BIOMECHANICS

ANTH 501 / 601 / 690
THE UNIVERSITY OF TENNESSEE

Instructor: Benjamin Auerbach, Ph.D.
Contact information: Office: 229 South Stadium Hall
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Time: Wednesdays, 5:45 – 8:30 P.M.
Location: 106 Humanities & Social Sciences Building

Course description: Biomechanics is the study of functional morphology. Broadly, in biomechanical studies, we examine the activities of organisms—from bacteria to trees to vertebrates—and attempt to understand the physical properties that allow them to engage in these behaviors. The literature in this subject is replete with examinations of the material properties of solid materials (e.g., the stiffness of wood, or the strength of bone), both statically or dynamically, as well as the movement of liquids through organisms or of organisms through liquids (including air).

This course, a graduate lecture-based seminar, focuses on the basic concepts of biomechanics and relates them to studies of vertebrates, especially humans. The course is roughly divided into three sections: scaling relationships (allometry) & basic mechanics; statics and bone; and kinematic and energetic studies. A review of bone biology precedes these topics. This is not an engineering course, though some engineering principles are introduced throughout the semester. You, participants in the course, will be asked to relate these general topics to areas of research that interest you, and to bring this into the weekly discussions of the seminar.

Course objectives: By the end of the course, you are expected to have developed a firm comprehension of the general areas of noted in the course description, especially bone biology, scaling, and basic mechanics. Moreover, the relationship of these topics to current biological anthropology research, including areas of consensus and debate, should be understood and appreciated.

Prerequisite: All students enrolled must have a good understanding of osteology and basic bone biology. Additional backgrounds in human and/or comparative anatomy, and some basic math knowledge are beneficial but not mandatory.
Course layout: The course is a lecture-based seminar. During most weeks, Dr. Auerbach will lecture on the topic of the week’s reading. This is an informal lecture, and your thoughts, questions, and input are welcome at any point during class meetings. After completion of lectures, the course will turn to an open discussion of the week’s readings.

As many readings for the course are not from peer-reviewed papers, and instead come from edited volumes and textbooks, it is up to you to introduce original research papers to the class. That is, you, as participants, are expected to regularly seek additional publications that are of interest and are relevant to current or past weeks. Each week, time will be set aside for you to introduce these studies to the rest of the class, as well as send their citations to Dr. Auerbach so that they may be posted on the course web site. These papers would then be added to the list of readings to be discussed in subsequent weeks. You should provide a paper to the course at a minimum of seven times (half the meeting sessions) during the semester.

Course web site: This course will utilize the online.utk.edu Blackboard site for the dissemination of course materials.

Commentary Papers: You must review the literature and select a peer-reviewed paper pertinent to each of the three topic areas of the course: scaling and mechanics; statics and bone; and kinematics / energetics. On the dates designated in the course schedule below, a brief paper (not to exceed six pages, double-spaced, including references) is due, in which you are expected to critically evaluate the topic, hypotheses, methods, and conclusions of the research conducted in their selected paper. Be sure to select papers that you are comfortable reading and critically appraising.

Seminar Paper: At the end of the semester, you are required to turn in a final seminar paper discussing a topic of research in anthropological biomechanics. This paper should choose a well-defined topic that can be assessed based on peer-reviewed studies. You are responsible for selecting three topics that you would be interested in using, and turning in a brief summary of each (one or two sentences) to Dr. Auerbach on 14 October. Dr. Auerbach will select one of these three topics for you to investigate and about which you will write your seminar paper. Seminar papers will be due by 5:00 on Monday, 7 December.

Evaluation: 25% - weekly participation in seminar discussions
35% - commentary papers
45% - seminar paper

Students with special needs: If you require accommodation because of special needs in
learning, please contact the Office of Disability Services at 2227 Dunford Hall (974-6087). Please also contact Dr. Auerbach immediately via e-mail after you register with the Office of Disability Services. Arrangements will be made to adjust exams to fit your needs.

Required texts: No textbooks are required reading for this course. You are, however, expected to keep up with the requisite reading each week, and are encouraged to read beyond the assigned papers. Papers and book chapters will be provided weekly to students as PDF files via Blackboard.

Course schedule: Readings listed for each meeting session should be read prior to each session. Bibliographic information for books may be found at the end of the schedule.

19 August  Introduction to biomechanics; discussion on the breadth of biomechanical research (no readings)

26 August  Bone biology I: Who cried Wolff?
   Currey – Chapter 1
   Martin et al. – Chapter 3
   Ruff et al. 2006

   Supplementary
   Frost 2003
   Martin et al. – Chapter 6
   Pearson and Lieberman 2004

2 September  A crash course in the basics of biomechanics
   Vogel – Chapters 1, 2 and 4

   Supplementary
   Ruff 2006 (from Katzenberg & Saunders, Biological Anthropology of the Human Skeleton)

9 September  Bone biology II: The importance of ontogeny
   Carter and Beaupré – Chapters 3 – 5

   Supplementary
   Ruff 2005
   Ruff 2007
   Sumner and Andriacchi 1996
16 September  Out on a beam: simple structures as models for complex ones
McGowan – Chapters 6 and 7
Vogel – Chapter 18

Supplementary
Lieberman et al. 2004

23 September  A matter of scale (FIRST COMMENTARY PAPER DUE)
Biewener 1989
Schmidt-Nielsen – Chapters 1 – 4, 6 – 7
Vogel – Chapter 3

Supplementary
Sylvester et al. 2008
West et al. 1997 (and comments)

30 September  Material properties of bone & cross-sectional properties 101
Currey – Chapters 3 & 7
McGowan – Chapter 5
Vogel – Chapters 15 and 16

Supplementary
Burr et al. 1989
Polk et al. 2000

7 October  Cross-sectional properties (continued) & the mechanics of joints
Currey – Chapter 8
McGowan – Chapter 8

Supplementary
Lieberman et al. 2001
Pontzer et al. 2006
Ruff 2002

14 October  Safety factors
Biewener 1993
Currey – Chapter 10 (part)
Vogel – Chapter 25 (part)
21 October  Mechanobiology and evolution
Carter and Beaupré – Chapter 9
Habib and Ruff 2008

**Supplementary**
Richmond 2007

28 October  The motility of muscle *(SECOND COMMENTARY PAPER DUE)*
McGowan – Chapter 9
Vogel – Chapters 22 and 23

**Supplementary**
Higham and Biewener 2008
Lieberman et al. 2006
Ravosa et al. 2000

4 November  Why trotting isn’t running
McGowan – Chapter 10
Vogel – Chapter 24

**Supplementary**
Hanna et al. 2006
Hutchinson et al. 2002

11 November  Measuring costs and benefits of transport
Polk 2004
Pontzer 2007a
Pontzer 2007b

**Supplementary**
Kerdok et al. 2002

18 November  Conclusions?: functional morphology & human evolution
Raichlen et al. 2009
Richmond et al. 2005
Ruff et al. 1993
Shackelford 2007
Supplementary
Burr et al. 2002
Robling and Turner 2002
Robling et al. 2006

25 November No class! (Thanksgiving) (THIRD COMMENTARY PAPER DUE)

7 December Seminar papers due

Books used in the course


