

# Stevens Institute of Technology 2006-2007 Catalog

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## The Arthur E. Imperatore School of Sciences and Arts

### Department of Chemistry and Chemical Biology

FRANCIS T. JONES, DIRECTOR

#### FACULTY\*

##### Professors

Athula Attygalle, Ph.D. (1983), University of Keele, U.K.

Ajay K. Bose, Sc.D. (1950), Massachusetts Institute of Technology

Francis T. Jones, Ph.D. (1960), Polytechnic Institute of Brooklyn

Marc L. Mansfield, Ph.D. (1981), Dartmouth College

Harold J. Raveché, President of Stevens, Ph.D. (1967), University of California at San Diego

##### Associate Professors

Nuran Kumbaraci, Ph.D. (1977), Columbia University  
 James (Jun-Feng) Liang, Ph.D. (1993), NanKai University, China

Sunil K. Saxena, Ph.D. (1988), Nagpur University, India

Svetlana A. Sukhishvili, Ph.D. (1989), Moscow State University

Jiahua Xu, Ph.D. (1992), Meharry Medical College

##### Lecturers

Thomas Cattabiani, B.S. (1984), Stevens Institute of Technology

Anju Sharma, Ph.D. (1992), Kundnani College of Pharmacy, India

Yujun Zhao, Ph.D. (2001), Stevens Institute of Technology

##### Research Professors

Stanley A. Lang, Ph.D. (1970), Brown University, Director, Infectious Disease Chemistry Research, Wyeth-Ayerst Research

Maghar S. Manhas, Ph.D. (1950), Allahabad University, India

Salvatore S. Stivala, Ph.D. (1960), University of Pennsylvania

##### Distinguished Service Professor

A. K. Ganguly, Ph.D. (1959), Imperial College, London, formerly Senior Vice President, Chemical Research, Schering-Plough Research Institute

\*The list indicates the highest earned degree, year awarded, and institution where earned.

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Dr. Thomas Salzmann, Vice President, Chemistry, Merck Company

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## UNDERGRADUATE PROGRAMS

### Chemistry

Chemistry is often known as the central science, bridging the gap between the life sciences and physical science, and ranging from the very practical to the highly theoretical. It is the science of matter - its structure, its properties, and how it changes.

All around us we see the discoveries of chemistry: synthetic fabrics, aspirin, penicillin and other pharmaceuticals, detergents, better fuels, plastics, and more abundant food. Chemists enjoy the excitement and rewards of discovery and creation.

Career opportunities exist in research (creating new knowledge or synthesizing new chemicals) or in quality control (testing and analysis) in pharmaceuticals, petroleum, polymers and plastics, paints and adhesives, electronic materials, waste treatment, agricultural chemistry, and foods and fragrances, in addition to many other industries. Chemists are employed in hospitals, clinical, environmental control, and criminology laboratories. Chemistry also occupies a pivotal role in the high-technology areas of bioinformatics, biotechnology, materials technology, ceramics, polymers, and electronic materials. The Stevens program prepares you for employment with companies in these industries, and for graduate programs in chemistry or biochemistry.

The program is based on a solid foundation in the major areas of chemistry and biochemistry. Additional courses in advanced chemistry are available in those areas in which Stevens has unique strengths, such as polymer chemistry, natural products, medicinal chemistry, biochemistry, computational chemistry, and instrumental analysis. Research is strongly encouraged due to its importance in preparing for a career in chemistry; it also helps develop independence in solving open-ended problems.

The Stevens chemistry program is certified by the American Chemical Society (ACS). The course sequence for chemistry is as follows:

#### Freshman Year

##### Term I

		Hrs. Per Wk.		
		Class	Lab	Sem. Cred.
HUM	Humanities	3	0	3
CH 115	General Chemistry I	3	0	3
CH 117	General Chemistry Lab I	0	3	1
CS 105	Intro. to Scientific Computing	2	2	3
<i>OR</i>				
CS 115	Intro. to Computer Science	3	2	4
MA 115	Math Analysis I	3	0	3
PEP 111	Mechanics	3	0	3
PE 200	Physical Education I	0	2	1

**TOTAL** **14(15) 7 17(18)**

**Term II**

Hrs. Per Wk.

Class Lab Sem.  
Cred

HUM	Humanities	3	0	3
CH 116	General Chemistry II	3	0	3
CH 118	General Chemistry Lab II	0	3	1
CH 281	Biology and Biotechnology	3	0	3
MA 116	Math Analysis II	3	0	3
PEP 112	Electricity and Magnetism	3	0	3
PE 200	Physical Education II	0	2	1

**TOTAL** **15 5 17**

**Sophomore Year**

**Term III**

Hrs. Per Wk.

Class Lab Sem.  
Cred.

HUM	Humanities	3	0	3
MA 221	Differential Equations	4	0	4
CH 381	Cell Biology	3	3	4
CH 241	Organic Chemistry I	3	4	4
PEP 221	Physics Lab I	0	3	1
PE 200	Physical Education III	0	2	1

**TOTAL** **13 12 17**

**Term IV**

Hrs. Per Wk.

Class Lab Sem.  
Cred.

HUM	Humanities	3	0	3
MGT 244	Microeconomics	3	0	3
CH 321	Thermodynamics	3	0	3
CH 242	Organic Chemistry II	3	4	4
PEP 222	Physics Lab II	0	3	1
MA 227	Multivariate Calculus	3	0	3
PE 200	Physical Education IV	0	2	1

**TOTAL** **15 9 18**

**Junior Year**

**Term V**

Hrs. Per Wk.

Class Lab Sem.  
Cred.

HUM	Humanities	3	0	3
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CH 341	Bio-Organic Chemistry	3	4	4
CH 421	Chemical Dynamics	3	4	4
CH 362	Instr. Analysis I	3	4	4
PE 200	Physical Education V	0	2	1
<b>TOTAL</b>		<b>12</b>	<b>14</b>	<b>16</b>

**Term VI**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
PEP 242	Modern Physics	3	0	3
MA 222	Probability & Statistics	3	0	3
CH 461	Instr. Analysis II	3	4	4
CH 322	Theoretical Chemistry	3	0	3
PE 200	Physical Education VI	0	2	1
<b>TOTAL</b>		<b>15</b>	<b>6</b>	<b>17</b>

**Senior Year****Term VII**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
	Elective	3	0	3
CH 360	Spectra & Struct.	3	0	3
	Elective	3	0	3
CH 496/8	Project/Research*	0	8	3
<b>TOTAL</b>		<b>12</b>	<b>8</b>	<b>15</b>

**Term VIII**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CH 412	Inorganic Chemistry	3	4	4
CH 580	Biochemistry I	3	0	3
CH 582	Biophysical Chemistry	3	0	3
CH 497/9	Project/Research*	0	8	3
<b>TOTAL</b>		<b>12</b>	<b>12</b>	<b>16</b>

\* Project/Research can be either a project (CH 496/7) or thesis (CH 498/9) and can be done either in the junior/senior year or senior year.

**A Minor in Chemistry**

A minor in chemistry comprises the following courses: CH 115, CH 117 General Chem I + Lab, CH 116, CH 118 General Chem II + Lab, CH 241 Organic Chemistry I, CH 242 Organic Chemistry II, CH 421 Chemical Dynamics, CH 362 Instrumental Analysis I, and either

CH 412 Inorganic Chemistry or CH 580 Biochemistry I. This sequence meets the American Chemical Society guidelines for a minor in chemistry.

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## Chemical Biology

Chemical biology is the application of exact science, particularly chemistry, to the understanding and utilization of biological phenomena. The scientific approach to understanding living systems ultimately leads to the cell - the basis of all living systems. Modern biology focuses on how cells originate, differentiate, multiply, and function, with emphasis on their molecular components, their chemical and physical properties, and their interaction.

Chemical biology includes genetic engineering, the design and modification of genetic material, and molecular biology. It is an exciting field at the very core of biotechnology. Today's biology laboratory is equipped with sophisticated instrumentation to stimulate muscle tissue and measure action potentials; to determine the size, shape, and electrical charge of protein molecules; and to follow reactions within the cell. Biologists can study biological phenomena under controlled conditions to explore the mechanisms governing growth, differentiation, behavior, evolution, and aging-knowledge that provides a foundation for modern medicine. The field of medicine relies heavily on modern biology.

The Stevens program in chemical biology provides excellent preparation for the student to pursue a career in medicine, and satisfies requirements for admission to professional schools of medicine, dentistry, and veterinary medicine. Our program features the study of cell and molecular biology, molecular genetics, physiology, biochemistry, biophysical chemistry, organic and physical chemistry, and instrumental analysis. Equipped with this rigorous background - and here is where the Stevens chemical biology program differs from traditional biology and pre-medicine programs - our graduates also find employment in industrial research and pathology laboratories. Many continue their studies at the graduate level in the biological sciences, biochemistry, chemistry, or biophysics.

The chemical biology program is certified by the American Chemical Society (ACS) option - biochemistry. The typical course sequence at Stevens is as follows:

### Freshman Year

#### Term I

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CH 115	General Chemistry I	3	0	3
CH 117	General Chemistry Lab I	0	3	1
CS 105	Intro. to Scientific Computing	2	2	3
<i>OR</i>				
CS 115	Intro. to Computer Science	3	2	4
MA 115	Math Analysis I	3	0	3
PEP 111	Mechanics	3	0	3
PE 200	Physical Education I	0	2	1

**TOTAL 14(15) 7 17(18)**

**Term II**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred		
HUM	Humanities	3	0	3
CH 116	General Chemistry II	3	0	3
CH 118	General Chemistry Lab II	0	3	1
CH 281	Biology and Biotechnology	3	0	3
MA 116	Calculus II	3	0	3
PEP 112	Electricity and Magnetism	3	0	3
PE 200	Physical Education II	0	2	1

**TOTAL 15 5 17**

**Sophomore Year**

**Term III**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
MA 221	Differential Equations	4	0	4
CH 381	Cell Biology	3	3	4
CH 241	Organic Chemistry I	3	4	4
PEP 221	Physics Lab I	0	3	1
PE 200	Physical Education III	0	2	1

**TOTAL 13 12 17**

**Term IV**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CH 382	Biological Systems	3	3	4
CH 321	Thermodynamics	3	0	3
CH 242	Organic Chemistry II	3	4	4
PEP 222	Physics Lab II	0	3	1
PE 200	Physical Education IV	0	2	1

**TOTAL 12 12 16**

**Junior Year**

**Term V**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CH 484	Intro. to Molecular Genetics	3	3	4
CH 421	Chemical Dynamics	3	4	4

CH 362	Instr. Analysis I	3	4	4
PE 200	Physical Education V	0	2	1
<b>TOTAL</b>		<b>12</b>	<b>13</b>	<b>16</b>

**Term VI**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
PEP 242	Modern Physics	3	0	3
CH 461	Instr. Analysis II	3	4	4
CH 580	Biochemistry I	3	0	3
MA 22	Probability & Statistics	3	0	3
PE 200	Physical Education VI	0	2	1
<b>TOTAL</b>		<b>15</b>	<b>6</b>	<b>17</b>

**Senior Year****Term VII**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
	Elective	3	0	3
CH 583	Physiology	3	0	3
CH 681	Biochemistry II*	3	0	3
CH 496/8	Project/Research*	0	8	3
<b>TOTAL</b>		<b>12</b>	<b>8</b>	<b>15</b>

**Term VIII**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
MGT 244	Microeconomics	3	0	3
CH 686	Immunology*	3	0	3
	Elective**	3	0	3
CH 582	Biophysical Chemistry	3	0	3
CH 497/9	Project/Research*	0	8	3
<b>TOTAL</b>		<b>15</b>	<b>8</b>	<b>18</b>

\* With the approval of the advisor.

\*\* For American Chemical Society certification, CH 412 is required.

**A Minor in Chemical Biology**

A minor in chemical biology comprises the following courses: CH 115, CH 117 General Chemistry I + Lab, CH 116, CH 118 General Chemistry II + Lab, CH 241 Organic Chemistry I, CH 242 Organic Chemistry II, CH 421 Chemical Dynamics, CH 281 Biology and Biotechnology, CH 381 Cell Biology, CH 382 Biological Systems, CH

580 Biochemistry I, and CH 484 Introduction to Molecular Genetics.

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If you are pursuing the special combined degree program in medicine or dentistry, you are enrolled in the Accelerated Chemical Biology Program. A heavy course load is required during the three years of the program at Stevens, and completion of the B.S. degree requirements relies on transfer credit from the first year of study at the affiliated medical/dental school. Thus, enrolling in the Accelerated Chemical Biology Program is restricted to students admitted to these special programs.

**Freshman Year****Term I**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CH 115	General Chemistry I	3	0	3
CH 117	General Chemistry Lab I	0	3	1
CS 105	Intro. to Scientific Computing	2	2	3
<i>OR</i>				
CS 115	Intro. to Computer Science	3	2	4
MA 115	Math Analysis I	3	0	3
PEP 111	Mechanics	3	0	3
PE 200	Physical Education I	0	2	1
<b>TOTAL</b>		<b>14(15)</b>	<b>7</b>	<b>17(18)</b>

**Term II**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred		
HUM	Humanities	3	0	3
CH 116	General Chemistry II	3	0	3
CH 118	General Chemistry Lab II	0	3	1
CH 281	Biology and Biotechnology	3	0	3
MA 116	Calculus II	3	0	3
PEP 112	Electricity and Magnetism	3	0	3
PE 200	Physical Education II	0	2	1
<b>TOTAL</b>		<b>15</b>	<b>5</b>	<b>17</b>

**Sophomore Year****Term III**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
MA 221	Differential Equations	4	0	4

CH 381	Cell Biology	3	3	4
CH 241	Organic Chemistry I	3	4	4
PEP 221	Physics Lab I	0	3	1
Mgt	Economics	3	0	3
PE 200	Physical Education III	0	2	1
<b>TOTAL</b>		<b>16</b>	<b>12</b>	<b>20</b>

**Term IV**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CH 382	Biological Systems	3	3	4
CH 321	Thermodynamics	3	0	3
CH 242	Organic Chemistry II	3	4	4
PEP 222	Physics Lab II	0	3	1
PE 200	Physical Education IV	0	2	1
<b>TOTAL</b>		<b>12</b>	<b>12</b>	<b>16</b>

**Junior Year****Term V**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
HUM	Humanities	3	0	3
CH 484	Intro. to Molecular Genetics	3	3	4
CH 421	Chemical Dynamics	3	4	4
CH 362	Instr. Analysis I	3	4	4
PE 200	Physical Education V	0	2	1
<b>TOTAL</b>		<b>15</b>	<b>13</b>	<b>19</b>

**Term VI**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
HUM	Humanities	3	0	3
PEP 242	Modern Physics	3	0	3
CH 461	Instr. Analysis II	3	4	4
CH 580	Biochemistry I	3	0	3
CH 686	Immunology	3	0	3
PE 200	Physical Education VI	0	2	1
<b>TOTAL</b>		<b>18</b>	<b>6</b>	<b>20</b>

Two years of Summer Research are expected for participants in this program.  
The Senior Year is completed at the Medical/Dental School.

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Huge amounts of data are being generated by the new and powerful techniques of determining the structures of biological molecules and manipulating biomolecular sequences. Bioinformatics makes use of mathematical and computer science techniques to process the information that is pouring out of laboratories so it can be used for further scientific advances. The Stevens Bioinformatics Program is built on the foundations of Chemical Biology. After the first two years in the Chemical Biology Program, the Bioinformatics student begins replacing certain electives with mathematics and computer science courses, provided that CS 115 is taken in the freshman year.

The Third and Fourth Years of the Bioinformatics concentration are given below:

**Junior Year**

		<b>Term V</b>		
		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CH 484	Intro. to Molecular Genetics	3	3	4
CH 421	Chemical Dynamics	3	4	4
CH 362	Instr. Analysis I	3	4	4
CS 284	Data Structures & Algorithms I	3	0	3
PE 200	Physical Education V	0	2	1
<b>TOTAL</b>		<b>15</b>	<b>13</b>	<b>19</b>

**Term VI**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
PEP 242	Modern Physics	3	0	3
CH 461	Instr. Analysis II	3	4	4
CH 580	Biochemistry I	3	0	3
MA 222	Probability & Statistics	3	0	3
PE 200	Physical Education VI	0	2	1
<b>TOTAL</b>		<b>15</b>	<b>6</b>	<b>17</b>

**Senior Year**

		<b>Term VII</b>		
		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
MA 134	Discrete Mathematics	3	0	3
CS 385	Data Structures and Algorithms II	3	0	3
MGT 244	Microeconomics	3	0	3
CH 583	Physiology	3	0	3

CH 681	Biochemistry II	3	0	3
<b>TOTAL</b>		<b>18</b>	<b>0</b>	<b>18</b>

**Term VIII**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CS 442	Database Management Systems	3	0	3
CH 582	Biophysical Chemistry	3	0	3
CH 668	Computational Biology*	3	0	3
CH 686	Immunology	3	0	3
CH 497/9	Project/Research*	0	8	3
<b>TOTAL</b>		<b>15</b>	<b>8</b>	<b>18</b>

**Bioanalytical Chemistry**

The extreme complexity - and fragility - of biological molecules has made it necessary to develop special techniques and instrumentation for their detection and analysis. These methods were employed in the Human Genome Project, and have become vital in drug development efforts and in the field called Chemical Ecology. The bioanalytical chemist is a valued scientist in medical and biomedical research and in the pharmaceutical, flavors, and fragrances industries.

The program in Bioanalytical Chemistry is built on the foundations of Chemical Biology. After the first two years in the regular Chemical Biology Program, the Bioanalytical Chemistry student begins concentrating on special techniques such as mass spectrometry, nuclear magnetic resonance, and separations. The Third and Fourth Years of the program are shown below:

**Junior Year****Term V**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CH 360	Spectra & Structure	3	0	3
CH 421	Chemical Dynamics	3	4	4
CH 362	Instr. Analysis I	3	4	4
CH 484	Intro. to Molecular Genetics	3	3	4
PE 200	Physical Education V	0	2	1
<b>TOTAL</b>		<b>15</b>	<b>13</b>	<b>19</b>

**Term VI**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3

PEP 242	Modern Physics	3	0	3
CH 461	Instr. Analysis II	3	4	4
CH 580	Biochemistry I	3	0	3
MA 222	Probability & Statistics	3	0	3
PE 200	Physical Education VI	0	2	1
<b>TOTAL</b>		<b>15</b>	<b>6</b>	<b>17</b>

**Senior Year****Term VII**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CH 666	Modern Mass Spectrometry*	3	0	3
CH 662	Separation Methods*	3	0	3
MGT 244	Microeconomics	3	0	3
CH 496/8	Project/Research	0	8	3
<b>TOTAL</b>		<b>12</b>	<b>8</b>	<b>15</b>

**Term VIII**

		Hrs. Per Wk.		
		Class	Lab	Sem.
		Cred.		
HUM	Humanities	3	0	3
CH 660	Adv. Instrumental Analysis*	3	0	3
CH 582	Biophysical Chemistry	3	0	3
CH 412	Inorganic Chemistry	3	4	4
CH 497/9	Project/Research*	0	8	3
<b>TOTAL</b>		<b>12</b>	<b>12</b>	<b>16</b>

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The Accelerated Chemical Biology program gives you the opportunity to earn the B.S. degree at Stevens and the M.D. degree at the University of Medicine and Dentistry of New Jersey (UMDNJ)-New Jersey Medical School, or the D.M.D. degree at UMDNJ-New Jersey Dental School, in a total of seven years.

More information on this program can be found in the Pre-Professional and Accelerated Programs section of this catalog. You will also find a discussion of a program called Undergraduate Projects in Technology and Medicine (UPTAM), which is available to specially selected Stevens undergraduates.

**Interdisciplinary Program in Computational Science**

For students interested in interdisciplinary science and engineering, Stevens offers an undergraduate computational science program. Computational science is a new field in which techniques from mathematics and computer science are used to solve scientific and engineering problems. See the description of the Program in Computational Science in the Interdisciplinary Programs section.

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## GRADUATE PROGRAMS

Graduate study in the chemical sciences offers research opportunities of great variety and scope. It offers, too, an unusual receptivity to different kinds of research interests, from the most immediate and practical to the highly theoretical.

The Department of Chemistry and Chemical Biology includes faculty and programs in chemistry, as well as in the emerging area of chemical biology. In fact, Stevens pioneered this area with the first undergraduate program in Chemical Biology in the late 1970s. Chemists and biologists share instruments and collaborate on joint educational and research programs. The close proximity of these disciplines encourages cooperation and provides access to equipment and expertise not usually available within a single department.

The degrees Master of Science and Doctor of Philosophy are offered in chemistry or chemical biology with concentrations in physical chemistry, organic chemistry, analytical chemistry, polymer chemistry, chemical biology, and bioinformatics. Admission to the graduate program in chemistry requires an undergraduate education in chemistry. Admission to the chemical biology program requires either an undergraduate degree in chemistry with strong biology background or an undergraduate degree in biology with strong chemistry background.

Polymer synthesis and characterization, methods of instrumental analysis, medicinal chemistry, and structural chemistry (theoretical as well as experimental) are areas of chemistry in which the department has attained international recognition. Research in chemical biology focuses on protein trafficking through membranes, soil microbiology, drug encapsulation and dosing, and proteomics.

The department is the home for the Center for Mass Spectrometry - one of the best equipped mass spectrometry laboratories anywhere. Included are Electrospray, MALDI, GC/LC MS, and other new techniques used in pioneering work in chemistry and biology.

The department is housed in a modern building with well-equipped laboratories for tissue-culture work, protein separation and analysis, and small animal studies. State-of-the-art instrumentation is also available, including confocal microscopy, PCR, radio-isotope labeling, fluorometry, double-beam spectrophotometry, Fourier-transform infrared, nuclear magnetic resonance and high performance liquid chromatography, thermal analysis, and electron tunneling microscopy.

Periodically, the department invites a preeminent scientist for a sequence of informal talks and formal lectures. Previous lecturers have included Kenneth Pitzer and Herman Mark and the Nobelists William Lipscomb, Sir Derek Barton, Ilya Prigogine, Arthur Kornberg, Rosalyn Yalow, Sidney Altman, and George Palade. Periodically, The Stivala Lectures in Chemistry invites an outstanding scientist for a day of lectures and discussions on timely topics in chemistry. Dr. James Cooper, M.D., established this lecture series in memory of his father Charles Cooper, who was a close friend of Professor Salvatore Stivala, a professor of chemistry and chemical engineering at Stevens.

The department believes the vitality of an academic community depends on interaction among its members, and that teaching and

learning are essential activities for students and professors alike.

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### **Master's Programs**

Thirty graduate credits in an approved plan of study, that include the following core courses, are required for the Master of Science degree. Areas of concentration include analytical chemistry, chemical biology, organic chemistry, physical chemistry and polymer chemistry, and others can be designed. Research may be included in master's degree programs, either as a Special Research Problem (CH 800) or a master's thesis (CH 900), and is included in the 30 credits required for the degree. All fellows and teaching or research assistants are expected to complete a thesis.

#### **Core Courses in Chemistry**

CH 520 Advanced Physical Chemistry I (may be required for students with insufficient knowledge of quantum chemistry)

CH 561 Instrumental Methods of Analysis (may be required for students with insufficient knowledge of instrumental analysis)

CH 610 Advanced Inorganic and Bioinorganic Chemistry

CH 620 Chemical Thermodynamics and Kinetics

CH 640 Advanced Organic and Heterocyclic Chemistry I

CH 660 Advanced Instrumental Analysis

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#### **Core Courses in Chemical Biology**

CH 561 Instrumental Methods of Analysis

CH 580 Biochemistry I

CH 582 Biophysical Chemistry

CH 640 Advanced Organic and Heterocyclic Chemistry I

CH 668 Computational Biology

CH 687 Molecular Genetics

#### **Elective Courses**

Additional courses are chosen depending on the student's interests and background. The advisor must approve all elective courses.

#### **Doctoral Program in Chemical Biology**

Admission to the doctoral program is based on 1) GRE score, and 2) reasonable evidence that the student will prove capable of specialization on a broad intellectual foundation. Specifically, students will be admitted to the doctoral program only if the Admissions Committee feels that he/she is reasonably well-prepared for the Qualifying Examinations in Chemistry or Chemical Biology, which must be passed within a 10-month period in the Ph.D. program. Applicants with good academic records who lack this level of preparation may be admitted initially to the M.S. program.

A student enrolled in the Master's program in Chemistry or Chemical biology must request admission to the doctoral program through the department's Admissions Committee. Continuation in the doctoral program is contingent on passing the Qualifying Examinations, Preliminary Examination, and meeting all other requirements.

#### **Core Courses and Options**

##### **Core Courses in Chemistry**

CH 520 Advanced Physical Chemistry I (unless waived)

CH 561 Instrumental Methods of Analysis (unless waived)

CH 610 Advanced Inorganic and Bioinorganic Chemistry I  
CH 620 Chemical Thermodynamics and Kinetics  
CH 640 Advanced Organic and Heterocyclic Chemistry I  
CH 660 Advanced Instrumental Analysis

### **Core Courses in Chemical Biology**

CH 561 Instrumental Methods of Analysis (unless waived)  
CH 580 Biochemistry I – Cellular Metabolism and Regulation  
CH 582 Biophysical Chemistry  
CH 640 Advanced Organic and Heterocyclic Chemistry I  
CH 668 Computational Biology  
CH 687 Molecular Genetics

### **Specialization Areas:**

*The following are typical examples:*

#### **Analytical Chemistry**

CH 650 Spectra and Structure Determination  
CH 661 Advanced Instrumental Analysis Laboratory  
CH 662 Separation Methods in Analytical and Organic Chemistry  
CH 666 Modern Mass Spectrometry

#### **Chemical Biology**

CH 678 Experimental Microbiology  
CH 681 Biochemistry II – Bio-Molecular Structure and Function  
CH 682 Biochemical Laboratory Techniques  
CH 684 Molecular Biology Laboratory Techniques  
CH 685 Medicinal Chemistry  
CH 686 Immunology  
CH 688 Methods in Chemical Biology  
CH 689 Cell Biology Laboratory Techniques  
CH 780 Selected Topics in Biochemistry I  
CH 782 Selected Topics in Bioorganic Chemistry

#### **Organic Chemistry**

CH 641 Advanced Organic and Heterocyclic Chemistry II  
CH 642 Synthetic Organic Chemistry  
CH 646 Chemistry of Natural Products  
CH 650 Spectra and Structure Determination  
CH 685 Medicinal Chemistry

#### **Physical Chemistry**

CH 621 Quantum Chemistry  
CH 622 Molecular Spectroscopy  
CH 623 Chemical Kinetics  
CH 624 Statistical Mechanics  
CH 650 Spectra and Structure Determination

#### **Other Areas of Specialization**

Programs in other areas of specialization, such as Polymer Chemistry, Biochemistry, etc., can be designed by including the appropriate courses in that area and completing a research topic in the sub-discipline as approved by the research advisor.

#### **Electives**

To complete the course requirements for the degree, a student may choose additional courses with the approval of the advisor. Special courses are frequently offered under the title of Special

(or Selected) Topics, which can be included with the permission of the advisor. Some courses are offered as reading courses, with no designated lecture schedule.

### **Degree Requirements**

#### **Research Proposals**

All doctoral students in the Department of Chemistry and Chemical Biology must present two written research proposals and defend them in an oral examination.

#### **Language Proficiency**

The Department of Chemistry and Chemical Biology no longer requires a foreign language examination for the Ph.D. degree. However, every student is required to possess a high level of proficiency in written and spoken English. International students are required to take an English proficiency examination before beginning graduate course work, and one or more remedial English courses (without credit), if necessary. The Department will not waive this requirement for any student.

#### **Doctoral Dissertation**

The Policies and regulations governing the doctoral dissertation are described in detail in the Stevens Catalog and the Manual for Graduate Students.

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#### **Graduate Certificate Programs**

In addition to the degree programs, the department currently offers seven Graduate Certificate Programs. The courses may be used towards a master's degree. Each Graduate Certificate Program is a self-contained and highly focused collection of courses carrying 12 or more graduate credits.

#### **Analytical Chemistry**

CH 561 Instrumental Methods of Analysis  
CH 660 Advanced Instrumental Analysis  
CH 662 Separation Methods in Analytical and Organic Chemistry  
CH 665 Chemometrics

#### **Biomedical Chemistry**

CH 642 Synthetic Organic Chemistry  
CH 646 Chemistry of Natural Products

*and two of the following courses (with advisor approval):*

CH 647 Chemistry and Pharmacology of Drugs  
CH 685 Selected Topics in Medicinal Chemistry  
CH 800 Special Research Problems in Chemistry

#### **Polymer Chemistry**

CH 670 Synthetic Polymer Chemistry  
CH 671 Physical Chemistry of Polymers  
CH 672 Macromolecules in Modern Technology  
CH 673 Special Topics in Polymer Chemistry

The above Graduate Certificate Programs are regular graduate courses and are part of the Master of Science program, Chemistry concentration.

#### **Bioinformatics**

CH 681 Biochemistry II  
CH 664 Computer Methods in Chemistry  
CH 668 Computational Biology

CH 760 Chemoinformatics **or** CS 580 The Logic of Program Design

**Chemical Biology**

CH 580 Biochemistry I  
CH 681 Biochemistry II  
CH 686 Immunology  
CH 687 Molecular Genetics

**Chemical Physiology**

CH 580 Biochemistry I  
CH 583 Physiology  
CH 684 Molecular Biology Laboratory Techniques

*and one of the following courses with the approval of your program advisor:*

CH 686 Immunology  
CH 782 Selected Topics in Bioorganic Chemistry  
CH 800 Special Research Problems in Chemistry

**Laboratory Methods in Chemical Biology**

CH 561 Instrumental Methods of Analysis  
CH 682 Biochemical Laboratory Techniques  
CH 684 Molecular Biology Laboratory Techniques  
CH 689 Cell Biology Laboratory Techniques

The above Graduate Certificate Programs are regular graduate courses and are part of the Master of Science program, Chemical Biology concentration.

**UNDERGRADUATE COURSES**

**CH 115 General Chemistry I  
(3-0-3)**

Atomic structure and periodic properties, stoichiometry, properties of gases, thermochemistry, chemical bond types, intermolecular forces, liquids and solids, chemical kinetics, and introduction to organic chemistry and biochemistry.

**CH 116 General Chemistry II  
(3-0-3)**

Phase equilibria, properties of solutions, chemical equilibrium, strong and weak acids and bases, buffer solutions and titrations, solubility, thermodynamics, electrochemistry, properties of the elements, and nuclear chemistry. Prerequisite: CH 107 or CH 115.

**CH 117 General Chemistry Laboratory I  
(0-3-1)**

Laboratory work to accompany CH 107 or CH 115: experiments of atomic spectra, stoichiometric analysis, qualitative analysis, and organic and inorganic syntheses. Corequisite: CH 107 or CH 115.

**CH 118 General Chemistry Laboratory II  
(0-3-1)**

Laboratory work to accompany CH 116: analytical techniques, gases, kinetics, equilibrium, acid-base titrations, oxidation-reduction reactions, and electrochemical cells. Corequisite: CH 116.

**CH 189 Seminar in Chemistry and Biology  
(1-0-1)**

Introduction to chemistry as the "central science" and its impact on other fields, particularly biology. Areas to be explored include the interaction of radiation with matter, the effect of symmetry on

chemical and physical properties of molecules, hyphenated methods of analysis, the chemistry of biological signals, biochemical cycles, the physiology of exercise, and chaotic reactions. By invitation only; Corequisite: CH 115/116.

**CH 241 Organic Chemistry I**  
**(3-4-4)**

Principles of descriptive organic chemistry; structural theory; reactions of aliphatic compounds; and stereochemistry. Laboratory includes introduction to organic reaction and separation techniques, reactions of functional groups, and synthesis. Prerequisites: CH 116, CH 118.

**CH 242 Organic Chemistry II**  
**(3-4-4)**

Continuation of CH 241; reactions of aromatic compounds; infrared and nuclear magnetic resonance spectroscopy; laboratory work in synthesis, spectroscopy and chromatographic separation techniques. Prerequisite: CH 241.

**CH 281 Biology and Biotechnology**  
**(3-0-3)**

Biological principles and their physical and chemical aspects are explored at the cellular and molecular level. Major emphasis is placed on cell structure, the processes of energy conversion by plant and animal cells, genetics and evolution, and applications to biotechnology.

**CH 282 Introductory Biology Laboratory**  
**(0-3-1)**

An introductory laboratory illustrating basic techniques and principles of modern biology by means of laboratory experiments and simulated experiments. This laboratory does not satisfy medical school admission requirements. Prerequisite or Corequisite: CH 281.

**CH 321 Thermodynamics**  
**(3-0-3)**

Laws of thermodynamics, thermodynamic functions, and the foundations of statistical thermodynamics. The chemical potential is applied to phase equilibria, chemical reaction equilibria, and solution theory, for both ideal and real systems. Prerequisites: CH 116, MA 116.

**CH 322 Theoretical Chemistry**  
**(3-0-3)**

Quantum mechanics of molecular systems are developed. The techniques of approximation methods are employed for molecular binding and spectroscopic transitions. Examples are taken from infrared, visible, ultraviolet, microwave, and nuclear magnetic resonance spectroscopy. Prerequisites: CH 116, MA 221.

**CH 341 Biological Chemistry**  
**(3-4-4)**

Survey of biologically important classes of compounds, including fats and lipids, terpenes, steroids, acetogenins, sugars, carbohydrates, peptides, proteins, alkaloids, and other natural products. Prerequisite: CH 242.

**CH 360 Spectra and Structure**  
**(3-0-3)**

Interpretation of infrared, ultraviolet, nuclear magnetic resonance, and mass spectra. Emphasis is on the use of these spectroscopic methods in identification and structure determination of organic

compounds. Prerequisite: CH 241.

**CH 362 Instrumental Analysis I**  
**(3-4-4)**

Experimental approach to spectroscopy. Topics include Fourier Transform infrared spectroscopy, ultraviolet, visible and fluorescence measurements, atomic absorption spectroscopy, and nuclear magnetic resonance spectroscopy. Prerequisites: CH 116, CH 118, and CH 241.

**CH 372 Organic Chemistry of Polymers**  
**(3-3-4)**

Survey of preparative methods of polymers, including condensation, free radical, ionic, group transfer, ring opening, stereoregular polymerization, and copolymerization. Newer techniques stressed. Prerequisites: CH 241, CHE 210.

**CH 381 Cell Biology**  
**(3-3-4)**

The structure and function of the cell and its subcellular organelles is studied. Biological macromolecules, enzymes, biomembranes, biological transport, bioenergetics, DNA replication, protein synthesis and secretion, motility, and cancer are covered. Cell biology experiments and interactive computer simulation exercises are conducted in the laboratory. Prerequisite: CH 281.

**CH 382 Biological Systems**  
**(3-3-4)**

Physiochemical principles underlying the coordinated function in multicellular organisms are studied. Electrical properties of biological membranes, characteristics of tissues, nerve-muscle electrophysiology, circulatory, respiratory, endocrine, digestive, and excretory systems are covered. Computer simulation experiments and data acquisition methods to evaluate and monitor human physiological systems are conducted in the laboratory. Prerequisite: CH 281.

**CH 412 Inorganic Chemistry**  
**(3-4-4)**

Lecture and laboratory; ionic solids, lattice energy, and factors determining solubility; thermodynamics in inorganic synthesis and analysis; acid-base equilibria; and systematic chemistry of the halogens and other non-metals. Prerequisite: CH 362.

**CH 421 Chemical Dynamics**  
**(3-4-4)**

Chemical kinetics, solution theories with applications to separation processes, electrolytes, polyelectrolytes, regular solutions and phase equilibria, and laboratory practice in the measurements of physical properties and rate processes. Prerequisites: CH 321 or CHE 234 and MA 221.

**CH 422 Supplemental Topics in Physical Chemistry**  
**(1-0-1)**

Additional work in physical chemistry for transfer students to cover topics omitted from physical chemistry courses taken elsewhere. A failure grade is entered on the student's record and the student is required to enroll in CH 421.

**CH 461 Instrumental Analysis II**  
**(3-4-4)**

Theory and practice of analytical chemistry. Topics include sampling techniques, potentiometric and conductometric titrations,

chromatographic separations (gas and high-performance liquid chromatography), polarimetry, and gas chromatography-mass spectrometry. Prerequisites: CH 116, CH 118.

**CH 484 Introduction to Molecular Genetics  
(3-3-4)**

Introduction to the study of molecular basis of inheritance. Starts with classical Mendelian genetics and proceeds to the study and function of DNA, gene expression and regulation in prokaryotes and eukaryotes, genome dynamics and the role of genes in development, and cancer. All topics include discussions of current research advances. Accompanied by laboratory section that explores the lecture topics in standard wet laboratory experiments and in computer simulations. Prerequisites: CH 281, CH 381.

**CH 496-497 Chemical Biology Project I-II  
(0-8-3) (0-8-3)**

Participation in a small group project, under the guidance of a faculty member, whose prior approval is required. Experimentation, application of chemical knowledge, and developmental research leading to the implementation of a working chemical process. Individual or group written report required. Open to juniors and seniors only.

**CH 498-499 Senior Chemical/Biological Research I-II  
(0-8-3) (0-8-3)**

Individual research project under the guidance of a chemistry faculty member, whose prior approval is required. A written report in acceptable journal format and an oral presentation are required at the end of the project. Senior students only. CH 498 and 499 cannot be taken simultaneously.

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**GRADUATE COURSES**

All Graduate courses are 3 credits except where noted.

**CH 500 Physical Chemistry Review**

Review of undergraduate physical chemistry by means of problem solving; atomic spectra; structure of atoms and molecules; thermodynamics; changes of state; solutions; chemical equilibrium; kinetic theory of gases; chemical kinetics, and electrochemistry. This course may not be counted toward the master's degree and is not open to undergraduate students.

**CH 520 Advanced Physical Chemistry**

The elements of quantum mechanics are developed and applied to chemical systems. Valence bond theory and molecular orbital theory of small molecules; introduction to group theory for molecular symmetry; fundamental aspects of chemical bonding, and molecular spectra.

**CH 540-541 Advanced Organic Laboratory I-II \***

Your needs and interests will be considered in the assignment of typical advanced preparations, small research problems, and special operations. Prerequisite: one year of organic laboratory. Laboratory Fee: \$60. Fall and spring semesters.

**CH 561 Instrumental Methods of Analysis**

Primarily a laboratory course, with some lecture presenting the principles and applications of contemporary instrumental analytical methods, with a focus on spectroscopy and separations. Laboratory

practice explores ultraviolet, visible, and infrared spectrophotometry; atomic absorption spectroscopy; nuclear magnetic resonance spectrometry; gas-liquid and high-performance liquid chromatography, and mass spectrometry. These instrumental techniques are utilized for quantitative and qualitative analyses of organic, inorganic, biological, and environmental samples. Laboratory fee: \$60.

### **CH 580 Biochemistry I - Cellular Metabolism and Regulation**

Discussions include metabolic pathways in biosynthesis and catabolism of biomolecules, including carbohydrates, proteins, lipids, and nucleic acids. The hormonal regulation of metabolism, as well as vitamin metabolism, is presented. Prerequisite: CH 242 or equivalent.

### **CH 582 Biophysical Chemistry**

The relationship of the chemical and physical structure of biological macromolecules to their biological functions as derived from osmotic pressure, viscosity, light and X-ray scattering, diffusion, ultracentrifugation, and electrophoresis. The course is subdivided into: 1) properties, functions, and interrelations of biological macromolecules, e.g., polysaccharides, proteins, and nucleic acids; 2) correlation of physical properties of macromolecules in solution; 3) conformational properties of proteins and nucleic acids; and 4) aspects of metal ions in biological systems. Prerequisite: CH 421 or equivalent.

### **CH 583 Physiology**

Fundamentals of control processes governing physiological systems analyzed at the cellular and molecular level. Biological signal transduction and negative feedback control of metabolic processes. Examples from sensory, nervous, cardiovascular, and endocrine systems. Deviations that give rise to abnormal states; their detection, and the theory behind the imaging and diagnostic techniques such as MRI, PET, SPECT; and the design and development of therapeutic drugs. The principles, uses, and applications of biomaterials and tissue engineering techniques; and problems associated with biocompatibility. Students (or groups of students) are expected to write and present a term project. Prerequisite: CH 382 or equivalent.

### **CH 610 Advanced Inorganic and Bioinorganic Chemistry**

A systematic treatment of the bonding and reactivity of inorganic substances; molecular shape and electron charge distribution of main-group and coordination compounds, including valence-bond theory and a group theoretical approach to molecular orbital theory; organometallic chemistry; the solid state; and the role of inorganic compounds in biological processes and the environment.

### **CH 620 Chemical Thermodynamics and Kinetics**

Applications of the laws of thermodynamics to solutions, electrolytes and polyelectrolytes, binding, and biological systems; statistical thermodynamics is developed and applied to spectroscopy and transition state theory; and chemical kinetics of simple and complex reactions, enzyme and heterogeneous catalysis, and theories of reaction rates.

### **CH 621 Quantum Chemistry\***

Theorems and postulates of quantum mechanics; operator relationships; solutions of the Schrödinger equation for model systems; variation and perturbation methods; pure spin states; Hartree-Fock self-consistent field theory; and applications to many-electron atoms and molecules. Prerequisite: CH 520 or

equivalent.

#### **CH 622 Molecular Spectroscopy\***

Theoretical foundations of spectroscopic methods and their application to the study of molecular structure and properties. Theory of the absorption and emission of radiation; line spectra of complex atoms; and group theory and rotational, vibrational, and electronic spectroscopy of diatomic and polyatomic molecules.

#### **CH 623 Chemical Kinetics\***

A detailed discussion of the kinetics and mechanism of complex reactions in the gaseous and liquid phases. Topics include stationary and nonstationary conditions; chain reactions; photo and radiation-induced reactions; and reaction rate theories.

#### **CH 624 Statistical Mechanics\***

Classical and quantum mechanical preliminaries; derivation of the laws of thermodynamics; applications to monoatomic and polyatomic gases and to gaseous mixtures; systems of dependent particles with applications to the crystalline solid, the imperfect gas, and the cooperative phenomena; electric and magnetic fields; and degenerate gases. Prerequisite: CH 620 or equivalent.

#### **CH 640-641 Advanced Organic and Heterocyclic Chemistry I-II**

An advanced course in the chemistry of carbon compounds, with special reference to polyfunctional compounds, heterocycles, techniques of literature survey, stereochemical concepts, and physical tools for organic chemists. Fall and spring semester.

#### **CH 642 Synthetic Organic Chemistry**

A survey of important synthetic methods with emphasis on stereochemistry and reaction mechanism. Prerequisite: CH 640.

#### **CH 645 Chemistry of Heterocyclic Compounds\***

A survey of the more important classes of heterocyclic compounds, their physical and chemical properties, and methods of synthesis. Prerequisite: Undergraduate Organic Chemistry.

#### **CH 646 Chemistry of Natural Products**

Structure, synthesis, and biogenesis of antibiotics, alkaloids, hormones, and other natural products. Prerequisite: Undergraduate Organic Chemistry.

#### **CH 647 Chemistry and Pharmacology of Drugs**

Discussion at the molecular level of drug receptor interaction, influence of stereochemistry and physicochemical properties on drug action, pharmacological effects of structural features, mechanism of drug action, metabolic rate of drugs in animals and man, and drug design. The application of newer physical tools and recent advances in methods for pharmacological studies will be emphasized. Prerequisite: Undergraduate Organic Chemistry.

#### **CH 650 Spectra and Structure Determination**

An intensive course on the interpretation of spectroscopic data; emphasis is on the use of modern spectroscopic techniques, such as NMR ( $^{13}\text{C}$ ,  $\text{D}$ ,  $^{15}\text{N}$ , and  $\text{H}$ ), mass (including  $\text{CI}$ ), laser-Raman, ESCA, ORD, CD, IR, and UV for structure elucidation. Special attention is given to the application of computer technology in spectral work. A course designed for practicing chemists in analytical, organic, physical, and biomedical areas. Extensive problem solving. No laboratory.

**CH 660 Advanced Instrumental Analysis**

Advanced treatment of the theory and practice of spectrometric methods (mass spectrometry, nuclear magnetic resonance, etc.) and electroanalytical methods with emphasis on Fourier Transform techniques (FTIR, FTNMR, etc.) and hyphenated methods (gc-ms, etc.), the instrument-sample interaction, and signal sampling. A survey of computational methods, such as factor analysis and other chemometric methods is also included. Prerequisite: Undergraduate Instrumental Analysis with laboratory or CH 561.

**CH 661 Advanced Instrumental Analysis Laboratory\***

Your needs and interests are considered in the assignment of work on one or more of the following: NMR spectrometry, mass spectrometry, electrochemical methods, infrared, ultraviolet, and visible spectrophotometry. Laboratory Fee: \$60.

**CH 662 Separation Methods in Analytical and Organic Chemistry**

An advanced course applying principles and theory to problems in chemical analysis. Theory of separations, including distillation, chromatography, and ultracentrifugation; heterogeneity and surface effects; and sampling and its problems.

**CH 663 Design of Chemical Instrumentation\***

A practical treatment of the mechanical, electronic, and optical devices used in the construction of instruments for research and chemical analysis and control; motors, light sources and detectors, servomechanisms, electronic components and test equipment, vacuum and pressure measuring devices, and overall design concepts are among the topics treated. Laboratory fee: \$60.

**CH 664 Computer Methods in Chemistry**

Discusses computational chemistry topics, including energy minimization, molecular dynamics, solvation mechanics, and electronic structure calculations. Applications in drug design and receptors will be discussed. Prerequisite: CH 321 or equivalent.

**CH 665 Chemometrics\***

Application of chemometric techniques to problems in analytical, physical, and organic chemistry, with emphasis on spectroscopic measurements. Includes optimization, analysis of variance, pattern recognition, factor analysis, experimental design, etc.

**CH 666 Modern Mass Spectrometry (3-4-4)**

A comprehensive hands-on course covering both fundamentals and modern aspects of mass spectrometry, with emphasis on biological and biochemical applications. Topics include: contemporary methods of gas phase ion formation [electron ionization (EI), chemical ionization (CI), inductively coupled plasma (ICP), fast atom bombardment (FAB), plasma desorption (PD), electrospray (ESI), atmospheric pressure chemical ionization (APCI), matrix assisted laser desorption ionization (MALDI), detection (electron and photomultipliers, and array detectors), and mass analysis [magnetic deflection, quadrupole, ion trap, time of flight (TOF), and Fourier-transform (FTMS)]. Detailed interpretation of organic mass spectra for structural information, with special emphasis on even-electron-ion fragmentation. Qualitative and quantitative applications in environmental, biological, pharmacological, forensic, and geochemical sciences.

**CH 668 Computational Biology**

Topics at the interface of biology and computer technology will be

discussed, including molecular sequence analysis, phylogeny generation, biomolecular structure simulation, and modeling of site-directed mutagenesis. Prerequisite: CH 321, CH 580, or equivalent.

#### **CH 670 Synthetic Polymer Chemistry**

Mechanisms and kinetics of organic and inorganic polymerization reactions; condensation, free radical and ionic addition, and stereoregular polymerizations; copolymerizations; and the nature of chemical bonds and the resulting physical properties of high polymers.

#### **CH 671 Physical Chemistry of Polymers**

Physio-chemical aspects of polymers, molecular weight distributions, solution characterization and theories, polymer chain configuration, thermodynamics of polymer solutions, the amorphous state, and the crystalline state.

#### **CH 672 Macromolecules in Modern Technology**

The course covers recent advances in macromolecular science, including polyelectrolytes and water-soluble polymers, synthetic and biological macromolecules at surfaces, self-assembly of synthetic and biological macromolecules, and polymers for biomedical applications.

#### **CH 673 Special Topics in Polymer Chemistry\***

Recent developments in polymer science will be discussed, e.g., physical measurements, polymer characterization, polymerization kinetics, and morphology. Topics will vary from year to year and specialists will participate.

#### **CH 674/NANO 674 Polymer Functionality**

Topics at the interface of polymer chemistry and biomedical sciences, focusing on areas where polymers have made a particularly strong contribution, such as in biomedical sciences and pharmaceuticals. Synthesis and properties of biopolymers; biomaterials; nanotechnology smart polymers; functional applications in biotechnology, tissue and cell engineering; and biosensors and drug delivery. Prerequisite: Undergraduate Organic Chemistry.

#### **CH 678 Experimental Microbiology**

Discussions in medical, industrial, and environmental microbiology will include bacteriology, virology, mycology, parasitology, and infectious diseases. Includes experimental laboratory instruction. Laboratory fee: \$60. Prerequisite: CH 382 or equivalent.

#### **CH 681 Biochemistry II - Biomolecular Structure and Function**

Discusses the physical and structural chemistry of proteins and nucleotides, as well as the functional role these molecules play in biochemistry. Extensive use of known X-ray structural information will be used to visualize the three-dimensional structure of these biomolecules. This structural information will be used to relate the molecules to known functional information. Prerequisite: CH 242 or equivalent.

#### **CH 682 Biochemical Laboratory Techniques**

Students will work actively in small collaborative groups to solve a unique research project that encompasses the purification, analysis of purity, kinetics, and structure-function analysis of a novel recombinant protein. Techniques in protein purification, gel electrophoresis, peptide digest separation, ligand binding,

steady-state and stopped-flow kinetics, and molecular simulation will be explored. Prerequisite: Admission into the graduate Chemical Biology program. Laboratory fee: \$60.

#### **CH 684 Molecular Biology Laboratory Techniques**

This laboratory course introduces essential techniques in molecular biology and genetic engineering in a project format. The course includes aseptic technique and the handling of microbes; isolation and purification of nucleic acids; construction, selection and analysis of recombinant DNA molecules; restriction mapping; immobilization and hybridization of nucleic acids; and labeling methods of nucleic acid probes. Laboratory fee: \$60. Prerequisite: CH 484 or equivalent.

#### **CH 685 Medicinal Chemistry**

A few topics of timely interest will be treated in depth,; recent chemical developments will be surveyed in fields such as antibiotics, cancer chemotherapy, CNS agents, chemical control of fertility, steroids and prostaglandins in therapy, etc. Prerequisite: CH 242 or equivalent.

#### **CH 686 Immunology**

The cells and molecules of the immune system and their interaction and regulation; the cellular and genetic components of the immune response, the biochemistry of antigens and antibodies, the generation of antibody diversity, cytokines, hypersensitivities, and immunodeficiencies (i.e. AIDS); and transplants and tumors. Use of antibodies in currently emerging immunodiagnostic techniques such as ELISA, disposable kits, molecular targets, and development of vaccines utilizing molecular biological techniques, such as recombinant and subunit vaccines. Students (or groups of students) are expected to write and present a term project. Prerequisite: CH 381 or equivalent.

#### **CH 687 Molecular Genetics**

This course is a modern approach to the study of heredity through molecular biology. Primary emphasis is on nucleic acids, the molecular biology of gene expression, molecular recognition and signal transduction, and bacterial and viral molecular biology. The course will also discuss recombinant DNA technology and its impact on science and medicine. Prerequisite: CH 484 or equivalent.

#### **CH 688 Methods in Chemical Biology**

A discussion of the theories underlying various techniques of molecular biology which are used in the biotechnology industry. Topics include all recombinant DNA techniques; DNA isolation and analysis; library construction and screening; cloning; DNA sequencing; hybridization and other detection methods; RNA isolation and analysis; protein isolation and analysis (immunoassay, ELISA, etc.); transgenic and ES cell methods; electrophoresis (agarose, acrylamide, two dimensional, and SDS-PAGE); column chromatography; and basic cell culture including transfection and expression systems. Prerequisites: Undergraduate biology, especially cell biology (CH 381 or equivalent).

#### **CH 689 Cell Biology Laboratory Techniques**

Laboratory practice in modern biological research will be explored. Techniques involving gene and protein cellular probes, ELISA, mammalian cell culturing, cell cycle determination, differential centrifugation, electron microscopy, and fluorescent cellular markers will be addressed. Prerequisite: Admission into the graduate Chemical Biology program and CH 381 or equivalent. Laboratory fee: \$60.

**CH 690/NANO 690 Cellular Signal Transduction**

This advanced course covers the mechanism and biological role of signal transduction in mammalian cells. Topics included are extracellular regulatory signals, intracellular signal transduction pathways, role of tissue context in the function of cellular regulation, and examples of biological processes controlled by specific cellular signal transduction pathways. Prerequisites: Undergraduate Cell Biology, Molecular Genetics (Undergraduate). Cross-listed with BME 690.

**CH 700 Seminar in Chemistry**

Lectures by department faculty, guest speakers, and doctoral students on recent research. Enrollment during the entire period of study is required of all doctoral students. 0.5 credit, pass/fail. Must be taken every semester.

**CH 720-721 Selected Topics in Chemical Physics I-II \***

Topics of current interest selected by you are to be investigated from an advanced point of view.

**CH 722 Selected Topics in Physical Chemistry\***

Topics selected to coincide with research interests current in the department.

**CH 740 Selected Topics in Organic Chemistry\***

Selected topics of current interest in the field of organic chemistry will be treated from an advanced point of view; recent developments will be surveyed in fields such as reaction mechanisms, physical methods in organic chemistry, natural products chemistry, biogenesis, etc.

**CH 760 Chemoinformatics**

This advanced course in computational chemistry builds on the methods developed in CH 664. Students will analyze and design combinatorial libraries, develop SAR models, and generate calculated molecular properties. The hands-on course will use both PC and Silicon Graphics computers. Software, such as that from Oxford Molecular, Tripos, and Oracle will be used, as will MSI software, such as INSIGHT/DISCOVER, Catalyst, and Cerius 2. Prerequisite: CH 664 or equivalent.

**CH 780-781 Selected Topics in Biochemistry I-II \***

Topics of current interest in biochemical research are discussed, such as: enzyme chemistry, biochemical genetics and development, cellular control mechanism, biochemistry of cell membranes, bioenergetics, and microbiology.

**CH 782 Selected Topics in Bioorganic Chemistry\***

Topics of timely interest will be treated in an interdisciplinary fashion; recent developments will be surveyed in fields such as biosynthesis, radioactive and stable isotope techniques, genesis of life chemicals, nucleic acids and replication, genetic defects, and metabolic errors.

**CH 800 Special Research Problems in Chemistry\***

One to six credits. Limit of six credits for the degree of Master of Science.

**CH 801 Special Problems in Chemistry\***

One to six credits. Limit of six credits for the degree of Doctor of Philosophy.

**CH 900 Thesis in Chemistry\***

For the degree of Master of Science, five to ten credits with departmental approval.

**CH 960 Research in Chemistry\***

Original experimental or theoretical research that may serve as the basis for the dissertation required for the degree of Doctor of Philosophy. The work will be carried out under the guidance of a faculty member. Hours and credits to be arranged.

**NANO 600 Nanoscale Science and Technology**

This course deals with the fundamentals and applications of nanoscience and nanotechnology. Size-dependent phenomena, ways and means of designing and synthesizing nanostructures, and cutting-edging applications will be presented in an integrated and interdisciplinary manner.

\*By request.

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