Bi23 TUTORIALS
WINTER TERM 2020

1. The Chemistry of Conflict and Cooperation (3 units)

Unlike humans, most organisms exchange information via small organic compounds rendering chemical signaling the most abundant type of communication. Chemical signals or cues may be produced by plants or animals, but also by their associated micro-organisms. For this tutorial we will focus on chemical communication in the Metazoa (animals). We will explore how animals use chemistry to live together with conspecifics, engage in family life, form socially dynamic groups, but also how they use chemical tricks and weaponry to exploit other animal societies or defend themselves against their predators, respectively. Eventually, we will uncover how the chemistry of conflict and cooperation shapes interactions between individuals, population processes and structures communities. The tutorial mostly focuses on the >99.9% of animals that lack backbones.

Organizational Meeting on Thurs. January 9th at 4pm in B101 BBB

Tutor: Adrian Brueckner, PhD MC 216-76, bruckner@caltech.edu

2. Metals in Biology (3 units)

Imagine there would be no life without metals. You guessed it right. I am not talking about shiny gold and silver ornaments. From origins of life to essential metabolic reactions are all metallocentric. Do you want to know how metalloenzymes perform some of the hardest chemical reactions on this planet (and also at Caltech) with ease? This tutorial will focus on the role of metal ions in biological processes: in particular, a discussion of the role of transition metal ions (mainly, copper, zinc, iron and manganese). We will discuss how cells handle otherwise toxic metal ions in such a precise manner to carry out the essential functions. We will learn about metal ion homeostasis in all aspects of life and how some of diseases are caused by an imbalance in handling metal ions in humans. We will also uncover how bacteria are dependent on metal ions to cause infectious diseases.

Organizational Meeting on Weds. January 8th at 4pm in B136 KRK

Tutor: Rahul Purohit, PhD, x 1272, MC 164-30, purohit@caltech.edu

3. The Junkyard of Biology: What Genomes Hide in between Genes (3 units)

Did you know that only 3% of our DNA codes for protein coding genes? Have you ever wondered what sits in the rest of our genome? Do you want to learn what that genomic "junk" is composed of, what it does, and how researchers use it? This course is focused on the non-coding part of the genome and explores its origin, evolution, and function at the cellular and organismal level. It will discuss viral integrations, copy-paste mechanisms of transposable elements, and precise genome engineering by the CRISPR system. We will address questions like: How is the activity of non-coding DNA linked to gene regulation, cell-type specific transcription, limb and brain development and even to behavior such as maternal care? We will learn what defense mechanisms cells use against invading DNA/RNA and transposon activity and how (and why) we can hijack these. We will also dive into recent molecular biology techniques and learn how this junkyard is used in genetic engineering, the mapping of 3D genome structure and in modern day medicine.

Organizational Meeting on Thurs. January 9th at 4pm in B136 KRK

Tutors: Joanna Jachowicz, PhD, x1222, MC 156-29, jjach@caltech.edu

Máté Borsos, PhD, x2764, MC 139-74, mborsos@caltech.edu

4. Studying Wiring of the Nervous System with Model Organisms (3 units)

The brain is the most complex organ of the human body, composed of ~100 billion neurons. In order for us to feel, to think and to respond to changes in our environment, neurons must be organized into precisely connected networks. Indeed, within a dense neuropil, each neuron only makes connections to a set of specific partner neurons, although it would come into contact with many others during the wiring process. Past studies underscore the extraordinary diversity of neuronal cell types and the complexity of the connections between them and suggest many theories on how the nervous system is wired. In this class, we will review both classic and cutting-edge research for studying neuronal wiring in a model organism. We will read primary literature and talk about studies in different organisms, focusing on molecular, but also including physiological and modeling methods. The goal of the class is to provide a better understanding of the many different ways to tackle the complex wiring problem.

Organizational Meeting on Tuesday, January 7th at 4pm in B101 BBB

Tutor: Shuwa Xu, PhD, x8315, MC 114-96, shuwaxu@caltech.edu

Faculty Responsible for Bi23: Dr. Alice S. Huang, x3446, MC 156-29