BIBB 050 Forensic Neuroscience

Progress in behavioral neuroscience and brain imaging techniques, such as functional and structural Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) has forced the courts to reconsider the role of behavioral sciences in courtroom decision-making. The goal of this course is to enable students to understand and interpret the use of behavioral neuro evidence in the justice system. The course will introduce the students to the relevant behavioral neuroscience constructs, principles of brain imaging and rules of scientific evidence. Students will be asked to use this introductory knowledge to critically evaluate the use of brain imaging and other behavioral neuroscience techniques as evidence in representative legal cases. For each case, students will serve as neuroscience experts for the defense or prosecution and prepare, present and defend their testimony against the opposing team. Through this course, students will develop the ability to critically evaluate brain imaging and other neuroscience data in forensic and legal settings.

Taught by: Langleben
Activity: Seminar
1 Course Unit

BIBB 060 Music and the Brain

Every human culture that has ever been described makes some form of music. The musics of different cultures cover a wide range of styles, but also display fascinating similarities, and a number of features are shared by even the most disparate musical traditions. Within our own culture, music is inescapable—there are very few individuals who do not listen to some form of music every day and far more who listen to music virtually all day long. Appreciation of music comes very early: newborns prefer music to normal speech and mothers all over the world sing to their babies in a fundamentally similar way. And yet, despite this seeming ubiquity, the real origin and purpose of music remains unknown. Music is obviously related to language, but how? Why do so many cultures make music in such fundamentally similar ways? What goes into the formation of music “taste” and preferences? Does music have survival value, or is it merely “auditory cheesecake”, a superfluous byproduct of evolution as some critics have maintained? What is the nature of musical ability and how do musicians differ from non-musicians? In this course, we will look for answers by looking at the brain. Almost 200 years of scientific research into brain mechanisms underlying the production and appreciation of music is beginning to shed light on these and other questions. Although the sciences and the arts are often seen as entirely separate or even in opposition, studying the brain is actually telling us a lot about music, and studying music is telling us just as much about the brain.

Taught by: Kaplan
Activity: Seminar
1 Course Unit

BIBB 109 Introduction to Brain and Behavior

Introduction to the structure and function of the vertebrate nervous system. We begin with the cellular basis of neuronal activities, then discuss the physiological bases of motor control, sensory systems, motivated behaviors, and higher mental processes. This course is intended for students interested in the neurobiology of behavior, ranging from animal behaviors to clinical disorders.

For BA Students: Living World Sector

Taught by: Kane and McLean
One-term course offered either term
Also Offered As: BIOL 109, PSYC 109
Activity: Lecture
1 Course Unit
Biological Basis of Behavior (BIBB)

BIBB 150 Sex and Human Nature
This is an introduction to the scientific study of sex in humans. Within an evolutionary framework, the course examines genetic, physiological, ecological, social and behavioral aspects of sex in humans. After providing the basic principles of evolutionary biology, the course will examine the development of sexual anatomy and physiology. How is sex determined? How is orgasm achieved? Why do girls and boys develop sexually at different ages? The role of ecology and social life in shaping human mating patterns will be evaluated through the use of ethnographies and cross-cultural materials on a variety of human cultures. Does everybody have sex the way we do? Why marry? Are there biological bases for love? Why do we experience jealousy? Finally, topics relevant to human sexuality today will be discussed, such as recreational sex, contraception, and sexually transmitted diseases. Examples are drawn primarily from traditional and modern human societies; data from studies of nonhuman primates are also considered.
For BA Students: Living World Sector
Taught by: Schurr
Course usually offered in spring term
Also Offered As: ANTH 104, GSWS 103
Activity: Lecture
1 Course Unit

BIBB 160 ABCS of Everyday Neuroscience
This course is an opportunity for undergraduates to share their interest and enthusiasm for neuroscience with students in grades 9-12 attending urban public schools in West Philadelphia. The course will allow Penn students to develop their science communication and teaching skills. Students will prepare neuroscience demonstrations, hands-on activities, and assessment tools. In parallel, the course aims to engage local high school students, increasing their interest and knowledge in science, and ultimately promoting lifelong science literacy.
Taught by: Lori Flanagan-Cato
Prerequisite: BIBB109
Activity: Lecture
1 Course Unit

BIBB 217 Visual Neuroscience
An introduction to the scientific study of vision, with an emphasis on the biological substrate and its relation to behavior. Topics will typically include physiological optics, transduction of light, visual thresholds, anatomy and physiology of the visual pathways, retinal processing, properties of visual cortex, and color vision.
Taught by: Rust
Course usually offered in spring term
Also Offered As: PSYC 217, VLST 217
Prerequisites: BIBB 109, PSYC 001, COGS 001 or VLST 101
Activity: Lecture
1 Course Unit

BIBB 227 Physiology of Motivated Behaviors
This course focuses on evaluating the experiments that have sought to establish links between brain structure (the activity of specific brain circuits) and behavioral function (the control of particular motivated and emotional behaviors). Students are exposed to concepts from regulatory physiology, systems neuroscience, pharmacology, and endocrinology and read textbooks as well as original source materials. The course focuses on the following behaviors: feeding, sex, fear, anxiety, the appetite for salt, and food aversion. The course also considers the neurochemical control of responses with an eye towards evaluating the development of drug treatments for: obesity, anorexia/cachexia, vomiting, sexual dysfunction, anxiety disorders, and depression.
Taught by: Grill
One-term course offered either term
Also Offered As: PSYC 127
Prerequisite: PSYC001
Activity: Lecture
1 Course Unit

BIBB 231 Animal Behavior
The evolution of social behavior in animals, with special emphasis on group formation, cooperation among kin, mating systems, territoriality and communication.
Taught by: Seyfarth/Cheney
One-term course offered either term
Also Offered As: BIOL 231, PSYC 231
Prerequisite: PSYC 001 or BIOL 102 or BIOL 122
Activity: Lecture
1 Course Unit

BIBB 233 Neuroethology
In course, students will learn how neurobiologists study the relationship between neural circuitry and behavior. Behaviors such as bat echolocation, birdsong, insect olfaction, spatial navigation, eye movement and others will be used to explore fundamental principles of brain function that include brain oscillations, population codes, efference copy, sensorimotor maps and sleep replay. The course will also discuss the various methodologies that are used to address these questions. The reading material will be derived mostly from the primary literature.
Taught by: McLean
Course usually offered in spring term
Prerequisite: BIBB 109
Activity: Lecture
1 Course Unit

BIBB 240 Human Chronobiology and Sleep
Topics to be covered include basic principles of chronobiology; neuroscience mechanisms of circadian rhythms and sleep; phylogeny and ontogeny of sleep; human sleep and sleep disorders; circadian dysfunction; circadian and sleep homeostatic influences in human health and safety.
Taught by: Dinges
Course usually offered in spring term
Prerequisite: BIBB109
Activity: Lecture
1 Course Unit
Notes: Students may not receive credit for both BIBB240 and BIBB040
**BIBB 249 Cognitive Neuroscience**
The study of the neuronal systems that underlie human perception, memory and language; and of the pathological syndromes that result from damage to these systems.

Taught by: Epstein
One-term course offered either term
Also Offered As: PSYC 149
Prerequisite: PSY 001 or BIBB 109
Activity: Lecture
1 Course Unit

**BIBB 250 Neuroendocrinology**
This course is designed to examine the various roles played by the nervous and endocrine systems in controlling both physiological processes and behavior. First, the course will build a foundation in the concepts of neural and endocrine system function. Then, we will discuss how these mechanisms form the biological underpinnings of various behaviors and their relevant physiological correlates. We will focus on sexual and parental behaviors, stress, metabolism, neuroendocrine-immune interactions, and mental health.

Taught by: Flanagan-Cato
One-term course offered either term
Also Offered As: BIBB 250
Prerequisites: BIOL 101 and 102, or BIOL 121; PHYS 102 or 151 strongly recommended
Activity: Lecture
1.5 Course Unit
Notes: (3hrs. lec., 3hrs. lab, 1.5 c.u.)

**BIBB 260 Neuroendocrinology**
This course will introduce the student to the functioning of the autonomic nervous system (ANS), which is critically involved in the maintenance of body homeostasis through regulation of behavior and physiology. The course will begin with a review of the basic anatomy and physiology of the ANS including the sympathetic, parasympathetic and enteric divisions. The mechanisms by which the ANS regulates peripheral tissues will be discussed, including reflex and regulatory functions, as well as the effect of drugs which modulate ANS activity. The role of the ANS in regulating behavior will be addressed in the context of thirst, salt appetite and food intake.

Taught by: Heerding
Course usually offered in spring term
Prerequisite: BIBB 109
Activity: Lecture
1 Course Unit

**BIBB 269 Autonomic Physiology**
The course will begin with a review of basic concepts in pharmacology including: routes of drug administration, drug metabolism, the dose response curve, tolerance and sensitization. Following a brief overview of cellular foundations of neuropharmacology (neuronal biology, synaptic and receptor function), the course will focus on several neurotransmitter systems and the molecular and behavioral mechanisms mediating the mind-altering, addictive and neuropsychiatric disorders, including depression, schizophrenia and anxiety with an emphasis on their underlying neurobiological causes, as well as the pharmacological approaches for treatment.

Taught by: Kane
Course usually offered in fall term
Also Offered As: PSYC 225
Prerequisite: BIBB 109 or PSYC 109
Activity: Lecture
1 Course Unit

**BIBB 270 Drugs, Brain and Mind**
The course will begin with a review of basic concepts in pharmacology including: routes of drug administration, drug metabolism, the dose response curve, tolerance and sensitization. Following a brief overview of cellular foundations of neuropharmacology (neuronal biology, synaptic and receptor function), the course will focus on several neurotransmitter systems and the molecular and behavioral mechanisms mediating the mind-altering, addictive and neuropsychiatric disorders, including depression, schizophrenia and anxiety with an emphasis on their underlying neurobiological causes, as well as the pharmacological approaches for treatment.

Taught by: Kane
Course usually offered in fall term
Also Offered As: PSYC 225
Prerequisite: BIBB 109 or PSYC 109
Activity: Lecture
1 Course Unit

**BIBB 280 Developmental Neurobiology**
This laboratory course is designed to familiarize the student with the fundamental gross and histological organization of the brain. The mammalian brain will be dissected and its microscopic anatomy examined using standard slide sets. Comparative brain material will be introduced, where appropriate, to demonstrate basic structural-functional correlations.

Taught by: McLean
One-term course offered either term
Prerequisite: BIBB 109 or permission of instructor
Activity: Laboratory
1 Course Unit
Notes: Lab Fee: $50

**BIBB 300 Laboratory in the Structure of the Nervous System**
A laboratory course designed to acquaint the student with the basic anatomical and histological organization of the nervous system. The course will be to understand the form, function and pathology of the adult nervous system from terms of antecedent developmental processes.

Taught by: McGurk
One-term course offered either term
Prerequisites: BIBB 109 and BIOL 101 or permission of instructor
Activity: Laboratory
1 Course Unit

**BIBB 340 Independent Research**
Individual research of an experimental nature with a member of the standing faculty leading to a written paper. The grade is based primarily on a serious term paper describing original research carried out by the student. Students must submit a proposal prior to registering. During the semester, students must attend two seminars to discuss planning and independent research project, ethical concerns in research and writing a scientific paper. Attendance at the meetings is mandatory. Students doing more than one credit of independent study will be required to present a poster at the annual BBB Symposium.

Taught by: Standing Faculty
One-term course offered either term
Prerequisites: BIBB 109 and Permission of the Director
Activity: Independent Study
1 Course Unit
**BIBB 417 Seminar in Perception: Visual Processing**
This seminar will focus on how visual information is processed by the eye and the brain to produce visual perception. These issues will be explored through lectures and student presentations of journal articles, combined with Matlab-based tutorials and exercises. The course requires no prior knowledge of visual processing, math, or computer programming.
Taught by: Rust
One-term course offered either term
Also Offered As: PSYC 417
Prerequisites: BBB 109, Psych 149 or Psych 217, or permission of instructor
Activity: Seminar
1 Course Unit

**BIBB 420 Smell and Taste**
All organisms respond to chemicals in their environment. This chemosensation guides diverse behaviors such as a feeding, avoiding predators, sex, and social interactions. This course will provide a broad survey of our current understanding of taste and smell, focusing on insect and rodent model systems as well as studies in humans.
The course will begin with a review of chemical signal transduction mechanisms, and build to an exploration of the cortical integration of chemical signals and chemical guided behaviors. Class time will emphasize primary literature, discussion, and student presentations. The goal is to reach an integrated understanding of the physiology and psychology of chemical sensory systems. In the process, students will learn to read and critically evaluate data from primary research articles.
Taught by: Lewandowski
Course not offered every year
Prerequisites: Introductory Psychology and Biology, BBB 109. PSYC 111 (Perception) preferred.
Activity: Seminar
1 Course Unit

**BIBB 421 Functional Imaging of the Human Brain**
The course will provide a detailed overview of functional brain imaging and its potential uses. Issues regarding advantages and disadvantages of different modalities, study design image analysis & interpretation and how these relate to various neurological & psychological phenomena will be discussed. Class will cover the following specific topics in this general time frame: Introduction to functional brain function, basics of nuclear medicine imaging (including instrumentation, image acquisition, and radiopharmaceuticals for positron emission tomography and single photon emission computed tomography), imaging of neurological disorders, imaging of psychological disorders, introduction to activation studies, image analysis and statistical problems, study design, literature review, journal article presentation, tour of Penn imaging facilities, interpretation of imaging studies, implications for clinical and research, and implications for understanding the human mind and consciousness.
Taught by: Newberg
Course usually offered in spring term
Prerequisite: BIBB 109
Activity: Seminar
1 Course Unit

**BIBB 429 SEMINAR HUMAN MEMORY: Big Data, Memory, and the Human Brain**
Taught by: Kahana
Also Offered As: PSYC 429
Prerequisite: CIS121 & Python experience
Activity: Seminar
1 Course Unit
Notes: Instructor permission required. Application form can be found here: http://psychology.sas.upenn.edu/undergraduate/forms

**BIBB 430 Neurobiological Basis of Autism**
This course examines the neurobiological processes underlying autism spectrum disorders. In this seminar course, we will first examine the brain phenotypes associated with Autism Spectrum Disorders (ASD), in addition to investigating the genetic and environmental contributions to the etiology and pathophysiology of ASD. After an initial examination of the clinical literature and research, we will focus on animal models of ASD, including those of syndromic causes of autism (Rett Syndrome, Tuberous Sclerosis, Fragile X) and investigate changes in neurotransmitter systems and synaptic dysfunctions in the brain of these models.
Taught by: Herrington
One-term course offered either term
Prerequisite: BIBB 109
Activity: Lecture
1 Course Unit

**BIBB 442 Neurobiology of Learning and Memory**
This course focuses on the current state of our knowledge about the neurobiological basis of learning and memory. A combination of lectures and student seminars will explore the molecular and cellular basis of learning in invertebrates and vertebrates from a behavioral and neural perspective.
Taught by: Abel
Also Offered As: BIOL 442, NGG 575, PSYC 421
Prerequisites: BIOL 251, BIBB 251 or Permission of Instructor
Activity: Seminar
1 Course Unit

**BIBB 460 Neuroendocrinology Seminar**
This course is an upper-level seminar, designed to examine the various roles played by the nervous and endocrine systems in controlling both physiological processes and behavior. We will focus on sexual and parental behaviors, stress, metabolism, neuroendocrine-immune interactions, and mental health. The format will be a mixture of lectures and journal club discussions based on recent primary literature in the field of neuroendocrinology. Students will also write several short papers based on the clinical neuroendocrinology.
Taught by: Flanagan-Cato
One-term course offered either term
Also Offered As: PSYC 439
Prerequisite: BIBB 109 or Permission of Instructor
Activity: Seminar
1 Course Unit

**BIBB 466 Molecular Genetic of Neurological Disease**
Also Offered As: BIOL 466
Activity: Lecture
1 Course Unit
**BIBB 469 Stress Neuroscience**
Stress can be caused by a variety of conditions, ranging from low-level noise in the workplace to life-threatening situations and these stressors can cause changes in the physiology and behavior of individuals. This course will examine the neural mechanisms underlying physiological and emotional responses to stress in a journal club format. Topics to be covered include anxiety disorders, depression and other mood disorders, the differential effects of stress on males and females, the physiological effects of stress on the immune system and feeding behavior, the effects of maternal stress on offspring as well as strategies to mitigate the effects of stress.
Taught by: Kable
One-term course offered either term
Prerequisite: BIBB 109
Activity: Seminar
1 Course Unit

**BIBB 470 Animal Models of Neuropsychiatric Disorders**
This seminar will focus on the significant role of animal models in the investigation of the pathophysiology of a variety of human neuropsychiatric disorders as well as in the development of treatments for these disorders. The course will focus on the use of genetically modified mice in the investigation of Autistic Spectrum Disorders (ASD), anxiety and affective disorders, schizophrenia and obsessive-compulsive disorder (OCD), with an emphasis on the limitations of such models. Class time will consist of short lectures and open discussions via student-led presentations. Emphasis will be placed on the critical analysis of primary literature.
Taught by: Kane
Course not offered every year
Prerequisite: BIBB 109
Activity: Seminar
1 Course Unit

**BIBB 473 Neuroeconomics**
This course will review recent research that combines psychological, economic and neuroscientific approaches to study human and animal decision-making. A particular focus will be on how evidence about the neural processes associated with choices might be used to constrain economic and psychological theories of decision-making. Topics covered will include decisions involving risk and uncertainty, reinforcement learning, strategic interactions and games, and social preferences.
Taught by: Kable
Also Offered As: NGG 706, PSYC 473
Prerequisites: PSYC 149, 253, or 265
Activity: Seminar
1 Course Unit

**BIBB 475 Neurodegenerative Diseases**
This course will familiarize students with advances in our understanding of the clinical features and pathogenesis of a wide range of neurodegenerative diseases, including Alzheimer's disease and other dementias, prion diseases, Parkinson's disease and atypical parkinsonisms, neurodegenerative ataxias, motoneuron diseases, degenerative diseases with chorea, iron and copper disorders, and mitochondrial diseases. Students will analyze original research reports on a range of proposed pathological cellular processes that may represent steps in cell death pathways leading to neuron loss seen in these diseases. Significant emphasis will be placed on the fast-expanding field exploring genetic contributions to neurodegenerative disease, as identification of genetic mutations pathogenic for familial neurodegenerative diseases has been a major driving force in neurodegenerative research and pointed researchers towards essential molecular process that may underlie these disorders. Strategies for therapeutic intervention in the management, prevention, and cure of neurodegenerative disease will be addressed.
Taught by: Lexow
Course not offered every year
Prerequisite: BIBB 109 or Permission of Instructor
Activity: Seminar
1 Course Unit

**BIBB 479 Neural Systems and Behavior**
This course will investigate neural processing at the systems level. Principles of how brains encode information will be explored in both sensory (e.g. visual, auditory, olfactory, etc.) and motor systems. Neural encoding strategies will be discussed in relation to the specific behavioral needs of the animal. Examples will be drawn from a variety of different model systems.
Taught by: Schmidt, M./Medina
Course not offered every year
Also Offered As: BIOL 451, PSYC 479
Prerequisites: BIOL 251/BIBB 251 and permission of instructor
Activity: Lecture
1 Course Unit

**BIBB 480 Biological Basis of Psychiatric Disorders**
The contributions of basic sciences (neuroanatomy, neurophysiology, neurochemistry, and neuropharmacology) to an understanding of behavior and behavioral disorders will be covered and important psychiatric disorders will be discussed, primarily from the viewpoint of their biological aspects. Emphasis will be placed on critical evaluation of research strategies and hypotheses.
Taught by: Lexow
One-term course offered either term
Prerequisite: BIBB 109 or Permission of Instructor
Activity: Seminar
1 Course Unit

**BIBB 481 Behavioral Pharmacology**
This seminar course reviews the behavioral effects of drugs in animals, the general biological and psychological principles of drug action, and the relationship between drugs that affect brain monoamine and opiate systems and their behavioral effects. Introductory lectures on general topics will be followed by advanced discussion of specific topics in a journal club format through student presentations.
Taught by: Heerding
Course not offered every year
Prerequisite: BIBB 109
Activity: Seminar
1 Course Unit
**BIBB 482 Clinical Psychopharmacology**
This course examines the history, rationale and putative mechanism of action of drugs used in the treatment of psychiatric disorders. Emphasis is placed on neurobiological processes underlying psychopathology and pharmacological intervention. Drugs currently in use as well as new drugs in development will be covered. Strategies, techniques, issues and challenges of clinical psychopharmacological research will be addressed and new approaches to drug discovery, including the use of pharmacogenomics and proteomics to understand variability in drug response and identify new molecular drug targets, will be covered in depth. Specific drug classes to be considered include antidepressants, anxiolytics, typical and atypical antipsychotics, narcotic analgesics, sedative hypnotics, and antiepileptic medications. A contrasting theme throughout the course will be the use of drugs as probes to identify neural substrates of behavior.
Taught by: Lexow
Course not offered every year
Prerequisite: BIBB 109 or Permission of Instructor
Activity: Seminar
1 Course Unit

**BIBB 485 Signaling in Nerve and Muscle**
This seminar based course will expand and deepen knowledge gained in BIBB 251 about excitability in the nervous system and about how synapses function. A new area of study will be skeletal and cardiac muscle which are both excitable tissues. A particular focus of the course will be the roles which calcium ions play as second messengers in nerve, muscle and synapse. We will learn about how calcium is handled in nerve and muscle and about the techniques used to study intracellular calcium. The later part of the course will have a journal club format, based on the reading and presentation of original papers. These will include papers on calcium related muscle diseases and on the integration of nerve and muscle signaling in animal motor behaviors.
Taught by: Hollingworth
One-term course offered either term
Prerequisite: BIBB251 or Permission
Activity: Lecture
1 Course Unit

**BIBB 492 Experimental Methods in Synaptic Physiology**
In this lab course, a small number of students meet once per week to discuss topics in synaptic physiology and to become proficient at sharp electrode techniques for intracellular recording, using isolated ganglia from the snail Heliosoma. The first part of each class will consist of discussion of weekly reading from the primary literature, with the remainder of the class devoted to hands-on experiments. After learning to record from and characterize single neurons, students will study synaptic transmission by stimulating incoming nerve trunks or by recording from pairs of interconnected neurons. As a midterm assignment, students will prepare and present a short research proposal using this model system, to be evaluated by the class. For the last half of the course, the class will work together on one or two of these proposals, meeting at the end of each class to pool our data, analyze the results and discuss their significance.
Taught by: Kaplan
One-term course offered either term
Prerequisite: BIBB 251
Activity: Laboratory
1 Course Unit
Notes: Lab fee $100

**BIBB 499 Senior Honors Thesis**
Continuation of BIBB 399 research. Students will be required to give an oral presentation of their research at the annual BBB symposium Honors Seminar.
Taught by: Standing Faculty
One-term course offered either term
Prerequisites: BIBB 399, Permission of BIBB Director and a GPA of 3.5 or better
Activity: Independent Study
1 Course Unit

**BIBB 585 Theoretical and Computational Neuroscience**
This course will develop theoretical and computational approaches to structural and functional organization in the brain. The course will cover: (i) the basic biophysics of neural responses, (ii) neural coding and decoding with an emphasis on sensory systems, (iii) approaches to the study of networks of neurons, (iv) models of adaptation, learning and memory, (v) models of decision making, and (vi) ideas that address why the brain is organized the way that it is. The course will be appropriate for advanced undergraduates and beginning graduate students. A knowledge of multi-variable calculus, linear algebra and differential equations is required (except by permission of the instructor). Prior exposure to neuroscience and/or Matlab programming will be helpful.
Taught by: Balasubramanian
Course not offered every year
Also Offered As: BE 530, NGG 594, PHYS 585, PSYC 539
Activity: Lecture
1 Course Unit