Biology 230 *The Living Cell*

Introduction Biology 230 explores the vibrant activity of cells, which can range from the shuttling of vesicles within a cell to the migration of tumor cells throughout an organism, from the healing of wounds to the formation of the complex wiring of the brain. The unifying theme among all of these activities is movement. To understand how this cellular motility arises, the course examines the design and function of proteins in the cytoskeleton and cell membrane, as well as the signaling pathways that orchestrate complex movements.

Aims and Objectives The course aims to broaden and deepen students' understanding of cellular motility, as well as to offer students the opportunity to pursue their own interest in cell biology in depth. In addition, the course seeks to increase students' ability to: (a) think critically, (b) solve problems, (c) develop rigorous lines of argumentation, and (d) formulate new experiments and meaningful, testable hypotheses.

Teaching/Learning Methods Biology 230 uses several methods to help students meet the course objectives. Class sessions include instructor-guided analyses of published research, as well as group-based work on problems. Classes will be held Tuesday and Thursday. Additionally, small-group tutorials will meet once a week at times to be arranged. Designed to give students opportunities to share knowledge and to develop ideas with the instructor, the tutorials will feature analyses of the primary literature and discussion of essays prepared by members of the group. Over the course of the semester, each student will prepare and guide discussion of two essays in tutorial. The essays will generally be built around a study of primary literature from various journals.

Assessment The various forms of assessment used in the course are designed to provide students with a measure of their progress toward meeting the aims and objectives of the course. A description of the forms of evaluation and their contribution to the final grade for the course follows:

- 2 tutorial essays (3 pages each, double-spaced) analyzing topics chosen by the student in consultation with the instructor. The ideas in the essays, as well as the primary literature on which the essays are based, will be discussed within the tutorials. Essays must be submitted to the instructor and other members of the tutorial group by 4:30 pm on the day before the tutorial, and accompanying the essay should be 2 to 3 "thought questions" to guide the group's preparation and discussion. Material from the tutorials, in addition to that from classes, will be covered on the tests. (Essays collectively count 20% towards the final grade.)
- ~6 brief analyses of tutorial articles presented by others in your tutorial group (20% of final grade)
- ~4 problem-sets (30% of the final grade)
- 2 tests (20% of the final grade)
- 1 capstone project in lieu of final examination. This is an assignment that responds to the major concepts of the course, but one that does not take the form of an examination or formal essay. Instead, students are encouraged to be creative on this culminating project, which could take the form of a video (*e.g.*, prepared with iMovie), a letter written to a cell biologist of another age (past or future), a nomination to the Nobel Committee of a particular scientist for her/his fundamental contribution, a dance, or a musical piece. (10% of the final grade)

Assignments received late will be marked down. Since courses that involve active learning and collaborative projects are more effective at promoting learning and skill development than are those involving only listening and note taking, students are strongly encouraged to participate in class and tutorial.

Honor Code You are especially encouraged to work in groups for studying, for completing homework, and for planning, conducting, and making sense of projects. Your essays and tests, which may present views arrived at while working in a group, are nonetheless expected to be composed on your own.

General Information The location and time of tutorials will be determined in class. Each session will last about fifty minutes, during which time one member of the tutorial group will promote discussion of the ideas developed in her/his tutorial essay. My office hours for each week will be posted on my door (room A237 of the Science Center) each Monday morning. To schedule a meeting or to make an appointment for a time different from office hours, please see me after class or send an e-mail message.

Course Outline

Date	*Topic (supplemental reading assignments)*
Feb. 3, Tues.	Introduction
Feb. 5,Thurs.	Cytoskeleton: beams, cables, and ropes; their poisons (Howard -- ch. 7)
Feb. 10, Tues.	Zippers, blisters, myopathies, and neuropathies; cell mechanics (Howard -- chs. 2 & 3)
Feb. 12, Thurs.	Physico-chemical foundations I: snug bonds and multi-strandedness (Howard -- ch. 9)
Feb. 17, Tues.	Physico-chemical foundations II: thermodynamics
Feb. 19, Thurs.	Physico-chemical foundations III: kinetics
Feb. 24, Tues.	Physico-chemical foundations IV: kinetics and case study of neurite extension
Feb. 26, Thurs.	Actin binding proteins: lessons from gelsolin on nucleators, severers, and cappers (Bray – ch. 5)
Mar. 3, Tues.	no class
Mar. 5, Thurs.	Additional lessons from gelsolin; cellular context and steps of locomotion
Mar. 10, Tues.	Contractile forces I: myosins and sliding filaments (Bray -- chs. 7 & 9)
Mar. 12, Thurs.	Contractile forces II: how a molecular motor might work (Howard – chs. 12 to 16)
Mar. 17, Tues.	Contractile forces III: non-muscle roles of myosin
Test (~4 paragraph-answer questions; self-scheduled between March 17 and 19)	
Mar. 19, Thurs.	Regulation of actomyosin interaction and force production
Mar. 31, Tues.	Actin-dependent motility I: life at the leading edge (Bray -- chs. 6 & 8)
Apr. 2, Thurs.	Actin-dependent motility II: lessons from studying how pathogens hijack the actin cytoskeleton
Apr. 7, Tues.	Signals I: orchestrating the remodeling of the actin cytoskeleton I
Apr. 9, Thurs.	Signals II: adhesion complexes and small GTPases such as rho, rac, and cdc42
Apr. 14, Tues.	Case study: what happens after a cut -- clotting, immunosurveillance, and healing
Apr. 16, Thurs.	Case study, continued
Apr. 21, Tues.	Microtubules: nucleation and γ-tubulin; life amidst catastrophes (Bray -- ch. 11; Howard -- ch. 11)
Apr. 23, Thurs.	Microtubule-based motors: dynein, kinesin, and others (Bray -- chs. 12&14; Howard – chs. 12-16)
Apr. 28, Tues.	Mitosis, meiosis, and cytokinesis I (Bray – ch. 13)
Apr. 30, Thurs.	Mitosis, meiosis, and cytokinesis II
May 5, Tues.	Mitosis, meiosis, and cytokinesis III
May 7, Thurs.	**Test (~4 paragraph-answer questions)**
May 14, Thu.	Final project due at 4 pm

Readings The bulk of course readings will be taken from the primary research literature and will be treated primarily in tutorials. The readings listed here should be viewed as reference materials, suitable for amplifying on concepts from class. These suggested readings are drawn from two texts that have been placed on reserve: *Cell Movements*, second edition (by D. Bray); and *Mechanics of Motor Proteins and the Cytoskeleton* (by J. Howard). Students have found Bray's text straightforward and Howard's breathtakingly challenging, but worthwhile. One other text has been placed on reserve: G. Cooper's *The Cell*, second ed. Relevant chapters are 11 through 14.