

Biological Scaling: Why Size Matters

Biology 191 Fall 2007

TTH 2:40-4:00 pm, Higley Auditorium

Professor Drew Kerkhoff
Office 301 Higley Hall
Phone 427-5734
Email kerkhoffa@kenyon.edu

Office Hours

Mon 3-5 pm
Wed 9-11 am
Thu 9-10 am

MSSC Tutor Andy Boylan
(boylana@kenyon.edu)

Required Texts

Bonner, J.T. *Why Size Matters: From Bacteria to Blue Whales*. Princeton.

Schmidt-Nielsen, K. *Scaling: Why is Animal Size So Important?*. Cambridge.

Whitfield, J. *In the Beat of a Heart: Life, Energy, and the Unity of Nature*. Joseph Henry.



General Course Goals and Expectations

This class is based on the idea that you can learn an awful lot of biology just by asking that fundamental question: “Is it bigger than a breadbox?” We will explore how size determines the form, function, pace, and complexity of life. Our questions will span from the miniscule (Can bacteria see?) to the gigantic (How many species are there on Earth?) to the fantastic (What would it cost to feed King Kong, and could he actually feed himself, or walk for that matter?). Living things span an amazing range of sizes, and by studying the size extremes of the living world, we will develop a framework for comparing not just apples and oranges, but bacteria and blue whales. Surreal perspectives on size and life such as Swift’s *Gulliver’s Travels*, Kafka’s *Metamorphosis*, and films like *A Fantastic Voyage* and *Destroy All Monsters*, will further highlight the truly amazing nature of biological reality.

Through this course you will learn to:

1. Appreciate the amazing orders-of-magnitude size range of living things and the effects of size on all aspects of life.
2. Think on a magnitude scale.
3. Become familiar with basic statistical and graphical analyses of data (i.e., regression) and use these methods to interpret patterns, make inferences, and test hypotheses.

These skills will be achieved through lectures, readings, film viewings, homework problems, and a final project. As a student, you don't need a scientific background as much as you need a strong interest in understanding how nature works, and a desire to *participate* in the learning process. As the instructor, I will give focus to our studies, assist you in attaining your own understanding of the subject, and provide both formal and informal feedback and mentorship. **Our roles require that all of us come to class sessions prepared.**

Course Outline and Calendar

W k	Topics and Activities	Readings
1	Dimensions, Magnitude, and Similarity	<i>Powers of 10</i> (short film) Bonner Ch. 1 Schmidt-Nielsen Ch. 1-2
2	Organisms, Metabolism, and Biodiversity	Bonner Ch. 2-4
3	Logarithms, Exponents, and Regression	Whitfield 1 Schmidt-Nielsen Ch. 2
4	On Being the Right Size First response deadline	Haldane Essay Schmidt-Nielsen Ch. 3, 5 Bonner Ch. 3, 5
5	Possibilities and Impossibilities	LaBarbera Essay <i>Gulliver's Travels</i> I: Lilliput <i>Fantastic Voyage</i> (film)
6	Energy, Metabolism, and Kleiber's Fire of Life Second Response deadline First Project Proposal Due	Whitfield Ch. 2-3 Schmidt-Nielsen Ch. 6-8
7	Midterm Exam I (week of reading days)	
8	Life, Growth, Motion, Disease, and Death	Whitfield Ch. 4-6 Schmidt-Nielsen Ch. 11-12 (+13-15) Bonner Ch. 6
9	Giants Walk the Earth, the World Eaters Third Response deadline	Moses Paper Vitousek Paper <i>Gulliver's Travels</i> II: Brobdingnag <i>King Kong</i> (film)
10	Biodiversity in the Scales Project Progress Reports Due	Whitfield Ch. 7-8 Bonner Ch. 7
11	Islands, Carpets, Parasites and Hosts Fourth response deadline Film review deadline	Whitfield Ch. 9-10 Thomas Paper
12	Midterm Review and Exam II	
13	Thanksgiving Break	
14	Back to Basics Fifth response deadline	TBA
15	Special topics TBA	TBA
16	Last day of class, Presentations and Feedback	

Grades

Your course grade will be based on the following categories and their respective weights.

Attendance, Participation, and Enthusiasm (15%)

Homework, Reading Responses, Film Review, and Quizzes (25%)

Final Project (25%)

Midterm Exams (20% each)

Homework

Homework problems will be assigned on a semi-weekly basis. Problems will be meant to exercise the quantitative skills developed in the course and may include computer exercises using MS Excel. Collaboration on homework problems is encouraged **but you must acknowledge the effort of your colleagues.**

Reading Responses It is imperative that you carefully read the assigned material for each class meeting. Over the course of the semester, you must write at least five reading responses, with at least one in each period of the course (see Deadlines on the course schedule or moodle). **Responses can only be turned in on (or before) the day that we cover the reading to which you are responding.** Responses must be a double-spaced word-processed document consisting of:

- Keyword list. List at least 5 key terms used in the day's reading. You need not list definitions, but you should try to learn the meaning of each word. If you cannot find the meaning of a word in your list, put an "*" next to it.
- A one-page (maximum) response essay. The intent here is to write about some interesting aspect of the reading. **The essay must conform to one of the following formats. Please note your chosen format at the top of the page.**
 - **Controversy:** Identify a controversial topic in the reading and describe it.
 - **Key sentence:** Choose a key sentence in the reading, one that makes an important point. State the sentence, give the page number and line number, and explain it in your own words. Explain why the sentence is important.
 - **Connection:** Connect some aspect of the reading to another one of the assigned texts, to something else we've discussed in the course, to a different class, or some other aspect of your life.
 - **Contrast:** Take two examples (different taxa, different environments, different researchers) and contrast them, showing how they are different.
 - **Principle:** Identify a general principle in the reading and show how it relates to two or more different systems, taxa, situations, or approaches.

- **Paragraph:** Find a paragraph in the reading that is trying to make an argument. Give the page and location of the paragraph, so I know where to find it. Evaluate the strength of the argument. How strong is the evidence and how well is it presented?
- **Muddiest point:** Identify the muddiest point in the reading. Describe your confusion, explore alternative interpretations of the point, and/or provide your best guess as to the intended meaning.
- **Wild card:** Write something interesting about the reading. **No more than one wild-card can be used during the semester.** Be careful to focus your essay into a coherent and interesting argument.

Film Review (optional)

To offset another piece of coursework, you may choose to review a film depicting some aspect of gigantism or miniaturism, in the spirit of LaBarbera's essay *The Biology of B-Movie Monsters*. What thematic point is served by the change in scale imposed on the characters and the audience? How would that point change with better attention to physical and biological detail? Limited to two double-spaced pages. The film review may replace one homework assignment, reading response, or quiz.

Quizzes

Quizzes may be given, unannounced, each period. They will consist of a small number of brief questions related to course readings and lecture material, including mathematical calculations, if appropriate.

Midterms

The midterms will cover all material, both in the readings and in the lecture. Questions will emphasize critical thinking about size and life, applying quantitative principles in new problem-solving contexts, and interpreting graphical representations of data. You may be asked to make calculations.

Final Projects

Working individually or in groups of two or three, you will create a final project for the class that meaningfully addresses the issue of size and life in some way. I am relatively open in terms of the format of the project, and possibilities span from an analysis of actual data to address a scientific hypothesis, to writing a fictional story or essay that incorporates scientific and quantitative principles concerning size and life. Creativity is encouraged, but clear understanding and expression of course principles (including their quantitative nature) is required. *We will discuss this assignment more in the first weeks of the class.*

Attendance Policy

Class attendance is mandatory and failure to show up will negatively affect your grade. Please contact me **before** you miss a class. If you are an athlete or a member of another organization that travels, it is **your responsibility** (not your coach's or advisor's) to make arrangements with me concerning missed classes **well in advance**. Failure to do so will result in unexcused absences. Coursework missed due to unexcused absences may not be made up.

Late Policy

Assignments must be turned in on the assigned due date. If for any reason you cannot turn in your paper on the assigned date, you must contact me before class. If you are unable to visit me in person, you can leave a message via voicemail (427-5734) or e-mail (kerkhoffa@kenyon.edu). **No credit will be given for unexcused late work.**

Academic Honesty

Acquaint yourself with Kenyon's policy on academic honesty, printed in the *Student Handbook*. Adherence to standards of academic honesty is the responsibility of the student. If you have any questions or are unsure of appropriate conduct, please contact me.

Accommodating Disabilities

If you feel that you may have need for some type of accommodation(s) in order to participate fully in this class or to take exams, please feel free to discuss your concerns with me in private. Also identify yourself to Erin Salva, Coordinator of Disability Services at 427-5453 or via e-mail at salvae@kenyon.edu. All information is confidential.