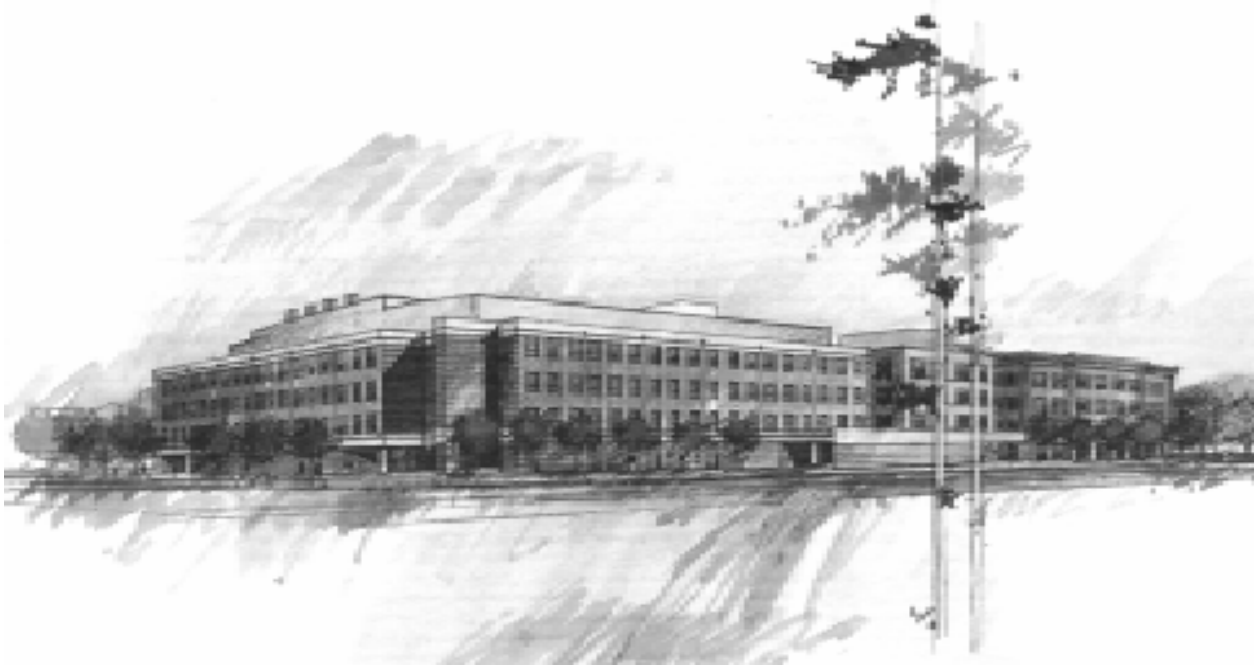
University of Michigan
Department of Chemistry

# *Undergraduate Handbook*

2007—2008



The purpose of this handbook is to make it easier for students to find answers to questions such as:

- How do I become a chemistry or biochemistry concentrator?
- What are my choices in chemistry or biochemistry?
- What forms of help are available to me?

This Chemistry Handbook supplements official college publications: *University of Michigan Bulletin* for LS&A, the *LS&A Course Guide* and the *Office of Academic Information and Publications (http://www.lsa.umich.edu/saa/).* Information is available on many websites on campus. The Handbook contains information specific to Chemistry and Biochemistry concentrations and, for convenience, includes copies of some information from official publications. However, if there is a discrepancy, the official publications have precedence.

In addition, many services such as academic advising, information on research opportunities, and summer and post-graduate employment are available in the Office of Student and Academic Services in 1500 Chemistry Building and on the Chemistry website. We encourage you to make use of our services and we welcome your suggestions.

Aiko Nakatani, Director Academic Services
Heonia Hillock, Coordinator Undergraduate Student Services
Office of Student and Academic Services
1500 Chemistry 734-647-2858
August 28, 2007

# INTRODUCTION

**Welcome to the Department of Chemistry!**

You come to the Chemistry program at Michigan at an auspicious and exciting time. Most of our classes and labs are in our modern Chemistry facility. Our curriculum emphasizes "how chemists think" and has received wide attention outside this University. In the last decade we have appointed more than twenty new faculty who bring freshness and energy to the program. It is an especially stimulating time to be a chemistry concentrator.

But why study Chemistry? You are considering for your concentration a discipline that is challenging and that stretches the imagination. At the same time Chemistry remains practical and down to earth. Chemists analyze, synthesize, quantitate and design materials. We relish creating models and theories that can rationalize what happens in the laboratory. We enjoy discussing our experiments and ideas with each other as well as with physicists, biologists, biochemists, computer scientists and with experts in electronics and materials science. We use sophisticated instrumentation such as lasers and nuclear magnetic resonance spectrometers routinely in our experiments. Chemistry has been and will continue to be a central focus for interdisciplinary research in biology, medicine and materials science. Our concentration in biochemistry addresses the interface of chemistry and biology.

The study of chemistry prepares individuals for the obvious real-life jobs in the chemical industries, including the pharmaceutical, biotechnological, petrochemical, fine chemicals and materials science sectors. It also prepares our graduates for careers in education and for advanced study in related fields such as biochemistry, molecular biology, materials science and chemical engineering. More fundamentally it develops the ability to solve problems and to think critically. These skills will be more valuable to you than any specific facts, theories and techniques you will master in your chemistry classes. Put simply, the study of chemistry provides a vehicle for obtaining an education for life in the broadest sense.

The department is committed to providing you with a first class education. You are invited to accept the challenge we offer to grow and mature under our guidance. Let me present you with another more specific, short term challenge. Set a goal to "get to know" one or two people in this department over the next year. This will take some initiative on your part since establishing a relationship requires effort on both sides. One such person might be a professor whom you regularly visit during office hours or in whose laboratory you decide to start research. Another might be a graduate student instructor who tutors you in a class or lab. Another such person could be the advisor assigned to monitor your chemistry and academic program. We extend this offer of person-to-person chemistry to you and believe that it could be a catalyst for some interesting transformations in your career trajectory.

Carol Fierke
Chair, Department of Chemistry

# UNIVERSITY OF MICHIGAN
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# CHOICES IN THE DEPARTMENT OF CHEMISTRY

Specifications for Chemistry and Biochemistry programs are given in the College of Literature, Science and the Arts issue of the *University of Michigan Bulletin*. For 2007-2008 these specifications, with appropriate clarifications, are listed below. **Both programs are American Chemistry Society certified**.

The curricula in Chemistry serve those preparing for careers in chemistry, biochemistry, medicine, chemical engineering, pharmacy, and allied fields as well as those seeking a general knowledge of chemistry and biochemistry as part of a liberal arts education. Beyond the first-year courses, there is an emphasis on development of technical knowledge and laboratory experience needed in chemistry and related scientific fields. The undergraduate concentration programs prepare students for work in research and testing laboratories, as well as for business positions in which a chemistry background is desirable. Graduate work is necessary for those planning to do college and university teaching or industrial research.

**Introductory Courses.** The Chemistry Department has three types of courses available to students starting toward careers in any of the sciences, engineering or medicine. Students are placed into these courses according to the results of the tests in chemistry and mathematics that they take during orientation. Either Chemistry 130 or Chemistry 210/211 can be the starting point for students interested in the sciences, engineering or medicine. Chemistry 130 has a section reserved for students who would benefit from more frequent contact with faculty. Honors students, students with Advanced Placement in chemistry, and other students with good preparation in high school chemistry have the opportunity to start their study in chemistry with courses 210/211, which introduce the major concepts of chemistry in the context of organic chemistry. This curriculum allows students to progress more rapidly to advanced courses in chemistry and to be able to participate earlier in undergraduate research.

**Special Departmental Policies.** The Department requires that a student earn a grade of at least C– in all CHEM courses which are prerequisite for subsequent elections. A concentration program grade point average of at least 2.0 is required; this includes chemistry courses, mathematics and physics prerequisites and advanced electives which are part of a concentration plan. Students must request any change in a grade before the end of the next regular academic term.

**Safety Regulations.** No contact lenses will be allowed in any chemistry laboratory. In laboratory classes students must wear either prescription or safety glasses at all times.

**Student Associations.** Chemistry concentrators are eligible to become student affiliates of the *American Chemical Society*. An active chapter exists in the Chemistry Department and provides opportunities for a variety of activities related to chemistry. In addition, *Alpha Chi Sigma* fraternity maintains a chapter house near campus. Men and women concentrating in chemistry, chemical engineering, and other related fields are eligible for membership.
"*Phi Lambda Upsilon*, an honorary chemical society, maintains a chapter at the University of Michigan. Its members have achieved academic excellence in chemistry, chemical engineering, or pharmacy."

**Awards and Prizes**. The department offers several undergraduate awards and prizes. The Undergraduate Awards Committee

invites recipients to attend the Undergraduate Awards Luncheon held in April of each year.

*Margaret and Herman Sokol Scholarship Awards.* Awards are given to freshmen with an interest in chemistry or biochemistry and with registration in a chemistry course; newly declared and declared chemistry and biochemistry students.

*Summer Research Fellowships.* Awards are given to students for ten weeks of full-time research with chemistry and biochemistry faculty. Students apply in February of each year. Awards are provided by the Alumni Fund, Seyhan Ege Undergraduate Research in Chemistry Fund, Florence Fenwick Memorial Fund, Gomberg Undergraduate Scholarship Fund, James E. Harris Scholarship Fund, PPG, Margaret & Herman Sokol Endowment, Walter R. Yates Fund, and the David W. Steward Memorial Fund.

*CRC Press Freshman Chemistry Achievement Award.* One complimentary copy of CRC Handbook of Chemistry and Physics awarded to one first-year student with exceptional performance in chemistry courses.

*First-Year Chemistry Alumni Achievement Award.* For first-year chemistry students who have demonstrated exceptional performance in laboratory and lecture work. Based on recommendations of instructors, graduate student instructors, and undergraduate advisors. Commended for outstanding promise as young scientists. Presented with a book, selected by instructor, that relates to the broad and interesting world of science.

*Alpha Chi Sigma First Year Student Award*. For first-year student in Chemistry who has demonstrated an interest in chemistry, shown outstanding academic potential and has exhibited productive interaction with fellow students. Award determined by UG Awards Committee in consultation with professors and GSI's in the courses. Gift certificate at Borders for books to be chosen with national representative of Alpha Chi Sigma or departmental faculty member.

*Florence Fenwick Memorial Scholarship* for an undergraduates at any level (incoming junior or senior), 3.0 GPA, scholarship and/or financial need.

*Outstanding Second Year Student Award*. Book and bookstore credit awarded for outstanding academic and research work. Research advisor and student choose books for presentation.

*National Starch Chemistry Scholarship*. Award for incoming sophomore, junior, or senior studying chemistry. Selection is based on academic achievement and research achievement.

*American Chemical Society Analytical Chemistry Award.* Subscription to Analytical Chemistry and monetary award to an outstanding junior. Must have completed CHEM 260/241/242 and be in or have taken CHEM 447.

*Lubrizol Chemistry Scholarship*. A tuition award for an incoming junior or senior studying chemistry. Selection is based primarily on academic achievement. Good citizenship and leadership qualities are also considered.

*American Institute of Chemists Award*. Recognition of potential advancement of the chemical profession on the basis of a student's demonstrated record of ability, character, and scholastic achievement. Student Associate membership in AIC, subscription to "The Chemist" and monetary award from the Alumni Fund. One award for chemistry and one award for biochemistry.

*Honors College Vanko Memorial Award*. Recognition of well-rounded senior chemist or biochemist with monetary award.

*Merck Index Award to Outstanding Seniors*. Recognition of academic and research work. Complimentary Merck Indices.

*Huron Valley Section of the American Chemical Society*. Outstanding Undergraduate Student Leadership Award. As presented in the citation, the award is designed to recognize the accomplishments

of an individual who, in the mind of the selection committee, has represented the best interests of the Chemistry Department, and chemistry in general, in private and public forums over an extended
period of time. Activities might include, and are not limited to, leadership
in activities of undergraduate chemistry organizations (AXE,
ACS affiliates), representing the chemistry department in local, alumni,
or national forums, and general professional service.
*Seyhan N. Ege Award* provided by the University of Michigan Women in Science
and Engineering Program. As presented in the citation, the award is designed to recognize the accomplishments of an undergraduate woman or student of color who, in the mind of the selection committee, has represented the best interests of the chemistry department, and chemistry in general, and who signifies scholarship, leadership, and the participation of traditionally underrepresented groups in the chemical sciences.

**Concentration Program Options.** The Department of Chemistry offers programs leading to a (1) *Bachelor of Science* degree with a concentration in chemistry (*B.S.* degree, 120 credits); (2) *Bachelor of Science in Chemistry* degree (*B.S. Chem.* degree, 124 credits); and (3) a *B.S. Chem.* degree with Honors in chemistry. The *Bachelor of Science in Chemistry (B.S. Chem.)* degree requires a more rigorous and more specialized program of study. The program leading to Honors in chemistry is available to qualified students. (4) The department participates in and administers an interdepartmental concentration "Biochemistry," which is described under that heading in the *Bulletin.* It is possible to incorporate a teaching certificate into any of these program options. In addition there is a five year joint degree program with the College of Engineering which leads to a *B.S. Chem.* and a *Bachelor of Science in Engineering (Chemical Engineering).* Information about the program leading to the joint degree with the College of Engineering and *general* information about teaching certificate requirements are described elsewhere in this *Bulletin*; departmental requirements for these programs are described below. It is strongly recommended that students who are thinking of degrees in chemistry should arrange an appointment with a Chemistry advisor via the online advising system as soon as possible, preferably before the end of the freshman year but certainly before the end of the sophomore year. The online appointment scheduling system can be found here: http://www.umich.edu/~michchem/undergrad/index.html.

**Teaching Certificate.** Those seeking a B.S. or B.S. Chem. degree with a teaching certificate in Chemistry must fulfill departmental as well as School of Education requirements. Students who plan to earn a teaching certificate with a major or minor in Chemistry should contact the School of Education Office of Academic Services.

## CHEMISTRY (B.S. or B.S. Chem)

Prerequisites to Concentration for Either Program. CHEM courses through 215, 216, 241/242, and 260 or 370; PHYSICS [135 or 140]/141 and [235 or 240]/241; and MATH 115, 116, 215, 216, or an equivalent sequence are required for any concentration program in Chemistry. PHYSICS 240 or 235 and MATH 215 are prerequisites for CHEM 461 and students should, wherever possible, complete both of these before the junior year.

**Bachelor of Science degree with a concentration in chemistry (120 credits).** Students can complete the B.S. degree with a concentration in chemistry (120 credits) by taking CHEM 302/312, 402, 447, 461, 462, 463, 480, and 485. Two credit hours of research (399) culminating in a written

report may be substituted for the projects lab, 485.

**Bachelor of Science in Chemistry (B.S. Chem.) (124 credits).** The curriculum leading to a *Bachelor of Science in Chemistry (B.S. Chem.* degree) serves students who are interested in professional careers in chemistry, biochemistry, or related fields. Requirements include CHEM 302/312, 402, 447, 461, 462, 463, 480, and four credits of CHEM 399 taken over at least two terms, as well as one advanced lecture course in chemistry.

**Honors Concentration in Chemistry.** The B.S. Chem. degree is the basis of the Honors degree in Chemistry. Substitution of Honors sections of CHEM 461 and 463, maintenance of a satisfactory GPA (3.4) in concentration courses including prerequisites, and satisfactory completion of an Honors thesis (CHEM 499) based on the research done in CHEM 399 are required for Honors. Most (but not all) students pursuing the Honors degree will have participated in the Freshman-Sophomore College Honors Program and will have completed CHEM 210/211, 215/216 in place of other concentration prerequisite courses. All students, whatever their program, who are interested in an Honors degree should see the Chemistry Honors advisor for approval for participation in the Junior-Senior Honors Program in Chemistry.

**Advising.** Students develop a concentration plan in consultation with a program advisor. Those interested in a B.S. degree with a concentration in chemistry (120 credits) or the specialized program leading to the *Bachelor of Science in Chemistry* (124 credits) are urged to consult a program advisor during the freshman and/or sophomore years. Prospective concentrators are advised that further study in chemistry requires adequate performance in early chemistry courses (preferably B– or better) as well as in the mathematics and physics prerequisites. Students interested in an Honors degree should see the Chemistry Honors advisor. Appointments are scheduled online at http://www.umich.edu/~michchem/undergrad/index.html. Students interested in the joint program with the College of Engineering should make an appointment with Chalmers Knight [Academic Advising Center, 1255 Angell Hall, (734) 764-0332] and then make an appointment to see a chemistry concentration advisor online.

## BIOCHEMISTRY (B.S.)

*May be elected as an interdepartmental concentration program*

**Prerequisites to Concentration**. BIOLOGY 162 or [171 and 172], CHEM 210/211, 215/216, MATH 115, 116, 215 (or the equivalent), PHYSICS [135 or 140]/141 and [235 or 240]/241.

In cases where a student is transferring to Biochemistry from outside the University or is entering later, from another concentration, the student may be awarded an override for Genetics after completion of only one of either Bio 171 or 172, and where taking the other would be a burden for timely graduation. The override request must come from a Biochemistry concentration advisor along with the assurance that the student has been informed of the material from 171 or 172 that he or she needs to review prior to enrolling in the Genetics course.

**Concentration Program**. Must include BIOLOGY 305; CHEM 241/242, 260, 302, 461/462 and 463 or 447; CHEM 451, 452, 453, and 454; and an advanced laboratory or undergraduate research course. Recommended options for the advanced laboratory course are BIOLCHEM. 416, MCDB 429, CHEM 480, or two terms (2 credits each) of an advanced undergraduate research project by permission of the concentration advisor. Students electing the undergraduate research option must execute an extended research project under the

supervision of a faculty member who agrees to oversee the project.

Courses recommended, but not required are: one advanced BIOLCHEM 500-level module, MCDB 427, 428, and CHEM 417. Requirements are flexible enough to accommodate a range of diverse interests in the physical, chemical, and biological sciences.

**Honors Concentration**. Qualified students may elect an Honors concentration. This program requires a thesis which describes and analyzes independent experimental work. The research topic and advisor must be approved by the Honors advisor in Biochemistry. Students in this program are expected to maintain an overall grade point average above 3.3 and at least a 3.4 in field of concentration, including prerequisite courses. CHEM 398 (4 credits) and the thesis course, CHEM 498, replaces the requirement for an upper-level laboratory course outlined above.

**Advising**. Appointments are scheduled online at http://www.umich.edu/~michchem/undergrad/index.html

## AREA DISTRIBUTION

By means of this requirement the College seeks to instill an understanding and an appreciation of the major areas of learning. Students are not expected to master all areas in detail, but should develop a coherent view of essential concepts, structures, and intellectual methods that typify these disciplines.

Courses offered by the academic departments and programs of the College are divided into five area categories: the *natural sciences*, the *social sciences*, the *humanities, mathematics and symbolic analysis, and creative expression.* Each of these divisions represents a different perspective on human knowledge and learning; some departments and programs overlap these divisions while others may stand outside them. *Interdisciplinary courses* combine the approaches of more than one area category in order to examine the differences and similarities between disciplines and explore alternative ways of discovering and organizing knowledge.

All candidates for the Bachelor of Arts and Bachelor of Science degrees from the College must fulfill the 30-credit Distribution Requirement.

This broad intellectual experience, which forms an essential part of a liberal arts education, is to be achieved in the following way:

1. Students must complete 7 credits in each of the following three areas: Natural Science (NS), Social Science (SS), and Humanities (HU), for a total of 21 credits.
2. Students must also complete 3 additional credits in each of three of the following five areas: (NS), (SS), (HU), Mathematical and Symbolic Analysis (MSA), and Creative Expression (CE), for a total of 9 credits. Credits in courses designated Interdisciplinary (ID) may be used to satisfy up to 9 credits of this part of the requirement.

### General Policies for Area Distribution Plans

An area distribution plan *may* include:

1. Prerequisites to a concentration elected outside the department of concentration.
2. Courses elected pass/fail, credit/no credit, or by any other non-graded pattern.
3. Courses elected to satisfy *one* of two concentration plans by students who elect a double concentration (see "Double Concentration" below in this chapter).
4. Transfer credit from other schools and colleges of the University of Michigan and from other academic institutions.
5. A course elected outside the department of concentration or concentration requirements to meet the Upper Level Writing Requirement, the Race and

Ethnicity Requirement, or the Quantitative Reasoning Requirement.

6. Courses in Non-LS&A Units offering courses with Creative Expression designation. (Credits are counted as Non-LS&A.)

An area distribution plan *may not* include:

1. Any course from the department of concentration.
2. Required cognates in a concentration plan.
3. Courses at the 400 level and above.
4. Experiential courses, Independent Study, and University (UC) mini-courses.
5. Advanced Placement credits.

Chemistry concentrators are encouraged to complete, as early as possible, the mathematics, physics, and language courses that are necessary for the concentration and to plan their distribution from among upper level courses which are open to juniors and seniors in social science, art, and humanities departments, often without prerequisites.

## ULWR REQUIREMENT

All LS&A students must complete the Upper-Level Writing Requirement (ULWR) any time after they have completed the First-Year Writing Requirement. The ULWR, which the College strongly recommends be completed within the student's concentration, aims to help students recognize and master the writing conventions of their chosen discipline, so that, upon graduation, they are able to understand and communicate effectively the central concepts, approaches, and materials of that discipline. A list of approved courses for a particular term is available from: *http://www.lsa.umich.edu.saa* (Student Academic Affairs website) and *http://www.lsa.umich.edu/swc/requirements/advcourses.html* (Sweetland Writing Center website). A course approved to meet the requirement one term is not necessarily approved in subsequent terms. When registering for a ULWR course, students must select the writing requirement box indicating they would like to use the course to satisfy the ULWR. In addition to giving the student a grade for the course at the end of the term, the instructor also indicates whether the student has successfully completed the writing requirement." Chemistry 495, offered only in the Winter Term, satisfies this requirement.

## RESOURCES ON CAMPUS

*REGISTRAR STUDENT SERVICES-CENTRAL CAMPUS*, 1207 LS&A, *647.3507 https://umich-regoff.custhelp.com/cgi-bin/umich_regoff.cfg/php/enduser/std_alp.php*

*LS&A ACADEMIC ADVISING*, 1255 Angell Hall, 764-0332, 764-0332 http://www.lsa.umich.edu/lsa/students/resources/academics/advising/

*COUNSELING AND PSYCHOLOGICAL SERVICES*, 3100 Michigan Union, 764-8312 http://www.umich.edu/~caps/

*PSYCHOLOGICAL CLINIC*, 525 E. University, Room 2463 East Hall, 764-3471 http://www.psychclinic.org/

*SWEETLAND WRITING CENTER*, 1139 Angell Hall, 764-0429 http://www.lsa.umich.edu/swc/

*FINANCIAL AID*, 2011 SAB, 763-6600 http://www.finaid.umich.edu/

*WOMEN IN SCIENCE AND ENGINEERING PROGRAM*, 1712 CHEM, 615-4455. http://www.wise.umich.edu/

CAMPUS INFORMATION CENTERS
First Floor, Michigan Union 764-INFO
http://www.umich.edu/~info/

*INTERNATIONAL PROGRAMS*
*LS&A Office of Study Abroad*, G513 Michigan Union, 764-4311.
http://www.umich.edu/~iinet/oip/

Chemistry students planning to take laboratory courses abroad need to be aware that laboratory space and equipment may present problems and need to be checked out

in advance. The department has some information on foreign programs. (In recent years several chemistry concentrators have found the courses of study in England and Germany fit in well with their chemistry program).

*Overseas Opportunities*, International Center, 647-2259, Room 23, Employment abroad.

## DECLARING A CHEMISTRY OR BIOCHEMISTRY CONCENTRATION

Prospective chemistry or biochemistry concentrators should have demonstrated some natural aptitude in science and mathematics. The student should note that good performance in the prerequisite mathematics and physics courses is essential to the more advanced chemistry courses. Math and physics courses are required cognates and may not be elected by the Pass/Fail grading option.

When you decide you would like to become a concentrator, make an appointment via the online advising system to see a concentration advisor. The advisor, who is a member of the faculty, will be glad to go over your schedule, answer questions, point out possible difficulties, and generally welcome you. You will be added to the concentration email group at the time of declaration where you will receive information on various chemistry and biochemistry opportunities.

The sooner you declare a concentration the more flexibility you will have in planning your college schedule.

## CONCENTRATION RELEASE

1500 Chemistry

When you have completed 90 credit hours toward your program and are within one year of graduation, it is wise to make an appointment with a concentration advisor to have your requirements reviewed and to fill out a Concentration Release Form. This form, signed by a concentration advisor, will indicate the additional courses you need to complete during your final term in order to receive a B.S. in Chemistry (124 credits), a B.S. with a concentration in chemistry (120 credits), or a B.S. in Biochemistry. By having the Concentration Release Form signed more than one full term in advance, you allow yourself time to correct any errors in election during your last term on campus. You should have other LS&A requirements reviewed in LS&A advising.

## DIPLOMA APPLICATION

1255 Angell Hall

The Diploma Application is a web form found in Student Business on Wolverine Access that students submit electronically.

Students should complete this form online and submit the Concentration Release form to the Academic Auditor's Office in G255 Angell Hall to generate a Senior Audit for graduation. The deadline for submitting these two forms is four weeks after classes begin in your final term (one week after classes begin Summer half-term). Diplomas are awarded in May, August and December, but graduation exercises are held only in May and December.

If you do not complete your degree requirements after you file a Diploma Application, you must file a new Diploma Application to be placed on a later degree list.

Students who have met degree requirements but have not yet been graduated may obtain a Letter of Certification from the Academic Auditors in G255 Angell Hall. This letter is usually acceptable as evidence that requirements have been met and a degree will be awarded.

## OFFICIAL TRANSCRIPTS

UM Transcript & Certification Dept., 555 LS&A Building, Ann Arbor, MI 48109-1382, FAX 764-5556

1010 LS&A Building (in person requests)

*http://www.umich.edu/regoff/trans.html*

*http://wolverineaccess.umich.edu/*

## CHEMISTRY RESEARCH

*(http://www.umich.edu/~michchem/)*

The curriculum requires research beyond any research done as CHEM 219. This can be fulfilled through the Projects Lab (CHEM 485(2)) or Undergraduate Research (CHEM 399) for 2 or 4 credits depending on your program. (Many students get their first undergraduate research experience by taking Chem 219, Independent Study, during their Freshman or Sophomore year.) Consult the Departmental Graduate Brochure for descriptions of research or check the Chemistry Website and speak with professors. Read the procedures for research and independent study courses (p. 41), fill out the Student-Professor Agreement Form (p. 42) and turn in the form and research description to Room 1500 to obtain an electronic override.

## BIOCHEMISTRY RESEARCH

*http://www.med.umich.edu/biochem/*
*http://www.umich.edu/~michchem/*
*http://www.umich.edu/~biophys*

Research is required for Honors and optional for non-honors concentrators in biochemistry. UROP credit does not count towards research credit. Students may get their first undergraduate research experience by taking CHEM 218, Independent Study in Biochemistry, in their Freshman or Sophomore year. CHEM 398, Undergraduate Research in Biochemistry, is an option for all junior and senior concentrators, required for Honors. Check the list of approved research faculty (p. 43) Read the procedures for research (p. 41), fill out the Student-Professor Agreement Form (p. 42) and turn in the form with the research description to Room 1500k for project approval by an advisor and an electronic override.

## CONCENTRATION ADVISING

Concentration Advisors are faculty members in the Chemistry Department or in the Biological Chemistry Department with knowledge and experience in various fields of chemistry and biochemistry. It is appropriate to discuss with them the implications of your concentration and matters such as chemistry's or biochemistry's relationship to other disciplines on campus, graduate school prospects, and career choices and their requirements. Concentration advisors have authority to modify departmental requirements, but not College-level requirements.

There are three times when students are required to see advisors:

1) To declare a concentration — the sooner the better.
2) To file a concentration release form - first term senior year.
3) To make any significant change in a concentration plan, including changes resulting in overloads and underloads.

Honors students are required to have course selections approved each term by an Honors Advisor and to obtain the necessary course overrides.

## REQUEST FOR ACADEMIC ADVISING

Information on the Chemistry or Biochemistry curricula is available from a number of sources. The LS&A issue of the *University Bulletin (http://www.lsa.umich.edu/saa/publications/bulletin/).* is the official source, but most of the information pertaining to Chemistry or Biochemistry can be found in this Handbook. The Handbook should be the starting point for academic advice. In addition to the times you *must* confer with an academic advisor (declaration and release), you *should* consult an advisor on any questions that arise about your program. Short questions can be answered very quickly by e-mail. **For more substantive discussion, schedule an appointment via the online advising system which can be found on the Undergraduate page of the Chemistry website (**https://www-a1.lsa.umich.edu/AdvAppts/AA_StuSelfSvc1.aspx?ctgy=CHEM)

Although the concentration advisors may be able to provide information on matters such as joint concentrations or pre-professional programs, those questions in general should be taken to LS&A advisors.

The schedules below illustrate recommended course elections for students with no AP credit. Students with AP credit should take upper level courses at an earlier time to facilitate early entry into research. Chem 260, 241, 242 can be taken concurrently. Chem 402 is a Fall only offering. Refer to the *LS&A Bulletin* for Area Distribution.

## POSSIBLE SCHEDULE OF COURSES FOR THE B.S. DEGREE, CONCENTRATION IN CHEMISTRY (120 CREDITS)

| | Fall Term | | Winter Term | |
|---|---|---|---|---|
| **Fr.** | Chem 130 | 3 | Chem 210,211 (Lab) | 5 |
| | Chem 125/126[+] (Lab) | 2 | Math 116 | 4 |
| | Math 115 | 4 | Language* | 4 |
| | English 125 | 4 | Humanities | 3 |
| | Language* | 4 | | 16 |
| | | 17 | | |
| **So.** | Chem 215, 216 (Lab) | 5 | Chem 260 | 3 |
| | Math 215 | 4 | Math 216 | 4 |
| | Language* | 4 | Language* | 4 |
| | Humanities | 3 | Physics 140, 141 (Lab) | 5 |
| | | 16 | | 16 |
| **Jr.** | Chem 241 | 2 | Chem 461, 462 (Lab) | 4 |
| | Chem 242 (Lab) | 2 | Chem 447 | 3 |
| | Chem 302 | 3 | Chem 312 (Lab) | 2 |
| | Physics 240, 241 (Lab) | 5 | Social Science | 3 |
| | Social Science | 3 | Humanities | 4 |
| | | 15 | | [#]16 |
| **Sr.** | Chem 402 (Fall only) | 3 | | |
| | Chem 463 | 3 | Chem 485 (Projects Lab) or Chem 399 | 2 |
| | Chem 480 (Lab) | 3 | Chem 495[#](or other ULWR course) | 2 |
| | Social Science | 4 | Elective | 4 |
| | | 16 | | 8 |

### POSSIBLE SCHEDULE OF COURSES FOR THE B.S. IN CHEMISTRY DEGREE (124 CREDITS)

| | Fall Term | | Winter Term | |
|---|---|---|---|---|
| **Fr** | Chem 210, 211 (Lab) | 5 | Chem 215, 216 (Lab) | 5 |
| | Math 115 | 4 | Math 116 | 4 |
| | Language* | 4 | Language* | 4 |
| | English Composition | 4 | Humanities | 3 |
| | | 17 | | 16 |
| **So** | Chem 260 (241, 242) | 3 (4) | Chem 241, 242 (Lab) (302/312) | 4 (5) |
| | Physics 140, 141 (Lab) | 5 | Physics 240, 241 (Lab) | 5 |
| | Math 215 | 4 | Math 216 | 4 |
| | Language* | 4 | Language* | 4 |
| | | 16 | | 17 |
| **Jr** | Chem 302 | 3 | Chem 461, 462 (Lab) | 4 |
| | Chem 312 (Lab) | 2 | Chem 447 | 3 |
| | Humanities | 3 | Advanced Chem Lecture | 3 |
| | Social Science | 3 | Social Science | 3 |
| | Elective | 4 | Chem 399 | 1 |
| | Chem 399 | 1 | Chem 495[#](or other ULWR course) | 2 |
| | | 16 | | 16 |
| **Sr** | Chem 402 (Fall only) | 3 | Chem 480 (Lab) | 3 |
| | Chem 463 | 3 | Chem 399 | 1 |
| | Chem 399 | 1 | Social Science | 4 |
| | Humanities | 4 | Chem 495[#](or other ULWR course) | 2 |
| | Elective | 4 | Elective | 4 |
| | | 15 | | 14 |

[+]Chem 125/126 is required for students with little or no high school chemistry laboratory experience.
*German is recommended for chemistry students.

[#]Chemistry 495(2), Winter Term only, meets the SWC Upper Level Writing Requirement as will other ULWR approved courses.

Paste in Concentration Worksheet (ssoff/ssugoff/ughand/flowchrt.xls)
Original in Master File

The schedule below illustrates recommended course elections for students with no AP credit. Students with AP credit in math and physics should take upper level courses at an earlier time to facilitate early entry into research. Chem 260, 241, 242 can be taken concurrently and 302, 312 may be taken the following semester. Chem 402 is a Fall only offering. Refer to the *LS&A Bulletin* for Area Distribution.

## POSSIBLE SCHEDULE OF COURSES FOR THE B.S. IN CHEMISTRY DEGREE WITH HONORS (124 CREDITS)

| | Fall Term | | Winter Term | |
|---|---|---|---|---|
| Fr | Chem 210 | 4 | Chem 215 | 3 |
| | Chem 211 (Lab) | 1 | Chem 216 (Lab) | 2 |
| | Math 115 (185) | 4 | Math 116 (186) | 4 |
| | Language* | 4 | Language* | 4 |
| | Great Books 191 | 4 | Great Books 192 | 4 |
| | | 17 | | 17 |
| So | Chem 260 (241,242) | 3(4) | Chem 241, 242 (Lab)(302/312) | 4 |
| | Physics 135 or 140, 141 (Lab) | 5 | Physics 235 or 240, 241 (Lab) | 5 |
| | Math 215(285) | 4 | Math 216 (286) | 4 |
| | Language* | 4 | Language* | 4 |
| | | 16 | | 17 |
| Jr | Chem 461/200 (Honors) | 3 | Chem 463/200 (Honors) | 3 |
| | Chem 462 (Lab) | 1 | Chem 480 (Lab) | 3 |
| | Chem 447 | 3 | Social Science | 3 |
| | Chem 302 (Chem 402) | 3 (3) | Humanities | 3 |
| | Chem 312 (Lab) | 2 | Chem 399 | 1 |
| | Social Science | 3 | Chem 495[#] (or other ULWR course) | 2 |
| | Chem 399 | 1 | | 15 |
| | | 16 | | |
| | | | Chem 399[&] | 1 |
| Sr | Advanced Chem Lecture | 3 | Chem 495[#] (or other ULWR course) | 2 |
| | Chem 399 | 1 | Chem 499 (Thesis) | 1 |
| | Chem 402 (Fall) | 3 | Social Science | 4 |
| | Humanities | 3 | Elective | 4 |
| | Elective | 3 | | 12 |
| | Elective | 3 | | |
| | | 16 | | |

*German is recommended for Chemistry students.

[#]Chemistry 495(2), Winter Term only, meets Upper Level Writing requirement as will other ULWR approved courses.

[&]Chemistry 399 culminates in the writing of an Honors Thesis, signified by election of Chem 499 that term. Overall GPA 3.2, concentration GPA 3.3.

## CONCENTRATION PLAN FOR CHEMISTRY

Name_____ EMPLID_____

Expected Date of Graduation_____ Degree (circle one)
B.S. (120 credits)
B.S. in Chemistry (124 credits)
B.S. in Chemistry Honors (124 credits)

| DONE | PREREQUISITES | TERM & YEAR |
|---|---|---|
| ☐ | Chem 125/126* | _____ |
| ☐ | Chemistry 130** | _____ |
| ☐ | Chemistry 210-211 | _____ |
| ☐ | Chemistry 215-216 | _____ |
| ☐ | Chemistry 260 | _____ |
| ☐ | Chemistry 241/242 | _____ |
| ☐ | Physics [135 or 140]-141 | _____ |
| ☐ | Physics [235 or 240]-241 | _____ |
| ☐ | Mathematics 115 | _____ |
| ☐ | Mathematics 116 | _____ |
| ☐ | Mathematics 215 | _____ |
| ☐ | Mathematics 216 | _____ |

*** Chemistry 125/126 is required for students with little or no high school chemistry laboratory experience**
**** Chemistry 130 is strongly recommended for students whose orientation exam scores do not place them in Chemistry 210/211.**
*****PHYSICS 240 or 235 and MATH 215 are prerequisites for CHEM 461 and students should, wherever possible, complete both of these before the junior year.**

| DONE | CONCENTRATION | TERM & YEAR |
|---|---|---|
| ☐ | Chemistry 302 | _____ |
| ☐ | Chemistry 312 (Lab) | _____ |
| ☐ | Chemistry 402 (Fall only) | _____ |
| ☐ | Chemistry 447 | _____ |
| ☐ | Chemistry 461/462 | _____ |
| ☐ | Chemistry 463 | _____ |
| ☐ | Chemistry 480 (Lab) | _____ |

| DONE | BS CHEM (124) | |
|---|---|---|
| ☐ | Chemistry 399 (4 credits over 2 semesters) | _____ |
| ☐ | Chemistry 499 (1) (Honors thesis) | _____ |
| ☐ | Chemistry Advanced Lecture (3) | _____ |

| DONE | BS CONCENTRATION (120) | |
|---|---|---|
| ☐ | Chemistry 399 or 485 (2) | _____ |

| DONE | OPTIONAL | |
|---|---|---|
| ☐ | Chemistry 495 (2) Winter only | _____ |
| ☐ | OR other ULWR requirement | |

**Representative Schedule for Combined**
**B.S. (Chemistry) - B.S.E (Chemical Engineering) Program**
**for Students Taking ChemE 230 before Fall 2001**

This is a 5 year program leading to 2 B.S. degrees. With respect to Chemistry and LS&A, it differs from the B.S. Chem degree (124 credits) program by allowing courses required by the engineering degree to substitute for one advanced chemistry lecture course and for Chem 399.
All other requirements, including College distributions, College language, and English composition, must be met. Consult with LSA Advising Office for distribution requirements. Upper Level English Composition may be met by individual arrangement through the Sweetland Writing Center, 1111 Angell Hall. LS&A courses must total at least 90 credit hours. An Honors Chemistry degree can be earned by meeting the requirements of the Departmental Honors Program.

Typical Program for B.S. (Chemistry) - B.S.E. (Chemical Engineering)

| | | | | | |
|---|---|---|---|---|---|
| I. | Chem 125/126 (Lab) | 2 | II. | Chem 210 | 4 |
| | Chem 130 | 3 | | Chem 211 (Lab) | 1 |
| | Math 115 | 4 | | Math 116 | 4 |
| | English 125 or Engin 100 | 4 | | Physics 135 or 140, 141 (Lab) | 5 |
| | Engin 101 | 4 | | Hum or SS[#] | 3 |
| | | 17 | | | 17 |
| III. | Chem 215 | 3 | IV. | Chem 261 | 1 |
| | Chem 216 (Lab) | 2 | | Math 216 | 4 |
| | Math 215 | 4 | | Physics 235 or 240, 241 | 5 |
| | Chem Eng 230 (Fall only) | 4 | | Language* | 4 |
| | | 13 | | Chem Eng 341 (Winter only) | 4 |
| | | | | | 18 |
| V. | Chem 241 | 2 | VI. | Chem 461 | 3 |
| | Chem 242 (Lab) | 2 | | Chem 462 (Lab) | 1 |
| | Chem Eng 342 (Fall only) | 4 | | Chem Eng 330 (Winter only) | 4 |
| | Engin Elective[+] | 3 | | Chem 302 | 3 |
| | Language* | 4 | | Chem 312 (Lab) | 2 |
| | | 15 | | Language* | 4 |
| | | | | | 17 |
| VII. | Chem 402 (Fall only) | 3 | VIII. | Chem 480 (Lab) | 3 |
| | Chem 463 | 3 | | Chem Eng 344 (Winter only) | 4 |
| | Chem 447 | 3 | | Hum or SS[#] | 3 |
| | Chem Eng 343 (Fall only) | 3 | | Hum or SS[#] | 3 |
| | Language* | 4 | | | 13 |
| | | 16 | | | |
| IX. | Chem Eng 466 (Fall only) | 3 | X. | Chem Eng 460 | 4 |
| | Chem Eng 486 (Fall only) or MSE 250 | 4 | | Chem Eng 487 | 4 |
| | | | | Upper Level ULWR | X |
| | Hum or SS[#] | 4 | | Hum or SS[#] | 3 |
| | Engin Elective[+] | 3 | | | 11 + X |
| | | 14 | | | |

*German is recommended as the language in which you meet the college language requirement.

[#]A sequence of 2 courses (6 hrs) must be in the same division in humanities or social science. At least one of those electives must be at the 300 level or above to satisfy College of Engineering requirements. Humanities/Social Science to include a race and ethnicity course to meet LS&A requiremeents.

[+] Electives must be 200 level or above and not in AOSS. One elective must be outside of Chemical Engineering.

Consult an advisor in each department to learn of any additions or corrections. (Chemistry Office of Student Services, 1500 Chemistry, and Chemical Engineering Program Office, 3086 Dow on North Campus.)

**Representative Schedule for Combined**
**B.S. (Chemistry) - B.S.E (Chemical Engineering) Program**
**for Students Taking ChemE 230 Fall 2001 or after**

This is a 5 year program leading to 2 B.S. degrees. With respect to Chemistry and LS&A, it differs from the B.S. Chem degree (124 credits) program by allowing courses required by the engineering degree to substitute for one advanced chemistry lecture course and for Chem 399 (the research component).
All other requirements, including College distributions, College language, and English composition, must be met. Consult with LSA Advising Office for distribution requirements. Upper Level English Composition may be met by individual arrangement through the Sweetland Writing Center, 1111 Angell Hall. LS&A courses must total at least 90 credit hours. An Honors Chemistry degree can be earned by meeting the requirements of the Departmental Honors Program.

Typical Program for B.S. (Chemistry) - B.S.E. (Chemical Engineering)

| | | | | | |
|---|---|---|---|---|---|
| I. | Chem 125/126 (Lab) | 2 | II. | Chem 210 | 4 |
| | Chem 130 | 3 | | Chem 211 (Lab) | 1 |
| | Math 115 | 4 | | Math 116 | 4 |
| | English 125 or Engin 100 | 4 | | Physics 140, 141 (Lab) | 5 |
| | Engin 101 | 4 | | Hum or SS[#] | 3 |
| | | 17 | | | 17 |
| III. | Chem 215 | 3 | IV. | Chem 261 | 1 |
| | Chem 216 (Lab) | 2 | | Math 216 | 4 |
| | Math 215 | 4 | | Physics 240, 241 | 5 |
| | Chem Eng 230 (Fall only) | 4 | | Language* | 4 |
| | | 13 | | Chem Eng 341 (Winter only) | 4 |
| | | | | | 18 |
| V. | Chem 302 | 3 | VI. | Chem 461 | 3 |
| | Chem 312 (Lab) | 2 | | Chem 462 (Lab) | 1 |
| | Chem Eng 342 (Fall only) | 4 | | Chem Eng 330 (Winter only) | 3 |
| | MSE 250 | 4 | | Chem 241/242 (Lab) | 4 |
| | Language* | 4 | | Language* | 4 |
| | | 17 | | | 15 |
| VII. | Chem 402 (Fall only) | 3 | VIII. | Chem 463 | 3 |
| | Chem 447 | 3 | | Chem 480 (Lab) | 3 |
| | Chem Eng 343 (Fall only) | 3 | | Chem Eng 344 (Winter only) | 4 |
| | Language* | 4 | | Hum or SS[#] | 3 |
| | | 13 | | Hum or SS[#] | 3 |
| | | | | | 16 |
| IX. | Bio/life science Elective | 3(5) | X. | Chem Eng 460 | 4 |
| | Chem Eng 466 (Fall only) | 3 | | Chem Eng 487[##] | 4 |
| | Hum or SS[#] | 4 | | Hum or SS[#] | 3 |
| | Engin Technical Elective[+] | 2 | | | 11 |
| | | 12? | | | |

*German is recommended as the language in which you meet the college language requirement.

[#]A sequence of 2 courses (6 hrs) must be in the same division in humanities or social science. At least one of those electives must be at the 300 level or above to satisfy College of Engineering requirements. Humanities/Social Science to include a race and ethnicity course to meet LS&A requiremeents.
[##] Chem E 487 is approved for ULWR, contact Sweetland Writing Center for notification form

Consult an advisor in each department to learn of any additions or corrections. (Chemistry Office of Student Services, 1500 Chemistry, and Chemical Engineering Program Office, 3086 Dow on North Campus.)

The schedules below illustrate recommended course elections for students with no AP credit. Students with AP credit in math and physics should take upper level courses at an earlier time to facilitate early entry into research. Chem 260, 241, 242 can be taken concurrently and 302 may be taken the following semester. Refer to the *LS&A Bulletin* for Area Distribution.

**PROPOSED SCHEDULE OF COURSES FOR THE B.S. IN BIOCHEMISTRY DEGREE (STARTING WITH CHEM 130) BEFORE FALL 2002**

| | Fall Term | | Winter Term | |
|---|---|---|---|---|
| **Fr** | Chem 130 | 3 | Chem 210, 211 (Lab) | 5 |
| | Math 115 | 4 | Biol 162 | 5 |
| | Language | 4 | Language | 4 |
| | English 125 | 4 | Math 116 | 4 |
| | | 15 | | 18(19) |
| **So** | Chem 215, 216 (Lab) | 5 | Chem 260 | 3 |
| | Math 215 | 4 | Physics140, 141 (Lab) | 5 |
| | Language | 4 | Math 216 | 4 |
| | Humanties | 3 | Language* | 4 |
| | | 16 | | 16 |
| **Jr** | Chem 451 | 4 | Humanities | 4 |
| | Chem 241, 242 (Lab) | 4 | Chem 302 | 3 |
| | Humanities | 3 | Chem 452 | 4 |
| | Physics 240, 241 (Lab) | 5 | Social Science | 4 |
| | | 16 | | 15 |
| **Sr** | Advanced Laboratory | 3 | Chem 463 or 447 | 3 |
| | or Chem 398 | 2 | Chem 398 | 2 |
| | Chem 461/462 | 4 | Chem 495[#](or other ULWR course) | 2 |
| | Biol 305 | 4 | Social Science | 3 |
| | Social Science | 3 | Elective | 1 |
| | | 14(13) | | 11 |

**PROPOSED SCHEDULE OF COURSES FOR THE B.S. IN BIOCHEMISTRY (STARTING WITH CHEM 210) BEFORE FALL 2002**

| | Fall Term | | Winter Term | |
|---|---|---|---|---|
| **Fr.** | Chem 210, 211[+] (Lab) | 5 | Chem 215,216 (Lab) | 5 |
| | Biol 162 or 195 | 4(6) | Math 115 | 4 |
| | English Compostion | 4 | Language* | 4 |
| | Language* | 4 | Humanities | 3 |
| | | 17(19) | | 16 |
| **So.** | Chem 260 | 3 | Chem 302 | 3 |
| | Math 116 | 4 | Math 215 | 4 |
| | Physics 140, 141 (Lab) | 5 | Physics 240, 141 (Lab) | 4 |
| | Language | 4 | Physics | 1 |
| | | 16 | Language | 4 |
| | | | | 16 |
| **Jr.** | Chem 451 | 4 | Humanities | 3 |
| | Chem 241 | 2 | Bio 305 | 4 |
| | Chem 242(Lab) | 2 | Chem 452 | 3 |
| | Math 216 | 4 | Chem 495[#] (not required) | 2 |
| | Humanities | 4 | Social Science | 3 |
| | | 16 | | 15 |
| **Sr.** | Chem 398 | 2 | Chem 398 | 2 |
| | Chem 461 | 3 | Chem 463 or 447 | 3 |
| | Chem 462 (Lab) | 1 | Chem 495[#](or other ULWR course) | 2 |
| | Social Science | 3 | Elective | 3 |
| | Elective | 4 | Social Science | 4 |
| | | 13 | | 14 |

[+]Chem 125/126 is required for students with little or no high school chemistry laboratory experience.
*German is recommended for chemistry students.
[#]Chemistry 495(2), Winter Term only, meets the Upper Level Writing Requirement as will other ULWR approved courses.

The schedule below illustrates recommended course elections for students with no AP credit. Students with AP credit in math and physics should take upper level courses at an earlier time to facilitate early entry into research. Chem 260, 241, 242 can be taken concurrently and 302 may be taken the following semester. Refer to the *LS&A Bulletin* for Area Distribution.

## PROPOSED SCHEDULE OF COURSES FOR THE B.S. IN BIOCHEMISTRY DEGREE WITH HONORS BEFORE FALL 2002

| | First Term | | Second Term | |
|---|---|---|---|---|
| Fr | Chem 210 | 4 | Chem 215 | 3 |
| | Chem 211 (Lab) | 1 | Chem 216 (Lab) | 2 |
| | Biol 162 | 5 | Math 115 (185) | 4 |
| | Language* | 4 | Language* | 4 |
| | Great Books 191 | 4 | Great Books 192 | 4 |
| | | 17 | | 17 |
| So | Chem 260 (241, 242) | 3 (4) | Chem 302 | 3 |
| | Physics 140, 141 (Lab) | 5 | Physics 240, 241 (Lab) | 5 |
| | Math 116(186) | 4 | Math 215 (285) | 4 |
| | Language* | 4 | Language* | 4 |
| | | 16 | | 16 |
| Jr | Chem 451 | 4 | Humanities | 3 |
| | Chem 241 | 2 | Chem 398 | 1 |
| | Chem 242 (Lab) | 2 | Chem 452 | 4 |
| | Humanities | 3 | Bio 305 | 4 |
| | Math 216 (286) | 4 | Social Science | 3 |
| | | 15 | | 15 |
| Sr | Chem 398 | 2 | Chem 398[&] | 1 |
| | Chem 461/462 | 4 | Chem 447 or 463 | 3 |
| | Social Science | 3 | Chem 495[#](or other ULWR course) | 2 |
| | Elective | 4 | Chem 498 (Thesis) | 1 |
| | | 13 | Social Science | 4 |
| | | | Elective | 1 |
| | | | | [#]12 |

*German is recommended for Chemistry students.

[#]Chemistry 495(2), Winter Term only, meets the Upper Level Writing requirement as will other ULWR approved courses.

[&]Chemistry 398 culminates in the writing of an Honors Thesis, signified by election of Chem 498 that term. Overall GPA 3.2, concentration GPA 3.3.

The schedules below illustrate recommended course elections for students with no AP credit. Students with AP credit in math and physics should take upper level courses at an earlier time to facilitate early entry into research. Chem 260, 241, 242 can be taken concurrently and 302 may be taken the following semester. Refer to the *LS&A Bulletin* for Area Distribution.

**PROPOSED SCHEDULE OF COURSES FOR THE B.S. IN BIOCHEMISTRY DEGREE (STARTING WITH CHEM 130) AFTER FALL 2002**

| | Fall Term | | Winter Term | |
|---|---|---|---|---|
| **Fr** | Chem 130 | 3 | Chem 210, 211 (Lab) | 5 |
| | Math 115 | 4 | Biol 162 | 5 |
| | Language | 4 | Language | 4 |
| | English 125 | 4 | Math 116 | 4 |
| | | 15 | | 18 |
| **So** | Chem 215, 216 (Lab) | 5 | Chem 260 | 3 |
| | Math 215 | 4 | Chem 241, 242 (Lab) | 4 |
| | Language | 4 | Physics140, 141 (Lab) | 5 |
| | HumanIties | 3 | Language* | 4 |
| | | 16 | | 16 |
| **Jr** | Chem 451 | 4 | Humanities | 4 |
| | Biol 305 | 4 | Chem 302 | 3 |
| | Humanities | 3 | Chem 452 | 4 |
| | Physics 240, 241 (Lab) | 5 | Social Science | 4 |
| | | 16 | | 15 |
| **Sr** | Advanced Laboratory | 3 | Chem 454 | 3 |
| | or Chem 398 | 2 | Chem 398 | 2 |
| | Chem 453 | 3 | Chem 495[#](or other ULWR course) | 2 |
| | Biochem Elective[+] (from list) | 3 | Social Science | 3 |
| | Social Science | 3 | Biochem Elective[+] (from list) | 3 |
| | | 13(12) | | 13 |

**PROPOSED SCHEDULE OF COURSES FOR THE B.S. IN BIOCHEMISTRY (STARTING WITH CHEM 210) AFTER FALL 2002**

| | Fall Term | | Winter Term | |
|---|---|---|---|---|
| **Fr.** | Chem 210, 211[+] (Lab) | 5 | Chem 215,216 (Lab) | 5 |
| | Biol 162 | 5 | Math 115 | 4 |
| | English Compostion | 4 | Language* | 4 |
| | Language* | 4 | Humanities | 3 |
| | | 18 | | 16 |
| **So.** | Chem 260 | 3 | Chem 302 | 3 |
| | Math 116 | 4 | Chem 241, 242 (Lab) | 4 |
| | Physics 140, 141 (Lab) | 5 | Math 215 | 4 |
| | Language | 4 | Language | 4 |
| | | 16 | | 15 |
| **Jr.** | Chem 451 | 4 | Humanities | 3 |
| | Physics 240, 241 (Lab) | 5 | Chem 398 | (1) |
| | Biol 305 | 4 | Chem 452 | 4 |
| | Humanities | 4 | Chem 495[#] (not required) | 2 |
| | | 17 | Social Science | 3 |
| | | | | 12(13) |
| **Sr.** | Chem 398 | 2 | Chem 398 | 2 |
| | Chem 453 | 3 | Chem 454 | 3 |
| | Biochem Elective[+] (from list) | 3 | Chem 495[#] (or other ULWR course) | 2 |
| | Social Science | 3 | Biochem Elective[+] (from list) | 3 |
| | Elective | 4 | Social Science | 4 |
| | | 12(15) | | 11(14) |

[+]Chem 125/126 is required for students with little or no high school chemistry laboratory experience.
*German is recommended for chemistry students.

[#]Chemistry 495(2), Winter Term only, meets the Upper Level Writing Requirement as will other ULWR approved courses.
[+]Biochem One Course Elective (No Substitutes): Bio 427, 428; Chem 420, 447, 461, 485/500; Med Chem 409, 410.

The schedule below illustrates recommended course elections for students with no AP credit. Students with AP credit in math and physics should take upper level courses at an earlier time to facilitate early entry into research. Chem 260, 241, 242 can be taken concurrently and 302 may be taken the following semester. Refer to the *LS&A Bulletin* for Area Distribution.

## PROPOSED SCHEDULE OF COURSES FOR THE B.S. IN BIOCHEMISTRY DEGREE WITH HONORS AFTER FALL 2002

| | First Term | | Second Term | |
|---|---|---|---|---|
| Fr | Chem 210 | 4 | Chem 215 | 3 |
| | Chem 211 (Lab) | 1 | Chem 216 (Lab) | 2 |
| | Biol 162 | 5 | Math 115 (185) | 4 |
| | Language* | 4 | Language* | 4 |
| | Great Books 191 | 4 | Great Books 192 | 4 |
| | | 18 | | 17 |
| So | Chem 260 (241, 242) | 3 (4) | Chem 241 | 2 |
| | Physics 140, 141 (Lab) | 5 | Chem 242 (Lab) | 2 |
| | Math 116(186) | 4 | Chem 302 | 3 |
| | Language* | 4 | Math 215 (285) | 4 |
| | | 16 | Language* | 4 |
| | | | | 15 |
| Jr | Chem 451 | 4 | Humanities | 3 |
| | Physics 240, 241 (Lab) | 5 | Chem 398 | 1 |
| | Bio 305 | 4 | Chem 452 | 4 |
| | Humanities | 3 | Social Science | 3 |
| | | 16 | | 11 |
| Sr | Chem 398 | 2 | Chem 398[&] | 1 |
| | Chem 453 | 3 | Chem 454 | 3 |
| | Social Science | 3 | Chem 495[#] (or other ULWR course) | 2 |
| | Biochem Elective[+] (from list) | 3 | Chem 498 (Thesis) | 1 |
| | | 13 | Social Science | 4 |
| | | | Elective | 2 |
| | | | | [#]13 |

*German is recommended for Chemistry students.

[#]Chemistry 495(2), Winter Term only, meets the Upper Level Writing requirement as will other ULWR approved courses.

[&]Chemistry 398 culminates in the writing of an Honors Thesis, signified by election of Chem 498 that term. Overall GPA 3.2, concentration GPA 3.4.

[+]Biochem One Course Elective (No Substitutes): Bio 427, 428; Chem 420, 447, 461, 485/500; Med Chem 410.

## DEPARTMENT OF CHEMISTRY INFORMATION FOR PROSPECTIVE CONCENTRATORS IN BIOCHEMISTRY

The biochemistry concentration program is intended for students interested in the chemical basis of biological phenomena. The concentration program is intellectually demanding and requires that students take advanced courses in math, (through 216), chemistry, including introduction to chemical analysis lecture with laboratory and chemical principles (Chem. 241/242 and 260), and physical chemistry (Chem. 461/462, and 463 or 447) and genetics (Bio. 305) as well as a 2-semester sequence of biochemistry courses (Chem. 451 and 452). This concentration is intended to prepare students for further education (graduate school or medicine). A B.S. degree in biochemistry is also a useful means of preparing for jobs in academic medical centers, the pharmaceutical industry, and in biotechnology companies. Because the concentration program is highly structured, it is essential that prospective concentrators follow the guidelines set forth below. **Please note that although a double concentration in Chemistry/Biochemistry is permitted, students are not allowed to concentrate in both Biochemistry and Cell/Molecular Biology.**

1. **You must elect prerequisites to the concentration as early as possible.** Introductory biology (Bio. 162) and chemistry (130 if necessary; 210-211 and 215-216) should be elected and completed in the first year of college study or as soon as possible. The physics courses (Phys. 140/141 - 240/241) are also important; they are prerequisites for physical chemistry courses which you will take in your junior or senior year. Completion of Math 115 and 116 is necessary in order to go on to Math 215 and 216 (Math 215 in revised curriculum, see #4). Math 215 is a prerequisite for physical chemistry.

2. **You should declare your concentration by seeing a biochemistry advisor no later than the winter term of your sophomore year, although the concentration can be declared earlier.** You need not complete all of the prerequisite courses in order to declare your concentration. Students who delay declaring the concentration until later than the junior year may find that they have inadequate time remaining to complete course elections and graduate in the normal four years.

3. **The actual concentration program for students declaring before Fall 2002 is on a separate sheet (p. 24) of this brochure.** In planning your course work, you can make use of the following "typical" pattern of elections in the concentration.

   Sophomore Year - Math 115, 116; Chemistry 260 and 241/242 or 302 should be completed; physics courses should be completed or underway.

   Junior Year - Physics should be completed; concentration elections should include Math (215), Chemistry (302 or 241/242) and Chemistry 451/452. Biology 305 can be elected in the Winter Term of your junior year or Spring-Half or Fall of your senior year. You should also have formulated a plan for the satisfaction of the ULWR junior-senior writing requirement. More information on the ways in which biochemistry concentrators may satisfy the writing requirement is provided later in this handout. If you are an honors concentrator or are interested in research, you should attempt to identify a laboratory in which you can carry out research for credits in Chem 398.

   Senior Year - Elect Chem. 461/462 and 463 or 447 along with electives; carry out a research project if you have elected this option.

4. **Important changes to the biochemistry curriculum for students declaring in Fall 2002 or later are on page 25.** Math 216 will no longer be required as a prerequisite. Students will be required to take Chem 453, *Biophysical Chemistry I: Thermodynamics and Kinetics* (3 credits), Fall only, and Chem 454, *Biophysical Chemistry II: Macromolecular Structure and Dynamics*, 3 credits, Winter only. These courses will replace the current requirement for Chem 461/462 and

Chem 463 or Chem 447. The only exception is for students who have declared a double concentration in Chemistry and Biochemistry who may use Chem 463 to satisfy the requirement for Chem 453. Students are required to take one elective course from the following list (no substitutions): MCDB 427, 428; Chem 420, 447, 461, 485/500; Med Chem 409, 410.

5. **Like other LS&A students, biochemistry concentrators must achieve fourth-semester proficiency in foreign language.** While there is no designated foreign language, students who are oriented towards graduate study may prefer French, German, or Russian since one of these languages is often required by graduate schools as part of the Ph.D. degree.

6. **Distribution courses are important.** One intent of the distribution requirement is to broaden your exposure to fields of knowledge outside the sciences and to provide, along with your science courses, the broad background and modes of thinking necessary for life as a truly educated person.

7. **Upper Level Writing Requirement.** As noted in the LS&A Bulletin (p. 11), all LS&A students must complete this College requirement as a prerequisite for graduation, usually by election of accredited writing courses in their area of academic interest. Biochemistry concentrators have three options: (a) election of Chemistry 495 and satisfactory completion of the writing therein; (b) with the advance approval of the professorial sponsor of an honors thesis, and the approval of the Honors Program, use of the senior thesis toward the requirement; or (c) election of any ULWR-approved course in an area outside Chemistry. Options (a) and (b) assist in development of writing skills within the area of concentration and are therefore very beneficial; however, choice (c) affords the possibility of enhancing the breadth of a student's overall curriculum and may assist in meeting the distribution requirements. Regardless of the option selected, fulfillment of the requirement depends on frequent submission of written material, revision following evaluation, and resubmission of it in a manner leading to progressive development of skills in exposition and reasoning.

## INFORMATION ABOUT THE HONORS CONCENTRATION IN BIOCHEMISTRY

A substantial number of biochemistry concentrators are in the Honors Program. For admission to honors (preferably early in the junior year), you must contact the biochemistry concentration advisor, even if you were in the Honors Program in your first and second years. To qualify for graduation with honors, a student must satisfy a series of requirements. First, you must maintain an overall GPA of at least 3.3 and at least a 3.4 in field of concentration, including prerequisite courses. Second, you must identify a professorial faculty member (on the biochemistry concentration research faculty list) who will allow you to work under his or her guidance on an independent biochemically oriented research project. This research is then presented as an honors thesis which is read by the concentration advisor, who makes a recommendation for "honors", "high honors", or "highest honors" based on the quality of the thesis and the final GPA of the student. Students in biochemistry may carry out their honors research in a number of units on campus. A list of Biochemistry Research Faculty is available on page 43 and in Room 1500 Chemistry.

It is incumbent on the student to find a laboratory and faculty advisor, and to do so early enough so that the techniques can be learned, a project carried out, and the thesis written. For some types of research, it is recommended that you begin independent studies in your junior year. Note that most faculty members on campus are more receptive to a student if genetics and biochemistry have been completed or elected when the student is interviewing for research. The research typically takes two to three terms of independent study in biochemistry, Chem 398 with the biochemistry advisor’s approval. The honors thesis should be written in the style of a paper found in the *Journal of Biological Chemistry* or other relevant scientific journals. Concentration advisors do not evaluate a thesis on its length but

rather on its content, although typical theses usually run to 20-25 pages. **The deadline for receipt of theses is one week before the date of graduation.** You are responsible for meeting the deadline, submitting your thesis to your professor and honors advisor, and for reminding your professorial supervisor to submit an evaluation of your work to the biochemistry honors advisor within 7 days from the date you have turned in your thesis.

**Honors theses which are copies of manuscripts submitted for publication, or which do not represent the sole written work of the student will not be read by the Honors Advisor.**

In addition to the honors thesis, biochemistry concentrators are encouraged to elect honors courses wherever possible. Consult the Honors Office (1330 Mason Hall) for up-to-date information. Honors biochemistry concentrators have unanimously enjoyed their research experience and have found that it has been a valuable part of their training. The record of successful biochemistry Honors concentrators in gaining scholarships and admission to graduate or medical school is outstanding. For further information on Honors, consult the Honors Handbook available in 1330 Mason Hall.

## CONCENTRATION PLAN FOR BIOCHEMISTRY BEFORE FALL 2002

Name_____ Student Number_____

Expected Date of Graduation_____

The curriculum in biochemistry offers integrated training in the chemistry of biological processes. It is designed to prepare students for graduate study in areas of life sciences and medicine which emphasize the quantitative and analytical approaches to the life sciences.

| **PREREQUISITES TO CONCENTRATION** | **TERM AND YEAR COMPLETED** | |
|---|---|---|
| Introductory Biology (Bio 162) | _____ | _____ |
| Chemistry 130** | _____ | _____ |
| Chemistry 210-211 | _____ | _____ |
| Chemistry 215-216 | _____ | _____ |
| Physics 140-141 | _____ | _____ |
| Physics 240-241 | _____ | _____ |
| Mathematics 115 | _____ | _____ |
| Mathematics 116 | _____ | _____ |
| Mathematics 215 | _____ | _____ |

**** Chemistry 130 is strongly recommended for students whose orientation exam scores do not place them in Chemistry 210/211.**

| **CONCENTRATION** | | |
|---|---|---|
| Chemistry 260 | _____ | _____ |
| Chemistry 241/242 | _____ | _____ |
| Chemistry 302 | _____ | _____ |
| Chemistry 451 | _____ | _____ |
| Chemistry 452 | _____ | _____ |
| Biology 305 | _____ | _____ |
| Chemistry 461/462 | _____ | _____ |
| Chemistry 463 or 447 | _____ | _____ |
| Advanced Laboratory Course* or undergraduate research experience** | _____ | _____ |

* The following courses are acceptable:
  Biol. Chem. 416 (Fall Term Only)
  Biol. 429 (Winter Term Only)
  Chem. 480 (Fall/Winter Terms)

**Two semesters of undergraduate research experience (2 credits of Chem 398 level independent study per semester); permission of a concentration advisor is required. Students electing this option must execute an extended research project under the supervision of a faculty member who agrees to oversee the project.

NOTE: Research and a written thesis are required of Honors Concentrators, Chem 498. This course replaces the requirement for an upper-level laboratory course outlined above. Overall GPA 3.3, concentration GPA 3.4.

Recommended, but not required, courses: Biol. Chem. 500-level modules, Biology 427, 428, and Chemistry 417.

## CONCENTRATION PLAN FOR BIOCHEMISTRY AFTER FALL 2002

Name_____ Student Number_____

Expected Date of Graduation_____

The curriculum in biochemistry offers integrated training in the chemistry of biological processes. It is designed to prepare students for graduate study in areas of life sciences and medicine which emphasize the quantitative and analytical approaches to the life sciences.

| **PREREQUISITES TO CONCENTRATION** | **TERM AND YEAR COMPLETED** | |
|---|---|---|
| Introductory Biology (Bio 162 or 171&172) | _____ | _____ |
| Chemistry 130** | _____ | _____ |
| Chemistry 210-211 | _____ | _____ |
| Chemistry 215-216 | _____ | _____ |
| Physics [135 or 140]-141 | _____ | _____ |
| Physics [235 or 240]-241 | _____ | _____ |
| Mathematics 115 | _____ | _____ |
| Mathematics 116 | _____ | _____ |
| Mathematics 215 | _____ | _____ |

**** Chemistry 130 is strongly recommended for students whose orientation exam scores do not place them in Chemistry 210/211.**

| **CONCENTRATION** | | |
|---|---|---|
| Chemistry 260 | _____ | _____ |
| Chemistry 241/242 | _____ | _____ |
| Chemistry 302 | _____ | _____ |
| Chemistry 451 | _____ | _____ |
| Chemistry 452 | _____ | _____ |
| Biology 305 | _____ | _____ |
| Chemistry 453 | _____ | _____ |
| Chemistry 454 | _____ | _____ |
| Biochem Elective Course (no substitutions)<br>(One Course from MCDB 427, 428; Chem 420, 447, 461, 485/500; Med Chem 410) | _____ | _____ |
| Advanced Laboratory Course* or<br>undergraduate research experience** | _____ | _____ |

* The following courses are acceptable:
  Biol. Chem. 416 (Fall Term Only)
  Biol. 429 (Winter Term Only)
  Chem. 480 (Fall/Winter Terms)

**Two semesters of undergraduate research experience (2 credits of Chem 398 level independent study per semester); permission of a concentration advisor is required. Students electing this option must execute an extended research project under the supervision of a faculty member who agrees to oversee the project.

NOTE: Research and a written thesis are required of Honors Concentrators, Chem 498. This course replaces the requirement for an upper-level laboratory course outlined above. Overall GPA 3.3, concentration GPA 3.4.

Recommended, but not required, courses: Biol. Chem. 500-level modules, Biology 427, 428, and Chemistry 417.

Biochemistry flow sheet – before Fall 2002

# Biochem Flow sheet after Fall 2002

# COURSE DESCRIPTIONS

The following math, physics, and chemistry course descriptions should give you an idea of the content of the courses you would be taking as a chemistry concentrator. You will need to check the *LS&A Bulletin*, *Course Guide* and *Time Schedule* for specifics on format and times given. Included here are the number of credit hours and whether the course is lecture, laboratory, or both.

 Prerequisite (grounding)

 Chemistry Requirement

 Biochemistry Requirement

 Chemistry Elective (broadening)

 Biochemistry Elective(broadening)

 Honors

## CHEMISTRY ELECTIVE COURSES

Elective courses provide many opportunities to extend the core curriculum. The Bachelor of Science in Chemistry degree (B.S. Chem degree, 124 credits, see p. 8) requires one elective. The list of electives includes the next course or the next two courses beyond the highest core course in the main areas of chemistry. Students who will not go on to graduate study in chemistry might look first for courses which extend his/her main chemical interests. Students who plan graduate study might select complementary courses as preparation for graduate qualifying examinations and to provide a broader foundation in chemistry; more specialized courses in the student's sub discipline can be taken in graduate school.

## HONOR COURSES 

The following honors courses are required for a Chemistry degree with honors: Chem 461, Honors section (200); Chem 463, Honors section (200); Chem 399 (4 credits) and Chem 499.

The following honors courses are required for a Biochemistry degree with honors: Chem 398 (4 credits over 2 terms) and Chem 498.

## MATH AND PHYSICS PREREQUISITE COURSES

**115**  **Calculus I.**

04 Lec *(Credit usually is granted for only one course from among Math 112, 115, 185, and 295. No credit granted to those who have completed Math 175).*

The sequence Math 115-116-215 is the standard complete introduction to the concepts and methods of calculus. It is taken by the majority of students intending to concentrate in mathematics, science, or engineering, as well as students heading for many other fields. The emphasis is on concepts and solving problems rather than theory and proof. All sections are given a uniform midterm and final exam. The course presents the concepts of calculus from three points of view: geometric (graphs), numerical (tables), and algebraic (formulas). Students will develop their reading, writing, and questioning skills. Topics include functions and graphs, derivatives and their applications to real-life problems in various fields, and definite integrals.

**116**  **Calculus II.**

04 Lec *(Math 115. Credit is granted for only one course from among Math 116,119,156,176, 186, or 296.)*

Topics include the indefinite integral, techniques of integration, introduction to differential equations, infinite series. Math 186 is a somewhat more theoretical course which covers much of the same material. Math 215 is the

natural sequel. A student who has done very well in this course could enter the honors sequence at this point by taking Math 285.

**215 //// Calculus III.**

04 Lec *(Math 116,119,156,176,186 or 296)*

The sequence Math 115-116-215 is the standard complete introduction to the concepts and methods of calculus. It is taken by the majority of students intending to concentrate in mathematics, science, or engineering as well as students heading for many other fields. The emphasis is on concepts and solving problems rather than theory and proof. All sections are given a midterm and final exam. Topics include vector algebra and vector functions; analytic geometry of planes, surfaces, and solids; functions of several variables and partial differentiation; line, surface, and volume integrals and applications; vector fields and integration; Green's Theorem and Stokes' Theorem. There is a weekly computer lab using Maple software. Math 285 is a somewhat more theoretical course which covers the same material. For students intending to concentrate in mathematics or who have some interest in the theory of mathematics as well as its applications, the appropriate sequel is Math 217. Students who intend to take only one further mathematics course and need differential equations should take Math 216.

**216 //// Introduction to Differential Equations.**

04 Lec *(Math 116, 119, 156, 176, 186, or 296)*

For a student who has completed the calculus sequence, there are two sequences which deal with linear algebra and differential equations, Math 216-417 (or 419) and Math 217-316. The sequence Math 216-417 emphasizes problem-solving and applications and is intended for students of engineering and the sciences. Math concentrators and other students who have some interest in the theory of mathematics should elect the sequence Math 217-316. After an introduction to ordinary differential equations, the first half of the course is devoted to topics in linear algebra, including systems of linear algebraic equations, vector spaces, linear dependence, bases, dimension, matrix algebra, determinants, eigenvalues, and eigenvectors. In the second half these tools are applied to the solution of linear systems of ordinary differential equations. Topics include: oscillating systems, the Laplace transform, initial value problems, resonance, phase portraits, and an introduction to numerical methods. There is a weekly computer lab using MATLAB software. This course is not intended for mathematics concentrators, who should elect the sequence 217-316. Math 286 covers much of the same material in the honors sequence. The sequence Math 217-316 covers all of this material and substantially more at greater depth and with greater emphasis on the theory. Math 404 covers further material on differential equations. Math 217 and 417 cover further material on linear algebra. Math 371 and 471 cover additional material on numerical methods.

**140 //// General Physics I.**

04 Lec *(Math 115. Phys. 140 and 141 are normally elected concurrently. No credit granted to those who have completed or are enrolled in 125, 145 or 160)*

Physics 140, 240, and 340 constitute a three-term sequence which examines concepts in physics fundamental to the physical sciences and engineering. This introductory sequence uses calculus, and, while it is possible to elect Physics 140 and Mathematics 115 concurrently, some students will find it more helpful

to have started one of the regular mathematics sequences before electing Physics 140. The introductory sequence is primarily designed to develop a skill: the skill to solve simple problems by means of mathematics. Developing this skill requires daily practice and a sense for the meaning of statements and formulas, as well as awareness of when one understands a statement, proof, or problem solution and when one does not. Thus one learns to know what one knows in a disciplined way.

Covers topics from classical mechanics including vectors, motion in one dimension, circular motion, projectile motion, relative velocity and acceleration, Newton's laws, particle dynamics, work and energy, linear momentum, torque, angular momentum of a particle, simple harmonic motion, gravitation, planetary motion, pressure and density of fluids, and Archimedes' principle.

**141 //// Elementary Laboratory I.**

01 Lab *(Concurrent election with Phys. 140 or 145 is strongly recommended. No credit granted to those who have completed or are enrolled in 127.)*

Physics 141 is a laboratory course intended to accompany Physics 140 and provide a perspective on physics as an experimental science. Evaluation is based on participation and performance in the laboratory classes, and on written laboratory reports and quizzes. Macintosh computers are used for data acquisition and analysis.

**240 //// General Physics II.**

04 Lec *(Physics 140, 145 or 160; and Math 116. Phys 240 and 241 are normally elected concurrently. No credit granted to those who have completed or are enrolled in 126 or 260.)*

See Physics 140 for a general description of the introductory physics sequence.

The topics covered in Physics 240 include classical electromagnetism: charge, Coulomb's Law, electric fields, Gauss' Law, electric potential, capacitors and dielectrics, current and resistance, electromotive force and circuits, magnetic fields, Biot-Savart Law, Ampere's Law, Faraday's Law of induction and simple AC circuits.

**241 //// Elementary Laboratory II.**

01 Lab *Concurrent election with Phys. 240 is strongly recommended. No credit granted to those who have completed or are enrolled in 128.)*

Physics 241 is a laboratory course intended to accompany Physics 240 and provide a perspective on physics as an experimental science. Evaluation is based on participation and performance in the laboratory classes, and on written laboratory reports and quizzes.

## BIOLOGY, BIOLOGICAL CHEMISTRY, AND MED CHEM COURSES

**162 B✓ Introductory Biology**

05 Lec/Lab (*Prior or concurrent enrollment in Chemistry 130. Biology 162 is not open to students who have completed Biol. 152, 154 Or 195. Credit is granted for a combined total of 12 credits elected in introductory biology I, II, IIIA. (5). (NS). (BS). Laboratory fee ($68) required.* A one-term introductory course intended for concentrators in biology, other science programs, or preprofessional studies. Other suitably prepared students wishing detailed coverage of biology are also welcome. The aims of Biology 162 are: (1) to provide factual and conceptual knowledge; (2) to give an integrated overview of the central tenets of modern biology; (3) to afford experience in obtaining and interpreting biological hypotheses; and (4) to develop thinking and writing skills.

Topics in Biology 162 are divided among four areas: (a) cellular and molecular biology; (b) genetics; (c) evolution; and (d) ecology. For Honors credit, register for one of the Honors discussion/lab sections. For further information contact the Introductory Biology office, 1039 Chemistry Building (764-1430).

**305** B **Genetics.**

04 Lec *(Biol 162 (or 152 or 195 Prior or concurrent enrollment in Chem 210. I, II, IIIa)*

This course is intended for students who are concentrating in the natural sciences, or who will apply for graduate or professional study in the biological sciences. The material is divided into two sections; classical studies of how genes are transmitted, and molecular studies of gene structure and regulation. There are three hours of lecture each week, and one discussion section directed by a graduate student instructor. The discussion sections are used to review and expand on lecture material, and to discuss problem assignments.

**409** B **Drug Assay.**

03 Lec/Lab *(Concurrent enrollment in Biochem 415. I)*

Open to graduate students by instructor's permission only. The application of chemical and instrumental methods of analysis to pharmaceutical substances. Two hours lecture, four hours laboratory a week.

**410** B **Principles of Medicinal Chemistry.**

03 Lec *(Biochem 415 or Chem. 451). II)*

This course introduces the concepts required to understand drugs as organic chemicals whose biological activities derive from their chemical structures and physical-chemical properties. The first third of the course covers the general principles of medicinal chemistry and pharmacognosy. The course continues with a general survey of specific drug classes by covering the structures and mechanisms of action of drugs affecting the peripheral and central nervous systems.

**416** B **Introductory Biochemistry Laborataory.**

03 Lab *(Chem 241/242/260; prior or concurrent election of Biol Chem 415 or Chem 451/452. No credit granted to those who have completed or are enrolled in Biol 429 or Biol Chem 516. I)*

A basic laboratory course in biochemical techniques and how to conduct and interpret biochemical laboratory experiments. Experiments include: spectrophotometry; enzymatic (including coupled) and protein assays; enzyme purification and kinetics; thermodynamic measurements; DNA manipulations; including mapping and cloning; PCR; and forensic testing.

**427** B **Molecular Biology.**

04 Lec *(Biol 305, and Chem 451. I.)*

Comprehensive coverage of the general principles governing the structures, synthesis, and functions of DNA, RNA, and proteins in the context of the cell. Emphasizes understanding methods and interpretation of data. Topics include genome organization, DNA replication and transposition, chromosome segregation, transcription and translation, the processing of macromolecules, signal transfer, and regulation at various levels. Two lectures per week are supplemented by a 1.5 hour discusssion section.

**428** B **Cell Biology.**

04 Lec (*Biol 305, and Chem 451. II.*)

Biology 428 is designed to provide students with a comprehensive overview of the biology of eukaryotes and prokaryotes at the cellular and molecular level. This course is intended for upper-level

undergraduates and graduate students. The information is presented at a level that requires students to integrate information from their other biology, chemistry, and biochemistry courses. Topics include: cell structure and function; cell membranes; intracellular organelles and cytoskeleton; inter- and intra-cellular signaling; cell development and cell cycle. Students will be expected to integrate the scientific data presented in class as well as to read and interpret basic research drawn from the current scientific literature. Grades will be based on four exams and the discussion section.

**429**  **Laboratory in Cell and Molecular Biology.**

03 Lab *(Biol 427 or 428, or concurrent enrollment in Biol 428. No credit granted to those who have completed or are enrolled in Biol Chem 416 or 516. II)*

The course consists of two lectures and one four-hour laboratory session each week. Additional time outside of scheduled lab sessions will be required. The laboratory sessions introduce microscopy and staining, electrophoresis and cell culture. Grades are based on weekly quizzes, two lecture exams and a lab grant proposal.

## CHEMISTRY COURSES

**125/126**  **General and Inorganic Chemistry: Laboratory**.

02 Lab *(Prior or concurrent with 130. No credit granted to those who have completed Chem. 211. I, II, IIIa)*

This laboratory course can be elected with, or following, Chem 130. It is intended that students planning to enroll in Chem 130 that have had little or no previous chemistry laboratory enroll concurrently in Chem 125/126. The focus of this guided inquiry laboratory is to foster critical thinking that allows students to design, perform, and interpret experiments. In addition, the student acquires technical skills that are required for further advancement in experimental sciences. Although an ability to collect and analyze data in a quantitative manner is developed, the emphasis of the course is to provide a qualitative understanding of the basic concepts of chemistry. This is accomplished by demonstrating that chemical principles are derived from experimental data. The goal is to provide students both with a more accurate picture of the scientific process and also with skills that are relevant to solving real life problems. Much of the course work is done as a member of a team. Student groups each explore the same problem with each group using different reagents and/or conditions. A networked computer system is used to collect, pool, and summarize the largely *qualitative* class data. Student groups address questions which require them to organize the class data using commercial graphing software. Group answers are presented in discussion.

**130**  **General Chemistry: Macroscopic Investigations and Reaction Principles.**

03 Lec *(3 years of high school math or Math 105; one year of high school chemistry recommended. Placement by testing or permission of Chemistry department. Intended for students without AP credit in chemistry. I, II, IIIa)*

This General Chemistry course is intended to fulfill the one term chemistry requirement for students interested in science, or as a natural science elective for non-science concentrators. This course may also be used as the first term in a four or more term chemistry sequence (probably 130, 210/211, 215/216, 260, 241/242 etc.) for science concentrators and pre-

professional students. Chemistry 130 provides an introduction to the major concepts of chemistry, including the microscopic picture of atomic and molecular structure, periodic trends in the chemical reactivity, the energetics of chemical reactions and the nature of chemical equilibria. Students will be introduced both to the fundamental principles of modern chemistry, the descriptive chemistry of the elements, and to the underlying theories that account for observed macroscopic behavior. In Chem 130, students will learn to think critically, examine experimental data, and form generalizations about data as chemists do. Chem 130 will meet three times each week in lecture sections with senior faculty (the intensive section will have four lectures a week), and once a week in small group discussion classes led by graduate student instructors (the intensive section will have four lectures a week), and once a week in small group discussion classes led by graduate student instructors. Lecturers and graduate student instructors will have scheduled office hours for outside of class help, and computerized study aids will be available to all students.

**CHEM 130.600** provides an introduction to the major concepts of chemistry in an experimental manner, integrating traditional lecture with hands on laboratory methods in a studio classroom. The topics will include the microscopic picture of atomic and molecular structure, periodic trends in chemical reactivity, the energetics of chemical reactions, and the nature of chemical equilibria. Students will be introduced to the fundamental principles of modern chemistry, the descriptive chemistry of the elements, and to the underlying theories that account for observed macroscopic behavior. The integrated CHEM 130.600 studio section will give students an opportunity to think critically, examine experimental data, and form generalizations about data as chemists do within a highly collaborative setting. Emphasis in the studio classroom will be on drawing a direct connection between lecture content and scientific phenomenon. The integrated CHEM 130.600 and 125.600 will meet in a large lecture hall one time each week for one and a half hours for instruction led by a faculty member and twice a week in three hour small group studio sections led by a graduate student instructor. Lecturers and graduate student instructors will have scheduled office hours for after-class help, and computerized study aids will be available to all students. Students in this course will earn Honors credit. Course grades will be determined from in class discussion and participation, two one-hour examinations (Tuesday nights), and a final examination including both written and hands-on portions.

**210 //// Structure and Reactivity I.**
04 Lec (*3 years high school math, strong background in high school chemistry, satisfactory grade on placement test, concurrent enrollment in 211. I, II, IIIa)*

Chemistry 210 is the first course in a two-term sequence in which the major concepts of chemistry are introduced in the context of organic chemistry. Emphasis is on the development of the capacity of students to think about the relationship between structure and reactivity and to solve problems in a qualitatively analytical way. This course is a particularly good first course for students with AP credit in chemistry, Honors students, and other students with a strong interest in chemistry and biology

**211 //// Investigations in Chemistry.**

01 Lab (*Concurrent enrollment in 210. I, II, IIIa)*

Chemistry 211 is a laboratory introduction to methods of investigation in inorganic and organic chemistry. Students solve individual problems using microscale equipment and a variety of techniques such as thin layer chromatography, titrations, and spectroscopy. The course consists of a four-hour laboratory period with a graduate student instructor under the supervision of the professor. Students keep laboratory notebooks, which also serve as laboratory reports. Grades are based primarily on performance in the laboratory and the laboratory notebooks.

**215 ~~////~~ Structure and Reactivity II.**

03 Lec (*210 and 211; Concurrent enrollment in 216. I, II, IIIa)*

CHEM 215 continues the study of organic chemistry started in CHEM 210. A functional group approach is used, centering on the carbonyl group. The chemistry of aldehydes, ketones, carboxylic acids and their derivatives are treated in detail. The course has three examinations and a final examination.

**216 ~~////~~ Synthesis and Characterization of Organic Compounds.**

02 Lab *(Must be taken with Chem. 215. I, II, IIIa)*

Chemistry 216 builds on the experimental approach started in Chemistry 211. Students participate in planning exactly what they are going to do in the laboratory by being given general goals and directions that have to be adapted to fit the specific project they will be working on. They use microscale equipment, which requires them to develop manual dexterity and care in working in the laboratory. They also evaluate the results of their experiments by checking for identity and purity using various chromatographic and spectroscopic methods. Students will be expected to keep a laboratory notebook that will serve as the basis for their laboratory reports.

**218 Independent Study in Biochemistry**

01 Lab *(Permission of instructor and less than junior standing, may be repeated for a total of 4 credits.)*

This course provides an introduction to independent biochemistry research under the direction of a faculty member whose project is in the biochemistry area. The Chemistry Department encourages students to get involved with undergraduate research as early as possible. The Advising Office, 1500 Chemistry, provides information to help students in meeting with faculty members to discuss research opportunities. Chemistry 218 is for biochemistry concentrators and research projects must be approved by a biochemistry advisor. Exact details such as nature of research, level of involvement of the student, credit hours awarded, and criteria for grading are individually determined in consultation with the faculty member. The student is expected to put in a minimum of three hours per week of actual work for a 14 week term for each credit elected. At the end of each term, three copies of a written report are submitted - one for the Advising Office, one for the student, and one for the faculty supervisor. Petitions to Register are in 1500 Chemistry and must be filled out to obtain an override. See Procedures for Research and Independent Study Courses and Student-Professor Agreement form (pp. 41-42). Chemistry concentrators should elect 219 rather than 218.

**219 Independent Study in Chemistry.**

01 Lab *(Permission of instructor and less than junior standing, may be repeated for a total of 4 credits)*

Research in an area of interest to, and supervised by a Chemistry faculty member. The Chemistry Department encourages students to get involved

with undergraduate research as early as possible. The Advising Office, 1500 Chemistry Building, provides information and help to students in meeting with faculty members to discuss research opportunities. Exact details such as nature of research, level of involvement of the student, credit hours awarded, and criteria for grading are individually determined in consultation with the faculty member. The student is expected to put in at least three hours a week of actual work for a 14 week term for each credit elected. At the end of each term, three copies of a written report are submitted- one for the Advising Office, one for the student, and one for the faculty supervisor. For a student to receive Chemistry credit for Chemistry 219, the student must work on a research project supervised by a faculty member of the Chemistry Department, either alone, or in collaboration with a colleague within the department, from another department, or from another school. This collaboration must be an ongoing one, and the student must receive direct supervision by all of the faculty who have agreed to sponsor the project. Final evaluation of the research effort and the report, as well as the grade for the course, rests with the faculty member from the Chemistry Department Petitions to Register are in 1500 Chemistry and must be filled out to obtain an override. See Procedures for Research and Independent Study Courses and Student-Professor Agreement form (pp. 41-42).

**230 Physical Chemical Principles and Applications.**

03 Lec *(Chem 215. No credit granted to those who have completed or are enrolled in Chem 260. Not for concentrators.)*

This Chemistry course is intended as a fourth term in chemistry for science concentrators and pre-professional students, completing the two year chemistry sequence required by, for example, the medical, dental, and engineering programs. Students who plan to continue beyond a fourth term in chemistry would typically enroll in Chemistry 260/242/242 instead of Chemistry 230; credit will not be given for both of these courses. In CHEM 230,students will be introduced to the physical principles underlying some of the major topics of inorganic and analytical chemistry. These include the gaseous, liquid, and solid states of matter; phase transitions and solutions; electrochemistry and the principles of oxidation-reduction reactions; chemical kinetics and the study of chemical orbitals and chemical bonding; transition metal chemistry and coordination complexes. These topics will be treated from the viewpoint of the experimental scientist, with an emphasis on the application of physical chemical principles to chemical behavior in a broad spectrum of settings.

**241 Introduction to Chemical Analysis.**

02 Lec (*Prior or concurrent enrollment in Chem 260. I, II)*

Chemistry 241 is a continuation of Chemistry 130, 210/211, and 215/216, and is designed primarily for students in the biological and chemical sciences. This course introduces the principles and techniques of modern quantitative chemical analysis. Chemical equilibrium as the basis of analytical techniques will be emphasized. Photometric and potentiometer titrimetry will be discussed to illustrate quantitative chemical measurements. Molecular (UV) and atomic spectroscopy as well as mass spectrometry will be discussed. Fundamental concepts of chemical separations including GC and HPLC will be discussed. Throughout the

course the fundamental principles of experiment design, laboratory data systems and statistical evaluation will be stressed.

Note: This course is linked to Chemistry 242. Students must elect both Chemistry 241 (for 2 credits) and Chemistry 242 (for 2 credits).

**242 //// Introduction to Chemical Analysis Laboratory.**

02 Lab *(Prior or concurrent enrollment in Chem 260. I, II)*

Chemistry 242 is the laboratory component of the Chemistry 241/242 course sequence. Experiments include studies of equilibria (titration, potentiometry), separations (gas and liquid chromatography), electrochemistry, and spectroscopy (atomic and molecular absorption and emission).

Note: This course is linked to Chemistry 241. Students must elect both Chemistry 241 (for 2 credits) and Chemistry 242 (for 2 credits).

**260 //// Chemical Principles.**

03 Lec *(Chem. 210/211, Math 115, and prior or concurrent enrollment in Physics 135, 140, or 160. I, II, IIIa)*

Chemistry 260 is a continuation of Chemistry 130, 210/211, 215/216, and is designed primarily for students in the biological and chemical sciences. The course introduces students to the quantal nature of matter (the Schrödinger equation and the mathematical machinery of quantum mechanics), the basic principles of chemical thermodynamics (1st and 2nd laws of thermodynamics) and kinetics (empirical rate laws). In addition, this course introduces students to the fundamental principles necessary to understand spectroscopy (electronic, vibrational, and rotational) and electrochemistry (free energy, Nernst and Faraday's laws).

**302 B✓ C✓ Inorganic Chemistry: Principles of Structure, Reactivity, and Function.**

03 Lec *(Chem 260. I, II)*

This course is intended to introduce students to the properties of the elements and the compounds that they form. The course should be elected by students concentrating in chemistry, chemical engineering or cellular and molecular biology. The course will provide an introduction to the structure and properties of those elements other than carbon. Topics that will be included are the electronic structure of atoms, molecules and extended solids, bonding, periodicity, main group and transition element chemistry, catalysis and bioinorganic chemistry.

**312 C✓ Synthesis and Characterization.**

02 Lab *(Chem 215 and 216. Prior or concurrent enrollment in Chem 302. I, II)*

Chemistry 312 introduces students to advanced techniques used in the synthesis, purification, and characterization of inorganic and organic compounds. This course emphasizes methods for handling air-sensitive material such as organo-metallic compounds, and includes syringe techniques, working under vacuum or inert gas atmospheres, vacuum distillations as well as various chromatographic and spectroscopic techniques.

**398 H Undergraduate Research in Biochemistry.**

01, 02, 03 or 04 Lab *(Junior standing, and permission of a biochemistry concentration advisor and the professor who will supervise the research. (1-4). May be elected for a total of 4 credits during junior or senior year.)*

Elected starting in the junior or senior year, this course is an optional requirement for Biochemistry students

and a requirement for Honors Biochemistry students, who must elect it for a total of four credits spread out over two or more terms. The student is expected to put in at least three hours a week of actual work for each credit elected. At the end of each term, a written report evaluating the progress of the project is submitted; one copy to the faculty member, one copy for the Advising Office (1500 Chemistry), and one copy for the student. Interim reports need not be lengthy, but the final report for Chemistry 398 is expected to be more detailed and longer than the reports in 218.

For a student to receive Chemistry credit for Chemistry 398, the student must work on a research project supervised by a biochemistry concentration research faculty and the project must be approved by a biochemistry advisor. Final evaluation of the research effort and the report, as well as the grade for the course, rests with the biochemistry research faculty member. See Procedures for Research and Independent Study Courses and Student-Professor Agreement form (pp. 41-42).

**399 H Undergraduate Research in Chemistry.**

01, 02, 03 or 04 Lab *(Junior standing, and permission of a chemistry concentration advisor and the professor who will supervise the research. (1-4). May be elected for a total of 4 credits during junior or senior year.)*

Elected starting in the junior or senior year, this course is a requirement for B.S. Chemistry students, who must elect it for a total of four credits spread out over two or more terms. The student is expected to put in at least three hours a week of actual work for each credit elected. At the end of each term, a written report evaluating the progress of the project is submitted; one copy to the faculty member, one copy for the Advising Office, and one copy for the student. Interim reports need not be lengthy, but the final report for Chemistry 399 is expected to be more detailed and longer than the reports in 219.

For a student to receive Chemistry credit for Chemistry 399, the student must work on a research project supervised by a faculty member of the Chemistry Department, either alone, or in collaboration with a colleague within the department, from another department, or from another school. This collaboration must be an ongoing one, and the student must receive direct supervision by all of the faculty who have agreed to sponsor the project. Final evaluation of the research effort and the report, as well as the grade for the course, rests with the faculty member from the Chemistry Department. See Procedures for Research and Independent Study Courses and Student-Professor Agreement form (pp. 41-42).

**402 C✓ Intermediate Inorganic Chemistry.**

03 Elective Lec *(Chem 302 and 461/462. I)*

Chemistry 402 is a second term course in inorganic chemistry at the undergraduate level. The goals of the course are two-fold. On the one hand, it will build upon the concepts presented in the earlier course. Topics included here will emphasize the interrelations of ideas presented earlier in the curriculum. For example, discussion can include the relation between oxidation and reduction and acidity, periodic trends in acids and bases, the relation of hard and soft ideas to molecular orbital theory, periodic trends in standard reduction potentials, and the relation of molecular structure to conductivity and magnetism. The key topics to be

covered in this portion of the course include acid-base chemistry, theories of bonding, periodic properties and d-metal complexes. The course goes on to cover additional topics selected from issues in catalysis, bioinorganic chemistry, structure-property relations, solid state chemistry, organometallic chemistry, kinetics of organometallic reactions, f-block compounds, electron deficient clusters, and quantum models of structure and bonding.

**417** C **Dynamical Processes in Biophysics.**

03 Elective Lec *(Math 216 and Physics 242 or Chemistry 463; or permission of instructor. II even years)*

Topics include diffusion in biology (electrical potentials across membranes, nerve action potentials, neuromuscular synapses, the physics of chemoreception, and reaction rate theory); optical techniques (visible and ultraviolet light absorption, fluorescence and phosphorescence); and random processes in biophysics (mathematics of random noise, membrane electrical fluctuations, quasielastic light scattering fluctuations, fluorescence fluctuations, and chaotic processes).

**420** C **Intermediate Organic Chemistry.**

03 Elective Lec *(215/216 or equivalents. II)*

Chemistry 420 is an exploration of selected topics in organic chemistry. The course builds on the basic concepts of structure and reactivity considered in Chemistry 210 and 215. Emphasis will be on the mechanisms of organic reactions. Molecular rearrangements and reactions involving the major types of intermediates - carbocations, carboanions, free radicals and carbenes will be covered in detail. The course is intended to strengthen the student's understanding of modern organic chemistry. It may serve as a terminal course on the topic or as a bridge between the first year of organic chemistry and further study in the area.

**436** C **Polymer Synthesis and Characterization.**

03 Elective Lec/Lab *(Chem 241, 242, 260 or equivalent or permission of instructor. II)*

Polymer Synthesis and Characterization introduces the special techniques and analyses appropriate for study of macromolecules. Students prepare polymers in the laboratory and characterize their preparations by various physical methods. Experiment list Emulsion Polymerization Styrene; Thermodynamics of Rubber Elasticity; Crosslink Density by Solvent Swelling; Cationic Polymerization of Trioxane; Anionic Polymerization of Styrene; X-ray Diffraction of Polymer Fibers; Co-polymerization of Methylmethacrylate/Styrene; UV/IR Analysis of Reactivity Ratios; Synthesis of Optically Active Polymer (Polybenzofuran); Gel Permeation Chromatography; Dilute Solution Viscosity; Light Scattering Molecular Weight; NMR of Poly (Benzylglutamate); DSC/TGA of Polymers; Computer Simulation of Polymer Molecules in Solution; Polymer Unknown.

**447** C **Physical Methods of Analysis.**

03 Lec *(CHEM 260 or 370, and 241/242. I, II)*

The course introduces the student to the principles and techniques of modern analytical chemistry. Atomic and molecular spectroscopy, mass spectrometry, and chromatographic separation techniques are stressed. Some discussion of contemporary electrochemistry is included. The principles of data collection and the processing and representation of analytical signals are introduced.

**451** C B **Introduction to Biochemistry I.**

04 Lec *(CHEM 215, prior or concurrent enrollment in 260 or 370, BIOLOGY 162, or [171 and 172], MATH 115. No credit granted to those who have completed or are enrolled in Biology 310, 311(411) or Biochem 415. I)*

This course is the first in a two-term sequence designed for biochemistry concentrators. Emphasis is on developing the capacity of the students to think about complex biological processes in terms of the underlying chemistry. An introductory section on proteins is followed by sections on enzymes and coenzymes. The discussion of biochemical energetics includes sections on glycolysis, the tricarboxylic acid cycle, electron transport, photosynthesis, and carbohydrate metabolism.

**452** C B **Introduction to Biochemistry II.**

04 Lec *(Chem 451. II)*

This course is the second in a two-term sequence designed for students who are concentrators in biochemistry. Emphasis is on developing the capacity of the students to think about complex biological processes in terms of the underlying chemistry. Initially nucleic acids and nucleotides are discussed. The biosynthesis of amino acids and their utilization in cellular metabolism including protein synthesis serves as a primer for an introduction to biochemical genetics and virology.

**453** B **Biophysical Chemistry I: Thermodynamics and Kinetics.**

03 Lec *(Chem 260 (or Chem 261 and ChemE 330), Chem 451, Physics 240, and Math 215. No credit granted to those who have completed or are enrolled in Chem 463. I)*

First in a two-term biophysical chemistry sequence for biochemistry students. Emphasis is on topics and applications relevant to biochemistry and modern biophysical chemistry, building on Chem 260. Rigorous mathematical theory of classical thermodynamics is developed, including application to entropy, heat engines, solution properties, and phase and chemical equilibrium. Modern statistical thermo- dynamics, modern theories of fundamental reaction rates and enzyme kinetics and molecular transport theories will be described and developed.

**454** B **Biophysical Chemistry II: Macromolecular Structure and Dynamics.**

03 Lec *(Chem 453 or 463, and Chem 451/452 or equivalent, II)*

This course builds on the Chem 451-453 sequence and aims at providing an understanding of the structure and dynamics of biological macromolecules. After introducing the necessary nomenclature and reviewing thermodynamic principles, modern techniques to characterize the structure and dynamics of biopolymers are the focus. Sedimentation, electrophoresis, mass spectrometry, X-ray diffraction, scattering, and spectroscopic techniques such as absorption, circular dichroism, fluorescence, and NMR are covered. Both physical principles and practical applications in the Life Sciences are highlighted.

**461.** B C **Physical Chemistry I.**

03 Lec *CHEM 260 or 370. PHYSICS 240 or 235, and MATH 215. No credit granted to those who have completed CHEM 397 or 469 I, II, IIIa)*

This is the second of the three term physical chemistry sequence Chemistry 260/461/463. Chemistry 461 builds on

the introduction to quantum mechanics that was given in Chemistry 260. Students will use the Schrödinger Equation in 1, 2, and 3-dimensions to solve exactly a series of important chemical problems including the harmonic oscillator, the rigid rotor, and the hydrogen atom. Group theory is introduced as an aid for understanding spectroscopic selection rules. Advanced spectroscopy, including transition probabilities, normal vibrational modes, and photoelectron spectroscopies are introduced and then used to deduce molecular structure. The valence-bond and molecular orbital theories of chemical bonding are discussed, and methods for performing quantum chemical calculations, including variational and perturbation methods, are introduced. The quantum mechanics of spin and angular momentum are discussed and used to interpret magnetic resonance spectra.

**461 H Section 200 (Fall only)**

This section is designed to introduce students to a more thorough, research oriented view of Physical Chemistry. Required for Honors Chemistry Concentrators

NOTE: Students are strongly encouraged to elect the Computational Chemistry Laboratory (Chemistry 462, 1 credit) in the same term that Chemistry 461 is taken.

**462 B C Computational Chemistry Laboratory.**

01 Lab *(Math 215, and prior or concurrent enrollment in Chemistry 461. I, II)*

This course introduces modern computational tools for symbolic mathematics and for graphical display (Mathematica and Maple). Examples are given of the use of these tools for solving problems in quantum mechanics and quantum chemistry, including exploration of the functional forms of wave functions, solutions of simple differential equations, and diagonalization of Hamiltonians. Molecular modeling software (HyperChem} and CAChe) is introduced and used to perform both *ab initio* and semi-empirical quantum chemical calculations. The examples used are taken largely from the topics discussed in Chemistry 461.

NOTE: Students are strongly encouraged to elect the second term of Physical Chemistry (Chemistry 461, 2 credits) in the same term that Chemistry 462 is taken.

**463 C Physical Chemistry II.**

03 Lec *(Chemistry 461/462. I, II)*

This is the third of the three term physical chemistry sequence Chemistry 260/461/463 and builds on material presented in both previous courses. The rigorous mathematical theory of classical thermodynamics will be developed, including applications to entropy, heat engines, solution properties, and phase and chemical equilibria. Modern statistical thermodynamics will be introduced. Modern theories of fundamental reaction rates will be used built on the phenomenological kinetics introduced in Chemistry 260. Methods for determining and understanding solid state structures will be discussed, building on group theory introduced in Chemistry 461.

**463 H Section 200 (Winter only)**

This section is designed to introduce students to a more thorough, research oriented view of Physical Chemistry. Required for Honors Chemistry Concentrators

**467 C Biogeochemical Cycles.**

03 Elective Lec *(Math 116, Chem 210, Physics 240. I)*

Biogeochemical cycles describe how carbon, nitrogen, sulfur, and other elements cycle through the environment (the atmosphere, ocean, and landmasses). This course is useful to workers in many fields, including engineering, atmospheric science, chemistry, physics, biology, geology, natural resources, and public health. The biogeochemical cycles of water, carbon, nitrogen, and sulfur; the atmosphere and oceans as reservoirs and reaction media; the fate of natural and human-made sources of carbon, nitrogen, and sulfur compounds; the interactions among major biogeochemical cycles and resultant global change; greenhouse gases, acid rain, and ozone depletion.

**480 C Physical and Instrumental Chemistry.**

03 Lab *(Chem 447 and 461/462 and concurrent enrollment in Chem 463 or permission of instructor. I, II)*

This course explores methods for the measurement of the physical and spectroscopic properties of substances and the application of these methods in instrumental analysis. The course is focused on essential laboratory principles and operations as they relate to the physicochemical properties of organic, inorganic, and macromolecular chemical species. Experiments study the areas of equilibria, chemical structure, chemical change, and computer simulation and calculation. Emphasis is placed upon the effective design of experiments together with synergistic coupling of modern instrumentation and computers. The course includes literature searches for physical data. Laboratory reports constitute an important component of the course.

**485 Projects Laboratory.**

02 Lab *(302/312 for inorganic/organic project, 480 for analytical/physical project. I, II)*

A project-oriented laboratory in which students work on one or two projects in depth during the term. The projects are suggested by the faculty and require library as well as laboratory work. The projects may be in any area of analytical, inorganic, organic, physical or polymer chemistry. Students interested in projects in inorganic or organic chemistry should elect section 100, 200 or 300. Those interested in analytical or physical projects should elect section 400. Section 500 is for biochemistry projects.

**495 Professional Development in the Chemical Sciences**

02 Lec *(Chem 461. ULWR. II)*

This course is intended for upper-level students in the chemical sciences who wish to enhance their writing, speaking, and critical analysis skills. The "studio" format will allow for projects to be discussed, demonstrated, or performed in an open peer-group environment. The subject matter will include a mixture of styles, topics, and modes of operation, including: critical analysis and topics, and proficiency of written and oral communication for the scientific community, the workplace, and the lay-public, including the preparation of materials; and an introduction to the multi-faceted features of professional life, including assuming professional responsibilities, ethical decision-making, interviewing, personal presentation skills, and issues related to diversity and multiculturalism. Grading will be based on an evaluation of a portfolio of evidence from the student's writing, speaking, and overall quality of participation. This course may be used to meet the Upper Level Writing Requirement.

**498 H Undergraduate Honors Thesis in Biochemistry.**

01 *(Chem 398 and permission of honors advisor)*

To be elected under the Honors advisor's indi number in the term in which an Honors biochemistry student presents a thesis on undergraduate research.

**499 H Undergraduate Honors Thesis in Chemistry.**

01 *(Chem 399 and permission of honors advisor)*

To be elected under the Honors advisor's indi number in the term in which an Honors chemistry student presents a thesis on undergraduate research.

**511 C Materials Chemistry.**

03 Elective Lec *(Chem 215/216 and Chem 241/242/260. I)*

This course presents concepts in Materials Chemistry. The main topics include (a) a survey of characterization methods appropriate for solid state materials, including XRD, PES, STM, AFM, SIMS, and thermal methods, (b) syntheses of representative materials, *e.g.*, ceramics via sol-gel, conjugated polymers, inorganic and coordination solids, and Nan structured materials, and (c) materials properties, including electrical, optical, and magnetic behavior, and how these properties are related to molecular and solid state structure.

**520 C Biophysical Chemistry I.**

03 Elective Lec *(Chem 463, Biol Chem 415, or Chem 420. I)*

This course is the first of a two term biophysical chemistry series Biophysics 520/521, but can be taken as a stand-alone course as well. The course offers an overview of protein, nucleic acid, lipid and carbohydrate structures. Intra- and inter-molecular forces, helix-coil transitions and protein folding will be treated in a thermodynamical context. Thermodynamics of solutions, configurational statistics, ligand interaction, multisite interactions and cooperativity are treated in depth. Kinetics of protein-ligand binding, including electron transfer and ligand diffusion are discussed. Chemistry 520 will introduce and explain the physico-chemical properties of biological macromolecules and their complexes, mostly in solution. Currently, biophysical, biochemical and pharmaco-chemical research literature is full with papers interpreting the properties of biological macromolecules on the basis of their three-dimensional structure. This course will expand on that concept by offering a rigorous background in energetics, folding, interactions, and dynamics. As such the course is important to any student who has to deal with the concepts of biomolecular function and structure such as biochemists, biophysicists, mathematical biologists, and molecular pharmacologists. Molecular dynamics will be introduced.

**535 C Physical Chemistry of Macromolecules**

03 Lec *(Chem 463. II)*

Among the topics covered are the thermodynamics of mixtures, the Flory-Huggins theory of polymer solutions, more modern theories of polymer solutions, the size and shape of macromolecular chains in solution and in bulk, rubber elasticity, polymer adsorption behavior, and polymer diffusion and scaling theories. The course begins with a short, intense review of thermodynamics, but a grounding in the subject to at least the level of Chemistry 463 (Physical Chemistry) is required. There is an assigned text and several original papers are assigned for study.

**538 C Organic Chemistry of Macromolecules**

03 Elective Lec *(Chem 215/216 and Chem 241/242/260. I)*

Chemistry of monomer and polymer synthesis; mechanistic analysis of reactions. Stereochemistry of polymer structures, both natural and synthetic. Scope of subject matter: free radical

and ionic polmerization, condensation polymerization, ring opening and nonclassical polymerization. Special topics from the recent literature.

**540 Organic Principles.**

03 Elective Lec *(Chem 312, 461. I)*

Mechanisms of organic chemical reactions, stereochemistry, and conformational analysis. The important types of organic reactions are discussed. Basic principles are emphasized; relatively little attention is paid to the scope and synthetic applications of the reactions.

**545 Analytical Chemistry.**

03 Elective Lec *(Chem 447, 461. I)*

Systematic consideration of contemporary analytical chemistry, emphasizing the basic principles and applicability of separation and physical measurement. Basic instrumentation for analysis; multistage separation and partition theory; theoretical and experimental fundamentals of chroma-tography and its important embodiments; photometric (optical) methods covering the whole radiant energy spectrum; electrochemical methods. Some other areas: magnetic field methods, radioactivity, data evaluation, topics on analysis of materials.

**567 Chemical Kinetics.**

03 Elective Lec *(Chem 461 or AOSS 479.)*

Chemical Kinetics is the study of the rates and mechanisms of systems undergoing chemical change. The extraction of rate data from reacting systems and the utilization of such data in other reacting systems is central to chemistry in the laboratory and in the practical worlds of combustion science, atmospheric science, and chemical synthesis. This course introduces the treatment of complex chemical systems and fundamental ideas about chemical reaction rates in gases and in solutions. Computer software will be utilized to treat complex reaction systems. Course Outline. Basic Concepts: Definitions, Elementary Reaction Rate Laws, Phenomenology. Macroscopic Kinetics: Complex Reaction Mechanisms, Kinetic Measurements, Data Analysis, Numerical Solutions. Microscopic Kinetics: Collision Dynamics, Measurements, Statistical Theories, Dynamics in Solution. Important Applications: Atmospheric Chemistry, Combustion Chemistry.

**571 Quantum Chemistry.**

03 Elective Lec *(Chem 461/permission. I)*

Constitutes with 576 a full course for students specializing in physical chemistry. Review of quantum mechanics from a postulational viewpoint; variational and matrix methods, time-independent and time-dependent perturbation theory; applications to molecular systems including potential energy surfaces and reaction pathways.

**Planning Advanced Courses.** Past experience is the best guide to when courses will be offered in the future. The following list gives times for recent terms. Courses offered in Spring Half Term have been 125/126, 130, 210/211, 215/216, 260 and 461.

| Course | Winter 2004 | Fall 2005 |
|---|---|---|
| Chem 241 | TTh 12-1 | TTh 12-1 |
| Chem 242 | MF 1-5 | MF 8-12 |
| | TTh 8-12, 1-5 | TTh 8-12, 1-5 |
| Chem 260 | MWF 10-11, 1-2 | MWF 10-11, 2-3 |
| Chem 302 | MWF 11-12, 3-4 | MWF 9-10 |
| Bio 305 | TTh 10-11:30 | TTh 8:30-10 |
| Chem 312 | MF 1-5 | MF 1-5 |
| Chem 402 | not offered | MWF 10-11 |
| Chem 420 | MWF 9-10 | not offered |
| Chem 447 | MWF 10-11 | MWF 8:30-10 |
| Chem 451 | not offered | MWF 9-10 |
| Chem 452 | MWF 9-10 | not offered |
| Chem 453 | not offered | MWF 11-12 |
| Chem 454 | MWF 10-11 | not offered |
| Chem 461 | MWF 11-12 | MWF 11-12 |
| Chem 462 | T 1-5, Th 1-5 | T 1-5, Th 1-5 |
| | | T 1-2 |
| Chem 463 | MWF 11-12 | MWF 11-12 |
| Chem 467 | not offered | TTh 10:30-12 |
| Chem 480 | MWF 1-5, TThF 1-5 | MWF 1-5 |
| Chem 485 | MW 1-5, MF 1-5 | MWF 1-5 |
| | TTh 1-5 | TTh 8-12, 1-5 |
| Chem 495 | T 10-12 | not offered |
| Chem 511 | not offered | TTh 9-10:30 |
| Chem 520 | not offered | TTh 2:30-4:00 |
| Chem 538 | not offered | TTh 10:30-12 |
| Chem 540 | not offered | MWF 9-10 |
| Chem 541 | MWF 9-10 | not offered |
| Chem 545 | not offered | MWF 10-11 |
| Chem 567 | not offered | not offered |
| Chem 571 | not offered | MWF 10-11 |
| Chem 616 | TTh 10:30-12 | not offered |

# PROCEDURES for RESEARCH and INDEPENDENT STUDY COURSES

The Department of Chemistry offers courses which allow undergraduate students to participate in the scholarly activities of the faculty. The courses require considerable initiative on the part of the student both in arranging for collaboration with a particular faculty member and in carrying out the collaboration. It is wise to start exploring possible arrangements THE TERM BEFORE YOU INTEND TO REGISTER, but in any event registration must be completed by the end of the free drop/add period of the term. The courses are:

**Chem 218. Independent Study in Biochemistry** ***Permission of instructor. For students with less than junior standing.(1) May be repeated for a total of 4 credits toward graduation requirements.***

**Chem 219. Independent Study in Chemistry** ***Permission of instructor. For students with less than junior standing.(1) May be repeated for a total of 4 credits toward graduation requirements.***

**Chem 398. Undergraduate Research in Biochemistry** ***Junior standing (55 credits toward program) and permission of the professor who will supervise the research. (1-4). May be elected for a total of 4 credits toward graduation requirements.***

**Chem 399. Undergraduate Research in Chemistry** ***Junior standing (55 credits toward program) and permission of the professor who will supervise the research. (1-4). May be elected for a total of 4 credits toward graduation requirements.***

## STUDENT

Consider research interests of the faculty as described in the chemistry graduate brochure, biochemistry research notebook in 1500 Chem, or websites *(http://www.umich.edu/~michchem, /biochem/, /~biophys/)* and make appointments for meetings. Reach agreement on the research project for the term with a professor of choice and complete the Student-*Professor Agreement for Independent Study* for each term registered. Handwrite your research description, signature and *indi* number of professor. Each credit is equivalent to at least three hours a week of actual work for a 14 week term (minimum 50 hours per term-credit hour).

Submit a copy of the form to 1500 Chemistry, obtain an electronic permission, and register on line. **Register no later than last day of regular drop/add.** No overrides will be given after this date and all overrides will expire after this date.

Watch safety video in the Science Learning Center (1720 Chem) before beginning lab work.

Maintain a laboratory notebook which will be turned in to the research advisor at the end of the term.

Submit a short report to your research advisor and a copy to Academic Services (1500 Chemistry) by the last day of exams unless required earlier by research advisor.

## PROFESSOR

Discuss research project with student.

Sign the *Student-Professor Agreement for Independent Study or Undergraduate Research* form for each term of registration.

Refer Honors students to the Honors Office, 1330 Mason Hall, to apply for thesis funding. The Honor's Thesis research Grant funds Honors projects (up to $150) with application deadlines in November and March.

Specify what type of report will be required in addition to lab notes, and when they are due (no later than the last day of exams).

Grade student (A-E).

When a report is not turned in, the professor will assign an “I” grade if "the amount of unfinished work is small, the work is unfinished for reasons acceptable to the instructor, and the student's standing in the course is at least C-." "Incomplete grades may be made up while a student is not in residence. An incomplete grade must be made up by the fourth week of a student's next fall or winter term in residence..."(p. 20 LS&A Bulletin).

## ACADEMIC SERVICES

Provide supplementary project descriptions. Listings of professors and research are in this handbook, Chemistry pp. 3-4, Biochemistry pp. 43-46. Give electronic permissions to students after submitting signed Agreement form. Biochemistry projects will be approved by a biochemistry advisor and then the electronic override will be issued.

File Agreements, semester reports and Honors Theses.

# STUDENT-PROFESSOR AGREEMENT

## CHEM 218 *or* 219 - Independent Study in Biochemistry *or* Chemistry
## CHEM 398 *or* 399 - Undergraduate Research in Biochemistry *or* Chemistry

**FULL NAME**_____ **UMID**_____

**EMAIL**_____ **DATE**_____

**PRINTED NAME OF RESEARCH ADVISOR** _____

| *(Check one)* | | *(Check one)* |
|---|---|---|
| ___ **Chemistry 218** (less than Junior standing) | **1 Credit Hour** | ___ **Fall** 2007 |
| ___ **Chemistry 219** (less than Junior standing) | | ___ **Winter** 2008 |
| ___ **Chemistry 398** (Junior standing) | ___**Credit Hours** | ___ **Spring Half** 2008 |
| ___ **Chemistry 399** (Junior standing) | | ___ **Spring-Summer** 2008 |
| ___ **Chemistry 498/499** | **1 Credit Hour** | ___ **Summer Half** 2008 |
| STUDENTS: PLEASE NOTE: | | ___ **Fall** 2008 |

(1) WHILE YOU CAN REGISTER FOR THESE INDEPENDENT STUDY AND RESEARCH COURSES FOR AN UNLIMITED NUMBER OF CREDITS, ONLY 4 CREDITS FOR ANY GIVEN COURSE MAY BE USED TOWARD GRADUATION REQUIREMENTS. IF YOU THINK YOU WILL NEED (OR WANT) MORE THAN 4 CREDITS TO COUNT TOWARD GRADUATION, THEN YOU SHOULD BEGIN WITH THE 218/219 COURSES AND THEN GO ON TO THE 398/399 COURSES.

(2) THINK CAREFULLY ABOUT THE TOTAL NUMBER OF CREDITS YOU THINK YOU MIGHT WANT TO COUNT FROM RESEARCH, BECAUSE CHEM 218/219 CREDITS DO NOT COUNT TOWARD THE CHEMISTRY AND BIOCHEMISTRY CONCENTRATIONS, ONLY 398/399 DO.

**Give a brief student-written description of the project; may attach.**

*The Honors Office has funding for Honors projects through the Dean's Thesis Grant (up to $150) with deadlines in November and March. Students should apply at the Honors Office.*

**Chem 218 and 398 (*BIOCHEMISTRY RESEARCH*)**

_____ _____
**Biochemistry Faculty Signature** **Phone #**

_____ _____
**Biochemistry Project Approval** **Phone #**

**Section Indi #** _____

**Chem 219 and 399 (*CHEMISTRY RESEARCH*)**

_____
**Out of Department Research Director**

_____
**Chemistry Faculty Signature**

**Section Indi #** _____

## CHEMISTRY UNDERGRADUATE SCHOLARSHIPS AND AWARDS

Declared Chemistry concentrators are eligible for merit based Departmental Academic year scholarships, Summer Research Scholarships, and Awards. These funds are made possible through the generosity of friends of the Department. Scholarships and awards are determined for the coming year in the previous winter. Application deadline for summer research scholarships is early February.

At the end of winter term the Department hosts a luncheon to honor outstanding undergraduates for National, Honors Program and Departmental awards. First and second year outstanding student awards, AXE second year student award, American Chemical Society Analytical Division award to a third year student, American Institute of Chemists outstanding senior and other senior awards are given. In addition scholarship recipients and summer fellows are recognized.

Chemistry concentrators who have unmet financial needs after they have exhausted the assistance which can be provided by the Office of Financial Aid may discuss their situation with any chemistry concentration advisor or with the Department Associate Chair for Undergraduate Affairs. The department has some paid positions available for undergraduates.

## AMERICAN CHEMICAL SOCIETY (ACS) STUDENT AFFILIATES

***(http://www.umich.edu/~acssa/)***

Any student working toward an undergraduate degree in chemistry or biochemistry may become a student affiliate of the ACS. There is an active chapter at the University of Michigan with meetings, speakers, field trips, and tips on careers in chemistry. The national organization provides student affiliates with an introduction to chemical journals, a newsletter, employment aids and invitations to regional, topical and national meetings of ACS. Information on joining ACS Student Affiliates may be obtained in 1500 Chemistry. National World Wide Web address: *http://www.acs.org*.

## ALPHA CHI SIGMA (AXE)

***(http://www.umich.edu/~axeab/)***

Men and women concentrating in chemistry, chemical engineering and other related fields are eligible for membership in Alpha Chi Sigma scientific fraternity. The University of Michigan chapter maintains a house at 1319 Cambridge, Ann Arbor, 48104 (995-3136).

## PHI LAMBDA UPSILON

Phi Lambda Upsilon honorary chemical society maintains a chapter at the University of Michigan. Membership is based on academic excellence in chemistry, chemical engineering or pharmacy.

## EMPLOYMENT OPPORTUNITIES SUMMER JOBS AND INTERNSHIPS - CHEMISTRY DEPARTMENT

1500 Chemistry, 647-2858

The Chemistry Department at U-M encourages its students to spend at least one summer during their undergraduate years in a chemistry-related job. We keep a current file of nationwide chemistry internships, arrange interviews with companies who are recruiting here, identify positions available in other department research laboratories and generally facilitate the summer job search for our students. Whether looking for an internship, or doing on or off campus research, it is important to plan ahead. Write your résumé in late summer to early fall to use for internship interviews in October-November or February. Ask for the ACS publication, *Tips On Résumé Writing*, look at old résumés in 1500 Chem, and have many people check your résumé.

## OTHER INTERNSHIP PROGRAMS AND SUMMER JOBS

Career Planning and Placement

*htttp://www.cpp.umich.edu*

3200 Student Activities Building, 764-7460

There is a summer internship and summer job coordinator at Career Planning and Placement who handles all summer opportunities that come to LS&A. Some employers may be looking for Chemistry or Biochemistry concentrators so it would be well to check with this office.

## CAREER PLANNING AND PLACEMENT IN CHEMISTRY

The University of Michigan Chemistry Department is fortunate in having its own placement office. Each Fall recruiters come from large and small companies throughout the United States to recruit our B.S., M.S. and Ph.D. students. We have a file of information from companies and a small, but select, shelf of reference books on how to write résumés, prepare for interviews and go about the job search.

The Department produces an Open Résumé Book each September. Companies receive this booklet and their representative may contact candidates directly about job opportunities. Others may ask candidates to sign up for an interview if the company is interviewing in the department. Recruiting begins the first of October, with the majority of companies coming before Thanksgiving.

Résumés should be submitted to the Chemistry Placement Office by the first week in September. The office is happy to assist with questions on preparation of a résumé as is Career Planning and Placement at 3200 SAB. The American Chemical Society publication, *Tips on Résumé Preparation*, is available in 1500 Chemistry and is most helpful. You may also wish to attend a workshop on résumé writing at Career Planning and Placement.

The Chemistry Department sponsors the Chemistry Placement Workshop each year in late September for B.S., M.S. and Ph.D. students. Learn about resources on campus, interviewing and plant trips, Chemistry Placement procedures, student experiences and the professor's role in the interview process. The Recruiting Schedule is available at this time also.

We e-mail, post and keep on file the following:

- specific jobs from industry that come to us through either written descriptions or telephone requests
- summer internship opportunites in industry and academia
- fellowship and scholarship information for undergraduate and graduate students

## LS&A CAREER PLANNING AND PLACEMENT

3200 SAB, 764-7460

*http://www.cpp.umich.edu/*

The Chemistry Placement Office is a satellite of the Office of Career Planning and Placement, 3200 Student Activities Building. Additional services in the form of counseling, workshops and a library are available there. Most companies coming to recruit chemists come directly to Chemistry, though a few may be looking for chemistry or biochemistry concentrators as well as other disciplines at Career Planning and Placement. Students are encouraged to register at CP & P and make use of their services.

## REFERENCE LETTER FILE

You would be wise to start a Reference Letter File at Career Planning and Placement, 3200 Student Activities Building. This is a file containing letters of recommendation which you solicit from people who know you and the sort of work you are capable of doing, such as professors and employers. When you apply for a job or to graduate or professional school, you would send a request, plus payment, for each service to the Reference Letter Center and they would send your letters of recommendation to the admissions office or employer you name. Phone 734-764-7459 for more details.

### MONSTERTRAK SUBSCRIPTION

Current students and new graduates (within last 12 months) are eligible to access, at no cost, jobs listed on JOBTRAK (www.monstertrak.com). Instructions and a password for on-line access will be emailed to you after filling out the on-line subscription form. Employers choose the university/college where they wish to list opportunities at B.S., M.S. and Ph.D. levels. Full time/permanent jobs remain on-line for 1 month from entry; part time jobs remain on-line for 2 weeks following entry.

## GRADUATE SCHOOL INFORMATION

A file of graduate school catalogs on chemistry and biochemistry programs all over the United States is kept in 1500 Chemistry for the use of our undergraduate concentrators. Normally undergraduates are encouraged to pursue studies at other universities in order to obtain a broader perspective in their discipline. A possible schedule for application to graduate school follows.

*Late in junior year.* Some students like to take the regular GRE exam earlier than the Advanced Subject Exam so they can focus their study on the Advanced Exam. For GRE registration and information check the website *(http://www.gre.org)* or to schedule call 1-800-GRE-CALL. GRE's may also be taken at any Prometric Testing Center.

*Summer prior to, and very early in Senior year.* Talk to as many faculty and students as you can to get information about potential graduate programs that match your background and experience. You can visit with nearby schools and other people whom your faculty might recommend. Criteria for selection of graduate programs often include the ranking of the department, area of interest, geography and personal reasons.

*September.* Put together a list of schools and send for application packets on line or by snail mail. The letter may be addressed to "Chair, Department of Chemistry" or "Graduate Admission Office, Department of Chemistry". The addresses and websites may be found in the *ACS Directory of Graduate Research.* Libraries usually carry this resource book.

*Early October.* All students are strongly encouraged to apply for National Science Foundation (NSF) Fellowships. Applications are available in early October; initial application due November 1. You must have taken both the subject and general GRE tests by or on the November testing date. Obtain the application from Fellowship Office, National Research Council, 2101 Constitution Ave., Washington, DC 20418, (202) 334-2872.

*October/November.* Take the GRE and/or the Chemistry Advanced Test. Narrow your list of schools and complete the applications. Limit your personal statement to about a page. Indicate a bit about your motivations and philosophy, experience, and some idea of what your long term goals are. Remember this is a statement of present intent, not a binding contract. You are better off understanding your options and not being able to choose rather than be ignorant of the choices.

*December/January.* The timing of action on your application depends on the institution. Your application to the graduate school is also an application for financial support. This support can be in the form of a Teaching Assistantship (TA), a Research Assistantship (RA) or a Fellowship. The stipends will vary from school to school.

*February/March.* A trip to visit the potential graduate department is a great way to compare the various schools in your narrowed field of choices. Depending on the distance, schools may compensate you for all or part of your travel, housing and meals. Students often string their trips together over Spring Break. You will get a chance to meet both faculty and graduate students in the departments you visit.

Don't hesitate to ask any and all questions. Even when you are back home, the faculty members in charge of admissions/recruitment in the graduate departments will always accept and welcome your call.

One of the best things you can do for yourself is to get independent study/research experience as an undergraduate. Many schools have an Honors or Senior Thesis as part of the undergraduate degree. A number of schools offer Pre-Matriculation programs for entering graduate students.

Apply for scholarships. You may obtain a schedule of major graduate fellowship programs from the Fellowships Office, 413 E. Huron, 764-8119, *http://www.rackham.umich.edu/Fellowships/fwplinks.html.*

**UNIVERSITY OF MICHIGAN AND NATIONAL SCHOLARSHIPS**

| ***SCHOLARSHIP/ DEADLINE*** | ***LEVEL*** | ***QUALIFY AREA*** | ***AVAILABLE*** |
|---|---|---|---|
| Barry Goldwater<br><br>Late Fall | Soph/ Junior | Math, natural science, engineering. | Honors Office<br>1330 Mason Hall |
| Otto Graf<br><br>Early January | Incoming Honors Seniors | Academic performance, intellectual accomplishment, potential for superior scholastic achievement. | Honors Office |
| Beinecke Memorial<br><br>Early January | Junior | Unusual ability in field, eager to pursue at graduate level. Demonstrated financial need. | Honors Office |
| Churchill Foundation<br><br>Early November | Senior | Study at Cambridge Churchill College. Science, math, engineering. GRE Aptitude and Achievement scores available by deadline. US citizen. | Honors Office |
| British Marshall<br><br>September 15 | Senior | Study at British University. US citizen. | Honors Office |
| NSF<br><br>November 1 | Senior | National competition for graduate students in science and engineering Ph.D. programs. | NSF Graduate Research Fellowship Program, ORAU, P.O. Box 3010, Oak Ridge, TN 37831-3010, (423-241-4300)<br>*http://www.fastlane.nsf.gov* |
| ONR (Office of Naval Research)<br><br>Early January | Senior | Doctoral programs in Electrical Engineering, Computers, Material Science, Naval Architecture, Aerospace/Mechanical Engineering, etc. Citizens or nationals of US. | American Society for Eng. Education (ASEE)<br>11 Dupont Circle Suite 200<br>Washington, DC 20036<br>(202-293-7080)<br>*http://www.onr.navy.mil/sci%5Ftech/industrial/gradfe.htm* |
| Rhodes Scholarship<br>September 15 | Senior | Study at Oxford. US citizen. | Honors Office |

## WHAT HAPPENS AFTER YOU GRADUATE?

In general, about one third of chemistry graduates go to graduate school, one third are enrolled in medical programs, and one third are in the chemical industry or other employment. Companies employing University of Michigan B.S. chemists have included Abbott, Dow Midland, Dow AgroSciences, Eli Lilly, Dupont-Pharmaceuticals, Merck, National Starch, Pfizer, PPG, Procter & Gamble, Lubrizol, Pfizer, Pharmacia & Upjohn, Sigma Chemicals, Warner-Lambert/Parke-Davis. A representative list follows of graduate schools, national awards, professional schools, and employment for chemistry majors from 1994-2001. The number of degrees per year were: 1994-57; 1995-69; 1996-64; 1997-57 (chemistry), 40 (biochemistry); 1998-32 (chemistry), 37 (biochemistry); 1999-23 (chemistry), 48 (biochemistry); 2000 – 26 (chemistry), 50 (biochemistry); 2001 – 32 (chemistry), 44 (biochemistry), of these 12 have 2 majors; 2002 – 29 (chemistry), 40 (biochemistry) with 3 double majors.

### SAMPLING OF GRADUATE SCHOOLS ATTENDED

| School | Department | School | Department |
|---|---|---|---|
| Arizona | Toxicology | U Florida | Pharmacology |
| Boston U | Biochemistry | U Houston | Cell Biology |
| Bowling Green | Chemistry | U Illinois-Champaign | Chemistry |
| Cal Tech | Chemistry | U Illinois-Champaign | Materials Sci |
| Carnegie Mellon | Polymer Science | U Kansas | Pharmacy |
| Case Western | Polymer Science | U Maryland | Molecular Bio |
| Central Michigan | Chemistry | U Massachusetts Amherst | Polymer Science |
| Chicago | Chemistry | U Miami | Chemistry |
| Clemson | Chemistry | U Michigan | Pharmacy |
| Colorado | Biochemistry | U Michigan | Public Health |
| Columbia U | Education | U Michigan | Epidemiology |
| Cornell | Chemistry | U Michigan | Toxicology |
| Cornell | Physics | U North Carolina | Pharmacology |
| Emory | Chemistry | U Pittsburgh | Business Ad |
| Harvard | Chemistry, | U Rochester | Chemistry |
| Harvard | Cell Biology, MD/PH.D. | U Washington | Biochemistry |
| Indiana | Biochemistry, Chemistry | U Wisconsin-Madison | Biochemistry, Chemistry |
| MIT | Chemistry, Materials Sci | UC Berkeley | Chemistry, CMB |
| Northwestern | Chemistry | UC Davis | Chemistry |
| Ohio State | Chemistry | UC Santa Barbara | Materials Science |
| Penn State | Chemistry | UC Santa Barbara | Biochemistry |
| Princeton | Chemistry | UC San Francisco | Biochemistry |
| Purdue | Chemistry | UCLA | Materials Sciences |
| Rockefeller U | Biochemistry | UNC - Chapel Hill | Chemistry |
| Scripps Institute | Biochemistry | USC | MD/Ph.D. |
| Stanford | Chemistry | Washington U | Biochemistry |
| Stanford | Biochemistry, Immunology | Washington U | Genetics, MD/Ph.D. |
| Texas A&M | Chemistry | Wayne State | MD/Ph.D. |
| U Florida | Materials Science | Wayne State | Biochemistry |

## NATIONAL GRADUATE AWARDS 1990-2002

| Name | Year | School | Department | Award |
|---|---|---|---|---|
| Schwartz, David | 1990 | UC Berkeley | Chemistry | Churchill Fellow |
| Noe, Mark C. | 1991 | Harvard | Chemistry | NSF Fellow |
| Knitt, Deborah | 1992 | Stanford | Biochemistry | NSF Fellow |
| Benezra, Valarie | 1993 | MIT | Materials Science | Naval Fellow |
| Machonkin, Timothy | 1993 | Stanford | Chemistry | NSF Fellow |
| Daniels, Douglas | 1995 | Scripps Institute | Chemistry | NSF Fellow |
| Smithers, Jeffrey | 1997 | Lübeck Medical U | Chemistry | Fulbright |
| Guisbert, Eric | 1998 | Stanford | Biochemistry | NSF Fellow |
| Haidle, Andrew | 1998 | Harvard | Chemistry | Hertz Foundation |
| Jacobs, Christina | 1998 | UC Berkeley | Chemistry | NSF Fellow |
| White, David | 1999 | Harvard | Chemistry | NSF & ONR Fellow |
| Lefurgy, Scott | 1999 | Wisconsin | Biochemistry | ASEE |
| Blum, Suzanne | 2000 | UC Berkeley | Chemistry | NSF Fellow |
| Desiree Thayer | 2001 | Scripps Institute | Biochemistry | NSF Fellow |

## SAMPLING OF PROFESSIONAL SCHOOLS

| Professional School | Department | Professional School | Department |
|---|---|---|---|
| Boston University | Medicine | U Chicago | Medicine |
| Harvard | Medicine | U Connecticut | Medicine |
| Indiana U | Medicine | U Illinois, Chicago | Medicine |
| Loyala U | Medicine | U Kentucky | Medicine |
| Maryland | Medicine | U Michigan | Medicine |
| Medical College of Ohio | Medicine | U Michigan | Dentistry |
| Minnesota | Dentistry | U Pennsylvania | Medicine |
| Michigan State U | Veterinary | U Pittsburgh | Dentistry |
| Michigan State U | Medicine | U Puerto Rico | Medicine |
| Northwestern | Dentistry | U of Rochester | Medicine |
| NY Medical College | Medicine | Vanderbilt | Medicine |
| Rutgers | Medicine | Wayne State | Medicine |
| Stanford | Medicine | U Wisconsin | Medicine |
| SUNY Brooklyn | Medicine | | |

## EMPLOYMENT

There are a wide variety of positions filled by chemistry majors: analytical chemist, chemical engineer, computer programmer, environmental field chemist, formulation assistant, high school chemistry teacher, materials engineer, nuclear power instructor, organic chemist, organic structure analyst, process chemist, quality control chemist, regional sales manager, research assistant, research chemist, sales engineer, science teacher, service representative, spectroscopist, technical services chemist, technician.

| Employer | Employer |
|---|---|
| 3M | Johnson + Johnson |
| Abbott Laboratories | Lubrizol |
| Amgen | Mallinckrodt |
| BASF | Merck |
| BF Goodrich | Millennium |
| Bioanalytical Systems | National Starch |
| Cayman Chemical | Peace Corps |
| Dow AgroSciences | Pfizer |
| Dow Chemical | Pharmacia/GDSearle |
| DuPont Pharmecuticals | PPG |
| Eli Lilly | Procter & Gamble |
| Eisai | Rollins Chempak |
| Flint Ink | Schering Plough |
| Genentech | Syntex Corporation |
| GE Plastics | Toyota Tech Center |
| GlaxoSmithKline | Unilever |
| Great Lakes Chemicals | US Navy |
| Hoffman LaRoche | Wyeth |

COURSE REQUIREMENTS FOR **CHEMISTRY** DEGREES
AT THE UNIVERSITY OF MICHIGAN

| B.S. Concentration<br>(120 credit hours) | B.S. in Chemistry<br>(124 credit hours) | B.S. in Chemistry (Honors)<br>(125 credit hours) |
|---|---|---|
| Chem 125/126, 130<br>Chem 210, 211<br>Chem 215, 216<br>Chem 241/242/260 (includes lab)<br>Physics 140, 141, 240, 241<br>Math 115, 116, 215, 216<br><br>LS&A Language Req.<br>German recommended | Chem 210, 211<br>Chem 215, 216<br>Chem 241/242/260 (includes lab)<br>Physics 140, 141, 240, 241<br>Math 115, 116, 215, 216<br><br>LS&A Language Req.<br>German recommended | Chem 210, 211<br>Chem 215, 216<br>Chem 241/242/260 (includes lab)<br>Physics 140, 141, 240, 241<br>Math, 115, 116, 215, 216 or 185, 186, 285, 286<br><br>LS&A Language Req.<br>German recommended |
| Chem 302, 312<br>Chem 402<br>Chem 447<br>Chem 461/462/463 | Chem 302, 312<br>Chem 402<br>Chem 447<br>Chem 461/462/463<br>Advanced Chem. Lecture (3 cr) | Chem 302, 312<br>Chem 402<br>Chem 447<br>Chem 461/462/463 (Honors)<br>Advanced Chem. Lecture (3 cr) |
| Labs 480, 485 (Projects Lab)<br>399 (2 credits may be substituted for 485) | Labs 480, 399 (4 credits) | Labs 480, 399 (4 credits)<br>Chem 499 (Thesis) |

COURSE REQUIREMENTS FOR **BIOCHEMISTRY** DEGREES
AT THE UNIVERSITY OF MICHIGAN BEFORE FALL 2002

| B.S.<br>(120 credit hours) | B.S. (Honors)<br>(120 credit hours) |
|---|---|
| Biology 162<br>Chem 125/126, 130<br>Chem 210, 211<br>Chem 215, 216<br>Chem 241/242/260 (includes lab)<br>Math 115, 116, 215, 216<br><br>Physics 140, 141, 240, 241<br><br>LS&A Language Req.<br>French, German, Russian recommended | Biology 162<br><br>Chem 210, 211<br>Chem 215, 216<br>Chem 241/242/260 (includes lab)<br>Math, 115, 116, 215, 216 or 185, 186, 285, 286<br>Physics 140, 141, 240, 241<br><br>LS&A Language Req.<br>French, German, Russian recommended |
| Chem 302<br>Chem 447 or 463<br>Chem 451 and 452<br>Chem 461/462<br>Biology 305 | Chem 302<br>Chem 447 or 463<br>Chem 451 and 452<br>Chem 461/462<br>Biology 305 |
| Chem398 (2 credits for 2 terms), or Biol Chem 416 or Biol 429 or Chem 480 | Chem 398 (2 credits for 2 terms)<br><br>Chem 498 (Thesis) |

COURSE REQUIREMENTS FOR **BIOCHEMISTRY** DEGREES
AT THE UNIVERSITY OF MICHIGAN AFTER FALL 2002

| B.S.<br>(120 credit hours) | B.S. (Honors)<br>(120 credit hours) |
|---|---|
| Biology 162<br>Chem 125/126, 130<br>Chem 210, 211<br>Chem 215, 216<br>Chem 241/242/260 (includes lab)<br>Math 115, 116, 215<br><br>Physics 140, 141, 240, 241<br><br>LS&A Language Req.<br>French, German, Russian recommended | Biology 162<br><br>Chem 210, 211<br>Chem 215, 216<br>Chem 241/242/260 (includes lab)<br>Math, 115, 116, 215,or 185, 186, 285<br>Physics 140, 141, 240, 241<br><br>LS&A Language Req.<br>French, German, Russian recommended |
| Chem 302<br>Biology 305 | Chem 302<br>Biology 305 |
| Chem 451 and 452<br>Chem 453 and 454<br>Elective from Bio 427, 428, Chem 461, 420, 447, 485/500, MedChem 409, 410 | Chem 451 and 452<br>Chem 453 and 454<br>Elective from Bio 427, 428, Chem 461, 420, 447, 485/500, MedChem 409, 410 |
| Chem398 (2 credits for 2 terms), or Biol Chem 416 or Biol 429 or Chem 480 | Chem 398 (2 credits for 2 terms)<br><br>Chem 498 (Thesis) |

## AREA DISTRIBUTION REQUIREMENT

A full explanation of the **Area Distribution Requirement** is given in *The University of Michigan Bulletin, Volume 10, No.1, page 12 (2002-2003).* The essential parts of the requirement follow.

> All candidates for the Bachelor of Arts and Bachelor of Science degrees from the College of LS&A must fulfill the 30-credit Distribution Requirement.
>
> This broad intellectual experience, which forms an essential part of a liberal arts education, is to be achieved in the following way:
>
> 1. Students must complete 7 credits in each of the following three areas: Natural Science (NS), Social Science (SS), and Humanities (HU), for a total of 21 credits.
>
> 2. Students must also complete 3 additional credits in each of three of the following five areas: (NS), (SS), (HU), Mathematical and Symbolic Analysis (MSA), and Creative Expression (CE), for a total of 9 credits.

Students concentrating in Chemistry or Biochemistry may use Physics (10 credits) and Mathematics prerequisites to the concentration to fulfill the (NS) and (MSA) parts of the Area Distribution Requirement. Students in Chemistry or Biochemistry must take the following in order to complete the two parts of the Area Distribution Requirement:

1. Humanities (HU), 7 credits. Social Science (SS), 7 credits.

2. Three (3) additional credits in one of the following three areas, (HU), (SS), or (CE).

Note that Advanced Placement credits may not be included in the area distribution plan. Thus, students who have Advanced Placement credit for Physics may need to take additional Natural Science (NS) courses.

### TOTAL CREDITS

For B.S. concentration degrees in Biochemistry and Chemistry credits must total 120.

For B.S. in Chemistry Honors and non-honors degrees credits must total 124.