

Biology: How Cells Work Syllabus

DESCRIPTION

How can a change in one organic compound, a single nucleotide in a genome made up of three billion bases, cause an entire disease? How do proteins take on so many different functions and roles within a living cell when they are all made up of the same basic “alphabet” of 20 amino acids? How can essentially blind, mindless enzymes carry out tasks so efficiently?

How can cells function and react to a constantly changing environment without a “brain”? How do these cells manage to survive and come together in the trillions to form a complex human individual such as yourself?

Learn how biological organisms function and survive, starting with the basics of physical science and working our way up!

This class will look at biology in the context of chemistry, physics, and more in order to build an understanding of how we go from the simplest reactions and compounds to the diverse populations of cells working in the human body. We will look at molecular and cellular biology with a deeper understanding of the forces that govern life. Create a dynamic picture of biology as a process in your head and forget about memorizing names and reactions!

COURSE PREREQUISITES

In terms of formal prerequisites, it is highly recommended that you have taken a class in physics, chemistry, and especially biology. If you have not taken a biology or chemistry class, you will likely find this course more difficult than it should be. These need not be advanced classes, but certain basic key words should be familiar to you.

The goal of this course is not to teach you the relevant background, such as chemical bonds or forces, for the first time. This class will cover these topics as a review and in the context of biological processes.

HOMEWORK

Homework will be assigned for each upcoming lesson and should take no more than 30-45 minutes each week. The required part of each assignment will be a reading, a video, or a game that reviews the topic covered the day it is assigned and/or relates to the topic to be covered the next week. Questions will also be handed out for students to think about as they go through the homework. More work will be posted for people who want a more rigorous learning experience.

Finally, you will benefit from reviewing your notes plus the posted notes/slides each week from the previous class before class meets again. You are highly encouraged to email me at mesako@mit.edu if you have questions about the subject material!

REFERENCES

Wikipedia and YouTube are obviously useful resources that you can certainly use throughout the course to review a pathway or process covered in class. Additionally, some of the material we cover can be found in recent editions of **Biology** by Campbell and Reece.

SCHEDULE

Day 1: Intro to Biology and the Class

- Class Syllabus and Goals
- Questions/Themes in Biology
- On the Cellular Level: Life's Building Blocks
- Life in a Chemical Context: Affinity and Bonds

ACTIVITY: Interest Discussion
DEMO: Cell Size and Scale
DEMO: Potential Energy Examples

Day 2: Biochemistry and a Science Background

- Sugars, Nucleic Acids, Lipids, Proteins
- Energy and Entropy, Form and Function
- Enzyme Chemistry and Thermodynamics
- Regulation on All Levels

ACTIVITY: Polymer Gallery
DEMO: Enzyme Reactions Game

Day 3: Molecular Biology (Part I)

- Genetics: Small Changes and Huge Effects
- DNA: Blueprints for Life
- Storage and Inheritance
- Replication and Repair
- Regulation: Dynamic DNA

ACTIVITY: Understanding Diseases
ACTIVITY: DNA Folding Challenge
DEMO: DNA Topology Models

Day 4: Molecular Biology (Part II)

- RNA: Messengers, Catalysts, and More
- Transcription and Processing
- Translation, Modification, and Transport
- Proteins: The Jack-of-All-Trades

ACTIVITY: Reading the Code
DEMO: Enzyme Recognition Simulation

Day 5: Cell Biology (Part I)

- Basic Intro to the Cell
- Structural Biology (Repeat)
- Organelles: What They Do and How
- Cell Cycle: Life, Death, and New Life

ACTIVITY: "What am I?" Game
DEMO: Cell Lineage Tree

Day 6: Cell Biology (Part II)

- Metabolism: How Cells Get and Use Energy
- Active/Passive Transport: Homeostasis
- Signaling and Movement
- Gene Expression: How Cells Function
- Cell Types: How They Differ and Why

DEMO: Potential Energy Revisited
DEMO: Cell Communication
ACTIVITY: Cell Type Exhibit

Day 7: Biological Systems

- Course Review
- Multicellular Life
- Tissues, Organs, Organisms
- Biology: Frontiers in Research and Medicine

ACTIVITY: Biology Jeopardy
ACTIVITY: Closer Look on Human Health