S12817: Next Generation Biology

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Prerequisites: This class doesn't have any prerequisites. We won't assume students have any background in biology — all we ask is that you be excited about biology and ready to learn!

Schedule and Topics:

Saturday, February 23: DNA, part I

- What is a cell? What do genes and DNA look like?
- How does the cell read the information contained in the DNA?
- How does the cell "do the right thing at the right time?"

This first introductory lecture will give an overview of our current understanding of concepts at the core of molecular and cellular biology. We will begin discussing how cells use information contained in their DNA to carry out complex biological functions such as dividing, managing resources and responding to their environment.

Saturday, March 2: DNA, part II

- How are genes and their products regulated?

- How do multicellular organisms develop in such a precise manner?
- What is CRISPR? How can we manipulate and edit genes?

This second introductory lecture will expand upon the ideas of precision in cellular function. By looking through the lens of evolution, we will try to understand how genes are regulated in both single cells and in multicellular organisms. And will explore the modern advances that allow us to change and control genes.

Saturday, March 9: Sequencing and RNA

- What is DNA sequencing? What is so powerful about sequencing technologies?
- How do genetic testing services like 23andMe work?
- What are the functions of RNAs in a cell?

DNA sequencing, or the decoding of the sequence on DNA molecules, has improved dramatically over the past decades, both in clinical and research settings. Sequencing technologies have readily make their way into movies like GATTACA, daily news and advertisements, and medical applications. This lecture introduces these technologies and their history, and provides an analysis of their impact.

These technologies have also revealed a new class of important molecules in cells. Numerous discoveries about RNAs in recent decades have completely transformed our understanding of the central dogma of molecular biology. This lecture will also present some key findings about RNA biology.

Saturday, March 23: Proteins!

- What is a protein? What are proteins made of?
- How do we look at proteins?
- Can we design a protein to do things we're interested in?

Proteins are the "workhorses" of the cell, and carry out most of the functions associated with life. This lecture will be a short crash course in what proteins are, how we understand the three-dimensional structures of proteins, and how we can create new proteins for specific applications of interest to medicine or research.

Saturday, March 30: Neuroscience

- Do we really only use 10% of our brain?
- Why do we worry about football players getting concussions?
- Is your gut a "second brain"?

The truth is that we scientists don't understand very much about how the brain works. We all agree that is important for sensation, movement, sensation, and consciousness, but after that, things get kind of sketchy. In this talk we will discuss the fact and fiction behind the headlines. Students will be encouraged to relate concepts to their own lives through several guided, interactive experiments.

Saturday, April 6: Bioethics

- What factors are important to consider when addressing bioethical issues?
- How should hospitals decide which individuals should get new organs?
- How do we balance the needs of society with the needs of an individual?

This lecture will discuss modern bioethical issues such as organ donation, the use of steroids in professional athletics, and testing new drugs on humans. We will discuss how to assess these issues both scientifically and morally, and work to better understand the opposing views and different sides that exist. We will discuss recent examples in the news and encourage students to bring up topics they have heard about previously.