Applied Exercise and Sport Physiology With Labs 4th edition Housh Solutions Manual

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Chapter 2

Structure of Muscle Tissue and Muscle Contraction

Lecture Outline

I. Types of Muscle Tissue and General Characteristics of Each
   1. Smooth Muscle
   2. Skeletal Muscle
   3. Cardiac Muscle

II. Skeletal Muscle Structure
   1. Connective Tissue Layers
      A. Epimysium
      B. Perimysium
      C. Endomysium
   2. Structure of the Muscle Fiber

III. Muscle Fiber Types
   1. Classification Systems
   2. Three Fiber Types and Their Characteristics
      A. Slow Oxidative
      B. Fast Oxidative Glycolytic
      C. Fast Glycolytic
   3. The Motor Unit
   4. Determinants of Fiber Type in an Individual

IV. Structure of the Myofibril and the Contractile Mechanism
   1. The Structural Unit of the Myofibril: The Sarcomere
   2. Sliding Filament Model of Muscle Contraction
      A. Steps involved
      B. Role of ATP

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V. Summary

Student Assignments

1. In small groups, discuss how the structural components of the sarcomere are related to the way in which muscle tissue contracts.
2. ***Develop reference skills.*** Find an article on the subject of fiber typing in athletes and summarize the practical implications of the article for the class.
3. List three sports/events where you might expect athletes to have a high percentage of (a) FG, (b) FOG, and (c) SO type fibers. Explain why.
4. Draw a diagram outlining the series of events that occur during skeletal muscle contraction. Include all relevant structures and events.

Discussion/Essay Questions

1. Describe the composition and distribution of muscle fibers within a motor unit.
2. Describe the process of muscle contraction from the activation of the muscle fiber to the breakdown of ATP.
3. Describe and contrast the two theories of ATP use during muscle contraction.
4. Diagram a cross-sectional and a longitudinal view of skeletal muscle. Label all relevant structures, including connective tissue layers.
5. Discuss the different methods of classifying muscle fiber type. In what ways are the resulting categories related? How are they different?

Quiz Questions

1. Which of the following structures is the cell membrane of a muscle fiber?
   A. Epimysium
   B. Perimysium
   C. Endomysium
   D. Sarcolemma

2. The perimysium divides muscle into which of the following?
   A. Filaments
   B. Myofibrils
   C. Fasciculi
   D. Fibers

3. What does a motor unit contain?
   A. One fiber type
   B. All fiber types in equal proportions
   C. All fiber types in different proportions

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D. Any of the above, depending on the muscle

4. What happens with endurance training?

   A. FG fibers improve their oxidative capacity.
   B. FOG fibers become more glycolytic in nature.
   C. SO fibers improve their anaerobic capacity.
   D. Both A and B.

5. Which of the following are most resistant to fatigue?

   A. SO fibers
   B. FOG fibers
   C. FG fibers
   D. Both B and C

6. Which of the following is the neurotransmitter of the motor nerves?

   A. Serotonin
   B. Epinephrine
   C. Acetylcholine
   D. Norepinephrine

7. Which of the following is the functional unit of the myofibril?

   A. A band
   B. I band
   C. Sarcomere
   D. Z line

8. What happens during muscle contraction?

   A. The A band shortens.
   B. The H zone may disappear.
   C. The I band stays the same length.
   D. Z lines are stretched further apart.

9. Depolarization of the sarcolemma results in which of the following?

   A. Calcium release from the sarcoplasmic reticulum
   B. Calcium uptake by the mitochondria
   C. Calcium uptake by the t-tubules
   D. Calcification of muscle tissue

10. What happens during relaxation?

   A. Calcium is removed from the sarcoplasmic reticulum.
   B. Calcium is bound to troponin.
   C. Actin-myosin interaction is inhibited.

D. All of the above.
E. None of the above.

Quiz Answers

1. D
2. C
3. A
4. A
5. A
6. C
7. C
8. B
9. A
10. C

Chapter 2 Lab

Determination of One-Repetition Maximum Bench Press and Leg Press Strength.

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Structure of Muscle Tissue and Muscle Contraction

Chapter 2

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After Reading This Chapter, You Will…

- Be able to describe differences among smooth, skeletal, and cardiac muscle.
- Understand the basic structure of skeletal muscle.
- Know the characteristics that differentiate fast-twitch from slow-twitch muscle fibers.
- Be familiar with the sliding filament model of muscle contraction.

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Reflections on…
What Happens When You Move

- Have you ever thought about the series of events that your muscles undergo in order to throw a baseball, dunk a basketball, do a push up, or jog a mile?
- How do you think understanding the processes of muscle contraction will help you later as an exercise professional, physical educator, or coach?

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Types of Muscle Tissue

- Smooth, nonstriated muscle
- Skeletal striated muscle
- Cardiac striated muscle

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Structure of Smooth Muscle

- Long, spindle-shaped fibers
- An external shape that may change to conform to surrounding elements
- One nucleus per fiber

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Structure of Skeletal Muscle

- Long, cylindrical fibers
- Up to several hundred nuclei in each cell
- Structural independence from each neighboring fiber or cell
- Cross-striations of alternating light and dark bands.

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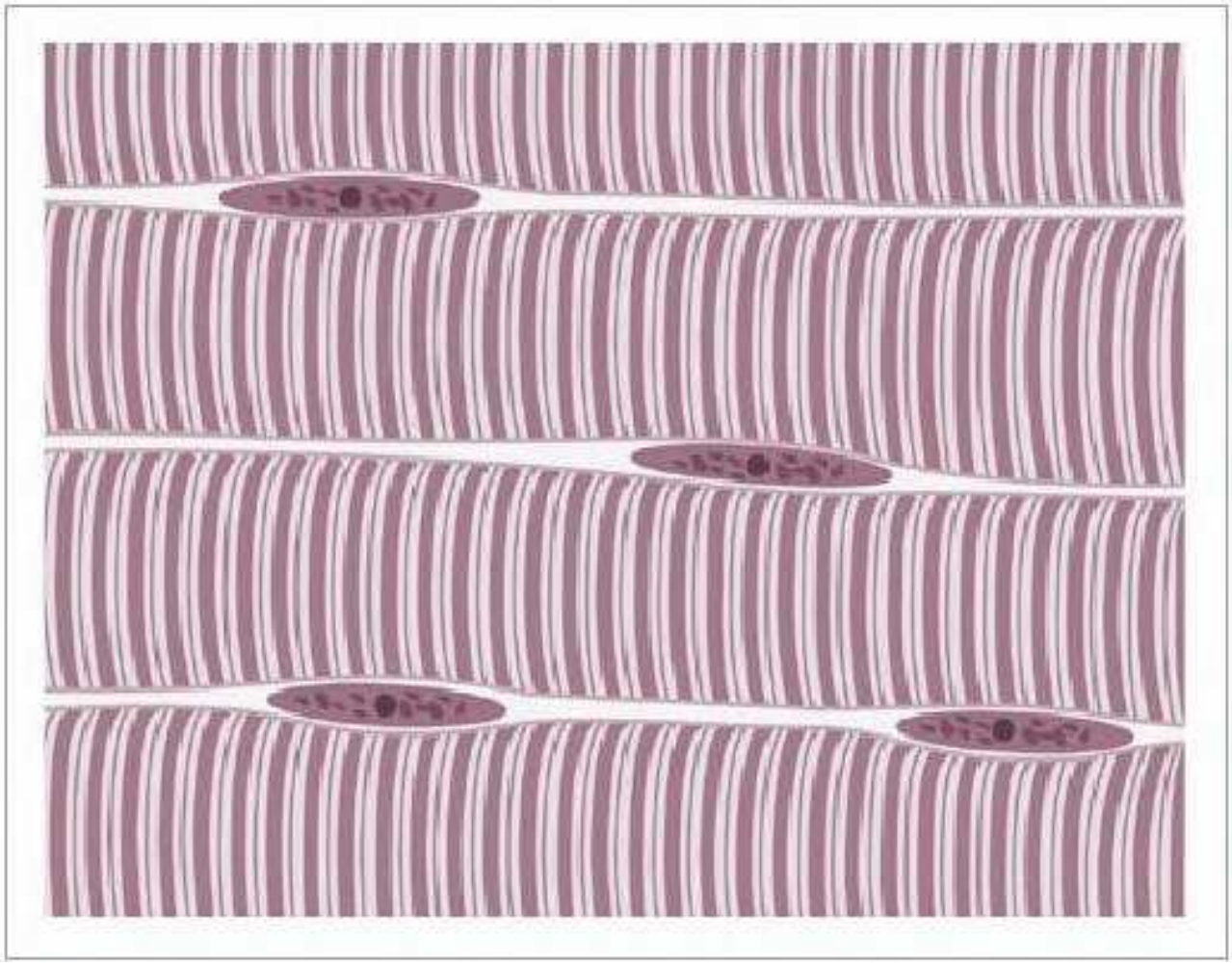
Skeletal Muscle Fibers Showing Cross-Striations



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Structure of Cardiac Muscle

- A network (syncytium) of interwoven striated muscle fibers
- Discrete fibers that can contract individually
- A network of fibers that responds to innervations with a wavelike contraction that passes through entire muscle

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Gross and Microscopic Structure of Skeletal Muscles

- Gross structure:
  - Fascia
  - Epimysium
  - Fasciculus
  - Perimysium
- Microscopic structure:
  - Endomysium
  - Vary in diameter from approximately 10 to 100 microns
  - Vary in length from 1 mm to the length of the whole muscle

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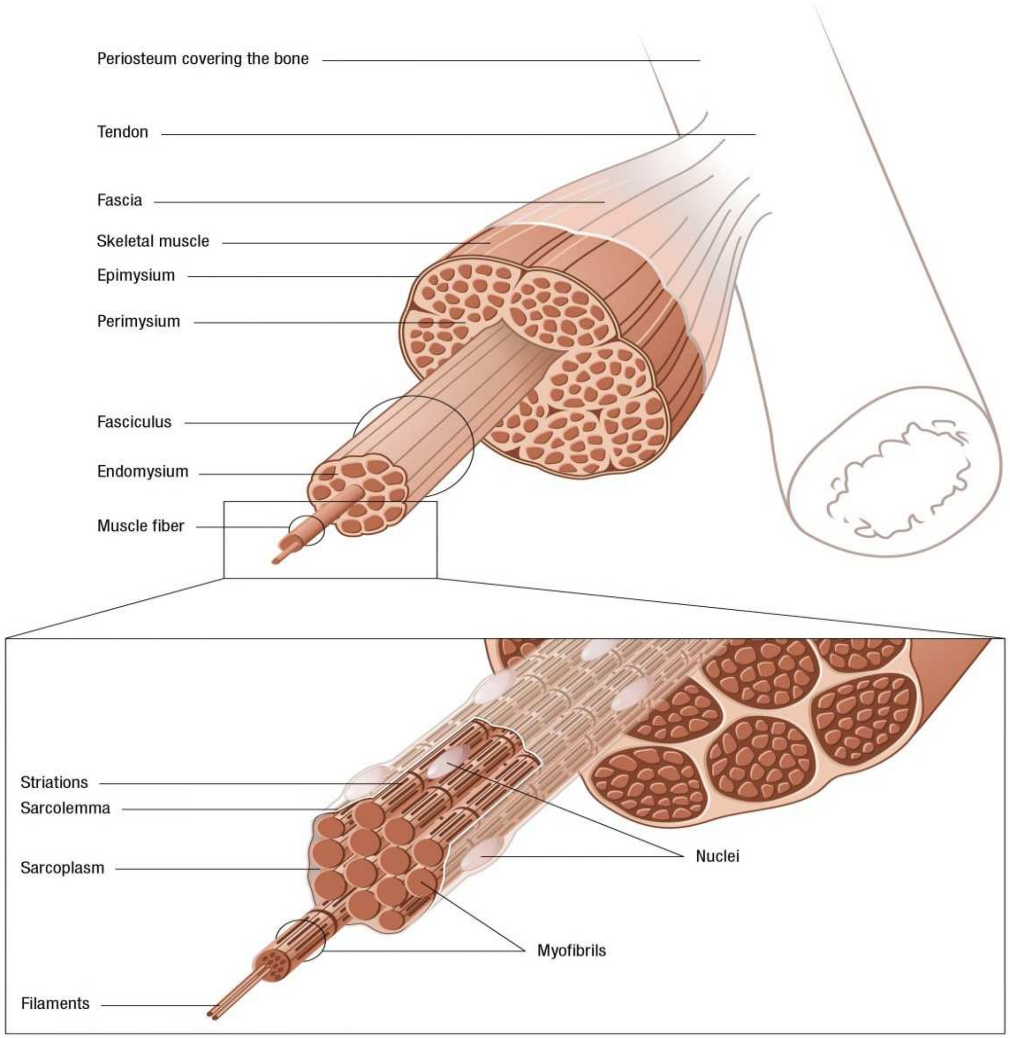
Muscle Fibers and Connective Tissue Sheaths



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Structure of the Muscle Fiber

- Sarcolemma
- Sarcoplasm
- Myofibrils

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Classification of Muscle Fiber Types

Based on . . .

- Anatomical appearance
- Muscle function
- Biochemical properties
- Histochemical properties

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Characteristics of Muscle Fiber Types

A. NOMENCLATURE			
1. Older systems	Red slow-twitch (ST)	White fast-twitch (FT)	
2. Dubowitz and Brooke[4]	Type I	Type IIa	Type IIb
3. Smerdu et al.[11]	Beta/slow	Type IIa	Type IIx
4. Peter et al.[9]	Slow, oxidative (SO)	Fast, oxidative, glycolytic (FOG)	Fast, glycolytic (FG)
B. CHARACTERISTICS			
1. Speed of contraction	Slow	Fast	Fast
2. Strength of contraction	Low	High	High
3. Fatigability	Fatigue resistant	Fatigable	Most fatigable
4. Aerobic capacity	High	Medium	Low
5. Anaerobic capacity	Low	Medium	High
6. Size	Small	Large	Large
7. Capillary density	High	High	Low

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Fiber Types in Human Skeletal Muscle

1. Slow-twitch oxidative
2. Fast-twitch oxidative glycolytic
3. Fast-twitch glycolytic

- Significance for athletes:
  - High percentage of SO fibers: good for endurance events
  - High percentage of FT fibers: good for power and sprint events
- Non-athletes: Even mix of fibers

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Structure of a Sarcomere

- Functional unit of the myofibril
- Z-line:
  - The membrane that separates sarcomeres
- Myofilaments:
  - Interlocking parallel filaments: Myosin and actin
- Bands:
  - A, H, and I

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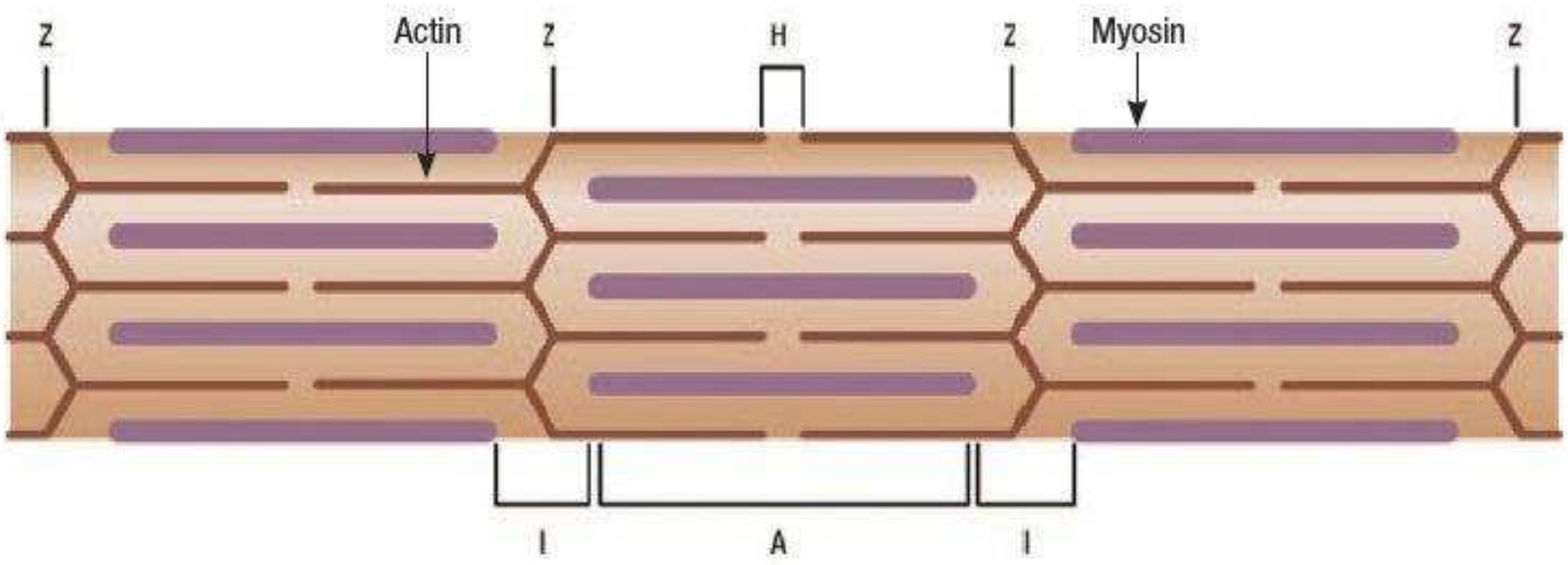
Sarcomere

- Extends from Z-line to Z-line
- A, H, and I bands give muscle a striated appearance



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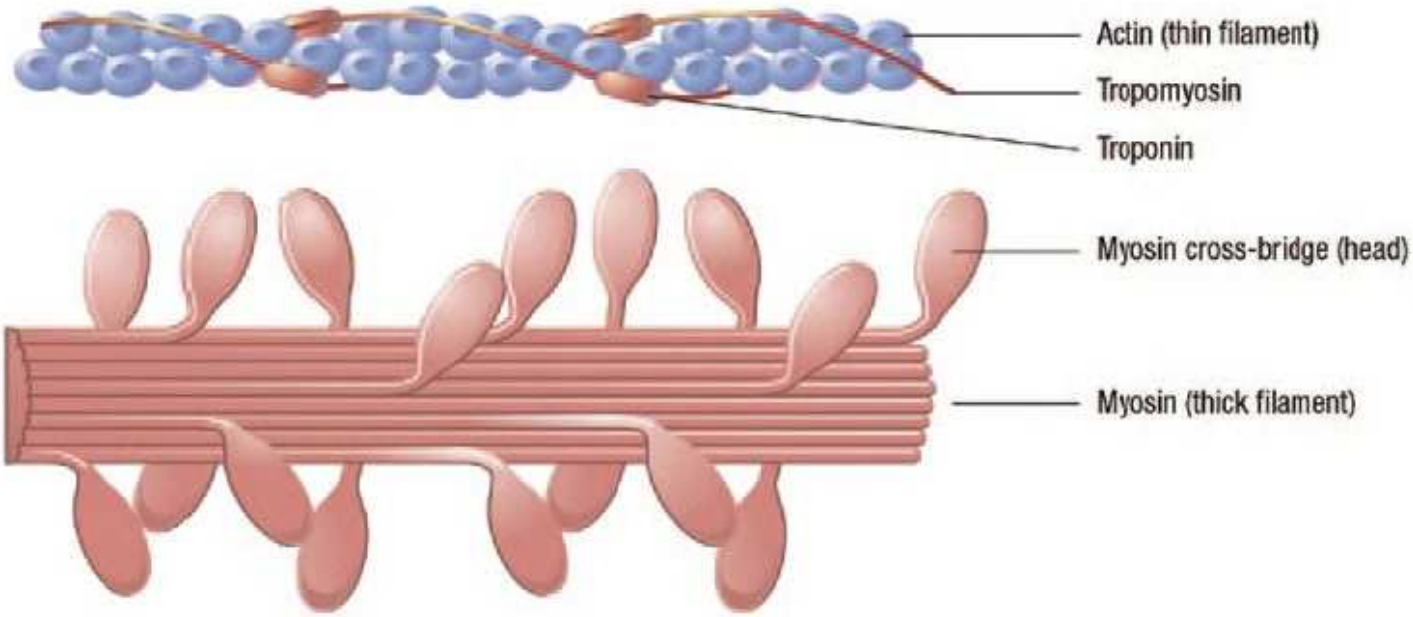
Actin, Myosin, Troponin, and Tropomyosin



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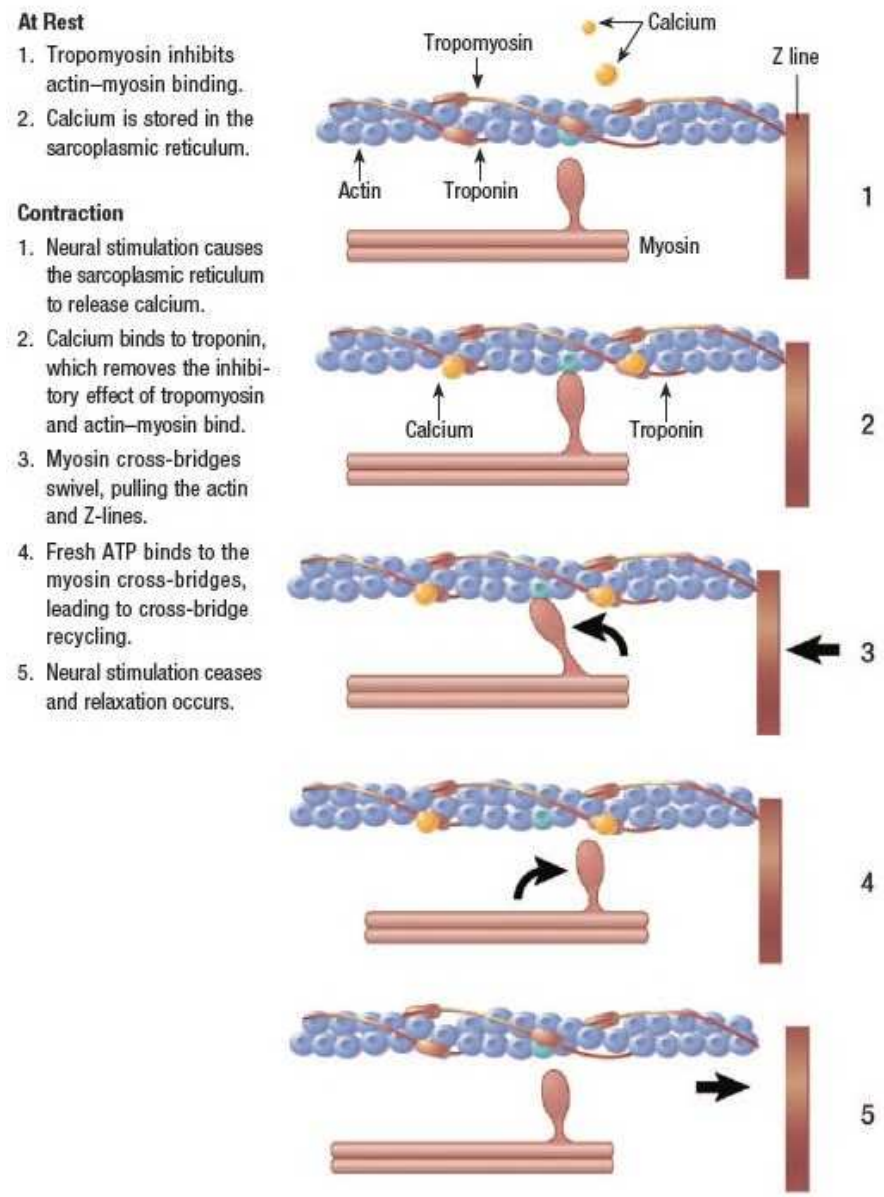
Sliding Filament Model

Widely accepted as the most complete explanation of the mechanism of muscle contraction.



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Reflections on…
Muscle Contractions

- Does it surprise you that debate continues regarding the exact mechanism of muscle contraction?
- Considering the explanation as laid out on pages 25–28 of the textbook:
  - Does it surprise you that something so apparently simple is actually so complex?
  - Or does it make sense to you that many different steps are involved?

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Learning More

- Muscles
- Muscle Physiology—Myofilament Structure
- Sliding Filament Model

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Student Website

- Go to the Chapter 2 page of the student website to see the Study Guide, Practice Quiz, Key Concepts, Artwork, and more.

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CHAPTER 2

lab

Determination of One-Repetition Maximum Bench Press and Leg Press Strength

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Background

- One-repetition maximum (1-RM):
  - The maximum amount of weight that can be lifted one time
  - The standard index to quantify muscle strength
- After a warm-up period, progressively heavier weights are lifted until the subject cannot successfully complete the lift of a given weight.
- A 1-RM value is affected not only by the subject's strength but also by the subject's skill in performing the task

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In This Lab…

- Learn to perform 1-RM strength testing for bench press and leg press exercises.
- Compare the 1-RM strength values to age- and gender-specific norms.

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Bench Press (with spotter)

The subject should lower the weight slowly until the barbell touches the mid-chest.

During ascent and descent, the forearms should be vertical to the floor and parallel to each other.

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Leg Press

The subject lowers the weight slowly until the angle at the knee reaches approximately 90 degrees.

The subject should keep the legs in line with the hips and ankles.

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Extension Questions for This Lab

1. What are some common mistakes that may occur in administering this lab?
2. Identify possible sources of error in this lab.
3. Assess the practicality of using this lab in the field.
4. Research the reliability and/or validity of this lab using online resources, journal articles, and other credible sources.

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