

## Introduction to Biomechanics

By the end of this lesson, you should :

- *Have all the tools you will need to undertake this course*

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## Outline

Review:

- Terminology
- Newton's laws
- Dimensions & Units
- Trigonometry

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## Biomechanics?

**Biomechanics:** Principles of mechanics are applied to the conception, design, development, and analysis of equipment and systems in biology and medicine

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## Reviewing Basic Concepts

- You will never be tested directly on the following slides, but if you do not know the material, you will have difficulty!

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## Physics Terminology

- Variables: a, b, c, x, y, z, alpha, beta, gamma, theta, sigma
- Vector
- Mass
- Distance
- Time
- Force
- Gravity, Weight
- Moment, Torque
- Speed, Velocity
- Acceleration

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## Medicine Terminology

- Bone, Muscle, Ligament, Tendon
- Arm / Humerus
- Forearm / Radius & ulna
- Spine
- Thigh / Femur
- Shank / Tibia
- Ankle, Knee, Elbow, Wrist

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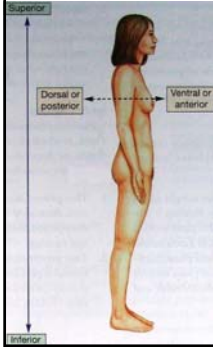
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## Directional Terminology



Term	Reference	Example
Anterior / <i>Ventral</i>	The front	The navel is anterior to the spinal cord
Posterior / <i>Dorsal</i>	The back	The shoulder blade is posterior to the rib cage
Superior	Above	The pectoralis major is superior to the psoas
Inferior	Below	The psoas are inferior to the pectoralis major

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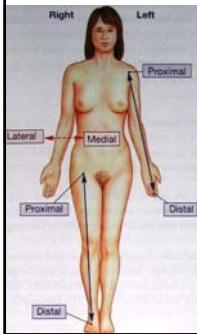
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## Directional Terminology



Medial	Toward the longitudinal axis	The medial surface of the thighs may contact each other
Lateral	Away from the longitudinal axis	The thighs articulate with the lateral surface of the pelvis
Proximal	Toward an attached base	The thigh is proximal to the foot
Distal	Away from an attached base	The foot is distal to the thigh

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## Directional Terminology

Superficial	Close to the surface	Skin is superficial to underlying structures
Deep	Away from the surface	The bone of the thigh is deep to surrounding muscles

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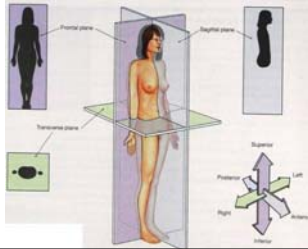
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## Planes of Section

Sagittal	Right / Left
Frontal (coronal)	Anterior / Posterior
Transverse	Superior / inferior



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## Newton's 1<sup>st</sup> Law

Objects at rest stay at rest  
& Objects in motion maintain the same velocity  
if the net force is 0.



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## Newton's 2<sup>nd</sup> Law

$$\underline{F} = \frac{d}{dt}(m\underline{v}) \approx m \frac{d}{dt}(\underline{v}) = m\underline{a}$$

Objects move in the direction they are pushed, and accelerate proportionately to the magnitude of the force

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## Newton's 3<sup>rd</sup> Law

For every action there is an equal and opposite reaction



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## Dimensional Analysis

Basic Dimensions:

Length = L

Time = T

Mass = M

Secondary Dimension Examples:

Area = Length \* Length = L<sup>2</sup>

Force = Mass \* Acceleration = ML/T<sup>2</sup>

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## Dimensionally Homogeneous?

- What is 3 kg + 5 m? ☺
- X + ZY + AB/C = K  
X, ZY, AB/C, and K must all have the same dimensions!

$$5Nm + 3 \frac{kgm}{s^2} * 2m = 11Nm$$

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## Dimensions & Units

Quantity	SI Unit	Special Name
Area	$m^2$	
Volume	$m^3$	
Velocity	$m/s$	
Acceleration	$m/s^2$	
Force	$kg \cdot m/s^2$	Newton (N)
Pressure & Stress	$N/m^2$	Pascal (Pa)
Moment (Torque)	N-m	
Work & Energy	N-m	Joule (J)
Power	$J/s$	Watt (W)

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## Units are important!

What is  $5 \text{ N} \cdot 10 \text{ m}$ ?

50 ???

50 Nm

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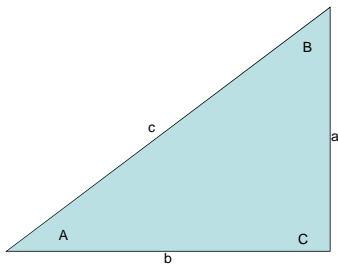
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## Trigonometry



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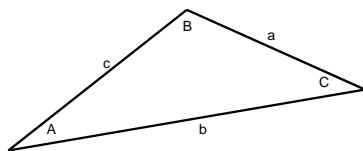
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### Law of Cosines



$$c^2 = a^2 + b^2 - 2ab\cos(C)$$

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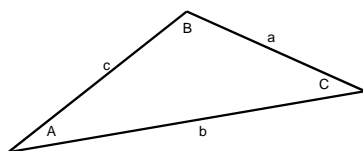
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### Law of Sines



$$\frac{\sin(A)}{a} = \frac{\sin(B)}{b} = \frac{\sin(C)}{c}$$

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