

**KIN 494(83532)/598(83435): Comparative Biomechanics and Motor Control
Fall 2009**

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COURSE DESCRIPTION

This course explores how the physical and mechanical properties of organisms and their environment affect biological tissues, structures, and motor control.

COURSE OBJECTIVES

- Understand some of the principles that govern the behavior of biological materials, structures, and physiology in the physical environment
- Apply these principles to answering physiological, behavioral, and ecological questions
- Study the interactions between biomechanics and motor control of movement

STUDENT LEARNING OUTCOMES

In addition to learning about interesting biological principles, this course is focused on learning several skills:

- Learning how to understand complex phenomena (such as tissue mechanics, fluid mechanics, and acute and chronic injury mechanisms) by reasoning using physical laws such as conservation of energy
- Learning how to use mathematical descriptions of biological systems to better understand the systems
- Learning how to critically evaluate experimental research studies
- Learning how to generate testable hypotheses based on identified gaps in the scientific literature
- Using scientific information to make specific, quantitative predictions
- Synthesizing and evaluating data to defend reasoned conclusions
- Written presentation of scientific reasoning in journal paper format

PREREQUISITES

Bio 181, Math 170, and Physics 111 or equivalents are recommended. Most important is a willingness to master challenging concepts and to think deeply about problems. This is NOT a survey course.

TEXT

Comparative Biomechanics: Life's Physical World. Steven Vogel. Princeton: Princeton Univ. Press, 2003. Pp. xii + 582.

BLACKBOARD

All students will be required to use the blackboard learning system to access instructor correspondence, grades, lecture notes, and/or handouts. If you need help with Blackboard or have any unique needs, please contact the instructor.

SCHEDULES

The schedules and reading assignments contained in this syllabus may be subject to change. You are responsible for all announcements concerning changes in the course outline, readings, assignments, exams, and other matters made during class periods whether or not you are in attendance when announcements are made. Reading assignments for each class are listed below. Students are expected to read this material before attending class.

ATTENDANCE

Regular attendance is essential. Missed in-class assignments CANNOT be made up, except in the case of university business or religious holiday. Homework assignments are to be turned in on the assigned due date, in class. No late assignments will be accepted.

PODCASTS

Podcasts of lectures can be found on [iTunesU](#). To get to the podcasts, you must have iTunes on your computer. Click the Course/Login button, login, then in iTunes go down to the "courses" section. Click the small "Fall 209" button, and you should see "KIN 494" in the window. Podcasts are through this link.

ACCOMODATIONS FOR DISABILITIES

We will make any reasonable accommodations for limitations due to any disability including learning disabilities. Please arrange an appointment to see us to discuss any needs you might have. You might also want to make an appointment with Disability Resources at 965-1234 to find out what campus assistance may be available to you.

GROUP WORK

You are encouraged to work in pairs or groups for short assignments and critiques. The objective of these assignments are to prepare you for the exams and the final paper.

SHORT ASSIGNMENTS

The short assignments will typically be one or more problems based on the reading and lecture material for that topic, and will be similar to questions on the exams. These problems are intended to reinforce the course material, encourage you to keep up-to-date, and prepare you for the format of the exams.

EXAMS

Exams will evaluate comprehension of the important concepts presented in the course, and the ability to apply these concepts to novel problems. Exams will consist of multiple-choice, calculation, and potentially short answer questions.

CRITIQUES

The critiques are opportunities to critically evaluate experimental research studies, and prepare for writing the research paper. The point of the critiques will be to dissect, understand, and critically evaluate the research study. We will evaluate two papers: one read by the entire class, and one on a potential final paper topic. For each paper, please read it carefully and write a 1-2 page critique addressing as many of the questions below that are relevant.

INTRODUCTION

1. What is the significance of the study?
2. What is currently known about the system being studied?
3. What hypotheses is the study designed to test?

4. What are the major assumptions that the authors make?
5. What type of experimental data are necessary to test the hypothesis?
6. How can the hypothesis be supported or rejected by the data?
7. What are the main limitations of the study or hypotheses?

METHODS

1. Did the experiments test the hypothesis?
2. What types of data were collected during the experiments?
3. What was the purpose of each type of data?
4. Which types of data are most important for testing the hypotheses?
5. What were the criteria used to test or reject the hypotheses?
6. What are the limitations of the methods used in the study?

RESULTS

1. What were the results of the experiment?
2. How was each type of data used to test the hypotheses?
3. Were the hypotheses supported or rejected?
4. Were the criteria used to test or reject the hypotheses reasonable?
5. What statistical tests were used to test the hypotheses?

DISCUSSION

1. What is the significance of the results?
2. Are the authors' interpretations of the results in the discussion convincing?
3. Would the interpretation of the results be different if the authors made different assumptions?
4. Were there any discrepancies in the results (i.e. results that do not seem to agree with each other)? If so, how can they be explained?
5. Can you come up with other interpretations of the results?
6. Do the results allow for an improvement in our theoretical understanding?
7. What is the next experiment that would logically follow from this study?

RESEARCH PAPER

The research paper will consist of designing a hypothesis-based study to test a question in comparative biomechanics and/or motor control of interest to you. This will be based on (1) a short literature review highlighting a gap in our knowledge of a particular problem; (2) the design of a new experiment that can address that problem (not the repeat of a previous experiment, but something that so far as you know hasn't been done); (3) using the techniques and information presented in class and the textbook to make quantitative predictions about possible outcomes based on different sets of assumptions; and (4) the discussion of the implications of possible outcomes of the experiment, and their implications. Students are encouraged to pre-submit a draft of the final paper for evaluation.

Proposal: You must submit a short proposal (one page and at least 5 references). **The proposal should include the specific hypothesis you plan to test, and a 1-2 sentence sketch of the methods you propose to use to test the hypothesis.** The paper topic should be separate from the critique (i.e. a separate document).

Evaluation: The paper should be organized into the following sections. Each section should have a separate section header and at the MINIMUM answer the following questions.

Background and significance

- a. Is there a critical, balanced review of the relevant literature?
- b. Is every statement of fact backed up by a peer-reviewed source?
- c. Does the literature review support the significance of the study?
- d. Does every sentence contribute to an ARGUMENT that leads directly to the proposed hypothesis?

Hypothesis

- a. Is the hypothesis clearly stated and specific enough to experimentally test?
- b. Is the hypothesis non-trivial?

Methods of Proposed experiment

- a. Will the proposed experiment test the hypothesis?
- b. Is the experiment feasible based on previous experiments?

Predicted Results

- a. Have specific predictions been made based on different assumptions?
- b. Are the assumptions, and resulting predictions, reasonable?
- c. Are the results SPECIFIC and QUANTITATIVE? For this paper I am really looking for SPECIFICS. If you argue that force will increase -- by how much? If you cannot calculate it based on the tools you have from simple physics or this course, then simplify the question until you can.

Implications of the study

- a. What would be the significance of these results?
- b. What are possible alternative sets of results? What would be the significance of these alternative results?

Overall evaluation criteria

* Do all of the statements and descriptions used in the Introduction apply to the problem and contribute to justifying the proposed experiment, estimated results, or interpretation of the data in the Discussion? There should be parallels between each section of the paper (use sub-headings if this helps to make these parallels clear). For example, if you identify 6 different phases of a swing of some sort in the introduction and argue that injuries are unlikely during two phases, then Results should discuss each phase separately and the Discussion should compare and contrast the phases.

* Are there quantitative predictions made, or are the qualitative predictions substantially novel and do they demonstrate a very firm logical foundation?

* Does the paper delve deeply into the MECHANISMS that might be responsible for causing the behavior, performance, injury, etc. being studied? I am not looking for cursory descriptions of every possible factor that can contribute to some performance or injury. What I am looking for is carefully, specifically thinking through the MECHANISMS underlying your chosen topic and using the concepts from the class to make specific predictions.

References

You should draw on at least **10** peer-reviewed scientific papers (at least **20** for graduate students). The emphasis should be on the statements you make, not on the content of the papers. Consequently, CITE REFERENCES ONLY AT THE END OF SENTENCES.

Do NOT have long paragraphs summarizing papers you are drawing from. Construct an argument based on the references you find, and use the references solely as support/justification for the statements you make in your argument.

REFERENCE ONLY PEER-REVIEWED SCIENTIFIC PAPERS. This means NO WEB SOURCES! Do not cite websites or other non-peer-reviewed material in your paper. You are free to read websites to get information and references to peer-reviewed publications, but they are not to be relied upon as references for the paper.

Format: The paper should be approximately 3,000 words (10-12 pages excluding references; 12-point font, double-spaced). Figures are encouraged.

Due Date: Drafts are due as indicated in the syllabus. The final paper will be due by the beginning of the final exam. You are encouraged to submit the paper early. No late papers can be accepted, since grades must be posted soon after the final exam period.

RESEARCH PAPER SUBMISSION

The research paper draft and final paper must be submitted through **Safe Assignment**. Documents submitted on paper, through email, or through the Digital Dropbox will not be accepted for credit. DO NOT SUBMIT ANYTHING TO DIGITAL DROPBOX. I DO NOT CHECK IT. Please make certain to submit only your final copy of the assignment through Safe Assignment, since documents cannot be re-submitted without contacting your instructor and receiving permission to resubmit the assignment. Further instructions on how to submit a document through Safe Assignment are located at:

<https://wiki.asu.edu/help/index.php/SafeAssignment>

GRADUATE STUDENTS

In addition to the coursework required for all students in the course, graduate students will be expected to (1) give oral presentations of their critiques, and make their written critiques available to the entire class, (2) Cite at least 20 primary literature studies in their research papers. Research papers from graduate students may also be longer (up to 5,000 words), although excellent research papers should be possible within the 3,000 word limit. Graduate research papers will be expected to have more developed background and justification of their hypothesis, more detailed predictions, and a written presentation comparable to published research studies.

GRADING

GRADING	Percent of final grade
Short Assignments	10%
Exam 1	5%
Exam 2	10%
Exam 3	15%
Final Exam (cumulative)	20%
Critiques + Research Paper	40%
Total	100%

PERCENTAGE	LETTER GRADE
100%-98.0%	A+
97.9%-93.0%	A
92.9%-90.0%	A-
89.9%-88.0%	B+
87.9%-83.0%	B
82.9%-80.0%	B-
79.9%-70.0%	C
69.9%-60.0%	D
59.9%-0.00%	E

CLASSROOM HONESTY AND INTEGRITY

Honesty and integrity are a reflection of your character. Because students compete with one another for grades and eventually career opportunities, cheating is considered a serious offense. Please refer to the department handout discussing honesty and integrity. Cheating an/or plagiarism is a serious offense with a minimum punishment of a failing grade on the assignment and a maximum punishment of expulsion from the University.

In the "Student Academic Integrity Policy" manual, ASU defines "Plagiarism" [as] using another's words, ideas, materials or work without properly acknowledging and documenting the source. Students are responsible for knowing the rules governing the use of another's work or materials and for acknowledging and documenting the source appropriately." You can find this definition at: <http://provost/asu.edu/academicintegrity>

CLASS SCHEDULE

***Subject to change at any time**

Classes are Tuesday and Thursday, 1:30-2:45 PM, Discovery 246

Date	Topic	Reading
25 August	Introduction to the course Learning objectives Background concepts Relevance of course material	Vogel: 3-17 Brand, "Structural outline of an archival paper for the journal of biomechanics"
27 August	NO LECTURE	Dickinson et al. (2000)
1 September	Physics Review	
3 September	Quantities and Units Dimensional Analysis	Vogel: 19-41 Vogel: 65-89
8 September	Scaling	Vogel Ch. 3: 43-64 Short Assignment 1 Due
10 September	Scaling, cont...	
15 September	EXAM 1 (Through Scaling)	Short Assignment 2 Due
17 September	Material Properties of Solids Stress, strain	Vogel Ch. 15: 301-323
22 September	Biological Materials Energy, Cracking, Tendons,	Vogel Ch. 16:325-351 CRITIQUE 1 DUE

	bones	
24 September	Viscoelastic Materials	Vogel Ch. 17: 353-364
29 September	Simple Structures Stiffness, Shape	Vogel Ch. 18: 365-388 Short Assignment 3 Due
1 October	Biological Structures	Vogel Ch. 19: 389-405
6 October	EXAM 2 (Cumulative to this date)	Short Assignment 4 Due
8 October	Exam 2 Answer Q&A	
13 October	Mechanisms and Hydrostatic Structures	Vogel Ch. 20: 407-422
15 October	Muscles and Lever Systems	Vogel Ch. 22: 443-462 Vogel Ch. 23: 463-476
20 October	NO LECTURE	Short Assignment 5 Due
22 October	Muscles and Lever Systems (cont.)	
27 October	Biomechanics of Locomotion on Land (cont.)	Vogel Ch. 24: 477-493 Ferris and Farley (1998)
29 October	Biomechanics of Locomotion on Land (cont.)	
3 November	Motor Control of Legged Locomotion	Short Assignment 6 Due CRITIQUE 2 DUE FINAL PAPER TOPICS DUE
5 November	Motor Control of Legged Locomotion (cont.)	
10 November	EXAM 3	Short Assignment 7 Due
12 November	EXAM 3 Answers Q&A	
17 November	Stability and Dynamical Systems Theory	Full et al. (2002) Biewener and Daley (2007)
19 November	Fluid Basics	Vogel Ch. 5: 93-117
24 November	Moving Fluids	Vogel Ch. 6: 117-138 Short Assignment 8 Due
26 November	THANKSGIVING -- NO CLASS	
1 December	Fluid Forces: Drag	Vogel Ch. 7: 139-165 FINAL PAPER DRAFTS DUE
3 December	Swimming and Flying	Vogel Ch. 12: 245-265
8 December	Swimming and Flying (cont.)	Vogel Ch. 13: 267-284 Short Assignment 9 Due
15 December Final Exam Period 12:10-2:00 PM	FINAL EXAM (cumulative)	FINAL PAPER DUE