McGill
Department of Bioengineering

# BIEN 550
# Biomolecular Devices

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The course content and evaluation methods below are tentative and may be changed to adapt to student progress and interests.

**Course Description.** Fundamentals of motor proteins and the cytoskeleton, focusing on their roles in neuronal transport, muscle contraction, protein synthesis, motility and cell division. Recent advances in using motor proteins to power nano-fabricated devices will be surveyed, along with designing a simple device.
**Prerequisite(s):** none.
**Credit Hours:** 3
**Lecture Schedule:** 8:35 - 9:55 am, Wednesdays and Fridays

**Text(s):** There is no required textbook. Handouts will be distributed during lectures and through myCourses.
Recommended reading:
· *Mechanics of Motor Proteins and the Cytoskeleton* (2001) Jonathon Howard.
· *Molecular Cell Biology* (2000) Harvey Lodish et al. (http://www.ncbi.nlm.nih.gov/books/NBK21475/)
· *Molecular Biology of the Cell* (2002) Bruce Alberts (http://www.ncbi.nlm.nih.gov/books/NBK21054/)
· www.ibiology.org

**Course Objectives:** At the completion of this course, students will be able to [bracketed items refer to engineering graduate attributes]:

1. describe the cellular roles and biophysical properties of motor proteins including myosin, kinesin, dynein, ATP synthase, ribosomes, and bacterial flagella [KB].
2. describe the properties and mechanics of cytoskeletal polymers including actin and microtubules [KB, DE].

3. be familiar with the available tools used to examine motor proteins and the cytoskeleton [KB, IN, ET].
4. understand the forces relevant to motor proteins, cytoskeletal dynamics, and nanoscale devices [KB, IN].
5. be able to interpret scientific journal articles and communicate the results to their peers [IT, CS, LL, PR].
6. use knowledge of motor protein function to design an engineered device [PA, DE, ET, CS, PR].

**Class participation.** Lectures will include discussion of recent literature and scientific presentations. It is important that students attend lectures and review the required readings or videos before coming to class. It is expected that all students contribute to discussions.

**Problem sets.** Four problem sets will be assigned based on the required readings and video assignments.

**Journal Paper Presentation.** During the semester, teams of 2-3 students will present a scientific journal article to the class that describes (1) new insights into the mechanism or function of motor proteins or (2) a novel application of motor proteins in engineered devices. The team is responsible for providing background to place the study in the context of the field, presenting the approaches and results, and leading the class in a discussion of the accomplishments and shortcomings of the paper, and opportunities for future work.

**Project.** Students will design a novel biomolecular device that uses biological machines (motor proteins, cytoskeletal filaments, simple organisms) to perform a simple function (sorting, alignment, transport, etc.).

**Grade Distribution:**

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|---|---|
| Class participation | 25% |
| Problem sets | 25% |
| Journal presentations | 25% |
| Project | 25% |

**Academic Integrity.** McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/students/srr/honest/ for more information).

**Course Outline:**

| Week | Content |
|---|---|
| 1 | • Introduction: motor proteins and the cytoskeleton |
| 2 | • Muscle |
| 3 | • Intracellular transport, kinesin, dynein |
| 4 | • Microtubules and microtubule-associated proteins |
| 5 | • Cell division |
| 6 | • Actin and actin-binding proteins |
| 7 | • Cell motility |
| 8 | • Mechanotransduction |
| 9 | • Synthetic motors |
| 10 | • Molecular motor-based devices |
| 11 | • RNA polymerase, ribosomes |
| 12 | • ATP synthase |
| 13 | • Proteases |
| 14 | • Hearing and hair cells |
| 15 | • **Projects due** |