

# Chemistry

*Chair of the Department:* Henry Tracy, 352 Science Building, Portland  
*Professors:* Tracy; *Associate Professors:* Prudenté; *Assistant Professors:* Benedict, Ford; *Professors Emeriti:* Gordon, Newton, Rhodes, Ricci, Sottery, Stebbins, Whitten

The field of chemistry is concerned with the structure of matter, its transformations, and the energy changes related to these transformations. Departmental aims are to contribute to the student's understanding of chemistry's place within the sciences and in today's industrial and business world, and to provide students concentrating in this field with a thorough and practical education that will be useful in teaching or in industrial, technical, or graduate work.

To achieve these aims the Department of Chemistry offers a four-year program with three tracks leading to baccalaureate degrees (B.A. in chemistry, B.S. in chemistry, and B.S. in biochemistry). Because the chemistry courses in each track are the same for the first two years, it is possible to switch tracks through the junior year. Students considering a chemistry major are strongly urged to consult with a member of the Department of Chemistry faculty to discuss the total program. They should pay particular attention to the pre- and co-requisites necessary for different courses.

## **Programs and Requirements**

To graduate as a chemistry major in any of the three programs, a student must earn a grade of C or better in all chemistry courses and a minimum grade point average of 2.0 in all other courses required for the major.

### *Bachelor of Science: Chemistry*

The minimum number of credits in chemistry and related areas (exclusive of the University's Core curriculum) required for the major in this track: 66.

The courses include: CHY 113K & 114K; 115 & 116; 231 & 232; 251 & 252; 253 & 254; 371 & 372, 373 & 374; 377 & 378; 401; 421; one of the following three offerings: 345, 351, 461 (a minimum of 44 hours within the Department). In addition PHY 121K & 114K; 123 & 116; MAT 152D, 153; COS 160/170 (Java) or a math/computer science course approved by the Chemistry Department are required (a total of 22 more hours). At least 12 credit hours beyond the 100-level must be taken within the Chemistry Department at USM.

### *Bachelor of Science: Biochemistry*

The minimum number of credits in chemistry and related areas (exclusive of the University's Core curriculum) required for the major in this track: 75-79.

The courses include: CHY 113K & 114K; 115 & 116; 231 & 232; 251 & 252; 253 & 254; 373 & 374; 461 & 462; 463; either CHY 421 or 377 & 378 (a minimum of 40-42 hours within the Department). In addition, either AIM 670 & 671 or BIO 409 & 410, and either AIM 620 & 621 or BIO 201 & 408 or BIO 305 & 306W or BIO 311 & 312W or BIO 401 & 402 (a total of 10-12 hours). Also, BIO 105K; PHY 121K & 114K; 123 & 116; MAT 152D, 153; COS 160/170 (Java) or a math/computer science course approved by the Department of Chemistry are required (a total of 22 more hours). At least 12 credit hours beyond the 100-level must be taken within the Chemistry Department at USM.

### *Bachelor of Arts: Chemistry*

The minimum number of credits in chemistry and related areas (exclusive of the University's Core curriculum) required for the major in this track: 61-62.

The courses include: CHY 113K & 114K; 115 & 116; 231 & 232; 251 & 252; 253 & 254; 371 & 372; 373 & 374; 401; two of the following five offerings; 345; 351; 377 & 378; 421; 461 (a minimum of 39-40 hours within the Department). In addition PHY 121K & 114K; PHY 123 & 116; MAT 152D, 153; COS 160/170 (Java) or a math/computer science course approved by the Chemistry Department are required (a total of 22 more hours). At least 12 credit hours beyond the 100-level must be taken within the Chemistry Department at USM.

### *Minor in Chemistry*

The minimum number of credits (exclusive of the Core curriculum) required for the minor: 17. At least 6 credit hours beyond the 100-level must be taken within the Chemistry Department at USM.

The minor consists of CHY 113K & 114K, 115 & 116 and either of the following two groups of courses: 231 & 232, 251 & 252, or 371 & 372; 373; 421.

|                    |                                      |                     |
|--------------------|--------------------------------------|---------------------|
| CHY 113K/114K      | General Chemistry I with Laboratory  | (4 credits)         |
| CHY 115/116        | General Chemistry II with Laboratory | (4 credits)         |
| CHY 231/232        | Analytical Chemistry with Laboratory | (4 credits)         |
| CHY 251/252        | Organic Chemistry I with Laboratory  | (5 credits)         |
| <b>Total hours</b> |                                      | <b>(17 credits)</b> |

**or**

|                    |                                       |                     |
|--------------------|---------------------------------------|---------------------|
| CHY 113K/114K      | General Chemistry I with Laboratory   | (4 credits)         |
| CHY 115/116        | General Chemistry II with Laboratory  | (4 credits)         |
| CHY 371/372        | Physical Chemistry I                  | (5 credits)         |
| CHY 373            | Physical Chemistry II with Laboratory | (3 credits)         |
| CHY 421            | Inorganic Chemistry                   | (3 credits)         |
| <b>Total hours</b> |                                       | <b>(19 credits)</b> |

### *Minor in Biochemistry*

The minimum number of credits required (exclusive of Core courses) for the minor: 23. The minor consists of CHY 113K, 114K, 115, 116, 251, 252, 253, 254, 461, and either 462 or 463. The biochemistry minor is not open to chemistry majors. At least 6 credit hours beyond the 100-level must be taken within the Chemistry Department at USM.

### ***Admission Requirements***

Students who apply for admission to the chemistry program should have completed college preparatory courses in chemistry, physics, and mathematics. At least two years of algebra and a semester each of geometry and trigonometry are recommended as part of the student's high school program. (Freshmen in the chemistry program who lack this preparation in mathematics are required to take MAT 140D, Precalculus Mathematics.)

### ***Laboratory Fees***

A laboratory fee is assessed in chemistry laboratory courses.

### **CHY 100 Foundations for College Chemistry**

The course will review basic chemical principles commonly presented in high school chemistry and emphasize solving mathematical problems usually done in freshman college-level chemistry. Prerequisite: satisfaction of math proficiency requirements. A high school chemistry course is recommended. Not open to students who have already passed a chemistry course numbered 101 or higher. Cr 2.

### **CHY 101K Introduction to Chemistry**

General topics in chemistry including introductory units on matter and its properties; measurement; elements and compounds; atomic structure; solutions, dispersions, and water; osmotic pressure; chemical bonds; chemical nomenclature; stoichiometry; radio-chemistry; gases; acids, bases and buffers; and energy relationships in chemical processes. Three hours lecture per week (usually concurrent with CHY 102K). Prerequisite: high school algebra. Not appropriate for science majors, pre-med, pre-vet or pre-dentistry students. Cr 3.

### **CHY 102K Introduction to Laboratory Measurement**

Experiments will be designed to teach students how to perform accurate and reliable measurements using the major parameters of mass and volume. Topics to be covered include: physical and chemical changes; separation of a mixture; analysis of an ionic solution; properties of water; gases; acids, bases and buffers; titration. One recitation and two laboratory hours per week. Corequisite: CHY 101K. Not appropriate for chemistry or biology majors. Cr 1.

### **CHY 103 Introduction to Organic and Biochemistry**

Stress will be placed upon topics of special importance for students of the health sciences: nomenclature of organic compounds; electron distribution in organic molecules; structural features of organic molecules; substitution, elimination, and addition reactions; oxidation reduction reactions; carbohydrates; lipids; proteins and amino acids; enzymes; nucleic acids; metabolism; summary of some aspects of nutrition; pharmaceuticals; medical applications of radiochemistry. Three lecture hours per week (usually concurrent with CHY 104). Prerequisite: a grade of C or better in CHY 101K. Not appropriate for science majors, pre-med, pre-vet or pre-dentistry students. Cr 3.

### **CHY 104 Introductory Organic and Biochemistry Laboratory**

Students will perform experiments to illustrate aspects of organic chemistry of importance to living systems, as well as elementary principles of biochemistry. Topics include separation and identification of organic compounds; qualitative reactions of lipids, proteins, and nucleic acids; introduction to enzyme chemistry. One recitation and two laboratory hours per week. Offered spring semester. Corequisite: CHY 103. Not appropriate for chemistry or biology majors. Cr 1.

### **CHY 107 Chemistry for Health Sciences**

A one-semester introduction to general, organic, and biological chemistry for the health sciences. Topics include acids and bases, pH, chemical kinetics and equilibria, the chemistry of organic compounds; carbohydrates, proteins, lipids, nucleic acids. This course is not suitable for chemistry majors, biology majors, or pre-professionals (pre-dental, pre-medical, pre-veterinary). Cr 3.

### **CHY 108 Chemistry Laboratory for Health Sciences**

Experiments in this laboratory are designed to illustrate principles from CHY 107. Aims of the course are to develop skill in using common laboratory equipment, measuring and analyzing data, and in reporting results of lab work. One three-hour meeting per week. Corequisite or prerequisite: CHY 107. Cr 1.

### **CHY 110K Chemistry, Life, and the Environment**

An introduction to chemistry and its importance to society. This course is centered on the nature of atoms and molecules, and how the structures of molecules give rise to the beneficial and harmful effects of chemicals. Classroom examples include medicines, consumer products, pollutants, and the molecules of life. Laboratory and home experiments include examining the chemical content of foods. This course is designed to satisfy the natural Sciences (Area K) requirement of the Core curriculum. Prerequisite: completion of all Core Basic Competence requirements. Cr 4.

### **CHY 113K Principles of Chemistry I**

A presentation of fundamental principles of chemical science. These principles will be presented in quantitative terms and illustrated by examples of their applications in laboratories and in ordinary non-laboratory experience. This course and CHY 114 (normally taken concurrently) provide the basis for further study of chemistry. Prerequisite: satisfaction of USM math minimum proficiency requirements. Cr 3.

### **CHY 114K Laboratory Techniques I**

Laboratory experiments to illustrate the principles that are presented in CHY 113 lectures. One recitation and two laboratory hours per week. Corequisite: CHY 113K. Cr 1.

### **CHY 115 Principles of Chemistry II**

A continuation of CHY 113K. This course is designed to provide the foundation for all further studies in chemistry and is a prerequisite for all upper-level chemistry courses. Prerequisite: a grade of C or better in CHY 113K. Cr 3.

### **CHY 116 Laboratory Techniques II**

Laboratory experiments to illustrate the principles presented in CHY 115 lectures. One recitation and two laboratory hours per week. Prerequisite: a grade of C- or better in CHY 114K. Corequisite: CHY 115. Cr 1.

### **CHY 231 Analytical Chemistry**

A survey of principles and applications of modern analytical chemistry and related calculations. Topics include volumetric and gravimetric analysis, electroanalysis, spectrophotometry, separations, statistics, and error analysis. Prerequisite: a grade of C or better in CHY 115. Cr 2.

### **CHY 232 Analytical Chemistry Laboratory**

Quantitative experimental determination by means of classical and instrumental methods. Techniques used include titration, gravimetric analysis, spectrophotometry, electroanalysis, and chromatography. Precision, accuracy, and statistical error analysis of results are emphasized. Four lab hours per week. Prerequisite: a grade of C or better in CHY 116. Corequisite: CHY 231. Cr 2.

### **CHY 251 Organic Chemistry I**

An intensive treatment of organic chemistry. Topics include: nomenclature; structure and stereochemistry; reaction types: substitution, addition, elimination and oxidation-reduction; reaction mechanisms and factors influencing them; spectroscopic techniques of structure determination (mass, nuclear magnetic resonance, ultraviolet-visible and infrared). Prerequisite: a grade of C or better in CHY 115. Cr 3.

### **CHY 252 Organic Chemistry Laboratory I**

Students conduct independent research by executing a multi-step synthesis of a series of compounds. An additional goal is the characterization of the physical and chemical properties of the target molecules as well as the intermediates. Students will develop proficiency in synthetic methods, chromatography, and spectroscopy by working with model compounds. Prerequisite: a grade of C or better in CHY 116. Prerequisite or corequisite: CHY 251. Cr 2.

### **CHY 253 Organic Chemistry II**

A continuation of CHY 251, but with a more extensive (and intensive) investigation of the principal categories of organic reactions. Extensive problem solving in such areas as structure determination, spectroscopy, and stereochemistry. The structures and fundamental chemical reactions of lipids, carbohydrates, proteins and nucleic acids will be presented. Prerequisite: a grade of C or better in CHY 251. Cr 3.

### **CHY 254 Organic Chemistry Laboratory II**

Students will apply the skills they developed by working with model compounds in CHY 252 to the synthesis of the desired target molecules. Prerequisite: A grade of C or better in CHY 252. Prerequisite or corequisite: CHY 253. Cr 2.

### **CHY 345 Polymer Chemistry**

We live in a plastic society. During the past 90 years plastics (synthetic polymers) have become an integral part of our daily lives. This course will survey

the past, present, and future of the chemistry of these essential materials. We will discuss the preparation of polymers under radical chain, step-reaction, ionic, and coordination conditions. Then we will consider methods of characterization of polymers, both experimental and theoretical. Finally we will examine commercial polymers and polymer technology. Prerequisites: CHY 253 and 373. Cr 3.

### **CHY 351 Advanced Organic Chemistry**

This course will explore fundamentals of organic reaction mechanisms. A partial list of the topics to be covered includes steric, electronic, and stereo electronic effects; conformational analysis; thermodynamic and kinetic principles; applications of molecular orbital theory; reactive intermediates; and modern techniques used to study reaction mechanisms. Course content may vary from year to year, depending on student interests. Prerequisite: a grade of C or better in CHY 253. Cr 3.

### **CHY 371 Physical Chemistry I**

Principles of theoretical chemistry: quantum mechanics and spectroscopy. Candidates for the B.S. degree elect this course in the fall semester of the junior year. Prerequisites: a grade of C or better in CHY 115, MAT 152D, and PHY 123. Cr 3.

### **CHY 372 Physical Chemistry Laboratory I**

Experiments illustrating material presented in CHY 371. One recitation and three laboratory hours per week. Prerequisite: a grade of C or better in CHY 116. Prerequisite or corequisite: CHY 371. Cr 2.

### **CHY 373 Physical Chemistry II**

Principles of theoretical chemistry: classical thermodynamics, molecular energetics, equilibrium, reaction kinetics, statistical thermodynamics, and electrochemistry. Prerequisites: a grade of C or better in CHY 115, MAT 152D, and PHY 123. Cr 3.

### **CHY 374 Physical Chemistry Laboratory II**

Experiments illustrating material presented in CHY 373. One recitation and three laboratory hours per week. Prerequisite or corequisite: CHY 373. Cr 2.

### **CHY 377 Instrumental Analysis**

A consideration of the applicability of current laboratory instrumentation both to the elucidation of fundamental chemical phenomena and to the measurement of certain atomic and molecular parameters. Topics include absorption and emission spectroscopy in the ultraviolet, visible and infrared regions; chromatography; electrochemistry; mass spectrometry; and magnetic resonance. Prerequisite or corequisite: CHY 231 and CHY 371 or permission. Cr 3.

### **CHY 378 Instrumental Analysis Laboratory**

Experiments will be performed in electrochemistry, mass spectrometry, gas and liquid chromatography, and UV-Vis, NMR, AA, and fluorescence spectroscopy. Prerequisites: grades of C or better in CHY 232 and CHY 371. One hour of pre-lab recitation and three laboratory hours per week. Cr 2.

**CHY 401 Seminar**

Oral and written presentation of a current topic in chemistry or of research results. Required of all senior majors. Satisfactory completion of written paper fulfills technical writing requirement. Cr 1.

**CHY 410-419 Special Topics**

Reading and discussion of advanced subjects or instruction in special topics/research. Permission of instructor required. 6 credits maximum. Cr 1-3.

**CHY 421 Inorganic Chemistry**

Descriptive chemistry of the inorganic compounds, structure, bonding and ligand field theory. Prerequisite or corequisite: CHY 371. Cr 3.

**CHY 422 Advanced Chemistry Laboratory**

Preparation and characterization of compounds utilizing advanced modern techniques and instrumentation. One recitation and three laboratory hours per week. Prerequisite or corequisite: CHY 421. Not offered every year. Cr 2.

**CHY 461 Biochemistry**

Application of chemical methods and principles to understanding biological processes. Topics include structure and action of nucleotides, proteins, lipids, and carbohydrates; enzyme kinetics and mechanisms; membranes and transport; and metabolism and energy conversion. This one-semester course provides a survey of the major areas of biochemistry, except for nucleic acids. Prerequisite: a grade of C or better in CHY 253 or by instructor permission. Cr 3.

**CHY 462 Biochemistry Laboratory**

Basic experimental methods in modern biochemistry. Experiments include detecting, purifying,

crystallizing, and characterizing proteins; analyzing protein structure, and measuring enzyme kinetics. Techniques include ultraviolet and visible spectrophotometry; ion-exchange, gel, and high-pressure liquid chromatography; electrophoresis, and analysis of protein structure by computer graphics. One hour lecture and three hours laboratory per week. Prerequisite: a grade of C or better in CHY 254. Prerequisite or corequisite: CHY 461. Cr 2.

**CHY 463 Biochemistry II**

Continuation of CHY 461. Topics include selected biosynthetic pathways, including photosynthesis; signal transduction applied to hormones, nerve transmission, and the five senses; and methods for structural analysis of macromolecules, including X-ray diffraction, nuclear magnetic resonance, and homology modeling. Participants present a seminar on a topic of current biochemical research. Prerequisite: a grade of C or better in CHY 461. Cr 3.

**CHY 464 Biochemistry Laboratory II**

Continuation of CHY 462. Experiments include detecting and characterizing lipids, sequencing proteins and nucleic acids, analyzing protein conformation, measuring protein synthesis, and characterizing antigen-antibody interactions. Techniques include paper and thin-layer chromatography, gel electrophoresis, and computer graphics. One hour lecture and three hours laboratory per week. Prerequisite: a grade of C or better in CHY 462. Prerequisite or corequisite: CHY 463. Cr 2.

**CHY 490 Senior Research Project**

Open to senior majors. Prerequisites include a 2.0 GPA in chemistry, completion of the Analytical and Organic Chemistry series, and permission of the department. 15 credits maximum. Cr 3-15.