

SYLLABUS
ME/BE/MS 524: Skeletal Tissue Mechanics

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ENG 221

Office Hours: M 9-11 a.m., W 4-4:45 p.m.

Course Description: Skeletal tissues—bone, cartilage, tendon and ligament—serve functions that are largely mechanical in nature and that are critical for our health. This course is structured around classical topics in mechanics of materials and their application to study of the mechanical behavior of skeletal tissues, whole bones, bone-implant systems, and diarthroidal joints. Topics include: mechanical behavior of tissues (anisotropy, viscoelasticity, fracture and fatigue) with emphasis on the role of the microstructure of these tissues; structural properties of whole bones and implants (composite and asymmetric beam theories); and mechanical function of joints (contact mechanics, lubrication and wear). Emphasis is placed on using experimental data to test and to develop theoretical models, as well as on using the knowledge gained to address common health related problems related to aging, disease, and injury.

Course Format: Semiweekly lectures with 6 approx. semimonthly homework assignments (30%), one midterm (30%), in-class activities (10%), and one course project (written and oral presentation, 15% and 15%, respectively).

Course Prerequisites: An undergraduate-level understanding of the mechanics of rigid bodies, mechanics of materials, and linear algebra is required. No previous courses in anatomy, physiology or biochemistry are required.

Course Text and Readings:

1. Martin, R. Bruce, Burr, David B., Sharkey, Neil A. Skeletal Tissue Mechanics. New York: Springer-Verlag, 1998. Sci/Eng reserve QP88.2.M184
2. Readings distributed over course of semester

Theme/Week	Topic	Reading ("Suppl."=reader)
<i>The Skeleton as a Structure</i>		
Wk 1 (Lect. 1-2):	Course Introduction and Basic Anatomy Static Analysis of Muscle and Joint Forces	Suppl. Suppl., 1.1-1.8
<i>Mechanics of Hard and Soft Skeletal Tissues</i>		
Wk 2 (Lect. 3-4):	Mathematical Preliminaries	Suppl., 4.1-4.2
Wk 3 (Lect. 5-6):	Anisotropic Elasticity	2.1-2.5, 4.4-4.7, Suppl.
Wk 4 (Lect. 7-8):	Viscoelasticity	2.6, 7.1-7.2, 8.1- 8.11, Suppl.
Wk 5-6 (Lect. 9-11):	Poroelasticity and Mixture Theories	Suppl.
Wk 7-8 (Lect 12-15):	Damage, Fracture and Fatigue	Suppl., 5.1-5.12
<i>Mechanics of Whole Bones and Bone-Implant Systems</i>		
Wk 9 (Lect. 16-17):	Asymmetric Bending	Suppl.
Wk 10 (Lect. 18-19):	Composite Beam Theory	Suppl.
<i>Mechanics of Diarthroidal Joints</i>		
Wk 11 (Lect. 20-21):	Contact Mechanics Lubrication and Wear	Suppl. 7.3, Suppl.
Wk 12 (Lect. 22):	Midterm	
<i>Mechanical Adaptation of Skeletal Tissues</i>		
Wk 13 (Lect. 23-24):	Remodeling Tissue Differentiation	Suppl., 2.9, 3.1-3.6, 6.1-6.9
<i>Synthesis and Summary</i>		
Wk 14 (Lect. 25-26):	Student Presentations	
Wk 15 (Lect. 27):	Student Presentations and Closing Remarks	

Reserve Texts (This Course)

Malvern, Lawrence E. Introduction to the Mechanics of a Continuous Medium. Englewood Cliffs: Prentice-Hall, 1969. Sci/Eng reserve QA808.2.F691

Carter, Dennis R. and Beaupré, Gary S. Skeletal Function And Form: Mechanobiology Of Skeletal Development, Aging, And Regeneration. Cambridge: Cambridge University Press, 2001. Mugar reserve RC925.5.C27

Nigg, Benno M. and Herzog, Walter, eds. Biomechanics of the Musculoskeletal System. 2nd edition. New York: Wiley, 1999. Sci/Eng reserve QP301.B478

Nordin, Margareta and Frankel, Victor H., eds. Basic Biomechanics of the Musculoskeletal System. 3rd edition. Philadelphia: Lippincott Williams & Wilkins, 2001. Sci/Eng reserve QP303.N57

Archer, Charles W., Caterson, B., Benjamin, M. Ralphs, JR., *Biology of the Synovial Joint*. Amsterdam: Harwood Academic, 1999. Sci/Eng reserve QP323.B54

Bilezikian John P., Raisz, Lawrence G., Rodan, Gideon A. *Principles of Bone Biology*. 2nd edition. Volumes 1 and 2. San Diego: Academic Press, 2002. Sci/Eng reserve QP88.2.P735

Reserve Texts (General)

Mow, Van C., Huiskes, Rik. *Basic Orthopaedic Biomechanics and Mechanobiology*. 3rd edition. Baltimore: Lippincott Williams & Wilkins, 2005. Mugar RD732.B353

Grant, J.C. Boileau. *Atlas of Anatomy*. Baltimore: Williams & Wilkins, 1978. Sci/Eng reserve HS367.BK02 and Mugar Reference X QM25.G7

Fung, Yuan-Cheng. *Biomechanics : Mechanical Properties of Living Tissues*. New York : Springer-Verlag, 1981. Sci/Eng reserve QP88.F87

Other Texts

Cowin, Stephen C., ed. *Bone Mechanics*. Boca Raton: CRC Press, 1989. Sci/Eng QP303.B66

Fung, Yuan-Cheng. *Biomechanics : motion, flow, stress, and growth*. New York : Springer-Verlag, 1990. Sci/Eng QP303.F86

Sahay, K.B. and Saxena, R.K. *Biomechanics*. New York: Wiley, 1989. Sci/Eng QP303.B568

Wainwright, S.A. *Mechanical Design in Organisms*. Princeton: Princeton University Press, 1982. Sci/Eng QP303.M4

Martin, R. Bruce and Burr, David B. *Structure, Function, and Adaptation of Compact Bone*. New York: Raven Press, 1989. Sci/Eng QP88.2.M185

Currey, John D. *The Mechanical Adaptations of Bones*. Princeton: Princeton University Press, 1984. Sci/Eng QP88.2C87

Chadwick, Peter. *Continuum Mechanics: Concise Theory and Problems*. New York: Wiley, 1976. Sci/Eng QA808.2 C48