

## Some Project Ideas

**Optimize Single Cell Traps** The single-cell traps you used in lab were designed as a prototype, with little effort put in to optimizing the design for efficiency of trapping (as you probably noticed). One project idea is to identify the parameters that affect trapping efficiency to allow trap design to be optimized for individual cell types. This project would involve fabricating a series of traps with slightly different configurations (trap size, trap spacing, uniformity, etc.) and testing each for efficiency of trapping.

**Design Microfabricated Valves** One significant challenge in making practical microfluidic devices is controlling the flow of fluid using valves. A variety of valve designs have been proposed and made. This project would involve testing various designs to find the best one, and potentially designing a new type of valve.

**Coulter Counter** A common application of microfluidic devices is cell counting. As you read in the paper, this step is often done visually, using a microscope and a camera. An alternate technique is to build a Coulter counter, which channels the cells through a narrow tube and measures the electrical change that occurs when the cells partially block the tube. This project would involve building and testing such a device, with the potential to integrate it into the T-cell and CTC-cell detecting devices being developed in Dr. Toner's group.

**Sorting Cells and Biomolecules by Size** A recent paper describes a microfluidic device that looks like a pachinko machine — cells flow past a series of pillars, and move to one side or the other of each pillar. The pillars are arranged so that larger cells tend to move to one side while smaller cells tend to move to the other. The net result is that at the end of the device, the cells are separated by size. This same concept could be applied to biomolecules or other cell types. This project would involve designing and fabricating the device, and testing its ability to sort the cells or molecules in question.

**Measuring Mechanical Properties Of Cells** Many cells adjust gene transcription and translation based on mechanical forces. Measuring the mechanical properties of cells is an important part of understanding how these proteins are regulated. There are a variety of devices that can be used to study cell mechanical properties. These include microfluidic traps in which cells can be squeezed, microfabricated probes to apply shearing forces to cells, and atomic force microscopy for measuring cell surface properties. This project would involve using one or more of these technologies to study the mechanical properties of cells and extracellular structures.

**Classifying Neutrophils** Characterizing the growth of new neutrophils in the blood of burn victims is an important diagnostic tool. Young neutrophils can be distinguished from adult ones by the shapes of their nuclei; the young ones are round while the adult ones are convoluted. Currently the process of counting young and adult neutrophils is done by hand. A computer algorithm that automatically detects the two types would greatly speed the diagnostic process. This project would involve developing image processing tools to distinguish the two types of neutrophils in images of stained tissue, and detecting the presence of contaminant cells.

**Cell Migration and Chemotaxis** Many cells, including neutrophils, migrate in response to chemical, electrical, and/or optical stimuli. The migration processes are not fully characterized, and may be useful clinically. This project would involve observing the migration of neutrophils in microfluidic devices in response to a variety of stimuli, and characterizing how the speed of migration depends on the stimulus, the type and age of the cell, etc.

**Designing a Cleanable Micro-filter** A common problem with microfluidic devices is contamination, since dirt and other crud can block the channels. One potential solution to this problem is to build a micro-filter that traps the junk before it enters the device. Such a filter would need to be cleanable, so that the trapped junk could be flushed out before it completely blocks the device. This project would involve designing, fabricating, and testing such a filter.