HEB 1311: Evolution of Human Locomotion **(Fall 2021)**

SYLLABUS

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

Meetings: Wednesday and Friday, 12:00-1:15pm, Peabody Museum 52H

Office Hours: one in person session and one online session per week (TBA)

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 will end with a review session and wrap-up discussion, followed by an online exam (see more below). Two lectures that review basic mechanical physics during Week 5 are not assigned to any module, but are integrated into the course material covered by the exams. The four modules are:

M1: Evolutionary Biomechanics
This module will introduce the field of evolutionary biomechanics. We 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: 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.

M3: 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.

M4: Modern Bipedalism
This module will address how we use our bodies in our modern environments, linking our bipedal locomotion to an incredible diversity of behaviors as well as an array of injuries and disease.

Module Reviews and Discussion: The last class period for each module will consist of a review session and class discussion. Short readings will be assigned before each session and

we will discuss the readings as a class. Attendance is mandatory (barring illness or other emergency) and participation in the discussions is part of the final grade. After a brief discussion of the reading, the second part of the class period will be a standard exam review session with an open mic for questions on the material.

NOTE: Current policy at Harvard mandates masks in the classroom, including for the instructor if they are not distanced 14 feet from the students. In our classroom I will be masked, so ***until further notice the review sessions at the end of the modules will be held online via Zoom so that I can get an opportunity to see your faces and talk to you without masks!*** *If Harvard policy changes such that we can be safely unmasked in the classroom then the review sessions will shift to in person, but until then we will use Zoom once per module.*

Exams: Each module will end with an open-notes online exam covering the current module material. Principles learned during previous modules will also be used in the formulation of exam questions. The exams will mostly consist of short answer questions, with other forms such as multiple choice possible but rare. *There is no final exam.*

Exams will be administered online through Canvas, and are designed to be completed in 75 minutes. The exams will open at 10:30am EST on the designated day, and must be completed by 11:59pm EST on the same day. I will be available on Zoom to answer questions about the exam if any confusion arises (but not about the material on the exam!) from 12:00-1:15pm EST during each exam day. If you choose to take the exam after the normal class time, you must email me any questions and bear in mind you may not get an immediate response.

Grades: Your semester grade will be determined using 400 total points for the semester. Each of the four Module Exams is worth 90 points (for a total of 90% of your total grade). Participation during discussions will be worth 40 points (10% of your total grade).

If an exam is not completed by the due date, you may still finish the exam but it will be docked 30 points for being late.

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.”

Attendance: You are *highly* encouraged to be present for every class period, including online reviews, during the semester!! Each class will involve discussion, and will be interactive with questions answered during the lectures.

However, I am aware of and fully understand that this semester is filled with many unknowns and that individual circumstances will vary greatly across the class. *If you do need to miss a class for any reason, please reach out to me via email and let me know which classes you will miss (you do not need to inform me why)* so I am aware of your absence and can help you plan how to catch up on the material you miss.

Collaboration Policy and Plagiarism: I hope for as much interaction with your fellow students as possible, but any and all work you turn in on your exams 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:

	MODULE/WEEK	WEDNESDAY	FRIDAY
M1: EVOLUTIONARY BIOM.	**Week 1 (Sept. 1-3)**	<<<<<<no class>>>>>>	Course Intro: Evolutionary Biomechanics
	Week 2 (Sep. 6-10)	Evolution By Natural Selection	The Evolving Field of Human Evolution
	Week 3 (Sep. 13-17)	Humans and the Tree of Life	What Exactly Is Locomotion?
	Week 4 (Sep. 20-24)	* *Module 1 Review and Wrap-up* *	**Module 1 Exam**
	Week 5 (Sep. 27-Oct. 1)	Mechanics: How the Universe Works	Energy: The Currency of Life
M2: WALKING	**Week 6 (Oct. 4-8)**	Simple Models of Bipedal Walking	The Bipedal Balancing Act
	Week 7 (Oct. 11-15)	Evolutionary Biomechanics of Bipedal Walking	Two Feet on the Ground: Hominin Bipedalism
	Week 8 (Oct. 18-22)	* *Module 2 Review and Wrap-up* *	**Module 2 Exam**
M3: RUNNING	**Week 9 (Oct. 25-29)**	Simple Models of Bipedal Running	You Have to Walk Before You Run
	Week 10 (Nov. 1-5)	When and Why Did Running Evolve in Hominins?	Running and the Evolution of Hunter-Gatherer Ecology
	Week 11 (Nov. 8-12)	* *Module 3 Review and Wrap-up* *	**Module 3 Exam**
M4: MODERN BIPEDALISM	**Week 12 (Nov. 15-19)**	Load Carrying: The Bipedal Innovation	Human Athleticism
	Week 13 (Thanksgiving)	<<<<<<no class>>>>>>	<<<<<<no class>>>>>>
	Week 14 (Nov. 29-Dec. 3)	How You Use Your Body Matters	**Module 4 Exam**