Reading Assignment:

Also, (re) read the Barich Ph.D. thesis section on fixturing for laboratory micromotion testing.

Homework Assignment:
Review the Davies et al. article and the Rimnac et al. article on the effects of cement centrifugation. Take a side in this controversy, and support your view by critical reasoning. Should PMMA be centrifuged? Write 2-3 pages, double-spaced 12 pt. **Due Wed Oct 9th.**
Biomechanics of Acrylic Cement Fixation
Polymerization Reaction
Setting Time: 8.5 mins.

Property Changes Approaching Setting Time
Effect of Aging on PMMA Breaking Stress
Effect of Aging on PMMA Elastic Modulus
Regions of High Cement Stress
Cement-Bone Interface

Shear stress on vertical interface
Shear stress on upper surfaces
Compressive stress on upper surfaces
Tensile stress on lower surfaces

Cement
S
δA₂
δA₄
δA₁
Bone
S
δA₃
δF
micro-gap

S = shear stress
δA₁, δA₃ = areas in shear
C = compressive stress
δA₂ = area in compression
T = tensile stress
δA₄ = area in tension
δF = force on bone rugosity

Stresses are drawn acting on the cement
Beam Theory

Load Transmission through the Stem
Construct Stresses from Beam Theory

- **M**: unit moment
- **$D_M$**: medullary diam.
- **$D_P$**: prosthesis diam.
FEA of Construct Stresses
Distribution of Bending Stresses
Cement Technique & Surface Preparation
Cement Technique & Surface Preparation
Fatigue Test Specimen
Uncentrifuged

Centrifuged

Simplex P

Cement Porosity
Survival Probability
FULLY REVERSED TENSION-COMPRESSION FATIGUE AT 2 HERTZ

PROBABILITY OF SURVIVAL

CYCLES TO FAILURE

Centrifuged
Uncentrifuged

ε = .008, .005, .008, .005, .002, .002

ε Strain Level

Survival Probability
Uniaxial Tensile Test

Ultimate Stress = \frac{\text{load-at-fracture}}{\text{area}}
Endurance Limit

\[ N_{\text{failure}} = N_{\text{initiation}} + N_{\text{propagation}} \]
Fracture Toughness Test

Compact Tensile Specimen

\[ K = \frac{P}{BW^{1/2}} \cdot f(\alpha/W) \]
Crack Propagation

Fatigue Crack Growth Rate

Cyclic Stress Intensity

Long Crack

Short Crack

Load
Compact Tensile Specimen
Fracture Toughness Comparisons
Fatigue Crack Propagation
Gel Permeation Chromatography

Molecular Weight Distributions
Contraction upon Setting
Fracture around Particles
Fracture through Particles
<table>
<thead>
<tr>
<th>Bone Cement</th>
<th>Weight Average</th>
<th>Number Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zimmer</td>
<td>256,000</td>
<td>58,700</td>
</tr>
<tr>
<td>Zimmer with gentamicin</td>
<td>188,000</td>
<td>49,400</td>
</tr>
<tr>
<td>Simplex</td>
<td>240,000</td>
<td>89,700</td>
</tr>
<tr>
<td>Simplex with gentamicin</td>
<td>252,000</td>
<td>78,000</td>
</tr>
<tr>
<td>Palacos</td>
<td>872,000</td>
<td>170,000</td>
</tr>
<tr>
<td>Palacos with gentamicin</td>
<td>1,070,000</td>
<td>230,000</td>
</tr>
</tbody>
</table>

Average Molecular Weights