correct? Theory A / Theory B

A typical myofibril consists of about 10,000 sarcomeres, each with a resting length of 2.0 micrometers. If each sarcomere shortens to 1.0 micrometer, what is the change in length of the typical myofibril in millimeters (1 mm = 1000 micrometers)? Show work:

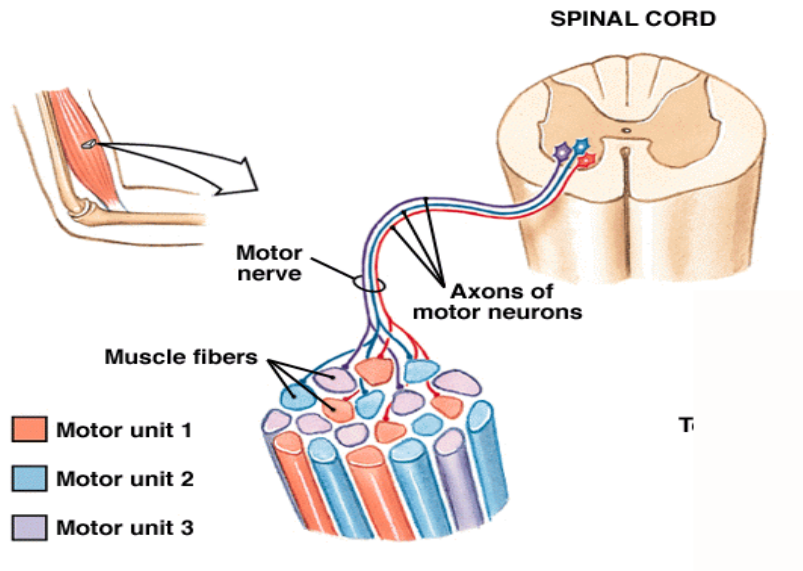
$$10,000 \text{ sarcomeres} \times 1.0 \text{ uM/sarcomere} \times 1 \text{ cm}/10,000 \text{ uM} = 1 \text{ cm} \approx \frac{1}{2} \text{ in.}$$

A. Innervation of Skeletal Muscle

1) Neuromuscular junction -



2) Motor Unit -

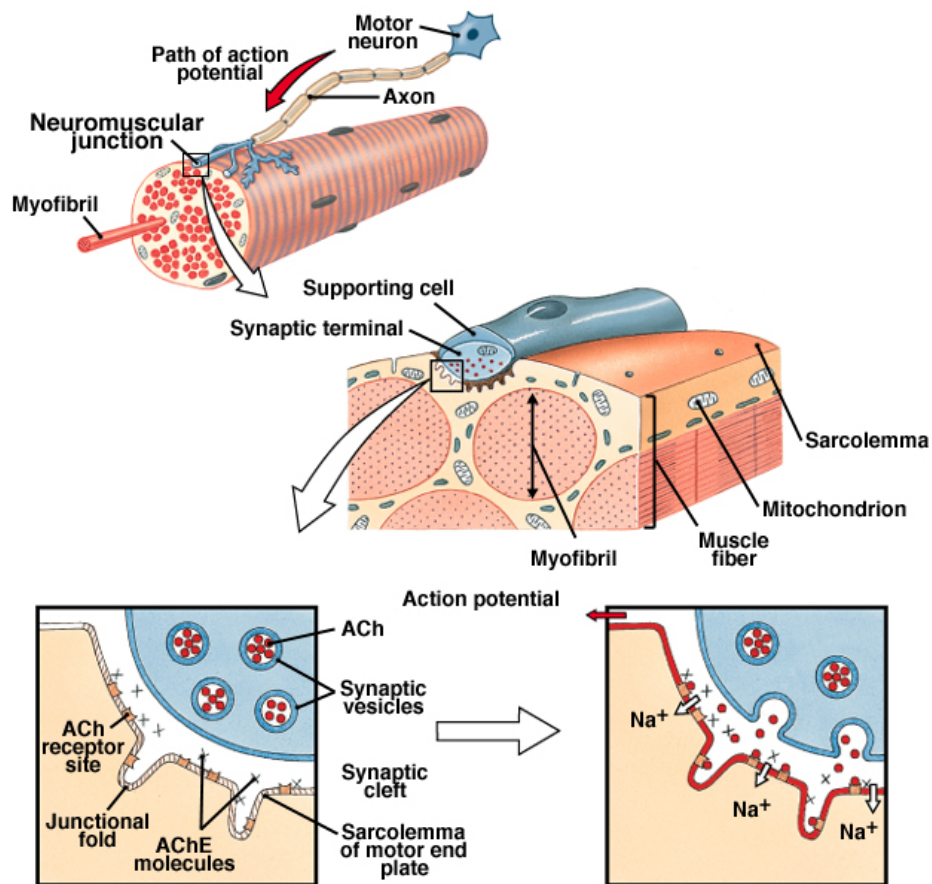


B. The Physiological Mechanism of Muscle Contraction

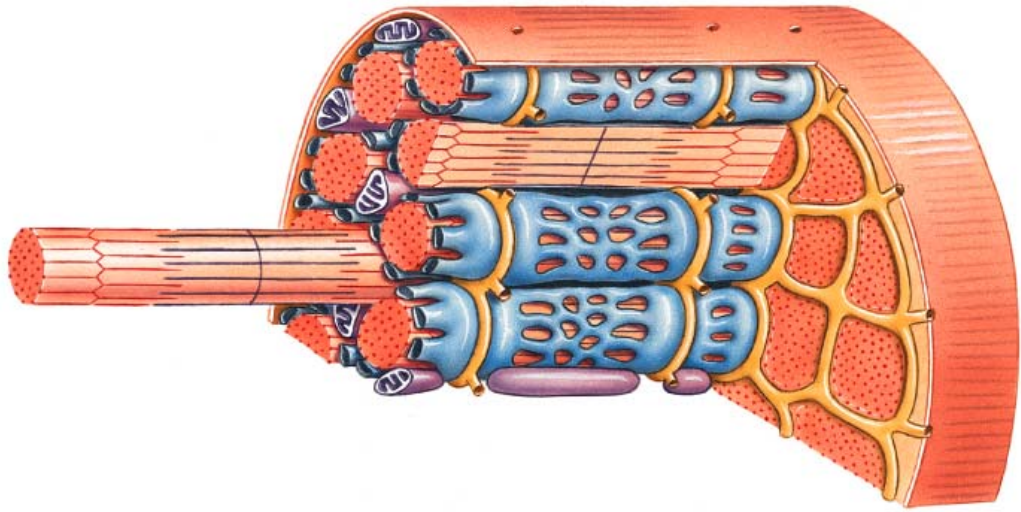
The Molecular & Cellular Events of a Muscle Contraction are Organized into Three Phases:

- 1)
- 2)
- 3)

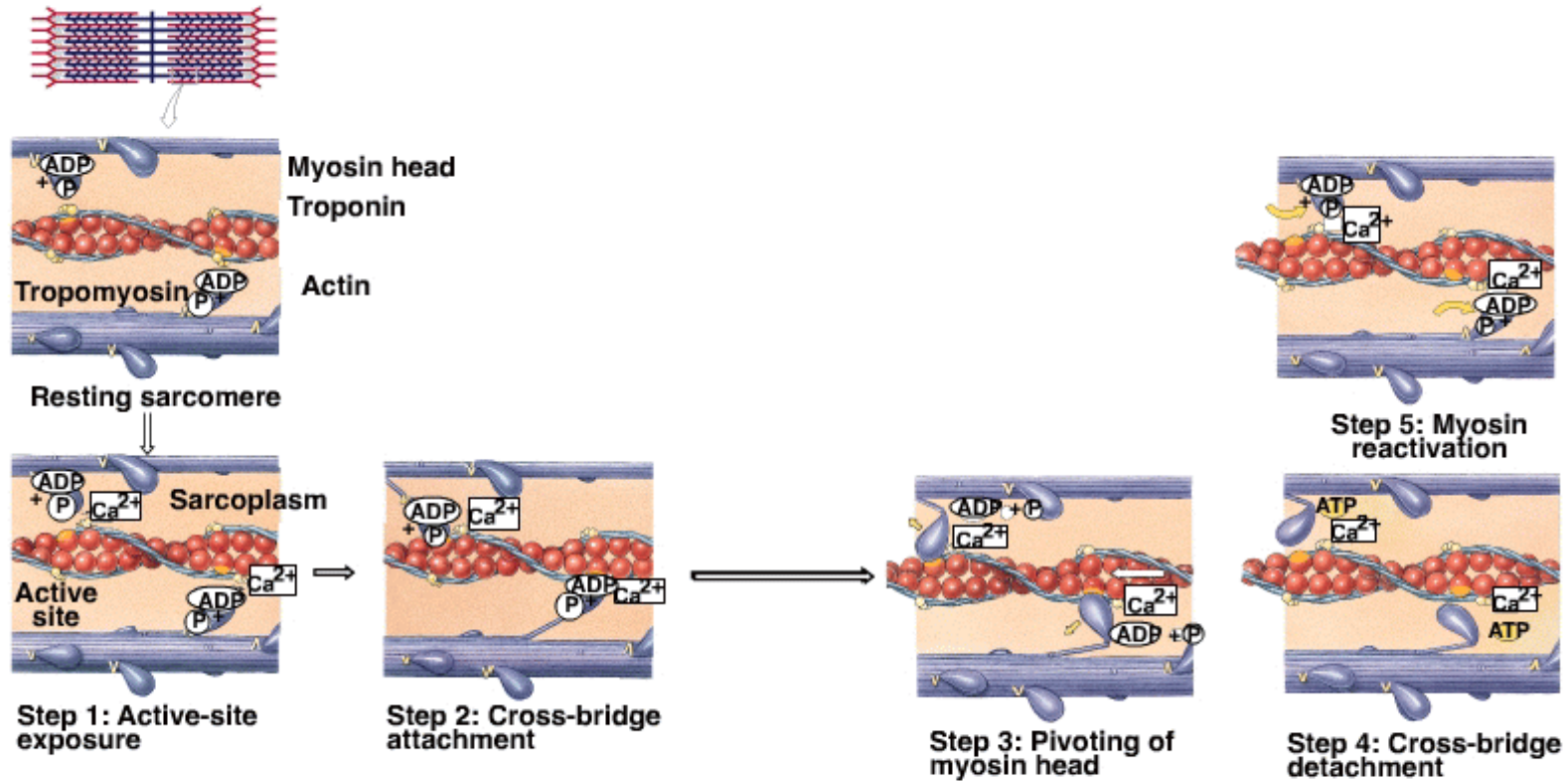
1) Events at the neuromuscular junction = _____



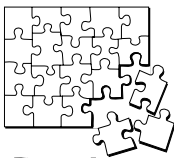
2) Events in the sarcoplasm = _____



3) Molecular events between the thick and thin filaments causes _____



C. Relaxation of Skeletal Muscle



Puzzler

What percentage of the myosin heads are attached during a normal muscle contraction? (circle one)

25% 50% 75% 100%

Rigor mortis is a period following death during which the muscles of the body are extremely rigid. Why are muscles stiff during rigor mortis and what percentage of myosin heads are attached during rigor mortis?

Why do the muscles of a corpse relax after 15-24 hours?

III. Whole-Muscle Performance

A. All or None Principle

B. The Muscle Twitch

C. Summation - adding single muscle twitches together to increase force of contraction; two types of summation can occur in whole muscle.

1) Wave (temporal) Summation

2) Multiple Motor Unit (Spatial) Summation

NOTES ON BIOPAC VIDEO DEMONSTRATION

ASSIGNED TOPICS IN MUSCLE PHYSIOLOGY (pages 288-299)

Must complete this before the “Muscles in Motion” Lab. If you have questions, organize them into a list and let’s discuss this in class day of lab.

Treppe: the staircase effect

Muscle tone: definition and purpose

Distinguish between isotonic and isometric contractions

Causes of muscle fatigue

Oxygen debt

Distinguish between slow twitch and fast twitch muscle fibers

Mechanism of muscle contraction in nonstriated (smooth) muscle

Sources of energy for a muscle contraction: roles of aerobic respiration, creatine phosphate, and anaerobic respiration

Muscle atrophy and hypertrophy: definitions and causes.

ASSIGNMENTS

LECTURE GUIDE

- 1) Define the following terms: epimysium, perimysium, endomysium, tendon, aponeurosis. How are these structures similar?
- 2) How is a muscle supplied with blood? How is it innervated by neurons? What specific type of neurons innervate skeletal muscle?
- 3) Describe the microscopic anatomy of a muscle fiber (myofiber). How does each of these structures function during a muscle contraction?
- 4) Diagram and label a sarcomere.
- 5) Explain the sliding filament model of contraction. In what phase of the muscle contraction do the myofilaments slide?
- 6) Where is calcium stored in the muscle fiber? What triggers its release into the sarcoplasm? What two events are coupled by the release of calcium?
- 7) What is a motor unit?
- 8) What changes occur, if any, in the A band, I band or H zone of the sarcomere?
- 9) When a sarcomere shortens, the _____ myofilament pulls the _____ myofilament.
- 10) How does a muscle know when to contract? When to relax? What is needed for a contraction to occur? What is needed for relaxation to occur?
- 11) What molecule(s) provide a source of energy for a muscle contraction?
- 12) Draw and label a muscle twitch. How is tetany different from a twitch?
- 13) Why does a muscle contraction get stronger as the strength of a stimulus (voltage) increases? Why is a strong sustained muscle contraction produced by high frequency stimulation? Use the terms multiple motor unit (spatial) summation and temporal summation in your explanations.
- 14) While “curling” weights, a person is using _____ contractions. If a person place his/her hands together and pushed each hand against the other, he/she would be performing _____ contractions.

TEXTBOOK CHAPTER 10 (pages 323-324)

Level 1 Reviewing Facts and Terms: 1-3, 6, 8-12, 14

Level 2 Reviewing Concepts: 18, 19, 21, 25

Level 3 Critical Thinking and Applications: 27, 29

STUDY GUIDE (page 172-192)

- (L1) Multiple Choice: 1-10, 13-15, 20, 21, 25, 27
Completion: 1-9, 13-15, 20, 21, 25, 27
Matching: 1-11
Drawing/Illustration: Figures 10.1 - 10.5
- (L2) Concept Maps 1-3
Body Trek: All
Multiple Choice: 1-9, 17
Short Essay: 1, 2, 3, 5-7
- (L3) Critical Thinking: 3, 4

CD ROM Interactive Anatomy

Choose the MUSCULAR SYSTEM from the table of contents. The following sections will provide an excellent visual aid and review of the difficult physiology topics: Anatomy Review, The Neuromuscular Junction, Sliding Filament Theory, Control of Motor Units, Control of Whole Muscle.