

HEB 1311: Evolution of Human Locomotion (Spring 2024)

Instructor: Dr. Andrew Yegian (ayegian@fas.harvard.edu)

Meetings: MW 10:30-11:45am, Northwest B101

Office Hours: Thursdays 12:00-1:00pm (Zoom); Fridays 12:00-1:00pm (Peabody 53b)

Course Summary: Why are humans bipeds? When did we evolve to walk on two feet and to run long distances? How does being a biped in the modern world affect our lives and our health? In this course we will use the multidisciplinary approach of *evolutionary biomechanics* to address these questions and more! Evolutionary biomechanics uses principles from physics and mechanical models of modern day humans and other species as tools for understanding evolution. From the our last common ancestor with chimpanzees millions of years ago through the modern day, we will explore the evolutionary processes that led to our unique two-footed locomotion and how bipedalism shaped our history and made us who we are today. The course will cover a wide range of topics, combining evolutionary theory and hypotheses with quantitative mechanics and physics. There are no prerequisites, and all topics will be taught assuming no prior knowledge. At the end of the semester you will have a deeper understanding of both how humans use physics to move, and how locomotion was central to the evolution of humans.

Course Structure: The semester will be divided into four modules that group lectures into major topics addressed by the course material. Each module also has two at home activities (completed for credit). Modules will end with a review session and wrap-up discussion, followed by a graded study guide (see more below). Two lectures at the end of the semester are not assigned to any module. At the conclusion of the class there will be a seated final exam covering the entire semester's material. The grading structure for the module study guides allow for revisions and increased grades (see more below.) The four modules are:

M1: Evolution

This module will cover the theory of evolution by natural selection and broadly comparative overviews of humans and other mammals, as well as the history of human evolution science.

M2: Biomechanics

This module will review Newtonian mechanics and principles of energy transfers along with musculoskeletal biology, integrating the two into the biomechanics toolbox.

M3: Walking

This module will cover the mechanical principles of human bipedal walking and will use those principles to assess the fossil record to determine how and when bipedal walking evolved, and how that changed the evolutionary trajectory of the human lineage.

M4: Running

This module will cover the mechanical principles of bipedal endurance running, and will use those principles to assess the fossil record to determine how and when endurance running evolved. We will also explore how the evolution of endurance running was an inflection point in the course of human evolution, leading directly to modern humans.

Study Guides and Grades: Each module will conclude with the construction of a study guide covering the module materials that you will have on hand during the final exam. At the end of the module you will turn in your draft guide for comments and an initial grade. Study guides may then be revised and resubmitted to earn points back up to full credit. *Your final revised study guides will be printed and provided to you during the final exam.*

At home activities are designed to be completed in 1-2 hours and will be graded on a complete/incomplete binary basis.

A seated final exam will be held (date and location TBA) and will consist of multiple choice and short answer questions covering all of the course materials. You will be allowed to use your module study guides during the exam. *The final exam cannot be revised for a higher grade.*

Grade Breakdown:

At Home Activities: 10 points each (40 total, 20%)

Module Study Guides: 15 points each (60 total, 30%)

Final Exam: 100 points (50%)

Letter grades will be determined using the standards set forth by the Harvard College Handbook for Students, which states the following standard for A grades: “Earned by work whose excellent quality indicates a full mastery of the subject and, in the case of the grade of A, is of extraordinary distinction.”

Collaboration Policy and Plagiarism: I hope for as much interaction with your fellow students as possible, but any and all work you turn in must be your own work. Refer to the Harvard College Honor Code:

“Members of the Harvard College community commit themselves to producing academic work of integrity – that is, work that adheres to the scholarly and intellectual standards of accurate attribution of sources, appropriate collection and use of data, and transparent acknowledgement of the contribution of others to their ideas, discoveries, interpretations, and conclusions. Cheating on exams or problem sets, plagiarizing or misrepresenting the ideas or language of someone else as one’s own, falsifying data, or any other instance of academic dishonesty violates the standards of our community, as well as the standards of the wider world of learning and affairs.”

SCHEDULE

		Monday	Wednesday
M1: Evolution	Week 1, 1/22 – 1/26	Evolutionary Biomechanics	Evolution by Natural Selection
	Week 2, 1/29 – 2/2	An Evolving Understanding of Human Evolution	What Exactly is Locomotion?
	Week 3, 2/5 – 2/9	Humans and the Tree of Life	<i>Module Discussion & Review</i>
M2: Biomechanics	Week 4, 2/12 – 2/16	Mechanics and the Laws of Motion	Statics and Dynamics
	Week 5, 2/19 – 2/23	*no class*	Musculoskeletal Function
	Week 6, 2/26 – 3/1	Analyzing Human Movement	<i>Module Discussion & Review</i>
M3: Walking	Week 7, 3/4 – 3/8	Simple Models of Bipedal Walking	The Bipedal Balancing Act
	Spring Break		
	Week 8, 3/18 – 3/22	Evolutionary Biomechanics of Walking	Hominin Bipedalism
	Week 9, 3/25 – 3/29	Load Carrying	<i>Module Discussion & Review</i>
M4: Running	Week 10, 4/1 – 4/5	Simple Models of Bipedal Running	You Have to Walk Before You Run
	Week 11, 4/8 – 4/12	Evolutionary Biomechanics of Running	Running Was an Evolutionary Leap
	Week 12, 4/15 – 4/19	*no class*	Human Athleticism
	Week 13, 4/22 – 4/24	*no class*	Wrap-Up