CHEMISTRY/BIOCHEMISTRY

Faculty: Mr. Seymour, Chairperson; Mr. Brown, Ms. Burnatowska-Hledin+, Ms. Chase+, Mr. Clark, Mr. Gillmore, Mr. Krueger, Mr. Lee, Mr. Mungall, Mr. Peaslee++, Mr. Pikaart*, Mr. Polik, Ms. Sanford, Mr. Silver**, Ms. Smith, Ms. Stewart, Mr. Taylor.

The Department of Chemistry is known nationally for its excellent program. In a study of chemistry programs at private four-year colleges published in the *Journal of Chemical Education*, the Hope College Department of Chemistry was recognized as outstanding in the productivity of its research program and for the accomplishments of its graduates. The chemistry program is certified by the American Chemical Society's Committee on Professional Training.

The program provides students with a rigorous introduction to the fields of chemistry and biochemistry in a setting that emphasizes knowledge of current developments in chemistry and experience with modern instruments and laboratory techniques. The chemistry faculty maintains a keen interest in students' professional involvement and scholarly development. The department has an active seminar program which brings students into contact with nationally recognized authorities in chemistry and chemistry-related fields.

The chemistry program places a strong emphasis on faculty-student research. Chemistry majors are encouraged to begin work with a professor on a research project early in their academic program. Research stipends are available to enable many students to work full-time on their projects during the summer. Student research is directed toward professional development and may result in joint authorship of scientific publications and in the opportunity to present research results at a regional or national scientific meeting.

The chemistry major includes sequences of both lecture and laboratory courses designed to establish a fundamental understanding of the major areas of the discipline. Students can elect to complete a chemistry major for a B.A. degree or a more extensive major for a B.S. degree. Students planning to do graduate work in the field or to enter industry should fulfill the requirements of the American Chemical Society's (A.C.S.) Certified Major Program which generally requires one course beyond the B.S. degree in chemistry. An A.C.S. certified B.S. Degree Program in Chemistry with Biochemistry Emphasis is available for students who have interests in chemistry and biology. Students who intend to enter medical or dental schools or plan a career in secondary education may design their major program according to their specific goals. Since students planning a chemistry major have a number of options, it is essential that they discuss their plans with the chairperson of the department or a chemistry advisor early in their academic program.

CHEMISTRY MAJOR PROGRAMS

BACHELOR OF ARTS DEGREE — The minimum requirements for a chemistry major are twenty-five (25) credits of science major chemistry courses, two semesters of physics with laboratory, and Calculus I (Math 131 or Math 125 and Math 126) and II (Math 132). While calculus based General Physics 121, 141, 122 and 142 are recommended for the B.A. degree and required for the B.S. degree, students seeking the B.A. degree may wish to consult their academic advisor to discuss if College Physics 105, 107, 106 and 108 are appropriate for their program of study. The chemistry courses must include: Chemistry 111, 121, 221, 231; six (6)

*Sabbatical Leave, Academic Year 2006-07
**Leave of Absence, Academic Year 2006-07
+Joint appointment with Department of Biology
++Joint appointment with Department of Geological and Environmental Sciences

credits of laboratory courses (e.g., Chemistry 113, 114, 255, and 256; Chemistry 315, 324, 332, 345 or other laboratory courses may be included in these 6 credits); and two courses selected from Chemistry 311, 322, 331 and 332, or 343. (Chemistry 331 and 332 must be taken together and are considered one course.) A minimum GPA of 2.0 is required for the science major chemistry courses.

BACHELOR OF SCIENCE DEGREE AND THE A.C.S. CERTIFIED MAJOR IN CHEMISTRY — The B.S. degree in chemistry requires thirty-six (36) credits of science major chemistry courses and a total of sixty (60) credits in the natural sciences. A minimum GPA of 2.0 is required for all science major chemistry courses that are part of the B.S. degree or A.C.S. certified major. Both the B.S. degree and the A.C.S. certified major in chemistry require the same core courses in chemistry (31 credits), physics (8 credits), and mathematics (8 credits) that are listed in the following table. Dependent on the student's background in mathematics, General Physics 121 may be taken concurrently with Chemistry 121 in the freshman year or taken no later than the second semester of the sophomore year. College Physics 105, 106, 107 and 108 do not satisfy requirements for the B.S. degree.

The core chemistry, mathematics, and physics courses required for the B.S. degree and for the A.C.S. Certified Chemistry Major are:

Chem 111 (3) General Chem I	Math 131 Calc I (or Math 125 and Math 126)
Chem 113 (1) Gen Chem Lab I	Math 132 Calc II
Chem 121 (3) General Chem II	Phys 121 Gen Phys I
Chem 114 (1) Gen Chem Lab II	Phys 141 Phys Lab I
Chem 221 (3) Organic Chem I	Phys 122 Gen Phys II
Chem 255 (2) Org Chem Lab I	Phys 142 Phys Lab II
Chem 231 (3) Organic Chem II	
Chem 256 (1) Org Chem Lab II	Strongly Recommended Courses:
Chem 322 (3) Inorganic Chem	Math 231 Multivariable Math I
Chem 331 (3) Analytical Chem	Math 232 Multivariable Math II
Chem 332 (1) Analytical Chem Lab	
Chem 343 (3) Physical Chem I	
Chem 345 (1) Phys Chem Lab I	
Chem 344 (3) Physical Chem II	

For the B.S. degree, in addition to all of the core courses, a student must complete Chem 346 and 4 other credits of 200, 300 or 400 level advanced lecture or laboratory courses for a total of 36 credits (see Chem 256 description regarding the advanced lab). Suggested advanced level courses are listed below.

For the A.C.S. Certified Chemistry Major with a B.S. degree, in addition to the core courses, a student must complete Chem 311, Chem 324, Chem 346, 3 other credits of 300 or 400 level advanced lecture, and additional advanced laboratory experience to exceed 500 total laboratory hours (the laboratory hours for the advanced courses are listed with the course descriptions). The required laboratory courses (core plus Chem 324 and Chem 346) provide 384 laboratory hours. The additional hours could be Chem 490 combined with any other advanced laboratory, or any combination of three 200/300 level advanced laboratories (see Chem 256 description regarding the advanced lab). Only 84 laboratory hours of Chem 490 may apply to the 500 laboratory hours. An eight-week summer research experience may be applied toward the 500 laboratory hours in the same manner as Chem 490, provided an appropriate report is submitted. With approval of the chairperson of the Department of Chemistry, a chemistry-related, advanced level course from another natural science department

may be substituted for one advanced level chemistry course in the A.C.S. Certified Chemistry Major Program.

Advanced level chemistry courses for the B.S. and A.C.S. Certified Chemistry Major include:

Chem 256 (1) Org Chem Lab II	Chem 347 (1) Chemical Modeling Lab
Chem 311 (3) Biochemistry	Chem 348 (1) Advanced Spectroscopy Lab
Chem 314 (3) Biochemistry II	Chem 421 (3) Struct. Dynam. & Syn. I
Chem 315 (1) Biochem Lab	Chem 422 (3) Struct. Dynam. & Syn. II
Chem 324 (1) Inorganic Lab	Chem 490 (1, 2, 3) Research
Chem 346 (1) Phys	Chem Lab II

For students planning to go to graduate school in chemistry it is essential to take Mathematics 231 and 232.

Premedical, predental and preveterinary students are advised to take the following courses in chemistry: 111, 113, 114, 121, 221, 231, 255, 256, and 311. To qualify for a chemistry major, health profession oriented students must meet the department's B.A. or B.S. degree requirements. These students design their chemistry major according to the specific requirement of their intended profession. Suggested courses to prepare for medical school are given on page 345.

Students who wish to major in chemistry for teaching in secondary school must complete all the requirements for a teaching certificate in the State of Michigan (pages 164-166), which include a 30-credit Department of Education approved major in chemistry. The chemistry major must consist of all the courses required for the B.A. degree (including the math and physics courses) and additional upper-level courses to meet the 30-credit requirement. With prior approval of the department chairperson, up to 4 credits of chemistry-based GEMS courses may be counted toward the 30-credit chemistry requirement. Students seeking the chemistry endorsement for teacher certification must have a major and/or minor GPA of 2.5.

Students interested in chemical engineering should consult with the chairperson of the Department of Chemistry or the engineering advisor early in their undergraduate program.

Students who are interested in combined science fields, special programs, or contract curriculums should consult with the appropriate chairpersons as early as possible to learn of opportunities, prospects, and requirements.

A.C.S. CERTIFIED BACHELOR OF SCIENCE DEGREE IN CHEMISTRY WITH BIOCHEMISTRY EMPHASIS — For the A.C.S. certified B.S. degree with biochemistry option, in addition to all of the core courses, a student must complete Chem 311, Chem 314, Chem 315, and at least three credits of advanced biology. The three advanced course credits may include Bio 356 (Genetics) or Bio 366 (Molecular Biology). The criterion of 500 laboratory hours is required for the biochemistry option, as described above for the A.C.S. certified chemistry major.

CHEMISTRY MINOR

The requirement for a chemistry minor is twenty-one (21) credits of chemistry courses including: Chemistry 111, 113, 114, 121, 221, 255, and eight (8) additional credits of science major chemistry courses.

BIOCHEMISTRY MINOR

The requirement for a biochemistry minor is twenty-two (22) credits of chemistry courses including: Chemistry 111, 113, 114, 121, 221, 231, 255, 311 and 314.

Note: The biochemistry minor is not awarded in conjunction with either the B.A. or the B.S. major in chemistry.

COURSES DESIGNED PRIMARILY FOR STUDENTS NOT MAJORING IN ONE OF THE SCIENCES

101. Introduction to Chemistry — This course presents selected chemical concepts at an introductory level for students who are not majoring in one of the sciences. Topics include atomic, ionic and molecular properties, bonding, balanced equations, acids and bases, solutions, simple organic structures, polymers, and nuclear chemistry. Laboratory activities support concepts presented in lecture. Lecture, 3 hours per week; laboratory, one 3-hour session per week. Co- or prerequisite: GEMS 100 (Mathematics for Public Discourse), Math 205, or any calculus or statistics course. This course is cross-listed as GEMS 160. *Four Credits Seymour Spring Semester*

103. Introduction to Biological Chemistry — This course is designed for pre-nursing students and for students not majoring in one of the sciences. The fundamental concepts of chemistry will be emphasized as they relate to organic chemistry and biochemistry. The course does not count toward a chemistry major. Lecture, 3 hours per week; laboratory, one 3-hour session per week. Prerequisite: a full year of high school chemistry with laboratory or Chemistry 101 or GEMS 160.
Four Credits Clark Spring Semester

COURSES DESIGNED PRIMARILY FOR SCIENCE MAJORS

111. General Chemistry I — This first course in chemistry is for all students who wish to major in science. Topics include stoichiometry, states of matter, periodicity, inorganic reactions, atomic structure, chemical bonding, geometry of molecules, chemistry of non-metals and solutions. Lecture, 3 hours per week; discussion, 1 hour per week. *Three Credits Clark, Krueger, Peaslee Fall Semester*

113. Laboratory of General and Analytical Chemistry I — This course provides an introduction to techniques and laboratory procedures. Topics include qualitative analysis, colorimetry, spectroscopy, colligative properties, gas laws, and computerized data collection and analysis. Laboratory, one 3-hour session per week (42 lab hours). Corequisite: Chemistry 111.
One Credit Clark, Peaslee, Polik, Seymour, Stewart, Staff Fall Semester

114. Laboratory of General and Analytical Chemistry II — This is a continuation of Chemistry 113 including volumetric analysis, potentiometric titration, calorimetry, study of reaction rates by spectrophotometry, determination of acid dissociation constants, electrochemistry, atomic absorption spectroscopy, and the Nernst equation. Laboratory, one 3-hour session per week (42 lab hours). Corequisite: Chemistry 121. *One Credit Brown, Peaslee, Seymour, Staff Spring Semester*

121. General Chemistry II — This course consists of a continuation of the basic principles of chemistry including chemical energy, electrochemistry, chemical kinetics, acids and bases, and ionic equilibria with an emphasis on inorganic reactions and the chemistry of metals. Lecture, 3 hours per week; discussion session, 1 hour per week. Prerequisite: a grade of C- or better in Chemistry 111.
Three Credits Brown, Krueger, Peaslee Spring Semester

221. Organic Chemistry I — The basic principles of organic chemistry are introduced through studies of the structures and reactions of carbon compounds. The mechanistic treatment of aliphatic and aromatic chemistry is stressed. Lecture, 3 hours per week; discussion session, 1 hour per week. Prerequisite: a grade of C- or better in Chemistry 121. *Three Credits Mungall, Sanford Fall Semester*

231. Organic Chemistry II — This is a continuation of Chemistry 221 with emphasis on complex molecules, including those found in biological systems. Lecture,

3 hours per week; discussion session, 1 hour per week. Prerequisite: a grade of C- or better in Chemistry 221. *Three Credits Gillmore, Sanford Spring Semester*

255. Organic Chemistry Laboratory I — This laboratory course stresses modern techniques for analyses of organic compounds and studies of the mechanisms of organic reactions. Infrared spectral analyses and chromatographic separations are introduced. Laboratory, one 5-hour session per week; discussion session, 1 hour per week (84 lab hours). Corequisite: Chem 221. Prerequisite: Chemistry 121.

Two Credits Gillmore, Sanford, Smith Fall Semester

256. Organic Chemistry Laboratory II — This is a continuation of Chemistry 255 with emphasis on use of the chemical literature in organic syntheses and qualitative organic analysis. Nuclear magnetic resonance spectroscopy and mass spectroscopy are introduced. Laboratory, one 5-hour session per week; discussion session, 1 hour per week. The first 8 weeks of this laboratory (48 lab hours) comprise the 1 credit that is part of the core requirements. The remaining 6 weeks (36 lab hours) consist of an independent synthetic project and comprise the 1 credit that is part of the advanced level courses. The advanced level credit must be taken in conjunction with the core level requirement. Corequisite: Chem 231. Prerequisites: Chemistry 221 and 255.

One or Two Credits Gillmore, Mungall, Sanford, Smith Spring Semester

295. Studies in Chemistry — A lecture and/or laboratory course in a chemical area of current interest. *Three Credits Staff Both Semesters*

311. Biochemistry I — The biochemistry of proteins, carbohydrates, lipids, enzymes and coenzymes is discussed together with the important metabolic pathways. Lecture, 3 hours per week; discussion session, 1 hour per week. Prerequisite: a grade of C- or better in Chemistry 231. *Three Credits Chase Fall Semester*

314. Biochemistry II — The course is a continuation of Chemistry 311 with emphasis on biosynthetic pathways, regulatory processes, transfer of genetic information, and recombinant DNA. Lecture, 3 hours per week; discussion session, 1 hour per week. Prerequisite: a grade of C- or better in Chemistry 311.

Three Credits Burnatowska-Hledin Spring Semester

315. Biochemistry Laboratory — This laboratory course introduces general biochemistry molecular experiments including characterization of amino acids, carbohydrates, proteins, nucleic acids, and lipids; N-terminal analysis of proteins; enzyme kinetics, and purification and characterization of DNA. Techniques include chromatography, electrophoresis and spectrophotometry. Laboratory, one 5-hour session per week; discussion session, 1 hour per week (42 lab hours). This course may be taken during the first half of the spring semester or during the second half of the spring semester. Prerequisite: Chemistry 311. *One Credit Chase Spring Semester*

322. Inorganic Chemistry — A detailed examination of covalent and ionic inorganic substances, Lewis acid-base concepts, thermodynamic aspects, coordination chemistry, chemistry of metals and nonmetals, inorganic aspects of aqueous and nonaqueous solvents. Lecture, 3 hours per week. Prerequisite: Chemistry 221.

Three Credits Clark Spring Semester

324. Inorganic Chemistry Laboratory — Laboratory experiments provide an introduction to modern laboratory techniques used in inorganic chemistry. The work stresses synthetic techniques (including the handling of air-sensitive materials in glove boxes and on vacuum lines), the preparation of novel materials of an inorganic and bioinorganic nature, and the study of their chemical, physical, structural, and kinetic