Types of Muscle:

**Skeletal**- muscle involved in movement of the skeleton. **Striated**, has alternating bands of light and dark due to overlapping filaments within the muscle cell. Skeletal muscle can be consciously controlled so is referred to as voluntary.
**Cardiac** - The muscle of the heart. It is also **striated** but is **involuntary**.

**Smooth** - Found in the internal organs and blood vessels. Is **not striated**, and is **involuntary**.
Functions of muscle-

A. Motion
B. Movement of substances within the body.
C. Maintaining body positions and controlling organ volume.
D. Production of heat
Characteristics of Muscle

A. **Excitability**- can respond to stimuli
B. **Contractility**- can become shorter
C. **Extensibility**- can stretch
D. **Elasticity**- can return to it’s original position after stretching or contracting
Fascia- A connective tissue found under the skin and located outside the epimysium

Epimysium- fibrous connective tissue covering the entire muscle

Fasiculi- bundles of muscle fibers

Perimysium- connective tissue surrounding the fasiculi

Muscle fiber-muscle cell
Figure 1: Muscle belly split into various component parts (from Essentials of Strength Training & Conditioning, National Strength & Conditioning Association)
Structure of muscle fibers

Sarcolemma - muscle cell membrane
Sarcoplasm - cytoplasm
Sarcoplasmic reticulum - endoplasmic reticulum in a muscle cell
Myofibrils - bundles of protein filaments
myofilaments - actin and myosin (proteins) that make up myofibrils

actin - thin protein filaments

myosin - thick protein filaments
T-Tubules- tubes running perpendicular through the sarcoplasmic reticulum, that carry nerve impulses to the muscle fiber
Muscle Contraction

-Nerve impulse travels to the muscle fiber
-T-tubules carry the impulse to the sarcoplasmic reticulum
-Sarcoplasmic reticulum releases calcium ions to the myofilaments (primarily actin)
ATP and Calcium ions (Ca ++) combine and create “crossbridges” on myosin heads.

ATP → ADP + P + Energy

ATP = adenosine triphosphate
Energy enables the crossbridges and myosin heads to change shape causing actin and myosin to slide over the top of one another. (Sliding filament mechanism)

When nerve impulse stops, the Ca++ are actively transported back to the sarcoplasmic reticulum and the muscle relaxes.
Thick and Thin Filaments

- Sarcomere
- I band
- A band
- I band
- M line
- Z disc
- Thin myofilament (actin)
- Thick myofilament (myosin)
- H zone
- Myosin heads

1 of 2
Sliding Filament Mechanism

Relaxed Muscle (2 Sarcomeres)

- A band
- I band
- H zone
- Thin myofilament
- Thick myofilament
- Z disc
Sliding Filament Mechanism

Partially Contracted
Sliding Filament Mechanism
Maximally Contracted
Motor unit- A motor neuron and all the muscle fibers it controls

-in the hands and fingers a motor unit may contain 10 muscle fibers

-in the large muscles of the leg a motor unit may contain several hundred muscle fibers.
Muscle Fiber types

-Muscle fibers are classified by their structure and the speed in which they contract.

-Type I- slow twitch: smaller with less overall contraction force but are more energy efficient (Also called slow oxidative—are fatigue resistant)
-Type II- Fast twitch: larger with greater overall force but are not as efficient and are more easily fatigued
  A-Fast oxidative-somewhat fatigue resistant
  B-Fast glycolytic-Fatigues quickly
Physiological differences in Muscle Fiber Types

- Fast twitch (Type II) fibers have greater amounts of the enzyme ATPase that enables ATP to breakdown and release its energy for muscle contractions
  - A-Fast oxidative have high amounts of myoglobin (carries oxygen) and more mitochondria.
  - B-Fast glycolytic have low myoglobin and high amounts of glycogen
Slow twitch (slow oxidative) fibers have poorly developed sarcoplasmic reticulum which does not allow for Ca++ to be released as quickly as fast twitch fiber
Fiber types and Athletic Performance

-Slow twitch fibers are better suited for endurance activities—Some studies show that world class runners have up to 80% slow twitch fibers in their legs.
-Fast twitch fibers are better suited for power activities—World class sprinters may have 75% fast twitch fibers in their legs.
All skeletal muscles are a combination of all three muscle fiber types:
- Type I - Slow twitch (slow oxidative)
- Type II - Fast twitch
  A - Fast oxidative
  B - Fast glycolytic
The determination of muscle fiber types in the body
Studies have shown that training increases the efficiency of all muscle fiber types but does not change the type of fiber.

(Endurance training can alter a Fast glycolytic(B) to a Fast oxidative(A))
Heredity appears to be responsible for determining the percentage of fiber types in individuals.
What happens to a muscle fiber when you train?

1. There is an increase in Actin and Myosin filaments (not muscle fibers)
2. Mitochondria increase in number
3. Increase in enzymes to catalyze reactions.
HOW MUSCLES CAUSE MOVEMENT

Muscles can only pull, they cannot push. A muscle pair is termed **antagonistic** if the contraction of one muscle (agonist) bends a joint and the contraction of the other (antagonist) straightens the joint.
Examples:
A muscle that bends is called a **FLEXOR**.

A muscle that straightens a joint is called a **EXTENSOR**.
The point at which the muscle is attached to the anchoring bone is the **ORIGIN**.

The point at which the muscle is attached to the moving bone is the **INSERTION**.
Two muscles of the upper arm: **BICEPS** and **TRICEPS**.
The biceps has its **origin** at the shoulder and its **insertion** on the radius, a bone of the forearm.
The **triceps** on the back of the upper arm has its **origin** on the humerus of the upper arm and its **insertion** on the ulna.
These two antagonistic muscles work to flex and extend the arm.
The following is a list of the principle actions of muscles:

- **flexion** - bending a joint
- **extension** - straightening a joint
- **abduction** - movement away from the body
- **adduction** - movement toward the body
supination-turning the palm upward
pronation-turning the palm downward
rotation-movement around an axis
levator-upward movement
depression-downward movement
inversion-movement of the ankle
inward
eversion-movement of the ankle
outward(sometimes called pronation by runners)
Muscle are named in the following ways:

1. Direction of fibers
   - rectus-parallel (rectus abdominis)
   - oblique-diagonal (external oblique)

2. Location (tibialis anterior)

3. Size (gluteus maximus)

4. Number of origins (triceps)

5. Shape (deltoid, trapezius)

6. Location of attachments
   - (sternomastoid)

7. Action (flexor digitorum)
Muscles of Head and Neck

Occipitofrontalis - elevates eyebrows (wrinkles forehead)
Orbicularis oris - closes and protrudes lips
Orbicularis oculi - closes and squints eye
Zygomaticus major - pulls corner of mouth back and upward
Platysma - tighten skin of neck, pulls corner of lower lip down
Masseter - closes mandible as in chewing
Sternocleidomastoid - rotates head down and to the side
Semispinalis and splenius capitus - pulls head backward
Muscles of Arm and Shoulder

Trapezius-raises shoulder, pulls shoulders together,
Deltoid-abducts upper arm
Latissimus dorsi-adducts upper arm and shoulder
Biceps brachii-flexes arm
Triceps brachii-extends arm
Flexor carpi-flexes wrist
Extensor carpi-extends wrist
Flexor digitorum-flexes fingers
Extensor digitorum-extends fingers
Brachioradialis-helps flex arm
Rotator muscles-(subscapularis, teres minor, supraspinatus, infraspinatus) -rotates upper arm
Muscles of the Chest, Back, Abdomen

Pectoralis major - pulls upper arm across chest

Rectus abdominis - flexes vert. column, compresses internal organs

External oblique - aids in breathing, compresses body cavity, some flexion of vert. column

Trapezius - raises shoulder and pulls it back

Latissimus dorsi - adducts arm, pulls shoulder down

Quadratus lumborum - extends lower vert. column

Erector spinae - extends upper vert. column
Muscles of the Legs

Gluteus maximus-extends upper leg

Hamstring(biceps femoris, semitendinosus, semimembranosus)-flexion of lower leg, extends upper leg

Quadriceps(vastus lateralis, vastus intermedius, vastus medialis, rectus femoris)-extension of lower leg

Tensor fascia latae-abduction of leg

Gracilis-adduction of leg

Adductor longus-adduction of leg

Gastrocnemius-plantar flexion (raises heel)

Tibialis anterior- dorsiflexion(pulls foot up)