SUMMER 2009 RESEARCH PROGRAM
CARLETON CHEMISTRY DEPARTMENT

This summer the Carleton Chemistry Department will offer its continuing summer research program for Carleton students. We expect to offer research positions to between 2 and 4 new students. For the most part, the new student researchers will come from the sophomore and junior classes. Professors Gittins, Gross, and Kohen will offer projects that reflect their research interests. These projects are financially supported through external grant agencies and Carleton College. The research projects offered by each faculty member will be presented briefly at the Friday, February 13, Chemistry Department Seminar in Olin 04 at 3:30 p.m. and are described in the following document. We strongly encourage you to attend this seminar if you are at all interested in doing research in the department this summer.

Dates of the Program: Monday, June 15, through August 21, for a total of 10 weeks. Each student will arrange starting and ending dates and summer vacation with his or her professor; these dates are often flexible.

Stipend: $4,200 for 10 weeks.

Expectations of Students by the Chemistry Department:
A research position in our summer research program is a full-time position. You should not plan on taking a second job during the same period.

Each week you will be expected to attend a research conference with all of our summer researchers. Once or twice during the summer you will give an oral presentation on your project. If you would like, you may have the opportunity to give a presentation on your research at state or national research meetings in the future. Following the summer of research, you will prepare a comprehensive written report and give a poster on your research at the fall All Science/Math Student Poster Session at Carleton.

Deadlines and How to Apply: By Wednesday, February 25, submit a one-page description of your interests and background to the Chemistry Department’s Administrative Assistant, Wendy Zimmerman. List the two professors you would like to work with in order of preference. Also tell us how strong your preferences are and how flexible you are in accepting a position in the two groups. In addition to attending the February 13 seminar, you should talk to individual professors in order to explore your interest in their research project. Keep in mind that some professors will not invite a student to join their research group unless the student has taken the time to stop by, meet the professor, and discuss the research project.

On Monday, March 2, offers will go out to individual students in campus mail. We will ask for your decision on our offer by Monday, March 9.

Reasons to Participate in the Summer Research Program: Research is considered by many to be at the pinnacle of intellectual endeavors as it is the main vehicle by which new knowledge is created. Research requires a demanding combination of intellect, creativity, endurance, and curiosity. Many valuable skills are developed in the research laboratory. Some examples include the ability to work as a member of a team, to operate sophisticated instrumentation, and
To use available resources to become a life-long learner. Research is also excellent preparation for graduate school, a career in the medical sciences, or a career in other scientific or quantitative fields.

Choosing to do research at Carleton offers a number of advantages. First of all, you will have the chance to get to know your professors much better. In addition, you can start preparing for your summer research experience during spring term. This additional preparation will improve the quality of the research you can perform during the short ten-week summer. Furthermore, if you wish, your research project can be continued as an independent study during the following academic year. Some students at Carleton who have had the most positive research experiences have worked on their research projects over the course of two years. Unlike the experience at a larger institution, colleges like Carleton offer research opportunities exclusively for undergraduate students. At a larger institution, you would probably work most directly with a graduate student or postdoc, which is a good, yet different kind of experience. At Carleton you are guaranteed to work closely with a professor and to have your peers as research colleagues.

Life at Carleton and in Northfield is much different during the summer than during the academic year. You will be surprised by the pace, and you will be pleased to know that you will not need your down jacket and face mask (you may want to buy a fan). Many of the facilities (such as the gym, pools, weekly movies, etc.) at Carleton are open for summer programs. We will have at least two expeditions; canoe trips, baseball games, Valley Fair, and tubing have been popular choices in the past.
The main focus of my research is in the area of synthetic polymer chemistry, specifically the synthesis and application of dendrimers and hyperbranched polymers. These are tree-like macromolecules with highly branched structures, low solution viscosity, and high degree of end-group functionalization. Their unique set of characteristics make dendritic molecules desirable for applications such as drug delivery, artificial light harvesting, and biomimetics.

Dendrimers are synthesized using a stepwise approach, which offers a high degree of control over the final structure and are highly tailorizable. The synthesis involved is however a time-consuming and expensive process. In contrast, hyperbranched polymers are prepared using single step polymerization techniques, making them much less costly – unfortunately at present the major challenge to using hyperbranched polymers for same types of application as dendrimers is the lack of structural control afforded by existing methodologies. A key objective of my research group is to increase the level of control available in preparing hyperbranched polymers.

The plan for this summer this summer is to work on two projects, with some overlap between the tow. One project which will focus on the development of a post-synthetic method of core incorporation for hyperbranched polymers (functionalization of the core remains a significant challenge.). A second project will investigate the branched structure of hyperbranched polymers to find out where exactly the branched structure lies between perfectly branched dendrimers and unbranched linear polymers. This second project will involve synthesis of a series of carefully prepared model compounds using a stepwise approach followed by comparison of their structures with hyperbranched systems made using a one-step method. Both these projects will require a significant amount of organic synthesis, as well as a range of opportunities to develop skills using analytical methods. Both projects will use NMR, Mass Spectrometry and GPC as the primary methods of characterization as well as UV/Vis, IR and HPLC.

I am hoping to take on a two students this summer. Students interested in working on these projects should contact me as soon as possible to talk about your interest. You should also note that projects are limited to 6 Weeks.
The air around us is full of aerosol particles (small droplets or chunks of solids), which impact our lives in many ways. These particles come from natural as well as anthropogenic (human) sources. They nucleate cloud droplets, they decrease visibility by scattering sunlight, and they impact our health when we inhale them. Our research group works with an Aerosol Time-of-Flight Mass Spectrometer (ATOFMS), code-named “Gromit,” to obtain size and chemical composition of the aerosol population in real time. With this data, we hope to try to increase our understanding of some of the complex issues in the atmosphere.

I hope to have two to three students (of which two might be returning students) work with me this summer. Students working in my lab will get an opportunity to acquire ambient data in the Northfield area as well as to analyze ATOFMS data sets obtained in collaboration with groups at the University of Minnesota, University of Wisconsin, and the Paul Scherrer Institute in Switzerland. We have long-standing collaborations with these groups, and have a number of complex data sets to work with. Our analysis is done using software under development by Dave Musicant’s group in the CS Department at Carleton. Our work in Summer 2009 will also include laboratory studies to characterize the chemical composition of particles formed from organosulfates, species implicated in secondary organic aerosols in the atmosphere.

**If you are interested in joining either of these projects, you should do all of the following things:**

- Come talk to me as soon as possible, to discuss the details of the research and to see the ATOFMS instrument. Email to make an appointment. I won’t accept anyone into the group unless we’ve talked about your interests, the projects, etc.
- Be prepared to spend part of the summer away from Carleton. While we are not sure yet of our specific plans, fieldwork could be included. Your expenses for fieldwork would be paid.
- Plan to enroll in independent studies (Chem 394) in Spring, 2009 as well as throughout the 2009-2010 academic year (except terms when you might be off campus) to continue to work on your project.
Professor Dani Kohen

I am a theoretical and computational physical chemist. I am interested in the general area of dynamics in condensed phase (how atoms and molecules move and interact when they're not by themselves). Currently, I am using atomistic simulations to understand and characterize at the molecular level how small gas molecules interact with pure CO$_2$ on molecular sieve's pores, and how this interaction changes in the presence of other gases that are present in our atmosphere. The goal of these studies is to provide a basic understanding of the use of molecular sieves as filters to remove CO$_2$ from the atmosphere. In recent years the power of computational research has been shown to provide scientific insight that might not result from experimental research alone.

This research introduces students to the study of chemistry through the lens of molecular simulations, which provide a powerful tool in giving new meaning to familiar concepts. It also serves as a reference point to understand not only the computational chemistry literature but also why the importance of this field as a tool for studying many problems keeps growing.

The way my research group works is that I mostly write the programs (software), my student collaborators use and modify these to investigate chemical systems; and then, together, we use the results to learn about the chemical processes that occur in the systems we study. This is exactly what my group, Lindsey Madison ('10), Henry Heitzer ('10) and Colin Russell ('10) have been doing for a year and a half now. In doing this kind of research the learning curve is steep, but the results are very satisfying and my student collaborators made significant progress in their own projects while enjoying doing research. I anticipate that I will be able to invite one or maybe two students to join my group. If you are interested in joining us, please stop by to talk to me and even better, ask a member of my group about their experience as their thoughts will be the best introduction to our work.