BEHAVIORAL BIOLOGY PROGRAM

http://krieger.jhu.edu/behavioralbiology

The David S. Olton Behavioral Biology Program seeks to establish a greater understanding of the relations of brain and behavior through an interdisciplinary program of study. Students in the Behavioral Biology Program examine the complex interplay between environment and behavior, and the processes and mechanisms that underlie behavior. One goal of the program is for students to learn how to integrate scientific discoveries from the wide array of scientific fields of inquiry that contribute to the study of behavioral biology, from molecular biology to sociology.

The interdisciplinary characteristics of the Behavioral Biology Program provide an excellent preparation for post-graduate work. For those interested in the health professions, behavioral biology can be integrated into a premedical curriculum that will provide a broad, humanistic perspective. For those who wish to pursue scientific careers in psychopharmacology, behavioral neuroscience, and physiological psychology, the program provides excellent preparation. Students interested in the fields of organismal or integrative biology should also consider this major.

Many students ask about the similarities and differences between the behavioral biology major and the neuroscience major. Both of these programs are interdepartmental, and a majority of professors teach courses that are listed for both majors. Behavioral Biology majors can explore many aspects of the biology of behavior, including the neural mechanisms of behavior (which obviously overlaps with the neuroscience major), but also biomechanical, evolutionary, ecological, and social aspects of behavior. The behavioral biology major also has fairly liberal course requirements which provide students with an opportunity to explore more choices in their liberal arts education. Students majoring in neuroscience focus directly on the brain and on neural function/mechanisms. Generally speaking, the systems neuroscience focus area in the neuroscience major has the most overlap with behavioral biology.

The core program of the behavioral biology major provides breadth and background in five fundamental areas:

1. physics, chemistry, mathematics
2. biology
3. psychology, anthropology, sociology
4. neuroscience
5. history of science

The exact courses to be taken are determined by the student in conjunction with the faculty adviser. A grade of C- or better is required for courses fulfilling major requirements and courses may not be taken satisfactory/unsatisfactory. Hopkins undergraduates may enter the Behavioral Biology Program at any time, provided all requirements can be completed before graduation. Additional information regarding the Behavioral Biology Program is available through Hope Fisher at hope.stein@jhu.edu or 410-516-6196.

Requirements for the B.A. Degree

Also see Requirements for a Bachelor’s Degree. (http://e-catalog.jhu.edu/undergrad-students/academic-policies/requirements-for-a-bachelors-degree) Requirements for the behavioral biology major are as follows:

**Math and Science Core Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS.030.101 &amp; AS.030.105 or AS.030.107</td>
<td>Introductory Chemistry I and Introductory Chemistry Lab I or Chemical Principles w/lab: An Integrated Studio Course</td>
<td>4</td>
</tr>
<tr>
<td>AS.030.102 &amp; AS.030.106 or AS.030.103</td>
<td>Introductory Chemistry II and Introductory Chemistry Laboratory II or Applied Chemical Equilibrium and Reactivity w/lab</td>
<td>4</td>
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<tr>
<td>AS.171.101 or AS.171.103 or AS.171.107</td>
<td>General Physics:Physical Science Major I or General Physics I for Biological Science Majors or General Physics for Physical Sciences Majors (AL)</td>
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<tr>
<td>AS.171.111</td>
<td>General Physics Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>AS.171.102 or AS.171.104 or AS.171.108</td>
<td>General Physics: Physical Science Majors II or General Physics/Biology Majors II or General Physics for Physical Science Majors (AL)</td>
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</tr>
<tr>
<td>AS.173.112</td>
<td>General Physics Laboratory II</td>
<td>1</td>
</tr>
<tr>
<td>AS.110.106 or AS.110.108</td>
<td>Calculus I (Biology and Social Sciences) or Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>AS.110.107 or AS.110.109 or AS.110.113</td>
<td>Calculus II (For Biological and Social Science) or Calculus II (For Physical Sciences and Engineering) or Honors Single Variable Calculus</td>
<td>4</td>
</tr>
<tr>
<td>AS.020.151 or AS.020.153 or AS.020.152 or AS.020.154</td>
<td>General Biology I or General Biology Laboratory I or General Biology II</td>
<td>3.00</td>
</tr>
<tr>
<td>EN.550.111</td>
<td>Statistical Analysis I *</td>
<td>4</td>
</tr>
<tr>
<td>EN.550.112</td>
<td>Statistical Analysis II</td>
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**Behavioral Biology Core Courses**

<table>
<thead>
<tr>
<th>Course</th>
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</thead>
<tbody>
<tr>
<td>AS.290.101</td>
<td>Human Origins</td>
</tr>
<tr>
<td>AS.200.141</td>
<td>Foundations of Brain, Behavior and Cognition</td>
</tr>
<tr>
<td>AS.200.208</td>
<td>Animal Behavior</td>
</tr>
<tr>
<td>AS.080.250</td>
<td>Neuroscience Laboratory</td>
</tr>
<tr>
<td>AS.290.490</td>
<td>Senior Seminar: Behavioral Biology</td>
</tr>
</tbody>
</table>

**Behavioral Biology Elective Courses**

Nine credits of advanced bio-behavioral science courses (BEHB-BIOBEH)

Six credits of intermediate/advanced social/developmental/cognitive sciences courses (BEHB-SOCSCI)

Total Credits **70**


** Students should refer to the program website (http://krieger.jhu.edu/behavioralbiology/courses) or the schedule of classes to identify elective choices.
## Sample Program

### Freshman

**Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS.110.106</td>
<td>Calculus I (Biology and Social Sciences)</td>
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</tr>
<tr>
<td>AS.030.101</td>
<td>Introductory Chemistry I</td>
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</tr>
<tr>
<td>AS.030.105</td>
<td>Introductory Chemistry Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>AS.200.141</td>
<td>Foundations of Brain, Behavior and Cognition</td>
<td>3</td>
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</table>

**Spring**

<table>
<thead>
<tr>
<th>Course Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>AS.110.107</td>
<td>Calculus II (For Biological and Social Science)</td>
<td>4</td>
</tr>
<tr>
<td>AS.030.102</td>
<td>Introductory Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>AS.030.106</td>
<td>Introductory Chemistry Laboratory II</td>
<td>1</td>
</tr>
<tr>
<td>AS.200.208</td>
<td>Animal Behavior</td>
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### Sophomore

**Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>AS.020.151</td>
<td>General Biology I</td>
<td>3</td>
</tr>
<tr>
<td>AS.020.152</td>
<td>General Biology II</td>
<td>3</td>
</tr>
<tr>
<td>AS.290.101</td>
<td>Human Origins</td>
<td>3</td>
</tr>
<tr>
<td>EN.550.111</td>
<td>Statistical Analysis I</td>
<td>4</td>
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**Spring**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>AS.020.153</td>
<td>General Biology Laboratory I</td>
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</tr>
<tr>
<td>AS.020.154</td>
<td>General Biology Laboratory II</td>
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</tr>
<tr>
<td>EN.550.112</td>
<td>Statistical Analysis II</td>
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</tr>
<tr>
<td>Upper Level Elective (BEHB-SOCSCI)</td>
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### Junior

**Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>AS.080.250</td>
<td>Neuroscience Laboratory*</td>
<td>3</td>
</tr>
<tr>
<td>AS.171.103</td>
<td>General Physics I for Biological Science Majors</td>
<td>4</td>
</tr>
<tr>
<td>AS.173.111</td>
<td>General Physics Laboratory I</td>
<td>1</td>
</tr>
</tbody>
</table>

**Spring**

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS.171.104</td>
<td>General Physics II</td>
<td>4</td>
</tr>
<tr>
<td>AS.173.112</td>
<td>General Physics Laboratory II</td>
<td>1</td>
</tr>
<tr>
<td>Upper Level Elective (BEHB-BIOBEH)</td>
<td>3</td>
<td></td>
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<tr>
<td>Research (optional)</td>
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### Senior

**Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS.290.490</td>
<td>Senior Seminar: Behavioral Biology**</td>
<td>1</td>
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</table>

**Spring**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS.290.101</td>
<td>Upper Level Elective (BEHB-SOCSCI)</td>
<td>3</td>
</tr>
<tr>
<td>Research (optional)</td>
<td>3</td>
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</table>

Total Credits: 70

* Neuroscience Lab can be taken anytime after 200.141
** Senior Seminar can be taken either fall or spring of senior year.

## Research for Undergraduates

While research is not required for behavioral biology majors, it is strongly recommended students consider participating in a research experience as an undergraduate.

### Honors in the Major

To receive honors in behavioral biology, students must have met the following criteria:

1. Earn a GPA of 3.5 or better in major requirements
2. Conduct research and give a research presentation
3. Receive a recommendation from research mentor

For current faculty and contact information go to http://krieger.jhu.edu/behavioralbiology/faculty_directory/

### Faculty

**Chair**

Cynthia Moss
Professor, Psychological and Brain Sciences

**Teaching Professor**

Linda Gorman, Director of Undergraduate Studies
Psychological and Brain Sciences

**Professor**

Peter Holland
Psychological and Brain Sciences

**Lecturers**

Kisi Bohn
Behavioral Biology Program

Chris Kraft
Johns Hopkins Center for Marital and Sexual Health, Sexual Behaviors Consultation Unit, Johns Hopkins Medical Institutions

For current course information and registration go to https://sis.jhu.edu/classes/

### Courses

**AS.290.101. Human Origins. 3.00 Credits.**

This course examines the origins of human structure, function and behavior from an evolutionary perspective. It includes study of the evolution, behavior and behavioral ecology of nonhuman primates, hominid evolution (including the paleontological and archaeological records), and the origins of human cognition, social behavior and culture. Cross-listed with Psychological and Brain Sciences

Instructor(s): P. Holland

Area: Natural Sciences, Social and Behavioral Sciences.
AS.290.301. Stress and the Brain. 3.00 Credits.
The purpose of this course is to explore the phenomenon of stress by investigating the neural, endocrine and molecular mechanisms involved. By reviewing both animal and human research, this course will consider disorders of the stress control system and the adverse impact of stress on human physical and mental health. Topics in this class will include, but are not limited to I) disorders such as PTSD, anxiety, major depression; II) interactions between stress and neurodegenerative disorders; III) stress-immune-inflammatory interactions; IV) the role of stress in obesity, hypertension, and other metabolic syndromes; V) stress effects on reproduction. Students will finish this course with a greater understanding for the fundamental neuroendocrine responses to stress and its consequent and/or associated adverse effects on human health.
Prerequisites: AS.020.306 OR (AS.050.203 OR 080.203) OR AS.200.141 OR (AS.080.305 AND AS.080.306)
Instructor(s): F. Madison
Area: Natural Sciences.

AS.290.303. Animal Communication. 3.00 Credits.
The study of animal communication involves the study of neural and hormonal mechanisms mediating the production of communication signals and the evolutionary function of the different signals animals produce to communicate with one another. In this course, information from both of these approaches to the study of behavior will be integrated to provide a comprehensive examination of the causes and functions of different animal communication systems. Topics will include both a consideration of the mechanisms of signal production and of signal perception. The course will review the basic features of communication and features of signaling systems. We will also discuss neural and endocrine functioning and the fundamentals of evolutionary theory relevant to the study of animal communication. Finally, this course will include a field component where students will quantify different aspects of communicative behaviors including song, mating, and parental behavior in several species.
Prerequisites: AS.200.208 AND AS.200.141 AND ( AS.171.102 OR AS.171.104)
Instructor(s): K. Bohn
Area: Natural Sciences, Social and Behavioral Sciences.

AS.290.420. Human Sexual Orientation. 3.00 Credits.
This course will examine the historical and current theories of sexual orientation and sexual variation development by examining the biological, psychological and social contributing factors that influence the development of sexual orientations and variations along with treatment and modification of problematic sexual behaviors. Open to Seniors in the Biology, Behavioral Biology, Cognitive Sciences, Neuroscience, Psychology, Public Health, Studies of Women, Gender & Sexuality, Medicine, Science & the Humanities, Sociology, and Molecular and Cellular Biology majors.
Prerequisites: Students may enroll in both AS.200.204 and AS.290.420, but cannot do so in the same semester.
Instructor(s): C. Kraft
Area: Social and Behavioral Sciences
Writing Intensive.

AS.290.490. Senior Seminar: Behavioral Biology. 1.00 Credit.
Great ideas in Behavioral Biology. Discussion of classic and cutting edge articles in the original literature. Student presentations and reaction papers. Capstone course for senior Behavioral Biology majors.
Instructor(s): P. Holland
Area: Social and Behavioral Sciences.
AS.020.152. General Biology II. 3.00 Credits.
This course builds on the concepts presented and discussed in General Biology I. The primary foci of this course will be on the diversity of life and on the anatomy, physiology, and evolution of plants and animals. There will be a special emphasis on human biology.
Prerequisites: Prereq: AS.020.151
Instructor(s): C. Roberson; R. Pearlman; R. Shingles
Area: Natural Sciences.

AS.020.153. General Biology Laboratory I. 1.00 Credit.
Student must have enrolled in AS.020.151 either this term or in past terms. Students who have credit for AP Biology but take General Biology Lab I will lose all eight credits of AP Biology credit. This course reinforces the topics covered in AS.020.151. Laboratory exercises explore subjects ranging from forest ecology to molecular biology to animal behavior. Students participate in a semester-long project, identifying bacteria using DNA sequencing. Cross-listed with Behavioral Biology.
Prerequisites: AS.020.151
Instructor(s): R. Pearlman
Area: Natural Sciences.

Anthropology
AS.070.352. Evolution, Ecology, Becoming. 3.00 Credits.
The concept of evolution is central to social theory. Originating in the question of the species, it has moved into questions of human ecology, cultural forms and modes of thought. While it remains a deeply contested, often criticized concept, particularly in its neo-Darwinian manifestation, it orients anthropological thinking in ways that are as yet to be examined. Reaching into the archives of anthropology and other cognate disciplines, this course will examine the writings of Lyell, Darwin, Marx, Morgan, Boas, Steward, Bateson, Ingold among others. Co-listed with AS.070.610
Instructor(s): A. Goodfellow; N. Khan
Area: Humanities, Social and Behavioral Sciences.

The concept of evolution is central to social theory. Originating in the question of the species, it has moved into questions of human ecology, cultural forms and modes of thought. While it remains a deeply contested, often criticized concept, particularly in its neo-Darwinian manifestation, it orients anthropological thinking in ways that are as yet to be examined. Reaching into the archives of anthropology and other cognate disciplines, this course will examine the writings of Lyell, Darwin, Marx, Morgan, Boas, Steward, Bateson, Ingold among others. Co-listed with AS.070.352
Instructor(s): A. Goodfellow; N. Khan
Area: Humanities, Social and Behavioral Sciences.

Neuroscience
AS.080.330. Brain Injury & Recovery. 3.00 Credits.
This course investigates numerous types of brain injuries and explores the responses of the nervous system to these injuries. The course’s primary focus is the cellular and molecular mechanisms of brain injury and the recovery of function. Discussions of traumatic brain injury, stroke, spinal cord, and tumors, using historical and recent journal articles, will facilitate students’ understanding of the current state of the brain injury field. Cross-listed with Psychological and Brain Sciences and Behavioral Biology.
Prerequisites: ( AS.080.305 AND AS.080.306) OR (AS.020.312 OR AS.020.306) OR (200.141 and 020.306) OR Permission of Instructor
Instructor(s): L. Gorman
Area: Natural Sciences
Writing Intensive.

Psychological Brain Sciences
AS.200.141. Foundations of Brain, Behavior and Cognition. 3.00 Credits.
Formerly listed as Introduction to Physiopsychology. A survey of neuropsychology relating the organization of behavior to the integrative action of the nervous system. Cross-listed with Behavioral Biology and Neuroscience.
Instructor(s): L. Gorman
Area: Natural Sciences, Social and Behavioral Sciences.

AS.200.208. Animal Behavior. 3.00 Credits.
Examines basic principles of animal behavior (orientation, migration, communication, reproduction, parent-offspring relations, ontogeny of behavior and social organization). Evolution and adaptive significance of behavior will be emphasized.
Prerequisites: Prereqs: AS.020.151
Instructor(s): K. Bohn
Area: Natural Sciences, Social and Behavioral Sciences.

AS.200.328. Theory & Methods in Clinical Psychology. 3.00 Credits.
A critical examination of the methods of observation, description, reasoning, inference, measurement and intervention that underlie the clinical practice of psychology and psychiatry. Enrollment limited to Behavioral Biology, Cognitive Science, Neuroscience, Psychology, and Public Health majors or by instructor approval. Recommended: Junior & Senior
Prerequisites: AS.200.212
Instructor(s): D. Edwin
Area: Social and Behavioral Sciences
Writing Intensive.

AS.200.343. Motivation. 3.00 Credits.
Current biological, behavioral, and cognitive research and theory concerning the motivation of behavior are examined. Both human and non-human animal research is reviewed. Topics include the role of genetics, arousal, biological regulatory systems, incentives, expectancies, attributions, social processes and self-actualization in the general of behavior. Recommended Course Background: AS.200.101 and AS.200.146 or instructor permission.
Instructor(s): H. Petri
Area: Social and Behavioral Sciences.

AS.200.344. Behavioral Endocrinology. 3.00 Credits.
An examination of the effects of hormones on behavior in non-human and human animals. Topics will include the effects of hormones on sexual differentiation, reproductive behavior, parental behavior, homeostasis and biological rhythms, regulation of body weight, learning and memory. Cross-listed with Behavioral Biology and Neuroscience.
Prerequisites: Prereqs: ( AS.200.141 OR AS.080.306 ) OR (AS.020.151 AND AS.020.152) OR ( AS.020.305 AND AS.020.306 ) or instructor’s permission
Instructor(s): K. Bohn
Area: Natural Sciences, Social and Behavioral Sciences.

AS.200.355. Psych of Decision Making. 3.00 Credits.
This course will apply insights from cognitive psychology decision-making research to the stock market. The course investigates whether investors can beat the market benchmarks by exploiting marketplace investor sentiment. Juniors and seniors only. Recommended Course Background: six credits of Psychology course work.
Instructor(s): L. Raifman
Area: Social and Behavioral Sciences.
AS.200.366. Neuroscience of Motivation: Sex, Drugs and the Brain. 3.00 Credits.
This course is designed to address the growing literature on the neurobiology of motivational behaviors, integrating studies from invertebrates to birds, rodents, primates and humans. The course will begin with a century old, yet ongoing, discussion on how researchers define ‘motivation’. Following this primary introduction, we will discuss the brain circuitry that underlies emotion, reward, and motivation, so that students attain the necessary foundations for understanding the neurobiology of motivated behavior. In particular, we will proceed with an in-depth exploration of an inherently motivated and naturally rewarding social interaction, sexual behavior, which will be discussed at multiple levels. Subsequent lectures will address literature on how humans activate the same brain reward systems artificially by using drugs of abuse. Drawing on these theoretical and empirical foundations, we will then explore the possible involvement of these motivational systems on distinctly human pleasures such as religious experience, visual arts, and music.
Prerequisites: AS.200.141 OR AS.080.105 OR (AS.080.305 AND AS.080.306) OR Permission required.
Instructor(s): O. Iyilikci
Area: Natural Sciences, Social and Behavioral Sciences.

AS.200.367. Episodic Memory in Human and Nonhuman Animals. 3.00 Credits.
Episodic memory, or autobiographical memory, has been said to be a capacity that is uniquely human. Consisting of the what, when, and where components of our experiences, episodic memory is what makes each of us who we are. This course will explore each of these components individually—the psychology and neural underpinnings of each component—before discussing them in combination as episodic memory. Finally, we will visit one of the greatest ongoing debates in the memory literature: whether or not this ability is truly uniquely human or if our nonhuman animal counterparts also have this capacity. Throughout the course, we will draw on evidence from empirical articles based on studies in a variety of species including rodents, primates, and birds.
Prerequisites: AS.200.101 OR AS.200.141 OR AS.080.105 OR (AS.080.305 AND AS.080.306) OR Permission required.
Instructor(s): J. Asem
Area: Natural Sciences, Social and Behavioral Sciences.

AS.200.370. Functional Human Neuroanatomy. 3.00 Credits.
This course examines the general organizing principles of the anatomy of the human central nervous system and how this anatomical organization relates to function, from the level of neural circuits, to systems, to behavior. Students will learn to identify neuroanatomical structures and pathways in dissections and MRI images through computerized exercises. Readings and lectures will emphasize general structure-function relationships and an understanding of the functional roles of particular structures in sensory, motor, and cognitive systems.
Prerequisites: AS.080.250 OR AS.080.305
Instructor(s): S. Courtney-Faruqee
Area: Natural Sciences, Social and Behavioral Sciences.

AS.200.376. Psychopharmacology. 3.00 Credits.
Designed to provide information about how drugs affect the brain and behavior. The course focuses on biological concepts underlying structures and functions of the brain that relate to mental disorders. An introduction to neurobiology and brain function is presented as it applies to the interaction of various classes of drugs with the individual neurotransmitter systems in the brain. A brief historic review is followed by a discussion of clinical relevance. Cross-listed with Behavioral Biology and Neuroscience. Enrollment limited to juniors and seniors.
Prerequisites: AS.200.141 OR (AS.020.312 AND AS.020.306) OR (AS.080.305 AND AS.080.306) or permission required.
Instructor(s): H. Adwanikar
Area: Natural Sciences, Social and Behavioral Sciences.

AS.200.386. Animal Cognition. 3.00 Credits.
Examine relations between brain, mind, and behavior in nonhuman animals, focusing on topics such as learning, memory, attention, decision-making, navigation, communication, and awareness. We will take a variety of approaches, including behavioral, computational, evolutionary, neurobiological, and psychological perspectives.
Prerequisites: (AS.200.141 OR AS.200.208 OR AS.290.101) OR permission of instructor.
Instructor(s): P. Holland
Area: Social and Behavioral Sciences.