ANG 6524 **Spring 2018**

Skeletal Mechanics in Biological Anthropology

Class meets Mondays Periods 6-8 (12:50-3:50 PM) in TUR 1208H

Course materials accessed via Canvas: https://lss.at.ufl.edu/

Instructor: David Daegling, Department of Anthropology, 294-7603. daegling@ufl.edu
Office Hours: M 10:30-11:30; R 2:00 – 4:00.

Prerequisites: ANG 5525 Human Osteology and Osteometry and ANG 6583 Primate Functional Morphology or ANG 6740 Advanced Techniques in Forensic Anthropology

Course Objectives: Inference of past behaviors and adaptations from skeletal remains is crucial to the fields of bioarchaeology, functional morphology, forensic anthropology and human paleontology. This course examines the mechanical influences on skeletal morphology from the perspectives of growth, allometry and evolution. Analytical techniques for describing and inferring the mechanical behavior of bones are emphasized. Quantitative skills learned in this course include 1) modeling bone behavior at the tissue and structural level, 2) predicting physiological response of bone to load histories, 3) determination of scaling effects on skeletal form and composition and 4) consequences of ontogenetic shifts in skeletal development in a comparative evolutionary framework.

Course Requirements: Your grade will be based on the following:

1. Weekly problem sets to be completed outside of class (50%)
2. 10 in-class quizzes (30%)
3. Analysis and critique of supplementary readings (15%)
4. Final Exam (5%)

Policies: Quizzes missed due to late arrival or unexcused absences (i.e., other than medical or family emergency) cannot be made up. Problem sets submitted after stated deadlines are subject to half-credit grade reduction. Smart phones must be silenced or turned off. Plagiarism in any form is subject to university policy as outlined by the Dean of Students Office (http://www.dso.ufl.edu/judicial/academic.htm). Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation. Students experiencing personal problems that are interfering with their academic performance are encouraged to contact the University Counseling Center (301 Peabody Hall, 392-1575), Student Mental Health (Student Health Care Center, 392-1171), or Sexual Assault Recovery Services (Student Health Care Center, 392-1161).

Notes on the course assignments

Problem Sets: Problem sets are accessed on the Canvas course page. These are to be submitted online prior to the beginning of class each week. Showing how you arrived at problem solutions is essential. Submitting answers without such demonstration earns no credit. Copying problem solutions of others or allowing such copying earns zero points and is subject to additional penalties as allowed by university policy.

Supplementary Readings Analysis & Critique: During designated class times, you will answer questions from assigned articles individually on discussion boards, then convene as a group to seek a consensus to the question(s) raised. This will be followed by an in-class discussion. Approximately 2/3 of your credit in these exercises is based on individual posts and 1/3 based on your group's contribution to discussion.

Quizzes: These are unannounced and are given at the beginning of class. Missed quizzes cannot be made up unless you were sick or have a family emergency.

Final Exam: This is given as a "take-home" exam. In the event of outstanding collective work the instructor may cancel this assignment.

Course Materials

Text:

Martin RB, Burr DB, Sharkey NA, Fyhrie DP (2015) *Skeletal Tissue Mechanics*. New York: Springer. [STM]

Supplementary Readings [SR#]:

1. Antón SC. 1996. Tendon-associated bone features of the masticatory system in Neandertals. *Journal of Human Evolution* 31: 391-408.

2. Bouvier M, Hylander WL. 1996. The mechanical or metabolic function of secondary osteonal bone in the monkey *Macaca fascicularis*. *Archives Oral Biology* 41:941-950.

3. Butler DL, Kay MD, Stouffer DC. 1986. Comparison of material properties in fascicle-bone units from human patellar tendon and knee ligaments. *Journal of Biomechanics* 19: 425-432.

4. Carter DR, Van der Meulen MCH, Beaupre GS. 1996. Mechanical factors in bone growth and development. *Bone,* 18(1), pp.S5-S10.

5. Cerroni AM, Tomlinson GA, Turnquist JE, Grynpas MD. 2000. Bone mineral density, osteopenia, and osteoporosis in the rhesus macaques of Cayo Santiago. *American Journal of Physical Anthropology* 113:389-410.

6. Currey JD. 2003. The many adaptations of bone. *Journal of Biomechanics* 36:1487-1495.

7. Dechow PC, Wang Q, Peterson J. 2010. Edentulation alters material properties of cortical bone in the human craniofacial skeleton: functional implications for craniofacial structure in primate evolution. *The Anatomical Record* 293: 618-629.

8. de Jong WC, van Ruijven LJ, Brugman P, Langenbach GEJ. 2013. Variation of the mineral density in cortical bone may serve to keep strain amplitudes within a physiological range. *Bone* 55:391-399.

9. Erickson GM, Catanese J, Keaveny TM. 2002. Evolution of the biomechanical material properties of the femur. *Anatomical Record*, 268:115-124.

10. Frost HM. 1988. Vital biomechanics: proposed general concepts for skeletal adaptations to mechanical usage. *Calcified Tissue International*, 42(3), pp.145-156.

11. Jungers WL. 1988. Relative joint size and hominoid locomotor adaptations with implications for the evolution of hominid bipedalism. *Journal of Human Evolution*, 17: 247-265.

12. Keller TS, Lovin JD, Spengler DM, Carter DR. 1985. Fatigue of immature baboon cortical bone. *Journal of Biomechanics* 18(4):297-304.

13. Lieberman DE. 1996. How and why recent humans grow thin skulls: experimental data on systemic cortical robusticity. *American Journal of Physical Anthropology* 101: 217-236.

14. Lovejoy CO, Heipl KG, Burstein AH (1973) The gait of *Australopithecus*. *American Journal of Physical Anthropology* 38:757-780.

15. McFarlin SC, Terranova CJ, Zihlman AL, Enlow DH, Bromage TG. 2008. Regional variability in secondary remodeling within long bone cortices of catarrhine primates: the influence of bone growth history. *Journal of Anatomy*, 213: 308–324.

16. Ozcivici E, Luu YK, Adler B, Qin YX, Rubin J, Judex S, Rubin CT. 2010. Mechanical signals as anabolic agents in bone. *Nature Reviews Rheumatology 6:* 50-59.

17. Pearson OM, Lieberman DE. 2004. The aging of Wolff's “law”: ontogeny and responses to mechanical loading in cortical bone. *American Journal of Physical Anthropology*, 125(S39): 63-99.

18. Robling AG. 2009. Is bone’s response to mechanical signals dominated by muscle forces? *Medicine and Science in Sports and Exercise*, 41:.2044.

19. Ruff CB, Runestad JA. 1992. Primate limb bone structural adaptations. *Annual Review of Anthropology* 21: 407-433.

20. Skedros JG, Mason MW, Bloebaum RD. 1994. Differences in osteonal micromorphology between tensile and compressive cortices of a bending skeletal system: Indications of potential strain-specific differences in bone microstructure. *The Anatomical Record* 239:405-413.

21. Sun Z, Lee E, Herring SW. 2004. Cranial sutures and bones: Growth and fusion in relation to masticatory strain. *The Anatomical Record* 276A:150–161.

22. Tommasini SM, Nasser P, Schaffler MB, Jepsen KJ. 2002. Relationship between bone morphology and bone quality in male tibias: implications for stress fracture risk. *Journal of Bone and Mineral Research* 20: 1372-1380.

23. Trinkaus E, Churchill SE, Villemeur I, Riley KG, Heller JA, Ruff CB. 1991. Robusticity *versus* shape: the functional interpretation of Neandertal appendicular morphology. *Journal of the Anthropological Society of Nippon*. 99, 257-278.

24. Yeni YN, Fyhrie DP. 2002. Fatigue damage-fracture mechanics interaction in cortical bone. *Bone* 30:509-514.

25. Zioupos P, Currey JD. 1998. Changes in the stiffness, strength, and toughness of human cortical bone with age. *Bone* 22:57-66.

Course Schedule:

Week 1 (1/8)	Force and Energy
Week 2 (1/22)	Free-body analysis, Statics Readings: STM Chapter 1
Week 3 (1/29)	Skeletal biology: Tissues Readings: STM Chapter 2; SR 14
Week 4 (2/5)	Skeletal biology: Bone metabolic activity Readings: STM sections 3.1 – 3.4; SR 15
Week 5 (2/12)	Skeletal biology: Remodeling Readings: STM sections 3.5 – 3.8; SR 22
Week 6 (2/19)	Ligament and Tendon Readings: STM Chapter 4; SR 2, 20
Week 7 (2/26)	Cartilage and Joints Readings: STM Chapter 5; SR 1, 3
Week 8 (3/12)	Functional adaptation I: Wolff's Law Readings: STM sections 6.1 – 6.4; SR 11, 21
Week 9 (3/19)	Functional adaptation II: Signals Readings: STM section 6.5; SR 17, 23
Week 10 (3/26)	Functional adaptation III: Models Readings: STM sections 6.6 – 6.8; SR 16, 18
Week 11 (4/2)	Elastic properties and the stress tensor Readings: STM sections 7.1 – 7.2; SR 4, 8, 10
Week 12 (4/9)	Essentials of structural mechanics and material properties Readings: STM section 7.3 – 7.8; SR 5, 7
Week 13 (4/16)	Fracture and fatigue Readings: STM sections 8; SR 13, 19, 25
Week 14 (4/23)	Bone in evolutionary perspective Readings: SR 6, 9, 24