

**Requirements for the Chemistry Major  
(with or without a Biochemistry Concentration)  
March 2012**

Thank you for your interest in the chemistry major! The department offers an exciting and stimulating curriculum that will prepare you for a number of career options after Haverford College. Approximately 1/3 of our majors pursue graduate school in Chemistry and 1/3 a Health Related track, such as Medical School or Veterinary School. Approximately 1/3 graduates pursue careers in teaching, art preservation, science writing, software development etc. (see <http://www.haverford.edu/chem/alumni/>).

The detailed outline below will explain the requirements for the major or for a major with a biochemistry concentration, or for a minor. We also provide a visual layout of our four tracks. If we do not cover your particular situation below, please see any member of the Chemistry Department for assistance. We're happy to answer any questions you have.

**The Chemistry Major**

There are four options for the chemistry major. *Each of the following options assumes a common background of two semesters of organic chemistry (Chem 222 and 225).*

**1) Standard (Non-ACS) Chemistry Major**

In order to graduate with a Chemistry major, you must take the following courses:

- At least one semester of Mathematics (after enrollment at Haverford College) at the level of Math 114 or higher. An additional semester of math (e.g. Math 121) is strongly recommended and Math 215 is helpful for Quantum Chemistry (Chem 305).
- Two semesters of physics at the level of Physics (101/102 or 105/106) *or* two semesters of molecular-based Biology (200a/200b).
- Two semesters of Chemistry Superlab (Chem 301 and Chem 302; please note that Chem 301 is a pre-requisite for Chem 302)

*Instructors (tentative)*

<b>Chem 301</b>	<b>Fall 2012</b>	<b>Mark Schofield</b>
<b>Chem 302</b>	<b>Spring 2013</b>	<b>Alex Norquist and Rob Scarrow</b>

- One semester of Physical Chemistry (Chem 304), Statistical Thermodynamics and Kinetics or Chem 305 (Quantum).
 

<b>Chem 304</b>	<b>Fall 2012</b>	<b>Casey Londergan</b>
<b>Chem 305</b>	<b>Spring 2013</b>	<b>Josh Schrier</b>
- One semester of Inorganic Chemistry (Chem 320 (0.5 credit) followed by Chem 351, Chem 353 or Chem 354(each 0.5 credit).
 

<b>Chem 320g <i>Inorganic</i></b>	<b>Spring 2013</b>	<b>Alex Norquist</b>
<b>Chem 351h, <i>Bioinorganic</i></b>	<b>Spring 2013</b>	<b>Rob Scarrow</b>
<b>Chem 353d, <i>Materials (1D, nanowires)</i></b>	<b>Fall 2012</b>	<b>Josh Schrier</b>

<b>Chem 353e, <i>Materials (2D, graphene)</i></b>	<b>Fall 2012</b>	<b>Josh Schrier</b>
<b>Chem 354h, <i>Solid State</i></b>	<b>Spring 2013</b>	<b>Alex Norquist</b>

- One semester of advanced course electives in chemistry at the 300-level. (The Department can also approve selected 300-level and 400-level Biology and Physics courses (including research tutorials) as electives for the chemistry major.) In addition to the courses listed above, Chem 304, 305, 320, 351, 353 and 354, we offer the following during 2012-2013.

<b>Chem 358e, <i>Environmental</i></b>	<b>Fall 2012</b>	<b>Rob Scarrow</b>
<b>Chem 354h, <i>Solid State</i></b>	<b>Spring 2013</b>	<b>Alex Norquist</b>
<b>Chem 357g, <i>Proteins in Health &amp; Disease</i></b>	<b>Spring 2013</b>	<b>Karin Åkerfeldt</b>
<b>Chem 355g, <i>Metalorganic Chemistry</i></b>	<b>Spring 2013</b>	<b>Mark Schofield</b>
<b>Chem 357h, <i>Biomaterials</i></b>	<b>Spring 2013</b>	<b>Mark Schofield</b>
<b>Chem 351h, <i>Bioinorganic Chemistry</i></b>	<b>Spring 2013</b>	<b>Rob Scarrow</b>

- One Semester of Research (Chemistry 36x or Chem 380)  
**All faculty in the Chemistry Department mentor research students**
- Departmental Seminar (Chem 391) 0.5 credit course, senior year  
The following might be a typical schedule for a chemistry major who chooses to do a full year of research in his/her senior year (see also colored flow chart).

	<b>Junior Year</b>	<b>Senior Year</b>
<b>Fall</b>	Chem 301 (Superlab) Chem 304 (PChem I) (Physics or Biology)	(Chem 3xx (adv. course)) Chem 36x (Research) Chem 391 (Seminar)
<b>Spring</b>	Chem 302 (Superlab) Chem 320/35x* (Inorg) Chemistry 305* (PChem II)for ACS certification) (Physics or Biology)	Chem 391 (Seminar) Chem 36x (Research) (Chem 3xx (adv. course))

\*One of these courses may be deferred to the senior year.

If you choose not to pursue laboratory research (Chem 36x course(s)), then you are required to take Chemistry 380 "Independent Research in Chemistry", which involves a library research project and proposal.

## 2) American Chemical Society (ACS) Accredited Chemistry Major

We are the only department in the College that is certified by a professional organization, The American Chemical Society (ACS), which is a large national organization whose members include chemists in industry and academics. The ACS has specific curriculum guidelines for an undergraduate degree, and these include two semesters of physical chemistry, a year of introductory physics, and at least one semester of biochemistry. Consequently, the Chemistry Major becomes an ACS accredited Chemistry major by the addition of **Chemistry 305** (Quantum Chemistry), **Physics 101/102 or 105/106**, and either **Biol 200b** or two of the advanced 35x senior seminars selected from 351, 352 or 357 or **Chemistry B242** or **Chemistry B345** at Bryn Mawr College.

### 3) Standard (Non-ACS) Chemistry Major with a Biochemistry Concentration

The requirements for the Chemistry major with a Concentration in Biochemistry are the same for the standard Chemistry major with the following exceptions:

- Chemistry 301 is replaced by Biol 300a or 300b. (Chemistry 301 (Superlab I) is required of all chemistry majors and cannot be replaced.)
- One semester of an advanced biology course for the concentration requirement. Most, but not all, Bio 30x courses: Bio 301, 302, 303, 304, 306, 314). One elective must be 301 or 303.
- Two half semester advanced chemistry courses with a biological emphasis are required. These include **Chem 351** (0.5 semester, bioinorganic), **Chem 352** (0.5 semester, biophysical) or **Chem 357** (0.5 semester, multiple offerings, bioorganic). Note that Chem 351 satisfies both the concentration and half of the inorganic requirement, thus it is often taken by biochemistry concentrators.
- **Both Biol 200a/200b and Physics 101/102 or 105/106 are required.**

	Junior Year	Senior Year
<b>Fall</b>	Chem 301a (Superlab) Chem 304 (PChem I) (Physics)	Chem 357 (Bioorganic.) Chem 36x (Research) Chem 391 (Seminar)
<b>Spring</b>	Bio 300b (Superlab) Chem 320/351* (Inorg) Chem 305* (PChem II for ACS Certification) (Physics)	Chem 36x (Research) Chem 391 (Seminar) Biol 303, 304

\*One of these courses may be deferred to the senior year.

### 4) ACS Accredited Chemistry Major with a Biochemistry Concentration

The Chemistry major with a Biochemistry Concentration becomes ACS accredited by the addition of **Chem 305** (Quantum).

#### The Chemistry Minor

A student majoring in any other discipline can declare a Chemistry minor after successfully completing the courses below.

#### Course Requirements for the Chemistry Minor:

General Chemistry: Chemistry 100/101 or 105, or 111/112, or 115/112

Organic Chemistry: Chemistry 222, 225

Physical Chemistry: Chemistry 304 or Chem 305

Chemistry 3xx: One additional semester of advanced chemistry chosen from courses numbers between 301 and 369.

At least three of the courses taken for the chemistry minor must be taken at Haverford College.

**N.B. Students who major in biology or physics and complete the Biochemistry and Biophysics Concentration may not also declare a chemistry minor.**

### ***Declaring a Major or a Minor***

One of the Chemistry Faculty listed below will serve as your major or minor advisor. All new majors (or minors), please submit your paperwork to Karin Åkerfeldt, Chair, by **Friday, April 13<sup>th</sup>**. At that time, you also will be asked to list your 1<sup>st</sup> and 2<sup>nd</sup> choices for faculty major advisors. We will do our best to honor your first choice, and we will assign your advisor in the summer of 2012. Please note, your academic advisor is not necessarily the same as your senior research advisor.

### ***The Chemistry Department (alphabetically)***

**Fran Blase** ([fblase@haverford.edu](mailto:fblase@haverford.edu) phone 610-896-1216) Synthetic Organic Chemistry: synthesis of biologically active natural products.

*My research focuses on the enantioselective synthesis of organic molecules isolated from natural sources. In particular, we have been investigating the synthesis of secondary metabolites isolated from the myxobacterium Sorangium cellulosum. Two such metabolites are the **ripostatins** and the **chivosazols**. The Ripostatins, first isolated in 1996, have been reported to act as bacterial RNA polymerase inhibitors. Chivosazols, also discovered in strains of Sorangium cellulosum have interesting architectural features from a synthetic standpoint, and show activity against yeasts and filamentous fungi. Progress toward the **total synthesis** of these two families of molecules is the major focus of our research efforts, as well as the synthesis of structural analogs for investigations into mechanism of action and structure-activity relationships.*

**Louise (Lou) Charkoudian** ([lcharkou@haverford.edu](mailto:lcharkou@haverford.edu)); Biological Chemistry. **Starting Date: July 1, 2013.**

*Microorganisms are capable of synthesizing structurally complex and medicinally relevant **polyketides in "one-pot" aqueous reactions**. Many of these polyketides contain moieties that impart important pharmaceutically relevant properties but represent a significant challenge to build via traditional synthetic organic approaches. We seek to understand how nature controls these syntheses and how humans can harness these biological systems to better human health and the environment. As such, our research focuses on **the elucidation of bacterial biosynthetic pathways with the concomitant goals of developing novel biocatalysts and making new therapeutic agents**. In particular, we are interested in investigating aryl-aryl and aryl-ether coupling reactions catalyzed by Streptomyces (a genus of bacteria that usually reside in the soil) and will use this information to make new antibiotics and anticancer agents. Student collaborators will work at the interface of chemistry (natural product extraction, organic synthesis, chromatography, spectroscopy, and kinetics) and biology (bioinformatics, molecular cloning, and protein engineering).*

**Charlie Lerman** ([clerman@haverford.edu](mailto:clerman@haverford.edu) phone: 610-795-6236): **Visiting Professor**. Bioorganic and Computational Chemistry.

*I am currently working on a project with Fran and her students on molecular modeling in drug design.*

**Casey Londergan\*** ([clonderg@haverford.edu](mailto:clonderg@haverford.edu) phone 610-896-1217) Physical and Biophysical Chemistry: probing conformational flexibility and structural switching in proteins at the atomic level using vibrational spectroscopy.

*My main research interest is **the development of new physical techniques for understanding conformational flexibility and structural switching** in proteins on a site-selected basis.*

*The main instrumental techniques employed in my laboratory are infrared absorption spectroscopy and Raman scattering spectroscopy. **Vibrational spectroscopy** is uniquely suited to observation of structural distributions and solvent dynamics, rather than just averaged and solvent-free protein structures.*

*The techniques developed in my laboratory are being applied to understand the relationship between molecular flexibility and binding or self-assembly behavior in complexes made from multiple proteins*

and other biomolecular media: for example, viral capsids, multimeric enzymes, and membrane-bound proteins.

**Alex Norquist** ([anorquis@haverford.edu](mailto:anorquis@haverford.edu) 610-896-2949) Materials Science: crystal growth of new functional materials.

*My research interests are focused on **the synthesis of new solid state materials with desirable physical properties**. Specifically, mild hydrothermal conditions have been used to prepare a series of new organically templated inorganic compounds..... systematic means for the creation of new noncentrosymmetric materials. Two main systems are currently being studied in my lab, **templated vanadium tellurites and gallium sulfates and phosphates..... how one can control composition, structure and symmetry of new compounds**. Work on this system continues, with explorations including a wide range of starting materials.*

**Rob Scarrow\*** ([rscarrow@haverford.edu](mailto:rscarrow@haverford.edu) phone 610-896-1218) Inorganic Chemistry: synthesis of new ligands and their coordination to metals.

***Synthesis and characterization of novel coordination complexes and study of their biomimetic reactivity with oxygen and other small molecules.....** The control over which auxiliary ligands bind and how they react is in part through the choice of metal but also in part due to the cavity's size, shape, polarity and ability to provide or accept hydrogen bonds. In my lab we are **synthesizing chelating polydentate ligands that mimic the ability of metalloproteins to bind metals and create binding pockets that are specific** for particular small auxiliary ligands. Students working in my lab engage in organic and inorganic synthesis, physical characterization of the complexes that are formed and measurement of equilibrium constants for auxiliary ligand binding as well as measurements of reaction rates when we find cases where the auxiliary ligand undergoes reaction. These studies have the potential to lead to development of new catalysts for organic synthesis and/or degradation of toxic wastes.*

**Mark Schofield\*** ([mschofield@haverford.edu](mailto:mschofield@haverford.edu) phone 610-896-1214) Visiting Professor. Physical Inorganic Chemistry: hybrid materials and homogeneous catalysis.

*I am interested in **bioinorganic chemistry, homogeneous catalysis**, and the utilization of feedstocks from renewable sources in chemically-efficient ways. Most projects have a synthetic component, even **anti-cancer drug screening**, because we're always thinking of new synthetic targets. We use standard synthetic techniques for synthesis purification, and spectroscopic characterization with an emphasis on "green" (transition metal or enzyme-catalyzed, whole cell fermentation, etc.) methods.*

**Josh Schrier** ([jschrier@haverford.edu](mailto:jschrier@haverford.edu) phone 610-896-1388) Theoretical and Computational Chemistry: studies of nanometer-scale composite materials with potential applications in photovoltaic devices.

*Can we **predict and design the properties of new materials for information and energy technology**? My research efforts aim to **understand and utilize quantum mechanical effects to improve material properties**, develop simple rules that explain how chemical structure influences these properties, use these rules to guide computational screenings for new materials, and then interact with experimental collaborators to develop these materials. Some current areas of interest include **organic semiconductors, organically-templated inorganic solids and graphene nanostructures**. Haverford College undergraduate students play a key role in these studies, and many publish their work in top journals.*

**Helen White\*** ([hwhite@haverford.edu](mailto:hwhite@haverford.edu) phone: 610-795-6402) Environmental Chemistry (Biogeochemistry): understanding the sources, sinks and cycling of organic matter in marine sediments; development of microbial fuel cells.

*My teaching and research interests are centered in the field of biogeochemistry; a multidisciplinary approach focused at understanding the chemical, physical, geological and biological processes that govern the composition of the Earth's environment. As a chemist, I mostly employ chemical techniques to address questions in this area. In particular, I am interested in **understanding the sources, sinks and cycling of organic carbon in marine sediments**.*

**Karin Åkerfeldt\*** ([kakerfel@haverford.edu](mailto:kakerfel@haverford.edu) phone: 610-896-1213) Bioorganic Chemistry: protein design; protein structure-function relationship studies.

*I am interested in understanding how the intricate and beautiful structures of proteins relate to their function. Students in my group work on naturally occurring proteins as well as designed sequences for biomaterials applications (hydrogels, conducting nanowires, ion channel sensors).*

*The projects on Ca<sup>2+</sup>-binding proteins and peptide hydrogels are in collaboration with biophysicist and molecular biologist Professor Sara Linse at Lund University, Sweden*

*\*Rob, Casey and Karin will serve as advisor for biochemistry concentrators. Helen is typically the advisor for our Environmental Studies Minor, but she will be on leave 2012-2013 and questions can instead be directed to Rob. Karin and Casey will be on leave 2013-2014. Helen, Casey and Karin plan to take research students during their leave.*

#### **Support Staff**

**Daniel (Dan) Fabry** (instrument Specialist)

**Joanne Brown** (Purchasing and Budget Coordinator)

**Bruce Boyce** (Research Machinist)

**Kelly Matz** (Lab Supervisor and Lab Instructor for 100-level labs)

**Mark Stein** (Lab Supervisor and Lab Instructor for Chem 222)

**Mike Kukla** (Lab Instructor for Chem 225)