Structure & Function of Skeletal Muscle
“When a muscle contracts, it knows no direction; it simply shortens.” Lippert

Muscle is the sole producer of active force in the body which makes it responsible for all active motions.

Muscles also control and stabilize posture through their action on joints.
Muscles receive input from the nervous system

- Force develops in response to the stimulus
- The force is the result of a contraction which “pulls” to create movement
- However muscles are capable of:
  - Shortening
  - Lengthening
  - Remaining the same length
An active muscle develops force in only one of the following 3 ways:

<table>
<thead>
<tr>
<th>How</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>By contracting</td>
<td>Concentric</td>
</tr>
<tr>
<td>By resisting elongation</td>
<td>Eccentric</td>
</tr>
<tr>
<td>By remaining a constant length</td>
<td>isometric</td>
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</table>
As a muscle produces an active force and shortens the distance between the proximal and distal attachments of the muscle.
Eccentric

- As a muscle produces an active force attempting to contract but is simultaneously pulled to a longer length by a more dominant external force.
- Gravity is usually the external force which exceeds the internal ability of the muscle
- The muscle is effectively lengthened.
Isometric

- When a muscle generates an active force while remaining at a constant length
- There is no change in joint angle and no motion takes place
**Muscle Origins**

- The more stable point of connection
- The attachment point that the other end of the muscle moves toward

- **Biceps Brachii**
Muscle Contraction

- **Muscle Insertions**
  - The more moveable attachment point for the muscle
  - This attachment moves toward the more stable or proximal bony attachment point
**Muscle Terminology**

- **Agonist**
  - The muscle performing the task

- **Antagonist**
  - The opposing muscle to the task being performed

![Muscle Diagram](image)
Co-Contraction

- Agonist and Antagonist contract simultaneously
- Provide stabilization
Muscle Terminology

- **Synergists**
  - Muscles that work together

- **Force Couple**
  - Muscles that work together in opposite directions to produce torque in the same rotational direction
Muscle Names

- Location
- Shape
- Action
- Number of heads
- Attachments
- Direction of the fibers
- Size of the muscle
Muscle Names

- Location
- **Shape**
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**Rhomboids**

Located beneath the trapezius muscle

<table>
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<tr>
<th>Exercise</th>
<th>Description</th>
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<tr>
<td>Seated Rows</td>
<td>T-Bar Row</td>
</tr>
<tr>
<td>Bent-over Rows</td>
<td>Bent-over Rear Deltis with palms neutral (Reverse Flys)</td>
</tr>
<tr>
<td>Bent-over dumbbell rows</td>
<td></td>
</tr>
</tbody>
</table>

**Exercises:**
- Seated Rows
- T-Bar Row
- Bent-over Rows
- Bent-over Rear Deltis with palms neutral (Reverse Flys)
- Bent-over dumbbell rows with palms down (High Rows)
Muscle Names

- Location
- Shape
- **Action**
- Number of heads
- Attachments
- Direction of the fibers
- Size of the muscle

Extensor Indicis
Muscle Names

- Location
- Shape
- Action
- **Number of heads**
  - *Biceps Brachii*
  - *Triceps Brachii*
- Attachments
- Direction of the fibers
- Size of the muscle
Muscle Names

- Location
- Shape
- Action
- Number of heads
- **Attachments**
  - Sternocleidomastoid
- Direction of the fibers
- Size of the muscle
Muscle Names

- Location
- Shape
- Action
- Number of heads
- Attachments
- *Direction of the fibers*
  - Vastus Medialis Oblicus (VMO)
- Size of the muscle
Muscle Names

- Location
- Shape
- Action
- Number of heads
- Attachments
- Direction of the fibers
- Size of the muscle
  - Pectoralis Major
Muscle Fiber Arrangement

- Parallel
  - Tend to be longer
  - Have a greater range of motion
Muscle Fiber Arrangement

- Oblique
  - Shorter
  - More numerous (Dense)
    - Great strength
Muscle Fiber Arrangement

- Rhomboid muscle
  - Four sided
  - Usually flat
  - Broad attachments at each end
    - Pronator teres
    - Gluteus maximus
    - Rhomboids in the shoulder girdle
Muscle Fiber Arrangement

- Triangular Muscle
  - Narrow attachment on one end (*insertion*)
  - Broad attachment on the other end (*origin*)
  - Pectoralis major
Unipennate

- Fibers arranged in a pattern that resembles one side of a feather
  - Short fibers attaching diagonally into a central tendon
  - Tibialis posterior
Bipennate

- Short fibers that bilaterally attach into a central tendon
- Featherlike in appearance
  - Rectus femoris
  - Rectus abdominus
Multipennate

- Muscles have many tendons with oblique muscle fibers in between them
  - Deltoid
  - Subscapularis
The direction of a muscle’s force is referred to as its line of pull. This determines its action:
- If a muscle crosses a joint, it acts on that joint.
Active Length-Tension Relationship

- Strength of the muscle is the least when the muscle is in its shortest position and also when it is in its longest position.
- Strength is greatest at mid-length.
Passive Length-Tension Relationship

- A muscle generates greater internal elastic force when stretched.
Length-Tension Relationship

- **Excursion of a muscle**
  - The distance from maximum shortening to maximum lengthening
  - Think about the length of the quadriceps which must cross 2 joints, the hip and knee as a 2 joint muscle...
Speed Matters:

- Concentric muscle contractions
  - Muscle produces less force as the speed increases
  - You can repeatedly lift lighter versus heavy objects at great speed
  - The muscle cannot produce force at great speeds when the objects are heavy
Speed Matters:

- Isometric activation creates greater force than any speed contraction
- Eccentric activation
  - Force production increases slightly as the speed of the elongation increases
Muscular Tightness

Due to the adaptability of muscular tissue:

- Muscle will assume the length most common to it
- “What you don’t use, you lose”
- Immobility can cause muscle tightness and/or loss of motion
- Severe loss of motion can lead to joint contracture
  - The joint is incapable of permitting full motion
A protective mechanism:

- This is referred to as **muscle guarding**
- The muscular system “tightens” to help protect the body from further injury however;
  - Circulation is impaired
  - Metabolites build up
  - Pain results
  - Edema results
Irritability

- The ability to respond to a stimulus
  - A muscle contracts when stimulated.
**Contractility**
- The ability to shorten or contract, producing tension between the origin and insertion of the muscle.
  - Muscle may:
    - Stay the same length
    - (isometric)
    - Shorten
    - (concentric)
    - Lengthen
    - (eccentric)
Functional Characteristics of Muscle

- Extensibility
  - The ability to stretch when a force is applied.
Elasticity

- The ability to recoil, or return to a normal resting length once the stimulus or force to stretch or shorten has been removed.
Stretch a muscle and it will lengthen.

- extensibility
Remove the stretch, and it will return to its normal resting position.

- elasticity
Stimulate a muscle and it will respond,
- irritability
- by shortening
  - contractility
Then remove the stimulus and it will return to its normal resting position.

- elasticity
Tenodesis (based upon passive insufficiency)

- while resting the elbow on a table, flexing the wrist will have a tendency to extend the fingers
Functional Characteristics of Muscle

- Tenodesis (due to passive insufficiency)
  - Supinating the forearm and extending the wrist will have a tendency to flex the fingers.

*This can help someone either grasp something or release something…*