Comparative Biomechanics

BIO 3100:475/575

10:15 - 11:30 am MW

Henry C. Astley

Office: Auburn C308, Office phone: x8192

Office Hours: Thursday 10 pm - 12pm, or by appointment

Course Description: Comparative Biomechanics deals with the intersection between physics and biology, and the physics of organism morphology, function, and interactions with other organisms and their environment. This class will cover the physics and mechanics of biological materials, organ systems, feeding, locomotion, and more, with an emphasis on both the diversity of biomechanical systems and the underlying unifying principles. Ultimately, students will understand the unifying principles of physics and muscle physiology, how those determine movements of biological systems, and how adaptations in animals reflect these principles. The course includes lectures and individual projects.

Learning Objectives: At the end of this course, students will understand 1) how the fundamental principles of physics interact with biological systems in a variety of biomechanical contexts, 2) how the fundamentals of muscle physiology govern motion and motions, 3) how adaptations can reflect these principles, allowing broad conclusions across taxa, and 4) how organisms can use innovative adaptations to circumvent certain limits on performance, and the tradeoffs inherent in those adaptations. Additionally, 5) students will gain experience current biomechanics and literature research via a project on a topic of their choice (see below).

Grading: Grades will be based on two midterms (25%) and final exam (35%), project (25%), homework (15%). Exams will NOT be graded on a curve, but questions which >80% of the class miss may be discarded and grades adjusted accordingly. The final exam will be cumulative, but will be heavily weighted towards material from the latter portion of the semester.

Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
%	93-100	90-92	86-89	83-85	80-82	76-79	73-75	70-72	66-69	63-65	60-62	0-59

Grades will be evaluated at the end of class, and borderline cases considered. **However, once final grades are entered, I will not change grades without university-verified major cause (e.g. major illness). Students are encouraged to track their grades and consult with me if worried, particularly after exams.**

Final Project (Undergraduates): For undergraduates, students will decide on a biomechanical topic of interest, review the literature, and prepare a 4-page (single-spaced, 12 pt. font) research paper on the topic, highlighting what is known, why this topic is biomechanically interesting, and future areas of inquiry on the topic. Figures may be used, but should not use a total of more than ½ page of space. References are not included in page limits.

Final Project (Graduate Students): For students in the graduate section, the project will be an individual research proposal in the style of an NSF GRFP grant Graduate Research Plan Statement, but with a longer page limit (6 pages, single-spaced, 12 pt. font). This project will propose and justify a novel comparative biomechanics research project to address a currently unknown/unsolved topic, presenting formal hypotheses, experimental methods and experimental design. Figures may be used, but should not use more than a total of 1 page of space. References are not included in page limits.

Homework: Homework will be assigned for several of the early classes, in order to prompt quantitative engagement with the principles in the lectures. Homework is due 2 weeks after it is assigned, by 5 pm (e.g. if a homework is assigned on a Wednesday lecture, it will be due at midnight on a following Wednesday by 5). Please print the homework and either give it to me directly or put it in my mailbox in the Biology office at D401. You are encouraged to work in groups, consult others, and bring questions to office hours – it doesn't matter how you learn to solve these problems, only that you do. However, make sure you truly understand the answers, as similar questions may very well be on the midterm and final!

Required and Optional Texts: There is no required textbook for this course, though there are a variety of texts which each cover, in greater or lesser detail, a subset of topics in this class in a comparative context, including Vogel's 2003 "Comparative Biomechanics", Biewener's 2003 "Animal Locomotion", R. McNeil Alexander's 2002 "Principles of Animal Locomotion", Liber's 2002 "Skeletal Muscle Structure, Function, and Plasticity: The Physiological Basis of Rehabilitation", and Hildebrand's 1985 "Functional Vertebrate Morphology". These texts are on reserve at the library.

Graduate Student Reading Section: Graduate students will confer with Dr. Astely to select a one-hour time beyond regular class hours for weekly discussion of selected scientific papers; interested undergraduates are welcome to attend, though it is not mandatory.

Recitation Sections: During the early, math-heavy phase of the course, Dr. Astley will hold twice-weekly sessions outside of class (times determined according to consensus scheduling) to work through example problems and help students with this challenging section and provide a solid foundation for applying it to upcoming content. New material won't be covered, but rather homework help in a group setting. Students unable to attend can always meet 1-on-1 during office hours.

Course Calendar

	M	W
Week 1	Intro	Physics 1
Week 2	Holiday	Physics 2
Week 3	Solid Mechanics	Fluid Mechanics
Week 4	Scaling	Skeletons
Week 5	Muscle - Myosin	Muscle – Activ. & Cell Phys.
Week 6	Muscle - Geometry	Muscle-Tendon Units
Week 7	Exam	Motor Control
Week 8	Thermal Biology	Locomotion in Liquids
Week 9	Feeding in Liquids	Internal Fluid Flows
Week 10	Liquids at Small Size	Granular Media
Week 11	Exam	Locomotion on Land
Week 12	Limbless Locomotion	Maneuvering
Week 13	Terr. Feeding	Arboreality
Week 14	Flight Mechanics	Flight Evolution
Week 15	Health Biomechanics	Biomimicry
	Final Exam	