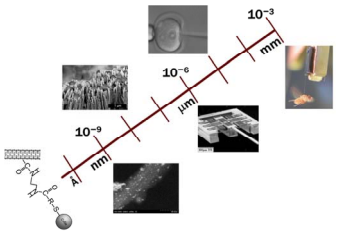
Undergraduate Research Topics



Lab: Advanced Micro and Nanosystems Lab

http://amnl.mie.utoronto.ca

Year: 2010

AMNL accepts strong undergraduate students from Engineering Science, Mechanical Engineering, Electrical and Computer Engineering, as well as Biomedical Engineering.

1. Topic: Microdevices for rapid cell immobilization

Number of Students: 1 (EngSci/MIE)

Description: The objective of this project is to develop microdevices for immobilizing many cells into a regular pattern rapidly. The student will conduct device design and microfabrication and will evaluate the effectiveness of the system.

2. Topic: Microdevices for mechanically active cell culture

Number of Students: 1 (EngSci/MIE)

Description: The student will design and microfabricate new types of devices to generate mechanical strain for stimulating cells during cell culture. The student will characterize the devices (e.g., strain fields) and apply the devices to cell culture.

3. Topic: CD-like cell manipulation devices

Number of Students: 1 (EngSci/MIE)

Description: The student will develop a system integrating motors and microdevices for manipulating cells using centrifugal forces. The student will conduct system analysis and system construction as well as testing the system with cells.

4. Topic: Development of an automated cell transfer device

Number of Students: 1 (MIE/EngSci)

Description: The student will design and machine a plastic device for manipulating biological cells (zebrafish embryos) – to assemble them into a regular array rapidly. The student should have skills in conducting mechanical design and experiments.

5. Topic: Development of a control system for interfacing with microfluidic devices

Number of Students: 1 (MIE/ECE/EngSci/)

Description: The student will develop a control system (using microcontroller circuits) to control valves and pumps for interfacing with microfluidic chips. The student should understand basics of microcontroller circuits (or is taking a course concurrently) and have strong experimental skills.

6. Topic: Design and construction of a temperature, CO_2-controlled chamber

Number of Students: 1 (MIE)

Description: The student will design and construct chambers around optical microscopes. The goal is to maintain biological samples under a microscope at 37 degrees with 5% CO_2. Tasks include CAD design, machining, working with temperature controllers, and assembling components around microscopes for testing.

7. Topic: Development of microsystems for quantifying mechanical properties of single cells

Number of Students: 1 (EngSci/MIE/ECE)

Description: The student will design and fabricate micro devices for quantifying mechanical properties of single cells. The project will involve device construction and cell experimentation. The student preferably understands microfabrication, microfluidics, and basics of cell biology.

8. Topic: Development of microsystems for quantifying electrical properties of single cells

Number of Students: 1 (EngSci/MIE/ECE)

Description: The student will design and fabricate micro devices for quantifying electrical properties of single cells. The project will involve device construction, circuit development, and cell experimentation. The

student preferably understands microfabrication, microfluidics, and basics of cell biology.

9. Topic: Computer Vision - visual feature tracking of scanning electron microscopy (SEM) images

Number of Students: 1 (EngSci/ECE/MIE)

Description: The objective of this project is to develop an image processing / computer vision algorithm for real-time visual tracking of nano-scaled features that move inside a scanning electron microscope during nanomanipulation. The student will develop the algorithm and implement it in C++. Visual tracking errors will be analyzed and minimized. The student is expected to have a sound background in mathematics and skills in programming.

10. Topic: Nanomaterials-based NEMS biosensors

Number of Students: 1 (EngSci)

Description: The students must have a fundamental understanding of nanomaterials (e.g., carbon nanotubes, Si nanowires) and MEMS design and microfabrication. The student will design and microfabricate sensors (mechanical and bio/chemical) that integrate nanomaterials as active sensing elements. The sensors will be developed and applied to detecting proteins secreted by biological cells.

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