INTRODUCTION

Readings: Ch. 1 pp. 3-15 & Ch. 3 pp. 39-46

- What is biomechanics?
  - Definition:

  - ______________
  - ______________
  - ______________
  - ______________
  - ______________
  - ______________

- Why study biomechanics?
  - From a mechanical perspective...
    - How do we generate and control movements?
    - What are the physical and anatomical limitations or restrictions that we must deal with?
    - How can we improve our movements or performance?
People (http://asb-biomech.org/historybiomech/index.html)

- Socrates
  - 2400 Years ago
  - Inward inquiry (perception)
- Plato
  - Mathematics basis of science – mechanics
- Aristotle
  - First biomechanist
  - On the Movement of Animals
  - Qualitative Analysis
- Galen
  - 1800 Years ago
  - On the Function of Parts
- da Vinci (1452)
  - Understood many things, but never published
- Galileo
  - Bone Mechanics
  - Hollow is stronger
- Borelli (1608)
  - De Motu Animalium
    - Musculoskeletal levers
    - CG and equilibrium

Improving our movements...

- Health and well being
- Technique
- Training
  - Footwear - running shoes
  - Sports equipment - landing mats, protective padding, braces/taping
  - Ergonomics - workplace assessments (lifting techniques, keyboard designs, etc.)
Optimization of movement

- Rehabilitation
  - rehab exercise safety and efficacy
  - surgical approaches/effectiveness, brace design
  - exercise and sport - sprint starts, swimming strokes, strength training equipment

Mechanics Overview

- Forms of Motion
  - Rectilinear
  - Curvilinear
  - General

- Mechanics
  - Statics
  - Dynamics
    - Linear
    - Angular
    - Linear
    - Angular

- Fluids
Muscle

Readings: Ch. 14, pp. 255-278

- How Muscle Force is Generated
  - Muscles convert chemical energy into mechanical work
  - Muscles are internal motors of human body responsible for all movements of skeletal system
  - Muscles can only pull; they cannot push
  - must ____________ to create motion
  - our focus--skeletal (striated) muscle

- Basic muscle characteristics
  - ____________________— sensitive to stimulation
  - ____________________— capacity to shorten
  - ____________________— capacity to lengthen
  - ____________________— ability to return to original state after lengthening or shortening

Muscle

- Basic muscle structure
  - considerable variation in ____________________ depending on function
  - need for power vs. ROM vs. fast movement vs. postural control vs. precise movement

- Active vs. passive muscle tissues...
  - Excitable (active) muscle tissues -- muscle fibers: actin/ myosin elements and their linkage (cross bridges)
  - Passive (non-excitable) tissues -- ____________________
   ____________________
Actin/Myosin arrangement

- thick filaments or myofibrils
- thin filaments

Sliding Filament Theory

- Steps
  1) ________________
  2) Myosin pulls actin
  3) ________________
  4) Myosin ready for another x-bridge formation
Muscle actions

- **Active** muscle that shortens against resistance
- Biceps brachii during elbow flexion in a standing biceps curl

**Eccentric**
- Active muscle that 
  __________ against a resistance
- Biceps brachii during elbow extension in a standing biceps curl

Muscle actions

- **Isometric** ("same length") or static
  - Essentially no change in overall muscle length during activation
  - It is important to remember that when a muscle is activated, the only thing it can try to do is to shorten (i.e., tries to bring the origin and insertion closer together)
  - Relates to directionality of cross-bridge function.
Factors affecting muscle force production

- Excitation factors - role of nervous system
  - Motor unit (MU) = a motor neuron and all muscle fibers it innervates.
  - When a motor neuron is activated, all of its muscle fibers are activated and contribute to force production.
  - To increase force, **NS recruits more MUs**.

- Rate at which MUs are stimulated.
  - To increase force, **NS recruits MUs more frequently** (e.g., from 10 Hz to 25 Hz).
Muscle architecture

- greater area, greater force producing ability (PCSA)
- Fiber orientation

<table>
<thead>
<tr>
<th>Longitudinal</th>
<th>Bipennate</th>
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<tr>
<td>CSA</td>
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<tr>
<td>Force</td>
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<tr>
<td>Shortening</td>
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Muscle mechanics

- Force production is a function of the _______ formed at any given time.

Length-tension relationship

- _______ component
  - related to actin-myosin overlap: # cross-bridges formed at any given time
- _______ component
  - related to connective tissue response: a very stiff rubber band
Force - velocity relationship

- faster speed of shortening, lower potential to form cross-bridge attachments, lower F producing potential
- greater forces can be sustained by muscle under eccentric conditions compared to concentric and isometric

"Directionality" of cross-bridge function
- takes more force to break attachment under eccentric conditions.

Muscle temperature
- Value of warm-up: primarily affects __________; has the effect of increasing force and power potential at any given velocity
Factors affecting muscle torque production

- **Muscle force**
  - Muscle moment arm
    - angle of pull
  - Time

**Muscle Model**

- Parallel Elastic Component
- Series Elastic Component
- Contractile Component
Factors affecting muscle torque production

- Muscle force
- **Muscle moment arm** - angle of pull
- Time
Factors affecting muscle torque production

Muscular Force Components

These components vary with joint angle

Stretch-Shorten Cycle
Strength training equipment

- Free weights
- Universal gym (circular pulleys)
- Nautilus (cams - elliptical pulleys)
- Life circuit (electronically controlled resistance)