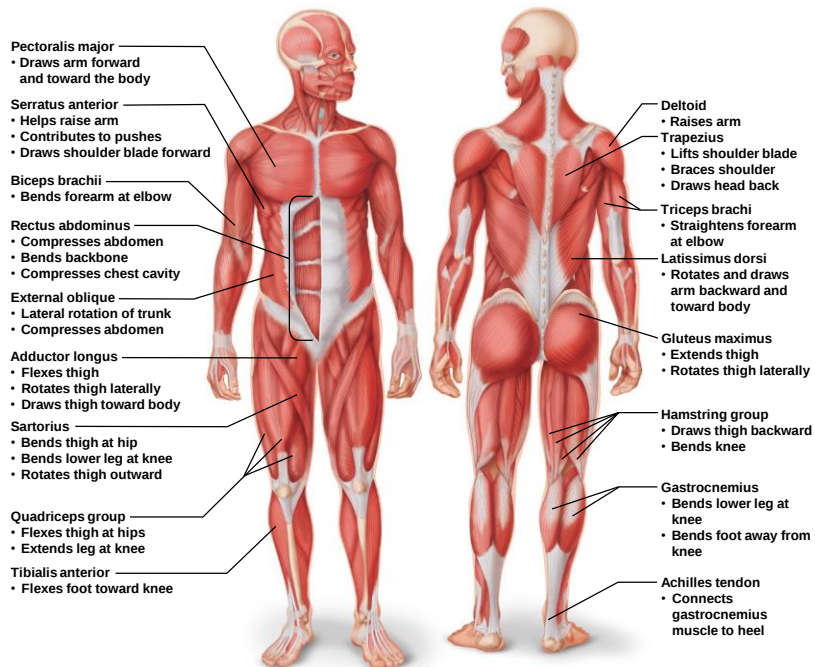


The Muscular System



1

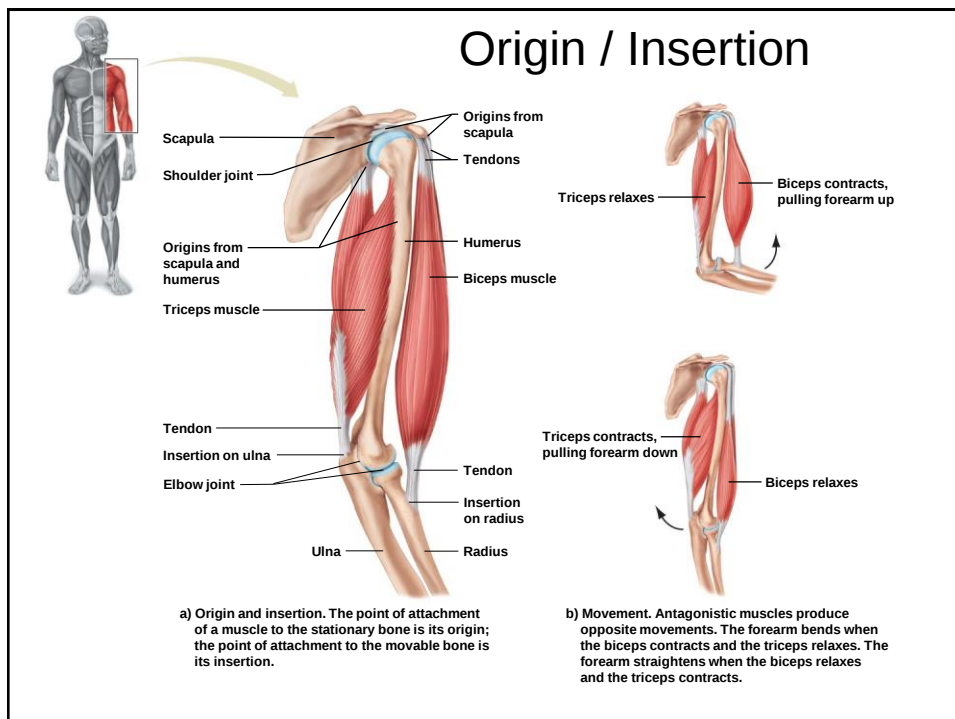


2

Muscle Function: Produce Movement or Generate Tension

- Principle function
 - **Contraction**
 - shortens distance between bones
 - Skeletal muscle moves bone
- Muscle groups
 - Synergistic
 - groups work together
 - Antagonistic
 - groups oppose each other

3

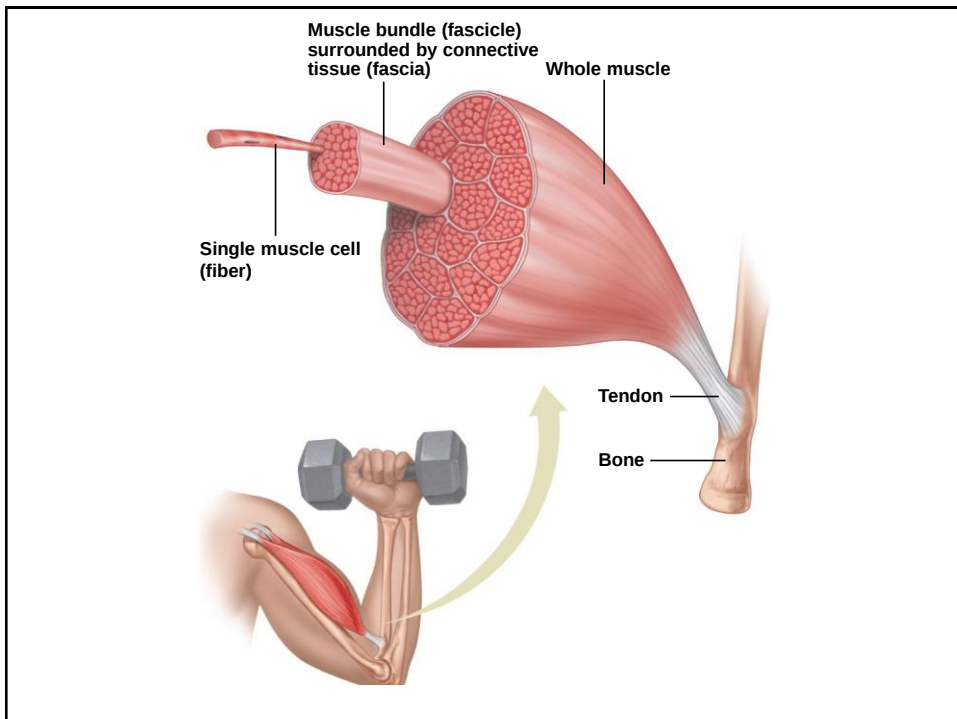


4

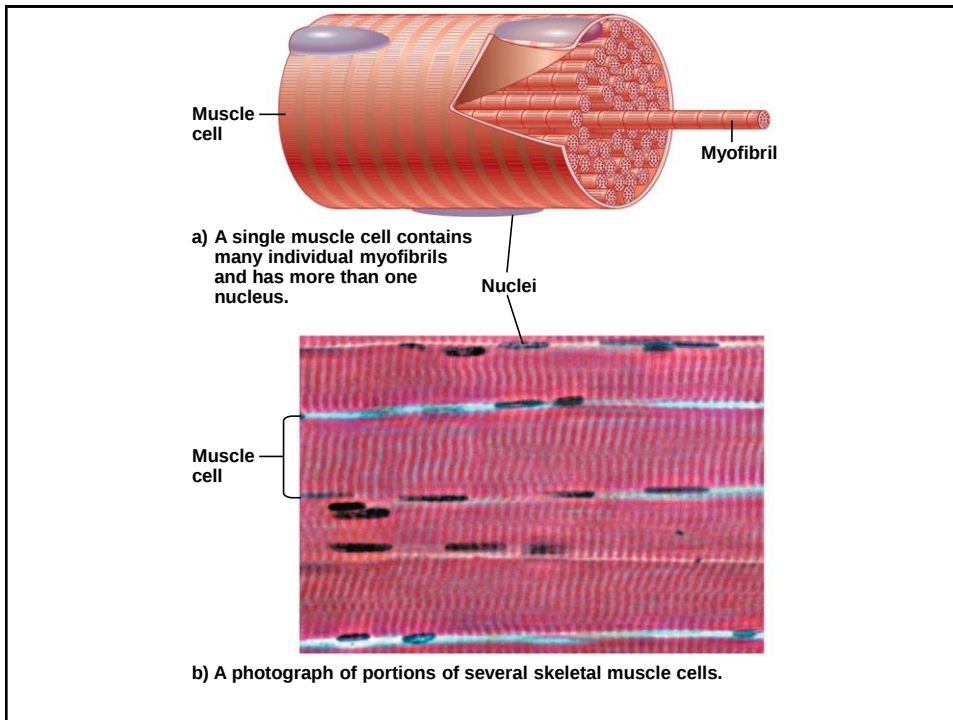
Muscle Structure

- Fascicles
 - Bundles of muscle fibers wrapped with connective tissue (fascia)
- Muscle fibers (muscle cells)
 - Long, tube shaped
 - Multinucleate
 - Packed with myofibrils
 - Myofibrils contain
 - Actin
 - Myosin

5



6

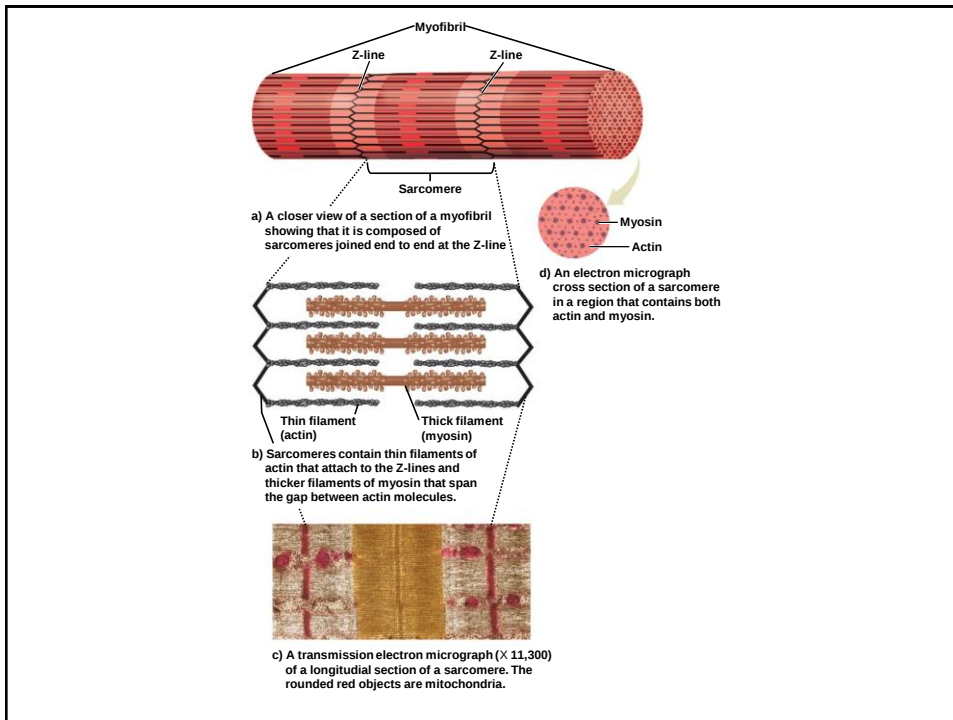


7

Skeletal Muscle Contractile Unit

- **Sarcomere:** contractile unit
 - **Myosin**
 - forms thick filaments
 - **Actin**
 - forms thin filaments
- **Z Lines**
 - attachment points for sarcomeres
- Arrangement of filaments gives rise to **striated** appearance of skeletal muscle

8

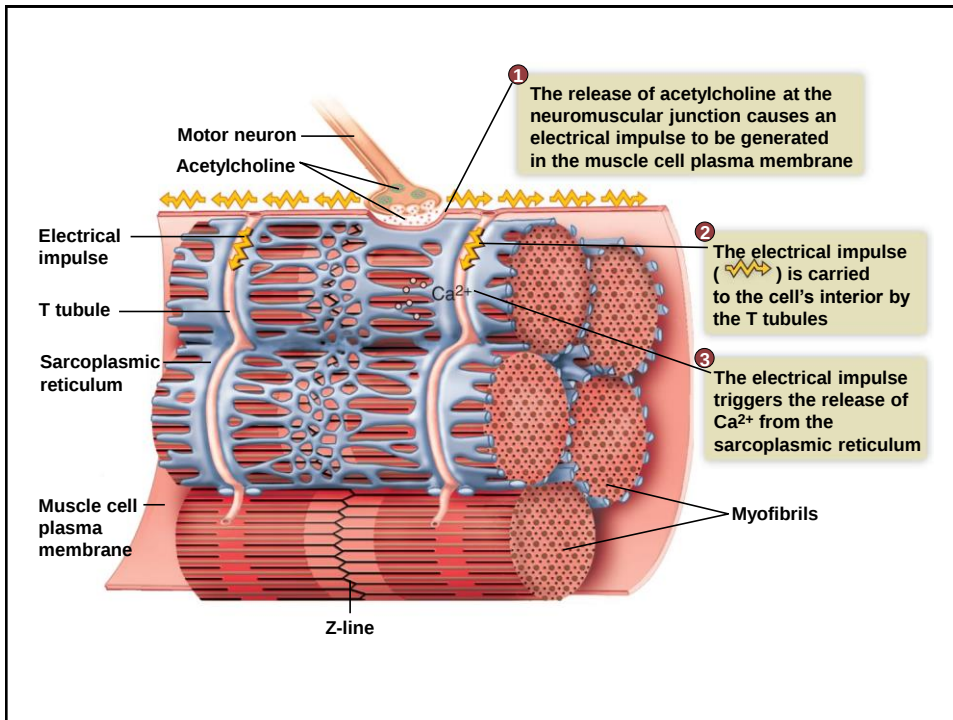


9

Nerve Activation of Individual Muscle Cells

- Acetylcholine is released from motor neuron at neuromuscular junction
- Electrical impulse transmitted along T tubules
- Calcium released from sarcoplasmic reticulum

10

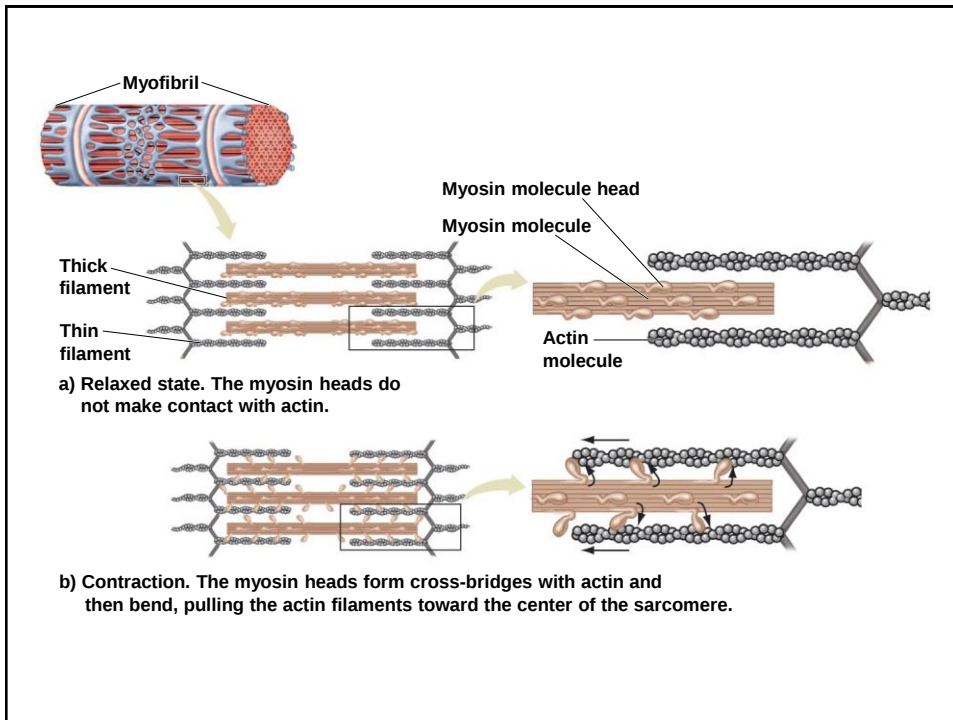


11

Calcium Initiates the Sliding Filament Mechanism

- Thick filaments
 - myosin
- Thin filaments
 - strands of actin molecules
- Contraction
 - formation of cross-bridges between thin and thick filaments

12

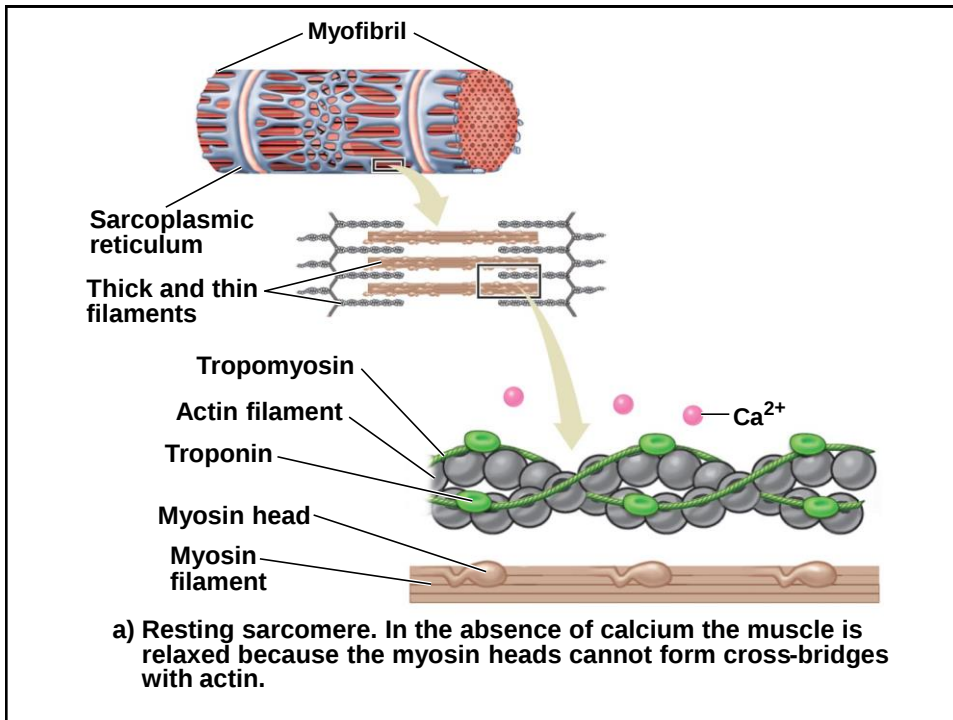


13

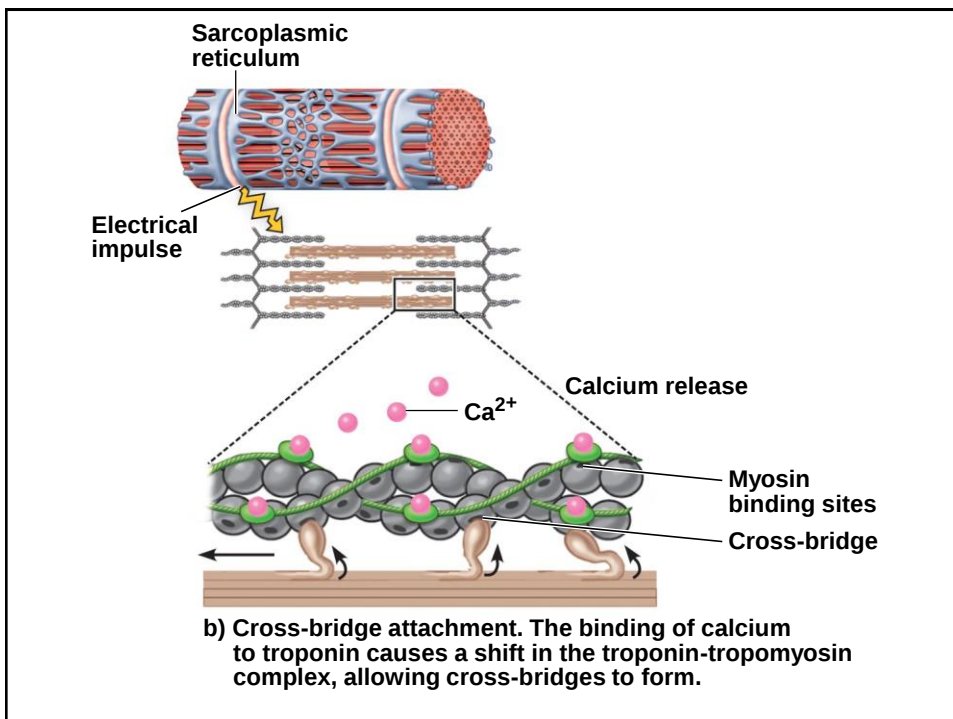
Mechanism of Muscle Contraction

- Calcium is released from sarcoplasmic reticulum
- Calcium binds to troponin
- Troponin–tropomyosin complex shifts position
- Myosin binding site is exposed
- Myosin heads form cross-bridges with actin
- Actin filaments are pulled toward center of sarcomere

14



15



16

Muscle Relaxation

- Nerve activation ends, contraction ends
- Calcium pumped back into sarcoplasmic reticulum
- Calcium removed from troponin
- Myosin binding site covered
- No calcium = no cross-bridges

17

Energy Required for Muscle Activity

- Principle source of energy
 - ATP
- ATP required for contraction
- ATP required for relaxation
- ATP is replenished by a variety of means
 - Creatine phosphate
 - Stored glycogen
 - Aerobic metabolism of glucose, fatty acids, and other high-energy molecules

18

Activity of Muscles Can Vary

- **Isotonic contractions**
 - muscle shortens, movement occurs
- **Isometric contractions**
 - muscle doesn't shorten, no movement
- Degree of nerve activation influences force

19

Degree of Nerve Activation Influences Force

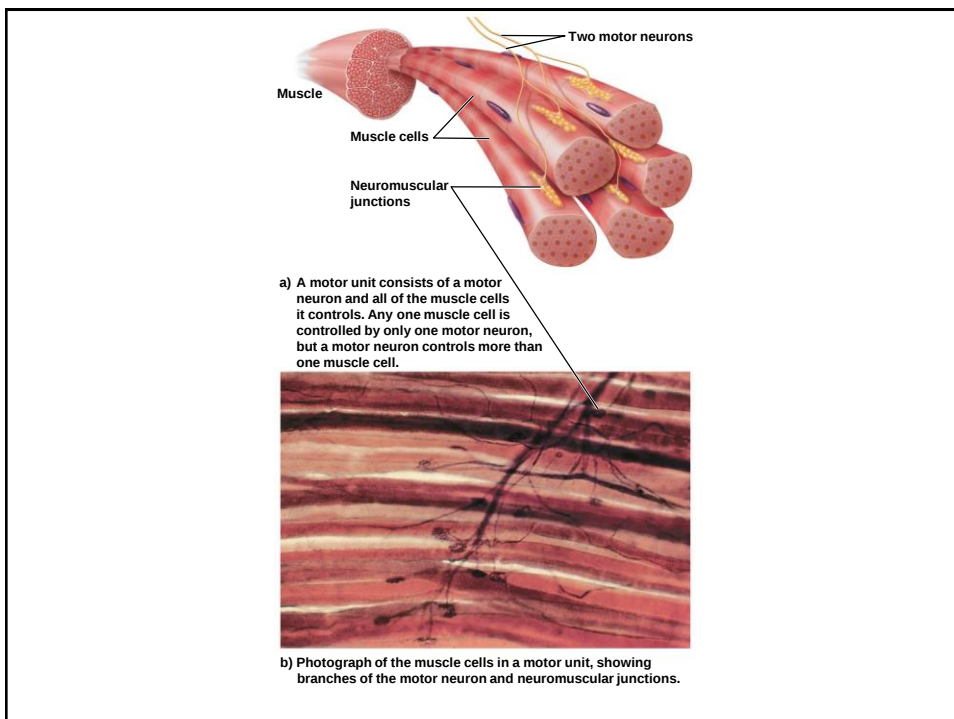
- **Motor unit**
 - Motor neuron and all the muscle cells it controls
 - Smallest functional unit of muscle contraction
- **Muscle tension**
 - Mechanical force that muscles generate when they contract
 - Determined by
 - Motor unit size
 - Number of active motor units
 - Frequency of stimulation of motor units

20

Degree of Nerve Activation Influences Force

- **All-or-none principle**
 - Individual muscle cells are completely contracting or are relaxed
- **Muscle tone**
 - Whole muscles – maintain intermediate level of force known as muscle tone
- **Recruitment**
 - Activation of additional motor units increases muscle tone

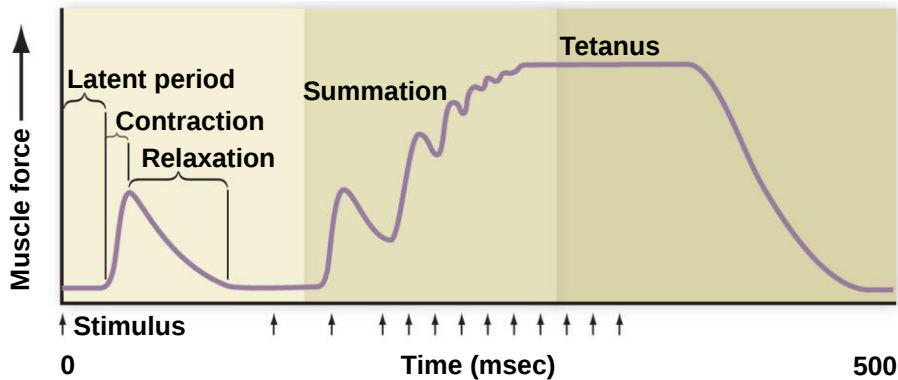
21



22

Muscle Twitch

- Complete cycle of contraction-relaxation in response to stimulus
- Can be observed using a myogram (laboratory recording of muscle activity)



23

Muscle Activity

- Two types of muscle fibers
 - **Slow twitch**
 - endurance, long duration contraction, contain myoglobin
 - Jogging, swimming, biking
 - **Fast twitch**
 - strength, white muscle, short duration contraction
 - Sprinting, weight lifting, tennis

24

Exercise Training

- **Strength training**
 - Resistance training
 - Short, intense
 - Builds more fast-twitch myofibrils
- **Aerobic training**
 - Builds endurance
 - Increases blood supply to muscle cells
 - Reach target heart rate for at least 20 minutes, three times a week

25

Diseases and Disorders of the Muscular System

- Muscular dystrophy
 - Hereditary diseases
 - Missing gene that produces protein (*dystrophin*)
- Tetanus
 - Bacterial infection
 - Causes muscles to 'lock up'

26

Diseases and Disorders of the Muscular System

- Muscle cramps
 - Uncontrolled flex of muscle
 - Caused by:
 - Dehydration & Ion imbalance
- Pulled muscles
 - Stretching the muscle too far
- Fasciitis
 - Inflammation of the connective tissue around muscles