5. Interactions between myosin and actin generate force during muscle contractions
6. Calcium ions and regulatory proteins control muscle contraction
7. Diverse body movements require variation in muscle activity
5. Interactions between myosin and actin generate force during muscle contractions

- The **sliding-filament model** of muscle contraction.

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Fig. 49.33
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6. Calcium ions and regulatory proteins control muscle contraction

- At rest tropomyosin blocks the myosin binding sites on actin.
- When calcium binds to the troponin complex a conformational change results in the movement of the tropomyosin-tropinin complex and exposure of actin’s myosin binding sites.

Fig. 49.34
• But, wherefore the calcium ions?
• Follow the action potential.
• When an action potential meets the muscle cell’s sarcoplasmic reticulum (SR) stored Ca$^{2+}$ is released.
• Review of skeletal muscle contraction.

Fig. 49.36

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7. Diverse body movements require variation in muscle activity

- An individual muscle cell either contracts completely or not at all.
- Individual muscles, composed of many individual muscle fibers, can contract to varying degrees.
  - One way variation is accomplished by varying the frequency of action potentials reach the muscle from a single motor neuron.

Fig. 49.37
• Graded muscle contraction can also be controlled by regulating the number of motor units involved in the contraction.
• **Recruitment** of motor neurons increases the number of muscle cells involved in a contraction.

• Some muscles, such as those involved in posture, are always at least partially contracted.
  
  • Fatigue is avoided by rotating among motor units.
• Fast and Slow Muscle Fibers.

• **Fast muscle fibers** are adapted for rapid, powerful contractions.

• Fatigue relatively quickly.
• **Slow muscle fibers** are adapted for sustained contraction.
  
  • Relative to fast fibers, slow fibers have.
    
    • Less SR $\rightarrow \text{Ca}^{2+}$ remains in the cytosol longer.
    
    • More mitochondria, a better blood supply, and **myoglobin**.
Other Types of Muscle.

In addition to skeletal muscle, vertebrates have cardiac and smooth muscle.

Cardiac muscle: similar to skeletal muscle.

- Intercalated discs facilitate the coordinated contraction of cardiac muscle cells.
- Can generate their own action potentials.
- Action potentials of long duration.
Fig. 40.4

(a) Skeletal muscle

(b) Cardiac muscle

(c) Smooth muscle
**Smooth muscle**: lacks the striations seen in both skeletal and cardiac muscle.

- Contracts with less tension, but over a greater range of lengths, than skeletal muscle.
- No T tubules and no SR.
  - \( \text{Ca}^{2+} \) enters the cytosol from via the plasma membrane.
- Slow contractions, with more control over contraction strength than with skeletal muscle.
- Found lining the walls of hollow organs.
• Invertebrate muscle cells are similar to vertebrate skeletal and smooth muscle cells.