

Bioinspired Design, HC 441H (CRN32644) Spring 2018
Class meeting time: Mon. and Wed. 2:00-3:50 pm, Chapman 202

Instructor: Dr. Kelly Sutherland ksuth@uoregon.edu 541-346-8783
Office Hours: Tues. 1- 3 pm in 473B Onyx Bridge, Wed. 10- 12 am in 308 Chapman

Description:

Over the course of 3.8 billion years, through the process of evolution, organisms have attained solutions to deal with complex problems in the natural world. How do geckos manage to adhere to a surface when they are upside down? How do fish schools swim in an organized formation to conserve energy? How do prairie dogs keep their burrows cool? In this course, we will explore basic **biological** and **physical** principles to understand how nature has solved these problems and others. We will then think across disciplines to consider how we can apply an understanding of how biological systems work to solve engineering or design problems. An example of a bioinspired product is Lotusan™-- a self-drying, self-cleaning paint inspired by the surface properties of lotus leaves.

Through case studies from the primary literature that exemplify how organisms deal with problems in the natural world, lab exercises, demonstrations, writing exercises and discussion we will develop critical thinking and an understanding of the scientific process. Early in the course we will organize into interdisciplinary teams, each of which will work to identify a design challenge and look to nature to develop a unique solution. The course will culminate with a written project and an oral presentation to share findings with the class.

Learning outcomes:

- An understanding of how science works through observations and hypothesis testing
- Experience with writing about and presenting scientific data
- Basic scientific literacy so that you can evaluate science stories you read in the media
- Familiarity with reasoning across disciplines in teams to come up with novel solutions

Readings:

The Gecko's Foot, Peter Forbes
Cat's Paws and Catapults, Steven Vogel
Other readings as assigned- hard copies in class and e-copies on Canvas

Grading:

Assignments: 50%
Tree scaling and motion analysis labs: 10% and 15%; other 5 assignments: 5% each
Final Project: 25% (10% for draft and 15% for final)
Project Presentation: 15% (5% for update and 10% for final presentation)
Participation: 10%

COURSE POLICIES:

Class participation: Like other courses in the CHC, participation through discussion, class activities, presentations and engagement with other students are core aspects of your study. It is your responsibility to come to class prepared to discuss readings and assignments. Furthermore, if you are absent, you won't be able to participate! Any more than 1-2 absences over the course of the term will negatively impact your participation grade.

Office hours: You are welcome and encouraged to stop by my office hours. If you aren't free during these times, you can also make an appointment to meet with me. Please use face-to-face interaction (office hours, before or after class) as your primary way of communicating with me and only use email as a last resort.

During most weeks, there will be a reading assignment and a writing assignment. Plan to do the reading before Monday's class and writing assignments will be due on Wednesday.

Homework assignments will not be accepted late. If you will not be in class, please have a classmate pick up and turn in your assignments.

Academic honesty: I expect each of you to abide by the University's policy on academic misconduct, described at <https://dos.uoregon.edu/conduct>. Plagiarism, cheating and other acts of academic dishonesty are serious offenses and will be handled accordingly.

Accessibility: The University of Oregon is working to create inclusive learning environments. Please notify me if there are aspects of the instruction or design of this course that result in disability-related barriers to your participation. You are also encouraged to contact the Accessible Education Center in 155 Oregon Hall at 541-346-1155 or uoaec@uoregon.edu

Prohibited Discrimination and Harassment Reporting: I am a designated reporter. For information about my reporting obligations as an employee, please see [Employee Reporting Obligations](#). Students experiencing any form of prohibited discrimination or harassment, including sex or gender based violence, may seek information on safe.uoregon.edu, respect.uoregon.edu, titleix.uoregon.edu, or aaeo.uoregon.edu or contact the non-confidential Title IX office (541-346-8136), AAEO office (541-346-3123), or Dean of Students offices (541-346-3216), or call the 24-7 hotline 541-346-SAFE for help.

COURSE SCHEDULE

Week 1: Evolution vs. design

Watch: Janine Benyus TED talk

http://www.ted.com/talks/janine_benyus_shares_nature_s_designs.html

Assignment 1: Inspiration from found object

- Overview of class and projects, What is bioinspired design?
- Evolutionary principles; Evolution versus engineer

Assignment 1 due in class Wed.

Week 2: Scaling

Reading: Two schools of Design (Cat's Paws and Catapults, Vogel, Chap. 2)

Matter of the Magnitude (Cat's Paws and Catapults, Vogel, Chap. 3)

Biomimicry design spirals

Assignment 2: Identify a problem and find a solution in nature

- Scaling: why size matters
- Designing with Biomimicry in mind

Assignment 2 due in class on Wed. (hard copy)

Week 3: Scientific process vs. design process

Reading: The Scientific Paper (Valiela, Chap. 6)

On Being Large (McMahon & Bonner, Chap. 5, pp. 137-150)

Assignment 3: Tree scaling write-up

- Tree scaling exercise (Assignment 3)
- Science writing and library research overview

Project topic due in class on Wed. (hard copy)

Week 4: Materials and surfaces 1

Reading: The great sacred lotus cleans up (The Gecko's Foot, Forbes, Chap. 2)

Purity of the sacred Lotus (Barthlott & Neinhuis 1997)

- Self-cleaning Lotus leaves
- Finding salient points in primary literature

Assignment 3 due in class on Wed. (hard copy)

Week 5: Materials and surfaces 2

Reading: Clinging to the ceiling (The Gecko's Foot, Forbes, Chap. 4)

Gecko adhesion as a model system (Autumn et al. 2014)

Assignment 4: Write a summary of scientific journal article

- Gecko's feet
- In-class peer review

Assignment 4 due in class on Wed. (bring two copies to class)

Week 6: Movement 1

Reading: On Being Large (McMahon & Bonner, Chap. 5, pp. 151-165)

Assignment 5: Experimental plan for motion analysis lab

- Animal locomotion; Gait analysis
- 5 minute progress reports

Assignment 5 due in class on Wed. (hard copy)

Week 7: Movement 2

Reading: Enhancing success of biomimetic programs (Wolff et al. 2017)

Assignment 6: Motion analysis laboratory write-up

- Motion analysis data collection
- Aquatic animal locomotion

Assignment 6 due in class on Wed. (hard copy)

Week 8: Collective behavior

Reading: Consensus in animal groups (Couzin et al. 2011)

- Collective behavior; Guest lecture: Dr. Tristan Ursell (Physics)
- Project discussions

Draft of final project due in class on Wed. (hard copy)

Week 9: Fluids and flow

Reading: Forces of flow (Vogel, pp. 163-168)

Assignment 7: Comparison of popular article and primary literature

- No class- Memorial Day Holiday on Monday
- Vortex rings, fish schools and wind farms; Oral presentation tips

Assignment 7 due in class on Wed. (hard copy)

Thurs. May 31, 4- 7 pm, FINAL PRESENTATIONS, Chapman 202

Week 10: Final projects due

Final project due by 5 pm on Wednesday, June 6 – electronic copy please
(Send final AND draft electronically to Prof. Sutherland at ksuth@uoregon.edu)

Week 11:

No Final Exam