

## BIOLOGICAL FRAMEWORKS FOR ENGINEERS

---

### Session #20b [m: Musculoskeletal System – Muscle/Bone Interactions]

#### General Objectives:

- ✓ The musculoskeletal system is the integration of connective, neural, and muscular tissues into a coordinated system for movement and support
- ✓ Biomechanics of the musculoskeletal system enables body motion through complex systems integration involving numerous variables
- ✓ Discuss the feasibility of reconstruction surgery

#### Central Framework:

- ✓ Biomechanics needs to examine several factors: the arrangement of muscle fibers within a muscle, and the arrangement of tendons with respect to the bone, the anatomy of the bones, the ligament connections between the bones, the cartilage mechanics of friction, wear, and compression, and the neuronal activation and reflex.

#### Interactive Activity:

- ✓ Worksheet examining the basic biomechanics of flexion of the elbow

#### Session Outline:

##### I. Systems Integration – Musculoskeletal System

Skeletal Muscles –

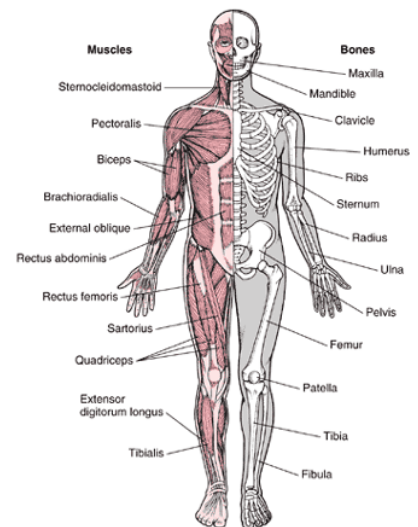
Bones –

Ligaments –

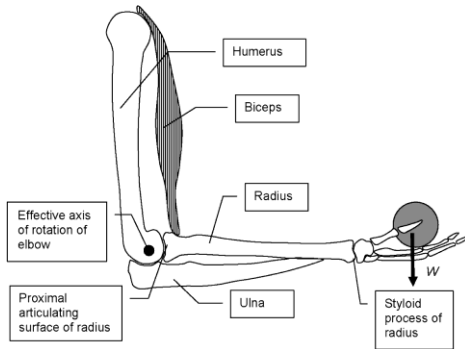
Tendons –

Cartilage –

Neurons –



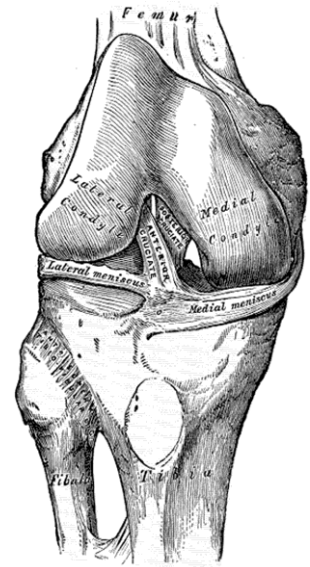
## Examining the Basic Biomechanics of Elbow Flexion System [In-class Worksheet]



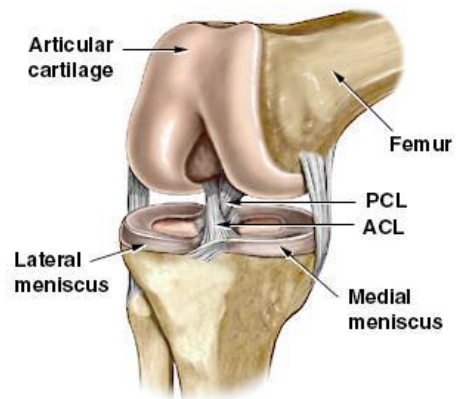
Muscle	$L_H$ (cm)	$L_F$ (cm)	PCSA ( $\text{cm}^2$ )	$\theta$ ( $^\circ$ )	Inserts into
Biceps	31 <sup>a</sup>	8	12.3	76	Radius
Brachialis	10	5	13.0	63	Ulna
Brachioradialis	8	24	2.9	18	Radius
Extensor carpi radialis longus	3	25 <sup>b</sup>	3.6	7	Radius

## II. The Human Knee

Bones



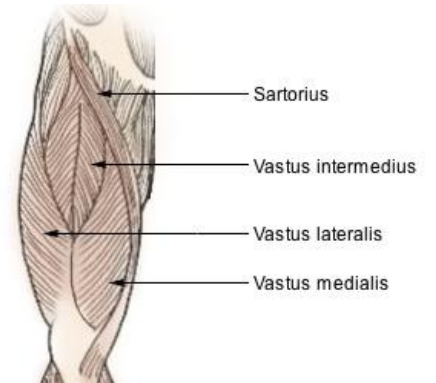
Ligaments



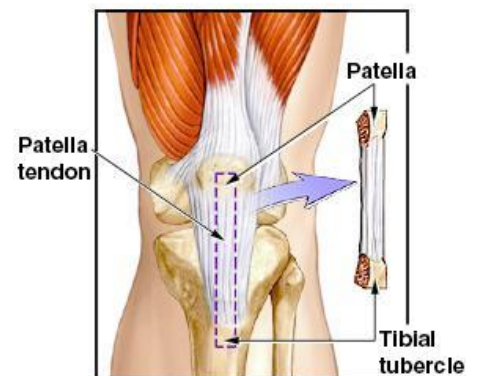
Cartilage

© 1998 Nucleus Communications, Inc. - Atlanta  
www.nucleusinc.com

Muscles

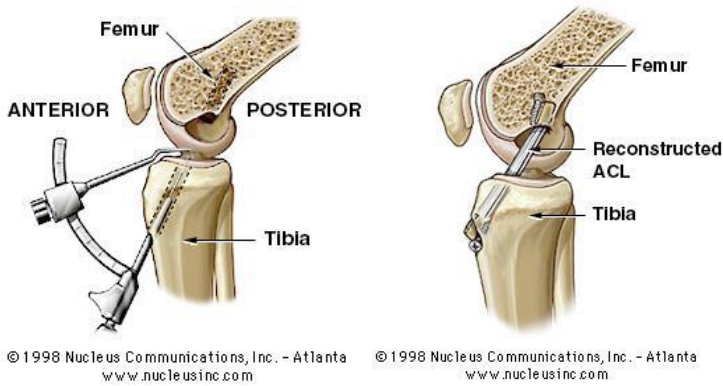


Tendons



© 1998 Nucleus Communications, Inc. - Atlanta  
www.nucleusinc.com

III. ACL reconstruction



IV. Biomechanics of the Knee

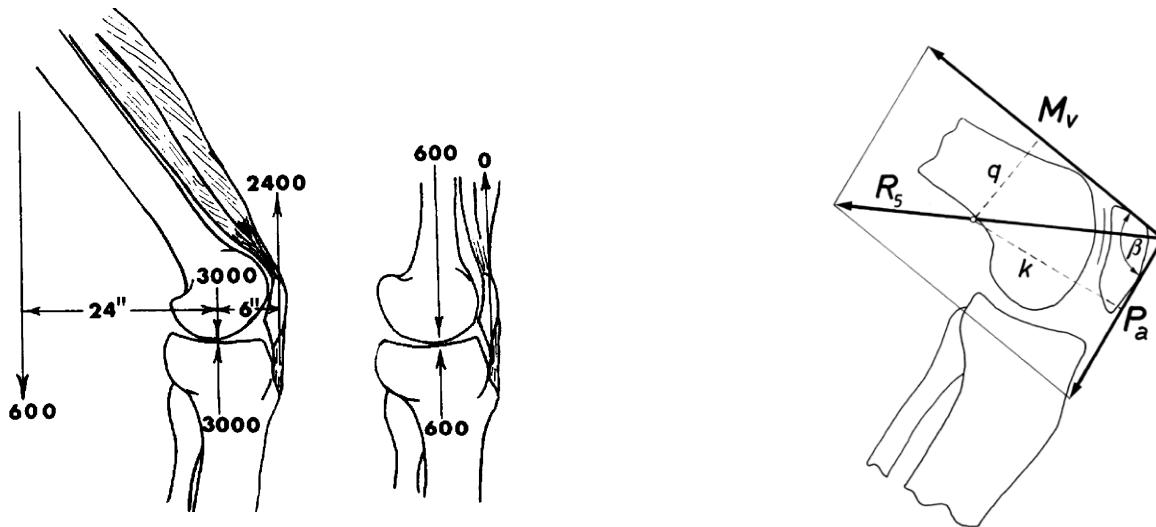


Table 8.2. Measured femoro-patellar contact loads during squatting, for physiological joint angles. Values in the last column are femoro-patellar contact forces, and should be multiplied by three to get in vivo loads. Values are mean for n = 12 knees ( $\pm 95\%$  confidence intervals). Reprinted from Huberti and Hayes [35]. With kind permission of Elsevier.

Knee flexion angle ( $^{\circ}$ )	Contact area ( $\text{cm}^2$ )	Contact area as percentage of total articular area (%)	Average contact pressure (MPa)	Resultant contact force (N)
20	$2.6 \pm 0.4$	20.5	$2.0 \pm 0.4$	$497 \pm 90$
30	$3.1 \pm 0.3$	24.9	$2.4 \pm 0.6$	$573 \pm 125$
60	$3.9 \pm 0.5$	30.4	$4.1 \pm 1.4$	$1411 \pm 331$
90	$4.1 \pm 1.1$	32.2	$4.4 \pm 1.0$	$1555 \pm 419$