# CHEMISTRY

## DEPARTMENT OFFICE

**3301 New Science Facility**
**Phone:** 906-227-2911
**Fax:** 906-227-1066
**Web Page:** www.nmu.edu/departments/chemistry
**Interim Department Head:** Suzanne E. Williams • swilliam@nmu.edu

### Chemistry at NMU

The Chemistry Department offers programs leading to either the bachelor of arts degree or the bachelor of science degree in biochemistry, chemistry, forensic biochemistry, secondary education chemistry and water science, as well as graduate-level programs. The department also supports courses for students in other areas needing chemistry cognates and electives. The program for majors at the undergraduate level is designed for students planning professional careers in chemistry and related fields, and in the teaching of chemistry. There are several program options available at the advanced undergraduate level depending upon the career interests of the student.

Northern's Chemistry Department is accredited by the American Chemical Society. ACS approval and periodic reviews of the department's capability to offer complete programs to prepare students for professional work in the chemistry field attests to the continuing academic soundness of the undergraduate program and to its ability to serve the student population's diverse needs and interests.

The Chemistry Department also provides advisement for students interested in pre-pharmacy. See the "Pre-professional Programs" section of this bulletin.

### Student Organizations

- American Chemical Society Student Affiliates
- Chemistry Club/Moles "R" Us
- Student Michigan Education Association

### Department/Program Policies

Students enrolled in a chemistry laboratory must pay the cost of replacement for glassware or equipment broken in excess of one dollar. Records of student breakage are maintained in the chemistry stockroom, and students are notified of any amount due after the last laboratory meeting. The breakage fee is not applicable to CH 490 or CH 491.

Only those chemistry courses passed with a grade of "C-" or better apply to the biochemistry, chemistry and Chemistry ACS Certified majors.

Students majoring in secondary education chemistry or minoring in chemistry education must maintain a grade point average of 2.70 or greater with no grade below a "C" in the professional education sequence, the major and/or minor and required cognates combined.

## BACHELOR DEGREE PROGRAMS

***Liberal Studies:*** *Complete information on the liberal studies requirements and additional graduation requirements, including the health promotion requirement, is in the "Liberal Studies Program and Graduation Requirements" section of this bulletin.*

*Courses within each major that can be used to satisfy liberal studies requirements are listed with the Roman numeral (in brackets) that coincides with the liberal studies division the course falls under.*

### Biochemistry Major

This major prepares students for entry into graduate programs in biochemistry and related disciplines. The program serves those interested in biochemical research or forensic science as a career or in pursuing pre-professional programs in medicine or dentistry. The biochemistry curriculum includes the credit-hour equivalent of a major plus a minor; therefore, no minor is required.

| | |
|---|---|
| **Total Credits Required for Degree** | **124** |
| **Liberal Studies** | **30-40** |
| **Health Promotion** | **2** |
| **Required Courses in Major** | **78-79** |
| **Chemistry** | |
| CH 111 General Chemistry I [III] | 5 |
| CH 112 General Chemistry II [III] | 5 |
| CH 241 Chemical Equilibrium | 3 |
| CH 242 Quantitative Analysis | 2 |
| CH 321 Organic Chemistry I | 4 |
| CH 322 Organic Chemistry II | 4 |
| CH 342 Physical Chemistry II | 4 |
| CH 450 Introductory Biochemistry | 4 |

| | |
|---|---|
| CH 452 Intermediary Metabolism | 4 |
| CH 454 Biochemical Techniques | 4 |
| **Biology** | |
| BI 111 Introductory Biology: Principles [III] | 4 |
| BI 112 Introductory Biology: Diversity [III] | 4 |
| BI 303 General Microbiology *or* | 4-5 |
| BI 313 Cell Biology (4 cr.) *or* | |
| BI 431 Plant Physiology (4 cr.) | |
| BI 312 Genetics | 4 |
| BI 418 Molecular Biology | 4 |
| **Mathematics** | |
| MA 161 Calculus I [III] | 5 |
| MA 163 Calculus II | 4 |
| **Physics** | |
| PH 220 Introductory Physics I [III] *or* | 5 |
| PH 201College Physics I [III] | |
| PH 221 Introductory Physics II [III] *or* | 5 |
| PH 202 College Physics II [III] | |
| **Biochemistry Electives** | **9** |

*Choose from the following:*

AIS 435 Electronic Information Resources (2 cr.)
BI 203 Medical Microbiology (5 cr.)
BI 210 Principles of Ecology (4 cr.)
BI 303 General Microbiology (5 cr.)
BI 313 Cell Biology (4 cr.)
BI 405 Immunology (3 cr.)
BI 411 Limnology (4 cr.)
BI 413 Biochemistry of Development (4 cr.)
BI 425 Endocrinology (3 cr.)
BI 431 Plant Physiology (4 cr.)
BI 495 Special Topics in Biology (1-4 cr.)
BI 498 Directed Studies in Biology (1-4 cr.)
CH 341 Physical Chemistry I* (4 cr.)
CH 415 Inorganic Chemistry (4 cr.)
CH 430 Environmental Chemistry (5 cr.)
CH 435 Gas and Liquid Chromatography (2 cr.)
CH 436 Modern Spectrometry (3 cr.)
CH 437 Atomic Absorption Spectrometry (1 cr.)
CH 456 Protein Structure and Function (3 cr.)
CH 460 Nuclear Chemistry (4 cr.)
CH 490 Senior Research and Seminar I (2-4 cr.)
CH 491 Senior Research and Seminar II (2-4 cr.)
CH 495 Special Topics in Chemistry (1-4 cr.)
CS 120 Introduction to Computing (4 cr.) [V]
BI 412 Biometrics (4 cr.) *or*
MA 171 Introduction to Probability and Statistics (4 cr.) [V]
MA 211 Introduction to Matrix Theory and Linear Algebra (3 cr.)
MA 361 Differential Equations (3 cr.)
MA 475 Intermediate Statistics (4 cr.)
PH 322 Modern Physics (4 cr.)

**Students wishing to pursue graduate studies in biochemistry or industrial careers should take CH 341.*

## Chemistry Major (ACS Certified)

This major prepares students who plan to pursue graduate-level work in chemistry or to work in the chemical industry. Students who successfully complete this program will meet at least the minimum standards of the Committee on Professional Training of the American Chemical Society. Students in this major may satisfy the minor subject requirement by completing the sequence of courses listed as an academic minor in another department or completing the group science minor.

| **Total Credits Required for Degree** | **124** |
|---|---|
| **Liberal Studies** | **30-40** |
| **Health Promotion** | **2** |
| **Required Courses in Major** | **49** |
| CH 111 General Chemistry I [III] | 5 |
| CH 112 General Chemistry II [III] | 5 |
| CH 215 Chemistry of the Elements | 4 |
| CH 241 Chemical Equilibrium | 3 |
| CH 242 Quantitative Analysis | 2 |
| CH 321 Organic Chemistry I | 4 |
| CH 322 Organic Chemistry II | 4 |
| CH 341 Physical Chemistry I | 4 |
| CH 342 Physical Chemistry II | 4 |
| CH 415 Inorganic Chemistry | 4 |
| CH 435 Gas and Liquid Chromatography | 2 |
| CH 436 Modern Spectrometry | 3 |
| CH 437 Atomic Absorption Spectrometry | 1 |
| CH 450 Introductory Biochemistry | 4 |
| **Other Required Courses** | **19** |
| MA 161 Calculus I [III] | 5 |
| MA 163 Calculus II | 4 |
| PH 220 Introductory Physics I [III] *or* | 5 |
| PH 201College Physics I [III] | |
| PH 221 Introductory Physics II [III] *or* | 5 |
| PH 202 College Physics II [III] | |
| **Minor** | **3-20** |

*The group science minor uses the other required courses and requires three additional credits; see page 74.*

## Chemistry Major

This major prepares students for further work in areas outside pure chemistry such as forensic science, the biological sciences, medicine, dentistry, pharmacy, engineering, material science, pollution control or ecology. Students in this major may satisfy the minor subject requirement by completing the sequence of courses listed as an academic minor in another department or completing the group science minor.

| **Total Credits Required for Degree** | **124** |
|---|---|
| **Liberal Studies** | **30-40** |
| **Health Promotion** | **2** |
| **Required Courses in Major** | **41** |
| CH 111 General Chemistry I [III] | 5 |
| CH 112 General Chemistry II [III] | 5 |
| CH 241 Chemical Equilibrium | 3 |
| CH 242 Quantitative Analysis | 2 |
| CH 321 Organic Chemistry I | 4 |
| CH 322 Organic Chemistry II | 4 |
| CH 341 Physical Chemistry I | 4 |
| CH 342 Physical Chemistry II | 4 |
| CH 415 Inorganic Chemistry | 4 |
| **Chemistry Electives** | **6** |
| *Must be at the 400 level, including at least one of the following:* | |
| CH 435 Gas and Liquid Chromatography (2 cr.) | |
| CH 436 Modern Spectrometry (3 cr.) | |
| CH 437 Atomic Absorption Spectrometry (1 cr.) | |
| **Other Required Courses** | **19** |
| MA 161 Calculus I [III] | 5 |
| MA 163 Calculus II | 4 |
| PH 220 Introductory Physics I [III] *or* PH 201College Physics I [III] | 5 |
| PH 221 Introductory Physics II [III] *or* PH 202 College Physics II [III] | 5 |
| **Minor** | **3-20** |

*The group science minor uses the other required courses and requires three additional credits; see page 74.*

## Forensic Biochemistry Major

This major is designed to prepare students for a career in the field of forensic science. It provides the science background required for working as a forensic investigator in a crime lab. In addition, it prepares students for entry into a graduate program in forensic science. The forensic biochemistry curriculum includes courses from multiple departments and is the credit-hour equivalent of a major plus a minor, therefore no additional minor is required. Students who are interested in pursuing this degree should have a strong background in science, including two years of high school algebra and one year of high school chemistry. The capstone course for this major, CH 440, is offered every other year, therefore students should consult with their adviser early in their program to ensure that they are prepared to take CH 440 when it is offered.

| **Total Credits Required for Degree** | **128** |
|---|---|
| **Liberal Studies** | **30-40** |
| **Health Promotion** | **2** |
| **Required Courses in Major** | **33** |
| CH 111 General Chemistry I [III] | 5 |
| CH 112 General Chemistry II [III] | 5 |
| CH 241 Chemical Equilibrium | 3 |
| CH 242 Quantitative Analysis | 2 |
| CH 321 Organic Chemistry I | 4 |
| CH 322 Organic Chemistry II | 4 |
| CH 435 Gas and Liquid Chromatography | 2 |
| CH 440 Forensic Chemistry | 4 |
| CH 450 Introductory Biochemistry | 4 |
| **Other Required Courses** | **48** |
| BI 111 Introductory Biology: Principles [III] | 4 |
| BI 112 Introductory Biology: Diversity [III] | 4 |
| BI 203 Medical Microbiology *or* BI 303 General Microbiology | 5 |
| BI 312 Genetics | 4 |
| BI 418 Molecular Biology | 4 |
| CJ 110 Introduction to Criminal Justice | 4 |
| CJ 214 Investigative Process I | 4 |
| MA 161 Calculus I [III] | 5 |
| MA 171 Statistics [V] | 4 |
| PH 220 Introductory Physics I [III] *or* PH 201College Physics I [III] | 5 |
| PH 221 Introductory Physics II [III] *or* PH 202 College Physics II [III] | 5 |
| **Electives** | **17** |
| *Choose from the following:* | |
| CH 215 Chemistry of the Elements (4 cr.) | |
| CH 341 Physical Chemistry I (4 cr.) | |
| CH 342 Physical Chemistry II (4 cr.) | |
| CH 415 Inorganic Chemistry (4 cr.) | |
| CH 436 Modern Spectroscopy (3 cr.) | |
| CH 437 Atomic Absorption Spectrometry (1 cr.) | |
| CH 454 Biochemical Techniques (4 cr.) | |
| CH 490/1 Senior Research and Seminar I & II (2-4 cr.) | |
| CH 493 Forensic Laboratory Internship (1-4 cr.) | |
| CJ 414 The Investigative Process II (4 cr.) | |
| MA 163 Calculus II (4 cr.) | |

*Note: Students interested in pursuing graduate studies in biochemistry or chemistry should take MA 163, CH 342, CH 452 and CH 454 or MA 163, CH 341, CH 342 and CH 415, respectively.*

## Secondary Education Chemistry Major

Completion of the chemistry courses as well as the professional education sequence lead to certification as a secondary teacher of chemistry. Students in this program must select an academic minor in another department. A minor in physics education is recommended. Advising for this major is provided by Dr. Mitchell D. Klett in the School of Education.

| **Total Credits Required for Degree** | **138-152** |
|---|---|
| **Liberal Studies** | **30-40** |
| **Health Promotion** | **2** |
| **Required Courses in Major** | **32** |
| CH 111 General Chemistry I [III] | 5 |
| CH 112 General Chemistry II [III] | 5 |
| CH 220 Introductory Organic Chemistry | 5 |
| CH 241 Chemical Equilibrium | 3 |
| CH 242 Quantitative Analysis | 2 |
| CH 341 Physical Chemistry I | 4 |
| CH 342 Physical Chemistry II | 4 |
| CH 450 Introductory Biochemistry | 4 |
| **Other Required Courses** | **27** |
| PH 220 Introductory Physics I [III] *or* PH 201College Physics I [III] | 5 |
| PH 221 Introductory Physics II [III] *or* PH 202 College Physics II [III] | 5 |
| MA 161 Calculus I [III] | 5 |
| MA 163 Calculus II | 4 |
| BI 111 Introductory Biology: Principles [III] | 4 |
| GC 246 Earth Science *or* GC 255 Physical Geography [III] *or* GC 385 Weather and Climate | 4 |
| **Teaching Minor, Minimum*** | **10-24** |
| **Professional Education** | **37** |
| ED 201 Introduction to Education | 2 |
| ED 231 Teaching and Learning in the Secondary Classroom | 4 |
| ED 301 Dimensions of American Education | 2 |
| ED 319 Teaching of Reading for Secondary Teachers | 3 |
| ED 349 Teaching for Diversity, Equity and Social Justice in the Secondary School Community | 2 |
| ED 361 Special Education and the General Classroom Teacher | 2 |
| ED 483 Educational Media and Technology | 2 |
| ED 430 Teaching in the Secondary School | 11 |
| ED 450 Seminar in Teaching | 1 |
| MSED 340 Fundamental Concepts in Science | 4 |
| MSED 350 Methods and Materials in the Teaching of Science Education | 4 |

**Students who minor in Physics Education can complete the minor with an additional 10 credit hours of physics.*

## Water Science Major

This major prepares students who are planning to pursue an advanced degree in oceanography, limnology, water chemistry, aquatic biology or environmental science. It also prepares students for state, federal and industrial positions related to water pollution and water quality. Students can select an adviser from either the chemistry or biology department. The water science major includes the credit-hour equivalent of a major plus a minor.

| **Total Credits Required for Degree** | **124** |
|---|---|
| **Liberal Studies** | **30-40** |
| **Health Promotion** | **2** |
| **Required Courses in Major** | **60-63** |
| BI 111 Introductory Biology: Principles [III] | 4 |
| BI 112 Introductory Biology: Diversity [III] | 4 |
| BI 210 Principles of Ecology | 4 |
| BI 303 General Microbiology | 5 |
| BI 411 Limnology | 4 |
| BI 412 Biometrics | 4 |
| CH 111 General Chemistry I [III] | 5 |
| CH 112 General Chemistry II [III] | 5 |
| CH 220 Introductory Organic Chemistry (5 cr.) *or* CH 321 Organic Chemistry I (4 cr.) *and* CH 322 Organic Chemistry II (4 cr.) | 5-8 |
| CH 241 Chemical Equilibrium | 3 |
| CH 242 Quantitative Analysis | 2 |
| CH 430 Environmental Chemistry | 5 |
| PH 220 Introductory Physics I [III] *or* PH 201College Physics I [III] | 5 |
| PH 221 Introductory Physics II [III] *or* PH 202 College Physics II [III] | 5 |
| **Other Required Courses** | **16** |
| *Choose from the following:* | |
| BI 310 Ecology Theory and Methods (4 cr.) | |
| BI 324 Invertebrate Zoology (4 cr.) | |
| BI 423 Parasitology (3 cr.) | |
| BI 441 Fisheries Management (4 cr.) | |
| BI 465 Aquatic Insect Ecology (4 cr.) | |
| BI 492 Research in Water Science (2 cr.) *or* CH 492 Research in Water Science (2 cr.) *or* GC 492 Research in Water Science (2 cr.) | |
| CH 215 Chemistry of the Elements (4 cr.) | |
| CH 435 Gas and Liquid Chromatography (2 cr.) | |
| CS 120 Computer Science I (4 cr.) [V] | |
| GC 225 Introduction to Maps (2 cr.) | |
| GC 255 Physical Geology (4 cr.) [III] | |
| GC 320 Environmental Policy and Regulation (4 cr.) | |
| GC 390 Oceanography (2 cr.) | |
| GC 465 Hydrology (4 cr.) | |

# MINOR PROGRAMS

## Chemistry Minor

| | |
|---|---|
| **Total Credits Required for Minor** | **22** |
| CH 111 General Chemistry I | 5 |
| CH 112 General Chemistry II | 5 |
| **Chemistry Electives (200 level or above)** | **12** |

## Chemistry Education Minor

| | |
|---|---|
| **Total Credits Required for Minor** | **22-30** |
| CH 111 General Chemistry I | 5 |
| CH 112 General Chemistry II | 5 |
| CH 220 Introductory Organic Chemistry | 5 |
| CH 215 Chemistry of the Elements (4 cr.) *or* | 4-5 |
| CH 241 Chemical Equilibrium (2 cr.) *and* | |
| CH 242 Quantitative Analysis (2 cr.) | |
| Chemistry Electives (200 level and above) | 2-3 |
| MSED 340 Fundamental Concepts in Science* | 4 |
| MSED 350 Methods and Materials in Teaching Science Education* | 4 |

**Not required if major is biology education, earth science education, physics education or integrated science education.*

## Group Science Minor

This minor is available only to students with majors in chemistry or Chemistry ACS Certified.

| | |
|---|---|
| **Total Credits Required for Minor** | **22** |
| MA 161 Calculus I | 5 |
| MA 163 Calculus II | 4 |
| PH 220 Introductory Physics I | 5 |
| PH 221 Introductory Physics II | 5 |
| MA or PH Elective (300 level and above) | 3 |