Bi23 Tutorials, Winter Term 2016, All 3 units

1. Visual Neuroscience: From Photon to Perception

Visual perception begins in the retina, where photoreceptors convert photons to electrical signals. The retina then sends signals to subcortical regions and the cortex. We will cover topics at these different stages, including neural coding of visual information, neural mechanism underlying visual perception, and neural basis of vision-guided decision-making. There will be homework, either reading an original paper or answering questions related to the lectures.

Organizational Meeting on Tuesday, January 5th at 4 PM in Broad 300

Tutor: Yatang Li, PhD. x4830, MC 216-76, yatangli@caltech.edu

2. Nanorobotics

Students will learn how to design, build, and study a nanoscale robot. Through a combination of interactive lectures, exercises, and literature research students will gain an understanding of engineering principles and techniques necessary to construct and investigate biologically inspired robots. Each student will design a nanobot for applications in medicine, computer science, and engineering.

Organizational Meeting on Wednesday, January 6th at 4pm in Keck 109

Tutor: Greg Tikhomirov, PhD, MC 138-78, x1231, dnano@caltech.edu

3. The Neuroscience of Sleep

Sleep is conserved throughout the animal kingdom, with a typical human being spending one third of their life asleep. Despite the amount of time we dedicate to this behavior, the function and regulation of sleep remain poorly understood. Furthermore, sleep and circadian disturbances and disorders affect millions of people across all demographic groups, making sleep an important healthcare issue. Topics to be covered include the genetic and neural regulation of sleep, sleep disorders, theories of sleep function, dreams and the role of sleep in memory and mental health. The class will be structured as a combination of lectures and discussions.

Organizational Meeting on Wednesday, January 6th, at 4PM in SFL Multimedia Conference Room

Tutors: Audrey Chen, PhD, x8123, MC 156-29, audchen@caltech.edu, Daniel Lee, PhD, x8123, MC 156-29, leed@caltech.edu, Grigorios Oikonomou, PhD, x8123, MC 156-29, grigoris@caltech.edu

4. Your Brain on Drugs: Molecules, Neurons, and Behavior

Psychoactive drugs have been hailed as saviors, for their use in treatment of conditions such as depression, schizophrenia, and sleep disorders, but also as demons, for the damage wrought by drugs such as cocaine, heroin, and crystal methamphetamine. Because many of these drugs target neuromodulatory systems, whose function (among others) is to regulate the state of neural circuits, their effects can be wide-ranging and difficult to predict. Understanding their mechanisms of action requires study across multiple levels of biological organization, from drug-receptor interactions to behavioral effects. This tutorial seeks to introduce students to thinking and integrating across these different levels of molecular, neurological, and psychological research. We will focus specifically on the serotonergic, dopaminergic, and opioid systems, and on drugs that target them, such as antidepressants, cocaine, heroin, and emerging therapeutics like ketamine. The first two classes will introduce basic concepts in neuropharmacology, the roles of signaling systems in shaping behavior, and the important molecular players. Subsequent classes will focus on student-led discussion of primary literature, examining endogenous functions of these systems in humans and other taxa, the effects of specific drugs on behavior, as well as the molecular mechanisms of action of these compounds. Each student will be required to give a short final presentation focusing on improvements in drug therapeutics. Course grade will be based upon the presentation and participation during discussions.

Organizational Meeting on Wednesday, January 6th, at 4PM in BBB 101

Tutors: Irene Kim, PhD, x4562, iskim@caltech.edu, MC 216-76, Ysabel Giraldo, PhD, x4562, MC 216-76, ygiraldo@caltech.edu

5. Nanotechnology for the Biologist

Nanotechnology refers to the development and study of very small materials with a characteristic scale that is about 1 to 100 nm. This relatively young research field is growing very rapidly and can be applied to other science fields, such as chemistry, physics, material sciences, engineering and biology. The course will provide a general overview of the field with an emphasis on biology. Many of the biological works of cells naturally occur at the nanoscale. Drawing on the natural nanoscale of biology, many medical researchers are working on designing tools, treatments, and therapies that are more precise and personalized than conventional ones — and that can be applied earlier in the course of a disease and lead to fewer adverse side effects. Some scientists are looking at ways to use nanoscale biological principles of molecular self-assembly, self-organization, and quantum mechanics to create novel computing platforms. Some researchers are investigating photosynthesis as a model for "green energy" nanosystems for inexpensive production and storage of nonpolluting solar power. Nanotechnology has great potentials, however some drawbacks related to toxicity are constantly pointed out.

Organizational Meeting on Wednesday, January 6th, at 4PM Noyes 147

Tutor: Adela Nano, PhD, x 3201, MC 127-72, anano@caltech.edu

6. Microbial Detection Techniques in Environmental Microbiology

Immediate detection and identification of microorganisms is a necessary application in many areas of everyday life. Medical, pharmaceutical, and food industries, as well forensic and planetary protection areas, strongly rely on microbial detection techniques as a gold standard for prevention of microbial contamination, disease outbreaks or forward contamination during space exploration for safety of people and their environments. In this tutorial, we will review recent publications on practical aspects of environmental microbiology, such as methods of environmental sampling, microbial detection and identification techniques, as well as data analysis.

Organizational Meeting on Wednesday, January 6th, at 4pm at Broad 300

Tutor: Aleksandra Checinska, PhD, 818-354-5799, JPL M/S 89-102D, Aleksandra.Checinska@jpl.nasa.gov

7. Parasite-Host Interactions

All free-living organisms are hosts to other organisms that are specifically adapted to live within or on them. We will cover the intimate and fascinating relationship between eukaryotic parasites and their hosts. Host-parasite interactions are the most highly co-evolved of relationships: parasites have adaptations that allow them to detect and invade hosts, evade host defenses, and use host energy to reproduce, while hosts have evolved ever more elaborate ways to evade or kill parasites, or at least to limit their damage. We will discuss the complex life histories of parasites and the behavioral, cellular, and molecular weapons used on both sides of this "arms race". Topics will include public health scourges (e.g., malaria, African sleeping sickness, guinea worm, schistosomiasis), the hygiene hypothesis (why parasites can sometimes be good for host health), the research that led to this year's Nobel Prize in Physiology or Medicine, population ecology, co-evolutionary theory, and even zombies (how parasites can control host behavior).

Organizational Meeting on Wednesday, January 6th, at 4pm at Braun 151

Tutor: Mary Yui, PhD, x4915, MC 156-29, yui@caltech.edu

8. Targeting Traditionally Difficult Proteins Responsible for Cancers with Newer Approaches

Cancer therapy is currently highly limited by the fact that targets that play key roles in the disease are traditionally not targetable by small molecule drugs due to technology limitations. This is especially true when the treatment involves interrupting protein-protein interactions. We shall look at how scientists are trying to solve this problem, and what medicinal advances have been made in targeting some key cancer pathways. The course will cover: Why key targets are not treatable by traditional approaches; Advances made by antibody therapeutics; Alternate approaches, such as fragment based drug discovery and stapled peptides; and overview of where scientists are in the journey of "treating the untreatable", important breakthroughs and caveats.

Organizational Meeting on Wednesday, January 6th, at 4pm at Noyes 32 (Basement)
Tutor: Arundhati Nag, PhD, x8919, MC 127-72, arundhat@caltech.edu

9. Human Genetics: From the Basics to Personalize Medicine

This course will cover how recent advances in science and technology have enabled an unprecedented understanding of our genome. The Human Genome Project was able to sequence the entire human DNA (2003); organizing and making sense of this genomic data is one of the greatest scientific challenges. We will present the recent research and diagnostic approaches to many hereditary disorders and quantitative phenotypes. What are the implications of using our growing knowledge of human genetic variation to improve health? Pharmacogenomics and Gene Therapy: Getting the right drug, at the right dose, at the right time. The knowledge generated will ultimately transform medicine through patient-specific treatments and prevention strategies. Finally, we will discuss the relationship between scientific information and Bioethics.

Organizational Meeting on Wednesday, January 6th, at 4pm at Broad 200
Tutor: Theodora Koromila, PhD, x5951, MC 114-96, koromila@caltech.edu

Bi 23. Biology Tutorials. Small group study and discussion in depth of special areas or problems in biology, involving regular tutorial sections with instructors drawn from the divisional postdoctoral staff and others. Faculty responsible: Dr. Alice S. Huang.