**Muscle Mechanics Outline**

1. Muscle force or human strength?

2. What are some of the factors that influence skeletal muscle force production capability?

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**How do muscle force and human strength relate?**

What is required to be strong?

- The ability to develop large internal joint torques

In review, what do large internal joint torques depend on?

1. Large skeletal muscle force
2. Large corresponding perpendicular distances

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**What factors influence skeletal muscle force production capacity?**

1. Cross Sectional Area
2. Muscle Design
3. Fiber Length
4. Contraction Velocity
5. Fiber Type
6. Neuromuscular Factors

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**Increasing Cross Sectional Area: Hypertrophy or Hyperplasia?**

**Hypertrophy:**

- 5% in 6 weeks; 15% in 8 weeks; 9-23% in 3-5 months

**Hyperplasia:**

- Antonio & Gonyea, 1993, and McCall et al., 1996

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**Muscle Design**

Muscle design affects skeletal muscle force production

2. Pennation angle.

Most muscles exhibit different combinations of these three characteristics

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**Fiber Architecture**

**In-series:**

- excursion = fiber excursion × fiber number
- force = fiber force

This arrangement results in greater ranges of motion and speeds, but less force

**Parallel fibers:**

- excursion = fiber excursion
- force = fiber force × fiber number

This arrangement facilitates high magnitude strength, but usually involves less motion
Pennation Angle
Angle is relative to the long axis of muscle (θ > 0)
Muscle excursion is less than fiber excursion, however more fibers in a given volume result in more force; results in less excursion, but greater force.

Fiber Length
Active muscle force is influenced by the amount of myofibril (actin and myosin) overlap, which partly depends on fiber and sarcomere length.

Fiber Length
Total tension = active tension + passive tension
Peak tension is reached at resting length, or slightly longer than resting length (~120% of resting)
Many muscles reach peak force near the middle of joint range of motion.

Fiber Action Velocity
Muscle force also depends on contraction velocity
Resistance training increases the isometric load level (i.e., raises the velocity × force curve)
What does this imply concerning eccentric training? Pros and cons?

Muscle Action Velocity & Power
Maximum power is reached at about 33% of peak force and shortening velocity
According to this figure, what is theoretically best when training for power?

Fiber Type
At a given speed of shortening, a muscle with more fast-twitch fibers can produce greater force than a muscle with more slow-twitch fibers.
Neuromuscular Factors:
Firing Rate and Recruitment