Genetic Basis of Behavior

BIO 490S Spring 2017
MEETING TIME
MEETING LOCATION

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Office: Biological Sciences 024
Office Hours: By appointment

Course Purpose: As part of the broader mission of the Duke Biology Undergraduate program, in this course you will:

- Practice thinking like a biologist by identifying major unresolved questions (specifically related to behavioral genetics) and developing ideas about how to investigate them through hypothesis driven science
- Synthesize a range of biological concepts and ideas across research fields (including animal behavior, genetics, neuroscience, psychology and statistics)
- Practice communicating effectively in written, oral, and visual mediums

Course Overview: Individual differences in human behavior have a profound effect on our experience in the world. In fact, across the animal kingdom, behavior is the primary means by which individuals flexibly adapt to and exploit their environment. Behavior emerges in the context of an individual with a particular developmental history and genetic background. The (in)famous Nature-Nurture debate attempted to explain behavioral differences between individuals by invoking either inborn natural differences (genes) OR experiential differences (environments) between individuals to explain individual differences in behavior. Today, the debate has largely been abandoned with the understanding that both genes and environments play important (and often interacting) roles in behavior.

This course will center around exploring the way behaviors are shaped by genes, environments and their interactions in humans, laboratory model organisms and animals in their natural habitats. We will explore common methods for investigating the relationship between genes and behavior as well as examine case studies describing these relationships from the primary literature. Topics will include foraging, social behavior (aggressive and affiliative behaviors), personality, parental care, human sexuality, mental illness, and mating behavior. Throughout the course, we will concentrate on identifying hypotheses and subsequent predictions as well as interpreting and creating visual displays of information.

Course Objectives:

By the end of this course you will be able to:

- Describe the different ways in which genes can affect complex behavioral phenotypes
- Evaluate the importance of genes, environments and their interactions in affecting behavior
- Evaluate the appropriateness of different quantitative and molecular genetic techniques for understanding the genetic basis of behavior
- Create and evaluate strong hypotheses and predictions
- Participate productively in a collaborative group to design a research plan to address an open question in behavioral genetics
- Analyze the effectiveness of scientific communication and create valuable visual displays of scientific data and results

Evaluation (1000 course points possible)

- In Class Solo Literature Analysis (12 at 20 pts each): **24**% of course grade
- In Class Group Literature Analysis (15 at 5 points each): **7.5**% of course grade
- Future research plan group project (220 points): **22**% of course grade
- Data visualization assignments (5 at 30 points each): **15**% of course grade
- Discussion facilitation handouts (3 at 72 points each): **21.5**% of course grade
- Attendance and participation (100 points): **10**% of course grade

Assignments:

Assignments will be described in detail in class throughout the semester at which time grading rubrics will be provided (see "Schedule"). See below for a brief description of coursework.

Literature Analysis: Problem sets will be given during the last class period of the week and they will consist largely of multiple-choice questions from the material covered throughout the week. Problem sets will often focus on identifying and distinguishing hypotheses and predictions, based on relevant examples from primary literature.

- **Solo Grade:** Each literature analysis will be worth a maximum of 20 points. We will record your highest 12 scores (out of 15 total quizzes) in calculating your total quiz score at the end of the semester.
- **Group Grade:** Four students will be assigned to each team and the composition of the teams will change each week, assigned by a random generator. Your team quiz grade for each week will be a participation score worth 5 points. To earn this, you need to attend class and participate in the team discussion about which answers are correct. You will either receive 5 points if you are present and participate on a team, or you will receive 0 if you have an unexcused absence.

Data visualization assignments: Scientific progress is impeded when new discoveries are not communicated clearly and scientists are notoriously self-centered communicators – delivering information in ways they understand, but that are often difficult for the public (or even other scientists) to comprehend. One of the primary ways scientists communicate their results is through data visualization (i.e., charts, graphs, and other figures). To promote effective communication, throughout this course we will work to understand what makes a good visualization and create well-designed visualizations of our own. These data visualization assignments fall under two categories: 1) Critique an existing visualization 2) Create your own visualization for a given dataset. You will complete 5 data visualization assignments: 2 "create", 2 "critiques" and one of your choice. Grading rubrics for this assignment will be provided in class.

Discussion facilitation projects: This project will be explained in detail on the first day of class and examples will be provided throughout the first unit. Broadly, you will be expected to provide a handout to facilitate class discussion and note taking for three class periods throughout the semester. These handouts will require you to think about the topic for class discussion in advance and generate questions and ideas that you think are worthwhile uses of your and your classmates' time and mental energy. I will be happy to meet with you while you are developing your handout and encourage you to set up a meeting with me a week to ten days in advance of planning your handout.

Future research in behavioral genetics: In small groups, you will identify an open research question and break it into manageable, integrated parts. Each group member will design an experimental (or observational) investigation into one of these integrated parts. As a group, your research design should have the potential to make a meaningful contribution to the field. A detailed description of this project and grading rubric will be provided later in the semester, but part of your grade will include a presentation to the class, as well as an evaluation of other groups proposed plans and effectiveness of communication.

Participation: Everyone will begin (and, hopefully end!) the semester with 100 participation points. Participation is separate from attendance – missing class has its own consequences (see 'Attendance Policy'). Participation points will be deducted if you choose to attend class, but fail to engage with the material and/or your classmates. If you would rather work on assignments for other classes, sleep, check email/facebook, talk on the phone, text, or play games than be in class, please own that choice and stay home and to do those things.

Attendance Policy:

This class is heavily discussion based, and a large percentage of your grade will be determined by leading and participating in discussions. Your attendance will also be necessary to do well on the weekly literature analyses and other short and long term assignments. You will not be penalized simply for missing class – the penalty for missing class will be felt due to poor performance on in-class assignments. However, as this class is certainly not your only priority I understand there may be times when you must miss a class. You may make-up up to two in class literature analyses with

no penalty. For the opportunity to make up more than two literature analyses, you must meet with me to discuss your attendance and we will determine a plan going forward on a case by case basis.

Disability statement: Students with disabilities who believe that they may need accommodations in the class are encouraged to contact the Office of Services for Students with Disabilities at 684-5917 or disabilities@aas.duke.edu as soon as possible to better ensure that such accommodations are implemented in a timely fashion.

Academic Integrity: In this, as in all classes at Duke, you are expected to complete your assignments with due regard to academic integrity and to adhere to Duke's Honor Code. In order to do so you should familiarize yourself with Duke's policy on academic integrity (pages 15-18 in The Bulletin of Duke University, 2005-6: Information and Regulations; available online at www.registrar.duke.edu/bulletins/inforeg/2005-06/inforegsbulletin2005-06.pdf). Failure to comply with these standards will be reported to the judicial board.

Schedule:

Note: Reading assignments are tentative and subject to change based on student interest and recent publications. You will notice that some weeks have only topics listed – relevant papers will be assigned at least one week in advance, and all readings will be available on Sakai. Expect an average of 30 pages of reading a week: slightly less when all the readings are from the primary literature, slightly more when much of the reading is from a textbook or popular press article. This schedule also be available on Sakai and will be updated frequently.

Unit	Week	Topic	Reading	Additional
	1	Course introduction. Genetics and Statistics Review	• Syllabus • "Nature-Nurture Interactions" – Chapter 1 from "Social Behavior" PDF available on Sakai. • Link from 538 on p-hacking	Rubrics for discussion facilitation handouts and group research project distributed
Foundational Concepts	2	Selection (and Kin Selection)	• Davies Behavioral Ecology textbook: Chapter 11, Box 11.4 on page 312, then pages 318-326 (from the section "How do individuals recognize kin?" through the section on "Selfish restraint"). • Davies Behavioral Ecology textbook: Chapter 11, pages 307-318 and Chapter 13, pages 364-371, and pages 380-381 (only the section on "Tests of Worker-Queen conflict"). We will cover this material in class	Rubrics for data visualization assignments handed out
	3	Heritability	• Relevant sections from Falconer and Mackay (PDF on Sakai)	
	4	Gene by Environment Interactions	• Crabbe JC, Wahlsten D, Dudek BC Genetics of mouse behavior: interactions with laboratory environment. Science 284: 1670-1673	Data Visualization assignment 1 Due
	5	Maternal and Other Indirect Genetic Effects	• Chapter from Quantitative Genetics in the Wild textbook book	
	6	Epigenetics	• Maternal care in rats	Data visualization assignment 2 due

Common Methods	7	Quantitative Genetics	• "An ecologist's guide to the animal model"	Group Research project topic due
	8	Candidate Genes and QTL mapping	• Drosophila behavior examples	
	9	Genomics	• Human disease examples	Data visualization assignment 3 due
Case Studies	10	Foraging Behavior	• de Bono M, Bargmann CI Natural variation in a neuropeptide Y receptor homolog modifies social behavior and food response in C. elegans. Cell 94: 679-689 • Pereira HS, Sokolowski MB Mutations in the larval foraging gene affect adult locomotory behavior after feeding in Drosophila melanogaster. Proc. Natl. Acad. Sci. U.S.A. 90: 5044-5046	
	11	Mate Choice	• Monogamy in prairie voles • T-shirt sniffing studies in humans	Group Research project outline due
	12	Parental Care	• Attachment in humans • Bi-parental care and IGEs in birds	Data visualization assignment 4 due
	13	Aggression	• IGEs and Aggression in Mice • Aggression in Wild Red deer	
	14	Learning and Memory	• Tully T Discovery of genes involved with learning and memory: an experimental synthesis of Hirschian and Benzerian perspectives. Proc. Natl. Acad. Sci. U.S.A. 93: 13460-13467 • Tang Y-P, Shimizu E, Dube GR, Rampon C, Kerchner GA, Zhuo M, Liu G, Tsien JZ Genetic enhancement of learning and memory in mice. Nature 401: 63-69 • Aaron Tower's Ph.D work	Data Visualization assignment 5 due

15	Behavioral Syndromes and mental illness	• Lauren Brent's heritability and selection on personality in macaques • Genetic basis of schizophrenia	
16	Human Sexuality		Group research project presentations during last class