# CMOP Undergraduate Intern Mentoring Opportunity

Deadline: **March 28, 2011**
Selections Announced: **April 1, 2011**

Name/Title/Institution(s) of senior mentor(s): Tawnya D. Peterson/Paul G. Tratnyek/Joseph A. Needoba (all OHSU)
Name/Title/Institution(s) of frontline mentor(s): Amanda Mather/OHSU

**Project Title:** Exploring holistic approaches to the characterization of particles in the environment

**Context for Project:** Most of the main determinants of water quality either consist of, or are controlled by, particles. Many of these are well characterized, such as the relationship between microbial pathogen size and their removal by coagulation and filtration-based water treatment technologies. However, all of this work has been done with the emphasis on particular particles (e.g., bacteria) in isolation or in binary combinations (e.g., bacteria attached to sediment). In this project the student will take a holistic approach to the characterization of the particle load in water, focusing on the aggregate properties of the particles rather than to individual components. We hypothesize that tracking changes in these aggregate properties will be an extraordinarily powerful way to assess water quality, particularly since recent developments in instrumentation and informatics render this approach both rapid and cost effective.

**Brief Description.** Through this project, the student will demonstrate that the advanced detection and description capabilities of flow cytometry can be adapted to characterize the suite of particles in aquatic environments, and that comparative analysis of these data using informatics methods can be used to address a wide range of key water quality issues, including the effects of source water quality on reclamation effectiveness, optimization of treatment processes, and persistence of microcontaminants (including water-borne pathogens, nanoparticles, and organic emerging contaminants).

Recent advances in technologies to detect human diseases such as cancer have spurred the development of instrumentation with the capability to rapidly detect and manipulate cells. Foremost among these is flow cytometry (FCM), which uses light scattering and fluorescence properties to distinguish cell shape and unique fluorescence properties associated with cell types. FCMs interrogate fluorescently-labeled cells using laser light (typically at 488 and 532 nm wavelengths) that excites a fluorophore, which emits fluorescent light at a higher wavelength (a Stokes shift). Emission detectors then capture information about the intensity of light emitted from the fluorescent excitation. Further information comes from scatter properties during particle interrogation, including forward scatter (FSC) and side scatter (SSC).

A typical state-of-the-art FCM can: determine the size of individual particles in suspension at a rate of >10,000 s-1, analyze multiple fluorescence signals from a single object, and sort individual cells after analysis into subsamples, to be retrieved for further studies. In addition, instruments are available that capture digital images of the particles as they travel through the interrogation region (e.g. Fluid Imaging Inc.'s Flow Cytometer And Microscope, 'FlowCAM'), thereby creating an image library that is linked to the fluorescence and scatter properties determined by the instrument. Because FCM systems sample in flow, large numbers of cells can be analyzed in a given sample, yielding extremely robust and statistically reliable data. No manual method (e.g., microscopy) can match the speed and sensitivity of FCM to perform these tasks. Since the early studies that demonstrated the applicability of FCM in environmental disciplines such as biological oceanography, FCM has become increasingly utilized to characterize marine and freshwater populations of viruses, bacteria, and phytoplankton.

The properties of environmental particles strongly influence water reuse applications including wastewater treatment, drinking water treatment, and desalination. Since the characterization of particles is often time consuming, applying an informatics-based approach would potentially speed up the evaluation of water quality and the assessment of treatment effectiveness. Further, the breadth of potential changes that could be detected using this multiplex approach may far surpass the abilities of current approaches to monitor threats to water quality. For example, a holistic approach might allow for 1) detection of fluctuations in steady-state operational conditions; 2) identification of changes in 'upstream' inputs before they reach sensitive process areas; or 3) monitoring of rare or low-abundance organisms that pose critical health hazards.