

IB 438 - How Organisms Move (4 credits)
Spring 2025
Course Syllabus

Course Description: Examines the interaction between biological processes and the fundamental laws of mechanics. Covers general topics, such as structural analyses of anatomy, kinematics of movement, the behavior of organisms in fluids, and the importance of scaling, as well as specific topics, such as bird flight, fluid flow in cardiovascular systems, and high speed predation. Lab culminates in student-designed, group projects to collect novel biomechanical data to answer questions about an organism of the students' choice.

Student Learning Outcomes:

- 1) Analyze how mechanical principles influence biological form and evolution across vertebrates, invertebrates and plants.
- 2) Use critical thinking skills and quantitative reasoning to solve biomechanical problems.
- 3) Apply biomechanical models to natural phenomena.
- 4) Learn biomechanical experimental design, including becoming familiar with several techniques and methods such as materials testing, high-speed videography and flow modeling.
- 5) Use the process of scientific inquiry to perform original research.

Prerequisites: IB202 and Junior standing or higher.

Requirements met: IB major, advanced lab course.

Professor: Dr. Philip Anderson
202A, Shelford Vivarium
One on One support: TuTh 3:20-4:20pm
Email: andersps@illinois.edu
I will aim to respond to course-related emails within 24 hours except on weekends. Keep this in mind when emailing questions concerning assignments with deadlines.

Teaching Assistants:

XXXXX

XXX is a graduate student in the School of Integrative Biology. They will assist during lectures and labs as well as help grade problem sets and lab reports.

Lecture: Natural History Building, Rm 4074. TuTh, 2:00-3:20pm

Lab: Natural History Building, Rm 4074. M or W, 2:00-4:50

Textbook: (available for purchase in the bookstore)

Required: Pennycuik 1988. Conversion factors. University of Chicago Press

Recommended: Vogel 2016. Comparative Biomechanics: Life's Physical World. Princeton University Press

Journal Articles: Readings from the primary literature for lectures and discussions and tutorials for the labs will be made available to students online via the Moodle site.

Course Structure: This is a 4-credit course including a lab. Students should expect to commit on average 8 hours of work time outside of lecture/lab for this course.

Lecture: Lectures will be given on Tuesday and Thursdays. During the first 7-9 weeks of the semester, these lectures will focus on fundamental principles in biomechanics and functional morphology. Examples include the material properties of biological tissues, fluid flow around organisms, and the mechanical significance of scaling in biology. The purpose of these lectures is to lay a foundation for understanding how organisms function in a physical world. Examples used in lecture will be drawn from vertebrates, invertebrates, plants and microbes. For the latter 5-7 weeks, lectures will focus on more complex mechanical problems drawing upon the knowledge gained from fundamentals. These could include flight in birds/insects, dental mechanics and fluid dynamics at extremely small sizes. Specific topics covered will be partly determined by class interests in a given year.

Certain lectures will have materials meant to be reviewed prior to lecture. These may be readings or pre-lecture videos. All such materials will be made available on the Moodle site.

Discussions: Throughout the semester, certain lecture periods will include discussion sessions based on the primary literature. The purpose of these sessions is to give the students exposure to a range of topics in biomechanics and how the fundamental principles they are learning can be applied to broader biological questions. For the first half of the semester, these topics will be chosen by the instructor to help reinforce the lecture material. During the latter half of the semester, any graduate students in the class will be tasked with presenting a paper of their own choosing for discussion. They will be expected to lead the discussion and fill the class in on any content that is required to understand the paper and put it into the larger context of the course.

Labs: Two lab sessions will be held Monday and Wednesday afternoon from 2-4:50pm. During the first eight weeks of the course, these 3-hour lab sessions will involve directed laboratory practicals designed to give the students hands-on experience with experimental techniques. The purpose of these labs is two-fold: 1) to further reinforce the course material through experiential learning and 2) to give the students an introduction to techniques they may wish to utilize for their projects. Three lab sessions will result in brief (3 page) lab write-ups to be graded.

In the latter half of the course, the lab time will be given over to work time for the final projects. The instructors will be available during this time period for consultation and other aid.

Expectations: Assessment in this course will include a combination of formative and summative assessments. A full grade breakdown follows:

Grade breakdown:

Project paper	20%
Project presentation	10%
Project milestones	20%
Lab reports (3)	15%
Problem sets (3)	15%
Participation	20%

Problem Sets: There will be three problem set due over the course of the term (worth 5% of the final grade each). These problems sets will include both basic word problems involving materials from lecture, interpretive questions based on graphical data, and larger exercises involving primary data that will be provided to the student. Three specific lecture sessions will be devoted to working in these problem sets, allowing students to work together and gain assistance from instructors on the problems. While working in groups is encouraged, each student will be expected to write-up their own answers. (each problem set is worth 5% of the final grade).

Lab Reports: Three of the directed labs during the first half of the course will result in brief (3 page) lab write-ups to be graded. The goal of these lab reports is to help students get practice at reporting scientific findings in a clear and concise manner. The content of the reports will vary based on the lab and grading will be based on improvement over the course of the term. Although lab work is generally done in groups, each student will submit their own lab write-up. (each report is worth 5% of the final grade).

Project: The ultimate goal of the course will be group-based projects (2-3 individuals per group) designed and executed by the students during the second half of the semester. These projects should be accomplishable with the resources available to the class, including materials testing devices, high-speed videography, computer simulations, and other equipment. The projects will be question-based, aiming to address specific hypotheses and accumulate novel data on a system of interest. The specific products associated with the project are as follows:

Project Milestones:

- **Project idea (5%):** Each group will submit a brief (1 paragraph) explanation of their idea for a project as well as a list of all the group members. The instructor will then evaluate the potential project for feasibility and discuss the projects with each group.
- **Project outline (5%):** Each group will submit a 1-2 page outline of the project after approval of the initial idea. The outline's main purpose to make sure the groups have thought through all of the required steps for executing the proposed data collection and analysis. The instructor will evaluate the outline and provide feedback on the methods.

- Methods draft (10%): Each individual student will submit a draft of the Methods section of their final paper. This is done to give the instructor one last opportunity to provide feedback on student writing.
- Project Presentation (10%): Each group will give a 15-20 minute presentation at the end of the term to the rest of the class. The presentation will be formatted as a conference talk, introducing the question asked and presenting method, results and interpretation by the group. Everyone member of the group is expected to participate in the presentation.
- Project paper (20%): Each student will individually write a scientific manuscript-style report of their groups results at the end of the course. The paper will be 5-10 pages long including figures and references. The paper should be comprised of an Introduction, Methods, Results and Discussion.

Students will have a chance at the end of the term to provide the instructor with self and peer evaluations of their group to help in assigning participation grades as outlined below.

Participation: 20% of the final grade falls under class participation. This is a small class and is meant to be interactive. My lectures are not as formal as you may be used to and will utilize the whiteboard in the classroom, as well as audio-visual tools and demonstrations extensively. I will also often ask you to take time to discuss ideas amongst yourselves in small groups. I expect all students to participate in these activities.

Students all start the course with full credit for participation. Participation points can be lost due to unexcused absence from lecture or lab (-2% each), not participating in small group discussions (-5% if it is a constant issue; students won't be penalized for having an off day), or not contributing to the final group project based on the peer evaluations mentioned above.

Quick note about group work: Both the labs and the final project involve extensive group work. Groups are not set in stone for the term and students may be in different groups for the individual labs as well as the final project.

Course Grading Philosophy

1) I do not 'curve' individual assignments. Instead, I will assign grade cut off points based on the distribution of student point totals at the end of the semester.

2) I use a scale from A to D including +/- (although I do not give A+ or D-). The starting cutoff points for each letter are standard (for example: 89-88% for B+, 87-83% for a B and 82-80% for a B-). Depending on the distribution of points at the end of the semester I **may** drop the cut off points slightly (e.g., 88% might become the A- cut off) but I **will not raise** the cut-offs.

Communication Plan

Communication between instructors and students will primarily occur during class. However, as an enrolled student, you will also have access to the course website from your Moodle dashboard. It is also accessible here:

<https://learn.illinois.edu/course/view.php?id=47820>

What you will find on Moodle:

- The syllabi for lecture and lab
- Pre-lecture materials including readings and pre-lecture videos.
- Pre-lab materials including guided activities and equipment documentation
- Updates from the instructors and TAs.
- Resources, lecture notes and handouts.
- Course gradebook

If you have an inquiry, you can use the emails listed for each instructor. Their bio section will also note how fast to expect an answer. If you would like further one-on-one discussion with Dr. Anderson please reach out via email to set-up an appointment. Dr. Anderson can also meet with small groups of students for discussion if you prefer.

As with all communication in a class, the expectation is for students to act in a professional and kind manner when interacting with both each other and with instructors.

Tentative Course Calendar (Spring 2025) (subject to change)

Week	Date	Day	Activity	Assignments Due
1	1/21	Tuesday	Introduction to biomechanics	
	1/23	Thursday	Biological tissue properties	
		Lab	No Lab	
2	1/28	Tuesday	Biological Structures	
	1/30	Thursday	Biological Composites	
		Lab	Lab: Materials testing methods	
3	2/4	Tuesday	How structures fail	
	2/6	Thursday	Endoskeleton Vs Exoskeleton	
		Lab	Lab: Materials testing methods	
4	2/11	Tuesday	Problem Set 1	
	2/13	Thursday	Biological Movement	
		Lab	Lab: Bending/Buckling mechanics	Lab Report 1
5	2/18	Tuesday	Biological Engines	Problem Set 1
	2/20	Thursday	Molecular engines	
		Lab	Lab: Kinematics/Linkages	
6	2/25	Tuesday	Paleobiomechanics	
	2/27	Thursday	Problem set 2	
			Lab: Videographic methods	
7	3/4	Tuesday	How fluids flow	
	3/6	Thursday	Forces in flow	Problem Set 2
			Lab: Fluid dynamic methods	Lab Report 2
8	3/11	Tuesday	Drag and lift in organisms	
	3/13	Thursday	Life in Low Re	

		Lab	Lab: Fluid dynamic methods	Project Idea
9	3/25	Tuesday	Problem Set 3	
	3/27	Thursday	Biomechanics and Diversity	
		Lab	Project brainstorming	Lab Report 3
10	4/1	Tuesday	TBD	Problem Set 3
	4/3	Thursday	Student Led Discussion	
		Lab	Project Work	Project Outline
11	4/8	Tuesday	TBD	
	4/10	Thursday	Student Led Discussion	
		Lab	Project Work	
12	4/15	Tuesday	TBD	
	4/17	Thursday	Student Led Discussion	
		Lab	Project Work	
13	4/22	Tuesday	TBD	
	4/24	Thursday	Student Led Discussion	
		Lab	Project Work	Project Methods
14	4/29	Tuesday	TBD	
	5/1	Thursday	Student Led Discussion	
		Lab	Project Work	
15	5/6	Tuesday	Presentations	
		Lab	Presentations	
Finals				Project Paper

*Lectures in the second half of the course will vary based on student interest.

Attendance Policies:

ATTENDANCE AT LECTURE IS REQUIRED. This is an interactive course as mentioned above under participation grade. Therefore, there is no substitute for regular attendance so make a note of the dates now. Notify Dr. Anderson prior to lecture or lab if you will have to miss. The only excuse for not informing the instructor prior to missing lecture or lab is personal illness or tragedy in your immediate family. If you have any questions regarding these policies, please review the Office of the Dean of Students webpage [About Absence Letters](#). This page describes how absence letters should be requested.

Late Submission Policy

Lab reports and problem sets turned in late without prior approval of the instructor will be docked 10% of the overall grade for each week that passes after the deadline. Effectively, any assignment turned in late within one week of the deadline will be docked 10% (maximum possible credit is 90%). If the assignment is turned in one week after the deadline (e.g. the following Friday after a Friday deadline) or anytime the following week it will be docked 20%, third week 30% and so on.

Final project: As there are no written exams for this course, there is no formal policy for make-up exams. The written report for the final project is under a stricter version of the guidelines for late work described above (10% per two days late). The final group presentations will be done during the final week of classes; attendance is mandatory without prior approval from the instructor.

Course Policies: All students are assumed to have read and understood the “Code of Policies and Regulations Applying to All Students,” University of Illinois, and will be expected to act accordingly.

The Code is available online at: <http://www.admin.uiuc.edu/policy/code/index.html>

Academic Integrity: According to the Student Code, ‘It is the responsibility of each student to refrain from infractions of academic integrity, from conduct that may lead to suspicion of such infractions, and from conduct that aids others in such infractions.’ Please know that it is my responsibility as an instructor to uphold the academic integrity policy of the University, which can be found here: http://studentcode.illinois.edu/article1_part4_1-401.html

Academic dishonesty may result in a failing grade. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Copyright

Student Content

Participants in University of Illinois courses retain copyright of all assignments and posts they complete; however, all materials may be used for educational purposes within the given course. In group projects, only the portion of the work completed by a particular individual is copyrighted by that individual. The University of Illinois may request that students' materials be shared with future courses, but such sharing will only be done with the students' consent. The information that students submit during a course may, however, be used for the purposes of administrative data collection and research. No personal information is retained without the students' consent.

Non-Student Content

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Disabilities: Please contact your instructors or TAs during the first week of classes to make requests for disability accommodations. To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to the DRES website. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available on campus that can help diagnosis a previously undiagnosed disability by visiting the DRES website and selecting “Sign-Up for an Academic Screening” at the bottom of the page.

Religious Observances:

Please reference the Community of Care’s Request for Accommodation for Religious Observances page (<https://odos.illinois.edu/community-of-care/resources/students/religious-observances/>). This links to the Request for Accommodation for Religious Observances form that should be completed for those students seeking religious accommodations.

Family Educational Rights and Privacy Act (FERPA) Statement: Any student who has suppressed their directory information pursuant to *Family Educational Rights and Privacy Act* (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See <https://registrar.illinois.edu/academic-records/ferpa/> for more information on FERPA.

Sexual Misconduct Policy and Reporting Statement: The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University’s Title IX and Disability Office. In turn, an individual with the Title IX and Disability Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here:

<https://wecare.illinois.edu/resources/students/#confidential>

Other information about resources and reporting is available here: wecare.illinois.edu.

Inclusivity Statement: The effectiveness of this course is dependent upon the creation of an encouraging and safe classroom environment. Exclusionary, offensive or harmful speech (such as racism, sexism, homophobia, transphobia, etc.) will not be tolerated and in some cases subject to University harassment procedures. We are all responsible for creating a positive and safe environment that allows all students equal respect and comfort. I expect each of you to help establish and maintain an environment where you and your peers can contribute without fear of ridicule or intolerant or offensive language.

Support Resources and Supporting Fellow Students in Distress: As members of the Illinois community, we each have a responsibility to express care and concern for one

another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (1-217-333-0050) or online at odos.illinois.edu/community-of-care/referral/. Based upon your report, staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe.

Further, as a Community of Care, we want to support you in your overall wellness. We know that students sometimes face challenges that can impact academic performance (examples include mental health concerns, food insecurity, homelessness, personal emergencies). Should you find that you are managing such a challenge and that it is interfering with your coursework, you are encouraged to contact the Student Assistance Center (SAC) in the Office of the Dean of Students for support and referrals to campus and/or community resources. The SAC has a Dean on Duty available to see students who walk in, call, or email the office during business hours. For mental health emergencies, you can call 911 or contact the Counseling Center.