This course provides an introduction to the structure, biochemistry, molecular biology and physiology of cells, as well as cell signaling and gene expression. Modern Cell Biology emerged as the fusion of three distinctly different disciplines of inquiry: cytology (exploring cellular structure); biochemistry (elucidating the chemistry of the cell); and genetics (describing the storage and expression of genetic information). Often scientists employ methods from all these areas in a single experiment to explore the inner workings of the cell. We will discuss many of these experimental approaches and you will learn to apply some of them in novel settings.

An important theme running throughout the course is how macromolecular structure influences function and is affected by evolution. Enzyme structure, activity, and control mechanisms are crucial to governing the cell’s metabolism and replication. Lipid structure and composition play important roles in membrane function and adaptation. Regulation of gene expression includes associations of numerous structural components that control the quantity of an active gene product as well as where and when each gene is expressed. Variation in nucleotide sequence is linked to differences in macromolecules and thus phenotype, natural selection, adaptation, and disease.

Class discussions will often address specific examples of the molecular and cellular basis for evolution, adaptation, or disease (for example: protein folding and misfolding links to disease; evolution of tetrodotoxin resistance and the predator-prey arms race; enzyme variation in temperature adaptation; potential for personalized medicine based on genotype). Readings from recent scientific journals and science news sources will provide supplemental insight into technologies, experimental design, and new discoveries about cellular function. You should read the textbook chapters and articles prior to class, so that we can devote more time to discussion and less to lecture.

Text: *Campbell Biology*, 10th ed., Reece, et al. (text can also be used for Bio 221);

**Mastering Biology** Assignments will be made through the Blackboard link.

**Blackboard:** On-line access to assignments, articles for discussion, calendar, study guides, power points, etc. [https://ole.sandiego.edu](https://ole.sandiego.edu)

**Expected Learning Objectives**

At the end of this course students should be able to:
- Describe basic structure and function of major biological macromolecules, cellular membranes, cytoskeleton and organelles.
- Relate chemical properties of molecules to their biological function.
- Apply kinetic and thermodynamic principles to enzyme function and cellular processes.
- Describe the relationship between the genome, gene expression, and cellular function.
- Identify major points of a scientific article and its experimental design, and describe how results support or refute a hypothesis.
- Apply general knowledge about cells and macromolecules in novel situations.
Make-up exams will only be given under rare special circumstances at my discretion. You must contact me **before** the exam to ask for an alternative exam time. Contact me as soon as possible after a serious emergency that prevents communication prior to the exam (for example, an accident on the way to USD). Collaboration on an exam, plagiarism, or use of unauthorized materials is a breach of academic integrity and will be dealt with seriously. Group discussions of homework questions are encouraged, but all answers must be written independently unless otherwise indicated.

Homework may include exercises in macromolecular and organelle structure, readings from scientific literature, problem solving sets, literature searches and case studies. We will explore some common physiological functions to illustrate how many cellular mechanisms are integrated.

**Informal Discussion Groups:** Small groups of students choose a topic, read a set of scientific articles for discussion at La Paloma with Dr. Lowery (or outside on the Strata Plaza). Times to be arranged.

**Grading:**
- Midterm Exams (100 points each) 200
- Final exam (Cumulative) 100
- Homework, self-studies, quizzes, and class discussions 75
- Total 375 points

General grading scheme: 
- ≥ 90% = A; 
- 80-89% = B; 
- 70-79% = C; 
- 60-69% = D; 
- ≤ 59% = F

Exams are designed to challenge students who earn an A, but provide opportunities for well-prepared students to achieve a solid score. Therefore, I don’t curve individual test scores. During the semester, we will work on developing strategies for more efficient studying.

**Dates** | **Topics for Bio 225** | **Chapters**
--- | --- | ---
1/27 | Introduction to the study of cells, structure and organization | 1
1/30-2/6 | Chemical Components of Cells; The Structure and Function of Large Biological Molecules | 4, 5


2/8-2/15 | Membrane Structure and Function; Transport Processes; Osmosis; Case study: Osmosis and Hyponatremia | 6

2/15 | Assignment due: A Self-guided Tour of the Cell | 6
| Why do cell's power plants hang on to their own genomes? (2016) Hamers, L. *Science* 351: 903

2/17-2/24 | Introduction to Metabolism | 8
| Free Energy; Enzyme structure, function and regulation | 7
| Temperature adaptation of cytosolic malate dehydrogenases of limpets Dong & Somero (2009) |
3/1     Exam 1

2/27- 3/15    Cellular Respiration and Fermentation 9

3/6-10 Spring Break

3/17- 3/22    Photosynthesis 10

3/24 – 3/31    Cellular Communication 11


4/5     Exam 2

4/3- 4/12    Ion Channels and Membrane Potential 48
Signaling in Nerve Cells
Jiang, P. and G. Beauchamp (2014) Sensing nectar’s sweetness: A taste receptor evolves to sense
Communications DOI: 10.1038/ncomms14014 |www.nature.com/naturecommunications

4/14- 4/17    EASTER BREAK

4/19- 4/24    DNA Replication Repair and Recombination 16

4/26 – 4/28    Gene Expression: From Gene to Protein 17

5/1- 5/8    Regulation of gene expression 18
http://www.hhmi.org/biointeractive/ppar-gamma-activation-fat-cell
http://www.hhmi.org/biointeractive/ppar-delta-activation-muscle-cell

Case Study: Modeling the regulatory switches of the Pitx1 gene in Stickleback fish.

5/10- 5/12    DNA/RNA Tools and Analysis of Gene Expression 20

5/15    Genomes and Their Evolution 21
Case Study: http://www.hhmi.org/biointeractive/making-fittest.birth-and-death-genes

5/19 (Friday)    Cumulative Final Exam    11:00 am – 1:00 pm
Additional Articles for Potential Class Discussion or Reference


