

**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.

#### <u>Smooth</u>- 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



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T-Tubules- tubes running perpendicular through the sarcoplasic 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





#### Sliding Filament Mechanism Partially Contracted



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#### Sliding Filament Mechanism Maximally Contracted



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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 <u>slow</u> <u>oxidative</u>-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 it's 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?

 There is an increase in Actin and Myosin filaments (not muscle fibers)
Mitochondria increase in number
Increase in eyzymes to catalyze reactions.

- HOW MUSCLES CAUSE MOVEMENT Muscles can only pull, they cannot push.
- A muscle pair is termed <u>antagonistic</u> 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 antgonistic 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)





Eversion sprain



Sprained medial ligament





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 upperleg
- 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)