Chemistry

Chemistry is often called the "Central Science," because chemical knowledge is essential not only to chemists, but also to biologists (through biochemistry, molecular biology, and environmental chemistry) and engineers (through materials science and polymers). A good knowledge of chemistry provides many options for graduate study and many options for career paths.

The study of chemistry can be divided into two parts: analysis and synthesis. Analysis determines the identities of the components of a real-world sample (a sample of polluted water, for example) and then measures how much of each component is present. Synthesis produces new, previously non-existent materials. Twenty-one million chemicals are known, and new ones are produced all the time. Will you synthesize one that reduces pollution? Cures a dreaded disease?

First-and second-year students interested in a chemistry major or minor are encouraged to discuss their career interests with members of the Department of Chemistry. This will allow good schedule planning, leading to on-time graduation.

Programs

- Biochemistry, Cellular and Molecular Biology, B.S. (Cellular and Molecular Emphasis) *major*
- Biochemistry, Cellular and Molecular Biology, B.S. (Biochemistry Emphasis) *major*
- Chemistry, B.A. *major*
- Chemistry, B.S. (Biochemistry/ Biotechnology Emphasis) *major*
- Chemistry, B.S. (Chemistry Emphasis) *major*
- Chemistry, B.S. (Environmental Chemistry Emphasis) *major*
- Chemistry, B.S. (Forensic Science Emphasis) *major*
- Science Education, B.S. (Chemistry Specialty (Teacher Licensure)) *major*
- Chemistry *minor*

Career Directions

Biologist
Chemist
Dentist
Engineer
Entrepreneur
Environmental Chemist
Forensic Scientist
Geochemist
Nutritionist
Optometrist
Pharmacist
Physical Therapist
Physician
Technical Management
Technical Sales
Toxicologist
Veterinarian
Also: Graduate Study

Preparation

Recommended High School Courses

Biology
Chemistry
Mathematics
Physics

Biochemistry, Cellular and Molecular Biology, B.S.

major

Cellular and Molecular Emphasis

A total of 120 semester credits are needed for the **Biochemistry, Cellular and Molecular Biology, Cellular and Molecular emphasis B.S.** degree and include the following:

- Completion of a minimum of 40 upper division credits (level 3000/4000)
- Completion of all required major credits
- Completion of Core Curriculum credits (Minnesota Transfer Curriculum [MnTC] Goal Areas 1-10 with a minimum of 40 credits) required for all baccalaureate degrees
- Completion of BSU Focus and Nisidotaading Course Requirements

Dual Degrees
Students wishing to complete two degrees concurrently, (example: Bachelor of Science and Bachelor of Arts) must complete a minimum of an additional 30 credits above the required 120 credits.

Multiple Credentials
Any additional major, minor or certificate in a degree must have at least 6 credits of course work not used to meet the requirements of another major, minor or certificate in the degree.

Required Credits: 75
Required GPA: 2.25

I REQUIRED COURSES

BIOLOGY CORE

Complete the following courses:

- BIOL 1400 Cellular Principles (4 credits)
- BIOL 2360 Genetics (4 credits)
- BIOL 3380 Molecular Genetics (3 credits)
- BIOL 3590 Cell Biology (3 credits)
- BIOL 3710 Microbiology (4 credits)

CHEMISTRY CORE

Complete the following courses:

- CHEM 2211 Principles of Chemistry I (4 credits)
- CHEM 2212 Principles of Chemistry II (4 credits)
- CHEM 3311 Organic Chemistry I (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- CHEM 3371 Organic Chemistry Laboratory I (1 credit)
- CHEM 3372 Organic Chemistry Laboratory II (1 credit)
- CHEM 4411 Biochemistry I (3 credits)
- CHEM 4412 Biochemistry II (3 credits)

- CHEM 4471 Biochemistry Laboratory I (1 credit)

RELATED FIELD REQUIREMENTS

Select one of the following groups:

GROUP 1:

- PHYS 1101 General Physics I (4 credits)
- PHYS 1102 General Physics II (4 credits)

GROUP 2:

- PHYS 2101 University Physics I (4 credits)
- PHYS 2102 University Physics II (4 credits)

SEMINARS

Complete the following courses:

- BCMB 1000 Biochemistry, Cell and Molecular Biology Careers (BCMB Careers) (1 credit)
- BCMB 3000 Biochemistry, Cell and Molecular Biology Research (BCMB Research) (1 credit)

TECHNIQUES CORE

Select one of the following:

- BCMB 3074 Molecular Techniques (2 credits)
  or BIOL 3074 Molecular Techniques (2 credits)

Select one of the following:

- BCMB 3075 Cellular Techniques (2 credits)
- BIOL 3075 Cellular Techniques (2 credits)
- BCMB 4476 Techniques in Biotechnology and Biochemistry (2 credits)
- CHEM 4476 Techniques in Biotechnology and Biochemistry (2 credits)

RESEARCH

SELECT ONE OF THE FOLLOWING GROUPS:

GROUP 1:

- BIOL 4894 Advanced Research Project I (2 credits)
- BIOL 4895 Advanced Research Project II (2 credits)

GROUP 2:

- CHEM 4894 Research I (2 credits)
- CHEM 4895 Research II (2 credits)

II REQUIRED EMPHASIS - CELLULAR AND MOLECULAR BIOLOGY

BIOLOGY ELECTIVES

Select 3 courses:

- BIOL 3250 Human Anatomy (4 credits)
- BIOL 3260 Human Physiology (4 credits)
- BIOL 3300 Introduction to Hematology (4 credits)
- BIOL 3580 Immunology (3 credits)
- BIOL 4270 Histology (4 credits)
- BIOL 4360 Developmental and Tumor Biology (3 credits)
- BIOL 4447 Genomics (3 credits)
- BIOL 4460 Stem Cells and Regenerative Medicine (3 credits)
- BIOL 4470 Introduction to Vaccinology (4 credits)
- BIOL 4715 Clinical Microbiology (3 credits)

CHEMISTRY ELECTIVES

Select one of the following groups:

GROUP 1:

- CHEM 3507 Analytical Chemistry (3 credits)
- CHEM 3570 Analytical Chemistry Laboratory (1 credit)

GROUP 2:

- CHEM 4614 Medicinal Chemistry: Drug Design (3 credits)
- CHEM 4615 Medicinal Chemistry: Drug Action (3 credits)

RELATED FIELD REQUIREMENTS

Complete one of the following courses:

- MATH 2471 Calculus I (5 credits)
- STAT 2610 Applied Statistics (4 credits)

Suggested Semester Schedule | Biochemistry, Cellular, and Molecular Biology, B.S.
Cellular and Molecular Biology emphasis

Freshman:

- BIOL 1400 Cellular Principles (4 credits)
- CHEM 2211 Principles of Chemistry I (4 credits)
- BIOL 2360 Genetics (4 credits)
- CHEM 2212 Principles of Chemistry II (4 credits)
- BCMB 1000 Biochemistry, Cell and Molecular Biology Careers (BCMB Careers) (1 credit)

Sophomore:

- BIOL 3590 Cell Biology (3 credits)
- CHEM 3311 Organic Chemistry I (3 credits)
- PHYS 1101 General Physics I (4 credits)
  or PHYS 2101 University Physics I (4 credits)
- BIOL 3380 Molecular Genetics (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- BCMB 3074 Molecular Techniques (2 credits)
  or BIOL 3074 Molecular Techniques (2 credits)
- PHYS 1102 General Physics II (4 credits)
  or PHYS 2102 University Physics II (4 credits)

Junior:

- BIOL 3710 Microbiology (4 credits)
- CHEM 4411 Biochemistry I (3 credits)
- BCMB 3075 Cellular Techniques (2 credits)
  or BIOL 3075 Cellular Techniques (2 credits)
- CHEM 4412 Biochemistry II (3 credits)
- BCMB 3000 Biochemistry, Cell and Molecular Biology Research (BCMB Research) (1 credit)
- STAT 2610 Applied Statistics (4 credits)
  or MATH 2471 Calculus I (5 credits)
- Emphasis Biology elective

Senior:

- BIOL 4894 Advanced Research Project I (2 credits)
- BIOL 4895 Advanced Research Project II (2 credits)
- Emphasis Chemistry elective(s)
- Emphasis Biology electives

Biochemistry, Cellular and Molecular Biology, B.S.

major

Biochemistry Emphasis

A total of 120 semester credits are needed for the **Biochemistry, Cellular and Molecular Biology, Biochemistry emphasis B.S.** degree and include the following:

- Completion of a minimum of 40 upper division credits (level 3000/4000)
- Completion of all required major credits
- Completion of Core Curriculum credits (Minnesota Transfer Curriculum [MnTC] Goal Areas 1-10 with a minimum of 40 credits) required for all baccalaureate degrees
- Completion of BSU Focus and Nisidotaading Course Requirements

Dual Degrees
Students wishing to complete two degrees concurrently, (example: Bachelor of Science and Bachelor of Arts) must complete a minimum of an additional 30 credits above the required 120 credits.

Multiple Credentials
Any additional major, minor or certificate in a degree must have at least 6 credits of course work not used to meet the requirements of another major, minor or certificate in the degree.

Required Credits: 80
Required GPA: 2.25

I REQUIRED COURSES

BIOLOGY CORE

Complete the following courses:

- BIOL 1400 Cellular Principles (4 credits)
- BIOL 2360 Genetics (4 credits)
- BIOL 3380 Molecular Genetics (3 credits)
- BIOL 3590 Cell Biology (3 credits)
- BIOL 3710 Microbiology (4 credits)

CHEMISTRY CORE

Complete the following courses:

- CHEM 2211 Principles of Chemistry I (4 credits)
- CHEM 2212 Principles of Chemistry II (4 credits)
- CHEM 3311 Organic Chemistry I (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- CHEM 3371 Organic Chemistry Laboratory I (1 credit)
- CHEM 3372 Organic Chemistry Laboratory II (1 credit)
- CHEM 4411 Biochemistry I (3 credits)
- CHEM 4412 Biochemistry II (3 credits)
- CHEM 4471 Biochemistry Laboratory I (1 credit)

RELATED FIELD REQUIREMENTS

Select one of the following groups:

GROUP 1:

- PHYS 1101 General Physics I (4 credits)
- PHYS 1102 General Physics II (4 credits)

GROUP 2:

- PHYS 2101 University Physics I (4 credits)
- PHYS 2102 University Physics II (4 credits)

SEMINARS

Complete the following courses:

- BCMB 1000 Biochemistry, Cell and Molecular Biology Careers (BCMB Careers) (1 credit)
- BCMB 3000 Biochemistry, Cell and Molecular Biology Research (BCMB Research) (1 credit)

TECHNIQUES CORE

Select one of the following:

- BCMB 3074 Molecular Techniques (2 credits)
  or BIOL 3074 Molecular Techniques (2 credits)

Select one of the following:

- BCMB 3075 Cellular Techniques (2 credits)
- BIOL 3075 Cellular Techniques (2 credits)
- BCMB 4476 Techniques in Biotechnology and Biochemistry (2 credits)
- CHEM 4476 Techniques in Biotechnology and Biochemistry (2 credits)

RESEARCH

SELECT ONE OF THE FOLLOWING GROUPS:

GROUP 1:

- BIOL 4894 Advanced Research Project I (2 credits)
- BIOL 4895 Advanced Research Project II (2 credits)

GROUP 2:

- CHEM 4894 Research I (2 credits)
- CHEM 4895 Research II (2 credits)

II REQUIRED EMPHASIS - BIOCHEMISTRY

CHEMISTRY

Complete the following courses:

- CHEM 3507 Analytical Chemistry (3 credits)
- CHEM 3570 Analytical Chemistry Laboratory (1 credit)
- CHEM 4614 Medicinal Chemistry: Drug Design (3 credits)
- CHEM 4615 Medicinal Chemistry: Drug Action (3 credits)

CHEMISTRY ELECTIVES

Select one of the following groups:

GROUP 1:

- CHEM 4510 Instrumental Methods of Analysis (3 credits)

- CHEM 4571 Instrumental Analysis Laboratory I (1 credit)

GROUP 2:

- CHEM 4711 Physical Chemistry I (3 credits)
- CHEM 4771 Physical Chemistry Laboratory I (1 credit)

GROUP 3:

- CHEM 3811 Intermediate Inorganic Chemistry (3 credits)
- CHEM 4871 Inorganic Chemistry Laboratory I (1 credit)

BIOLOGY ELECTIVES

Select one of the following:

- BIOL 3250 Human Anatomy (4 credits)
- BIOL 3260 Human Physiology (4 credits)
- BIOL 3300 Introduction to Hematology (4 credits)
- BIOL 3580 Immunology (3 credits)
- BIOL 4270 Histology (4 credits)
- BIOL 4360 Developmental and Tumor Biology (3 credits)
- BIOL 4447 Genomics (3 credits)
- BIOL 4460 Stem Cells and Regenerative Medicine (3 credits)
- BIOL 4470 Introduction to Vaccinology (4 credits)
- BIOL 4715 Clinical Microbiology (3 credits)

RELATED FIELD REQUIREMENTS

Complete one of the following courses:

- MATH 2471 Calculus I (5 credits)
- STAT 2610 Applied Statistics (4 credits)

Suggested Semester Schedule | Biochemistry, Cellular, and Molecular Biology, B.S.
Biochemistry emphasis

Freshman:

- BIOL 1400 Cellular Principles (4 credits)
- CHEM 2211 Principles of Chemistry I (4 credits)
- BIOL 2360 Genetics (4 credits)
- CHEM 2212 Principles of Chemistry II (4 credits)
- BCMB 1000 Biochemistry, Cell and Molecular Biology Careers (BCMB Careers) (1 credit)
- MATH 2471 Calculus I (5 credits)
  or STAT 2610 Applied Statistics (4 credits)

Sophomore:

- BIOL 3590 Cell Biology (3 credits)
- CHEM 3311 Organic Chemistry I (3 credits)
- BIOL 3380 Molecular Genetics (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- BCMB 3074 Molecular Techniques (2 credits)
  or BIOL 3074 Molecular Techniques (2 credits)
- CHEM 3507 Analytical Chemistry (3 credits)

Junior:

- BIOL 3710 Microbiology (4 credits)
- CHEM 4411 Biochemistry I (3 credits)
- PHYS 2101 University Physics I (4 credits)
- CHEM 4412 Biochemistry II (3 credits)
- BCMB 3000 Biochemistry, Cell and Molecular Biology Research (BCMB Research) (1 credit)
- BCMB 4476 Techniques in Biotechnology and Biochemistry (2 credits)
  or CHEM 4476 Techniques in Biotechnology and Biochemistry (2 credits)
- PHYS 2102 University Physics II (4 credits)

Senior:

- CHEM 4894 Research I (2 credits)
- CHEM 4895 Research II (2 credits)
- CHEM 4614 Medicinal Chemistry: Drug Design (3 credits)
- CHEM 4615 Medicinal Chemistry: Drug Action (3 credits)
- Emphasis Chemistry elective(s)
- Emphasis Biology elective

Chemistry, B.A. *major*

A total of 120 semester credits are needed for the **Chemistry B.A.** degree and include the following:

- 40 upper division credits (level 3000/4000)
- 31 required major core credits
- Completion of Core Curriculum credits (Minnesota Transfer Curriculum [MnTC] Goal Areas 1-10) - required for all baccalaureate degrees
- Completion of BSU Focus and Nisidotaading Course Requirements

Dual Degrees
Students wishing to complete two degrees concurrently, (example: Bachelor of Science and Bachelor of Arts) must complete a minimum of an additional 30 credits above the required 120 credits.

Multiple Credentials
Any additional major, minor or certificate in a degree must have at least 6 credits of course work not used to meet the requirements of another major, minor or certificate in the degree.

Required Credits: 31
Required GPA: 2.25

I REQUIRED COURSES

Note: Students enrolled in CHEM 1111 who elect this major should enroll in CHEM 2212 during the second semester.

Select one of the following:

- CHEM 1111 General Chemistry I (4 credits)
- CHEM 2211 Principles of Chemistry I (4 credits)

Complete the following courses:

- CHEM 2212 Principles of Chemistry II (4 credits)
- CHEM 3100 Journal Club (1 credit)
- CHEM 3110 Laboratory Management and Safety (2 credits)
- CHEM 3311 Organic Chemistry I (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- CHEM 3371 Organic Chemistry Laboratory I (1 credit)
- CHEM 3372 Organic Chemistry Laboratory II (1 credit)
- CHEM 3507 Analytical Chemistry (3 credits)
- CHEM 3570 Analytical Chemistry Laboratory (1 credit)

Select one of the following courses:

- CHEM 3811 Intermediate Inorganic Chemistry (3 credits)
- CHEM 4411 Biochemistry I (3 credits)

II REQUIRED ELECTIVES

Select 5 semester credits of electives from CHEM 3100 or above. Up to 4 semester credits of research CHEM 3980 or CHEM 4980 may be used in this area

Program Learning Outcomes | Chemistry, B.A.

1. Use the structure of atoms and their subatomic particles to explain chemical and physical properties.

2. Explain how atoms interact via chemical bonds and the energy changes associated with making and breaking bonds.

3. Relate the three dimensional geometric structures of chemical compounds to their chemical and physical behaviors.

4. Evaluate how intermolecular forces dictate the physical behavior of matter.

5. Categorize and analyze the chemical reactions involved in transforming matter into products with new chemical and physical properties.

6. Evaluate the energy changes that accompany chemical reactions.

7. Assess the various ways that affect how reaction rates vary with time.

8. Analyze the various factors that affect the equilibrium of chemical reactions.

9. Perform laboratory experiments that involve collecting and analyzing data and practicing chemical safety.

10. Evaluate chemical constructs at the particulate and macroscopic levels using models, graphs to visualize data, and mathematical equations.

11. Develop written reports and oral presentations that effectively communicate scientific principles and processes.

Suggested Semester Schedule | Chemistry, B.A.

The following is a list of required courses for the Chemistry Major, B.A., arranged by year. This schedule is intended to assist students in planning their academic program and may be altered somewhat to fit the students background and circumstances.

Freshman

- CHEM2211
- CHEM2212
- Core Curriculum requirements
- Electives

Sophomore

- CHEM3311
- CHEM3312
- CHEM3371
- CHEM3372
- CHEM3507
- CHEM3570
- Core Curriculum requirements

Junior/Senior

- CHEM3100
- CHEM3110
- CHEM4411
  or CHEM4811
- Chemistry electives
- Complete Core Curriculum requirements
- Electives

Chemistry, B.S. *major*
Biochemistry/ Biotechnology Emphasis

A total of 120 semester credits are needed for the **Chemistry, Biochemistry/ Biotechnology emphasis B.S.** degree and include the following:

- 40 upper division credits (level 3000/4000)
- 63 required major core credits
- Completion of Core Curriculum credits (Minnesota Transfer Curriculum [MnTC] Goal Areas 1-10) - required for all baccalaureate degrees
- Completion of BSU Focus and Nisidotaading Course Requirements

Dual Degrees
Students wishing to complete two degrees concurrently, (example: Bachelor of Science and Bachelor of Arts) must complete a minimum of an additional 30 credits above the required 120 credits.

Multiple Credentials
Any additional major, minor or certificate in a degree must have at least 6 credits of course work not used to meet the requirements of another major, minor or certificate in the degree.

Required Credits: 63
Required GPA: 2.25

I REQUIRED COURSES

SELECT 1 OF THE FOLLOWING COURSES:

- CHEM 1111 General Chemistry I (4 credits)
- CHEM 2211 Principles of Chemistry I (4 credits)

COMPLETE THE FOLLOWING COURSES:

- CHEM 2212 Principles of Chemistry II (4 credits)
- CHEM 3100 Journal Club (1 credit)
- CHEM 3311 Organic Chemistry I (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- CHEM 3371 Organic Chemistry Laboratory I (1 credit)
- CHEM 3372 Organic Chemistry Laboratory II (1 credit)
- CHEM 3507 Analytical Chemistry (3 credits)
- CHEM 3570 Analytical Chemistry Laboratory (1 credit)
- CHEM 4510 Instrumental Methods of Analysis (3 credits)
- CHEM 4571 Instrumental Analysis Laboratory I (1 credit)
- CHEM 4572 Instrumental Analysis Laboratory II (1 credit)
- MATH 2471 Calculus I (5 credits)

- PHYS 2101 University Physics I (4 credits)

II REQUIRED EMPHASIS

COMPLETE THE FOLLOWING COURSES:

- BIOL 1400 Cellular Principles (4 credits)
- BIOL 1500 Diversity of Life (4 credits)
- CHEM 4411 Biochemistry I (3 credits)
- CHEM 4412 Biochemistry II (3 credits)
- CHEM 4471 Biochemistry Laboratory I (1 credit)

SELECT 1 OF THE FOLLOWING COURSES:

- CHEM 4476 Techniques in Biotechnology and Biochemistry (2 credits)
- BCMB 4476 Techniques in Biotechnology and Biochemistry (2 credits)
- CHEM 4472 Biochemistry Laboratory II (1 credit)

SELECT 2 OF THE FOLLOWING COURSES:

- BIOL 2110 Human Anatomy and Physiology (5 credits)
- BIOL 2360 Genetics (4 credits)
- BIOL 3580 Immunology (3 credits)
- BIOL 3590 Cell Biology (3 credits)
- BIOL 3710 Microbiology (4 credits)

II REQUIRED EMPHASIS

Select 6 semester credits from CHEM 3100 or above.
CHEM 3100 may be repeated with 1 credit
applying to this area.

Program Learning Outcomes | Chemistry, B.S.

1. Use the structure of atoms and their subatomic particles to explain chemical and physical properties.

2. Explain how atoms interact via chemical bonds and the energy changes associated with making and breaking bonds.

3. Relate the three dimensional geometric structures of chemical compounds to their chemical and physical behaviors.

4. Evaluate how intermolecular forces dictate the physical behavior of matter.

5. Categorize and analyze the chemical reactions involved in transforming matter into products with new chemical and physical properties.

6. Evaluate the energy changes that accompany chemical reactions.

7. Assess the various ways that affect how reaction rates vary with time.

8. Analyze the various factors that affect the equilibrium of chemical reactions.

9. Perform laboratory experiments that involve collecting and analyzing data and practicing chemical safety.

10. Evaluate chemical constructs at the particulate and macroscopic levels using models, graphs to visualize data, and mathematical equations.

11. Develop written reports and oral presentations that effectively communicate scientific principles and processes.

Chemistry, B.S. *major*
Chemistry Emphasis

A total of 120 semester credits are needed for the **Chemistry, Chemistry emphasis B.S.** degree and include the following:

- 40 upper division credits (level 3000/4000)
- 71 required major core credits
- Completion of Core Curriculum credits (Minnesota Transfer Curriculum [MnTC] Goal Areas 1-10) - required for all baccalaureate degrees
- Completion of BSU Focus and Nisidotaading Course Requirements

Dual Degrees
Students wishing to complete two degrees concurrently, (example: Bachelor of Science and Bachelor of Arts) must complete a minimum of an additional 30 credits above the required 120 credits.

Multiple Credentials
Any additional major, minor or certificate in a degree must have at least 6 credits of course work not used to meet the requirements of another major, minor or certificate in the degree.

Required Credits: 71
Required GPA: 2.25

I REQUIRED COURSES

SELECT 1 OF THE FOLLOWING COURSES:

- CHEM 1111 General Chemistry I (4 credits)
- CHEM 2211 Principles of Chemistry I (4 credits)

COMPLETE THE FOLLOWING COURSES:

- CHEM 2212 Principles of Chemistry II (4 credits)
- CHEM 3100 Journal Club (1 credit)
- CHEM 3311 Organic Chemistry I (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- CHEM 3371 Organic Chemistry Laboratory I (1 credit)
- CHEM 3372 Organic Chemistry Laboratory II (1 credit)
- CHEM 3507 Analytical Chemistry (3 credits)
- CHEM 3570 Analytical Chemistry Laboratory (1 credit)
- CHEM 4510 Instrumental Methods of Analysis (3 credits)
- CHEM 4571 Instrumental Analysis Laboratory I (1 credit)
- CHEM 4572 Instrumental Analysis Laboratory II (1 credit)
- MATH 2471 Calculus I (5 credits)
- PHYS 2101 University Physics I (4 credits)

II REQUIRED EMPHASIS

COMPLETE THE FOLLOWING COURSES:

- CHEM 3811 Intermediate Inorganic Chemistry (3 credits)
- CHEM 4411 Biochemistry I (3 credits)
- CHEM 4711 Physical Chemistry I (3 credits)
- CHEM 4712 Physical Chemistry II (3 credits)
- CHEM 4771 Physical Chemistry Laboratory I (1 credit)
- CHEM 4772 Physical Chemistry Laboratory II (1 credit)
- CHEM 4871 Inorganic Chemistry Laboratory I (1 credit)
- MATH 2472 Calculus II (5 credits)
- PHYS 2102 University Physics II (4 credits)

SELECT 1 OF THE FOLLOWING COURSES:

- CHEM 4412 Biochemistry II (3 credits)
- CHEM 4812 Advanced Inorganic Chemistry II (3 credits)

II REQUIRED EMPHASIS

SELECT 9 SEMESTER CREDITS FROM CHEM 3100 OR ABOVE AND/OR THE FOLLOWING COURSES. (7 CREDITS MUST COME FROM 3000-LEVEL COURSES OR ABOVE). CHEM 3100 MAY BE REPEATED WITH 1 SEMESTER CREDIT APPLYING TO THIS AREA.

- PHYS 3300 Thermal and Statistical Physics (3 credits)
- PHYS 3103 University Physics III (4 credits)

- MATH 2210 Discrete Mathematics (4 credits)
- MATH 2480 Multivariable Calculus (4 credits)
- MATH 2490 Differential Equations (4 credits)
- STAT 2610 Applied Statistics (4 credits)

Program Learning Outcomes | Chemistry, B.S.

1. Use the structure of atoms and their subatomic particles to explain chemical and physical properties.

2. Explain how atoms interact via chemical bonds and the energy changes associated with making and breaking bonds.

3. Relate the three dimensional geometric structures of chemical compounds to their chemical and physical behaviors.

4. Evaluate how intermolecular forces dictate the physical behavior of matter.

5. Categorize and analyze the chemical reactions involved in transforming matter into products with new chemical and physical properties.

6. Evaluate the energy changes that accompany chemical reactions.

7. Assess the various ways that affect how reaction rates vary with time.

8. Analyze the various factors that affect the equilibrium of chemical reactions.

9. Perform laboratory experiments that involve collecting and analyzing data and practicing chemical safety.

10. Evaluate chemical constructs at the particulate and macroscopic levels using models, graphs to visualize data, and mathematical equations.

11. Develop written reports and oral presentations that effectively communicate scientific principles and processes.

Chemistry, B.S. *major*
Environmental Chemistry Emphasis

A total of 120 semester credits are needed for the **Chemistry, Environmental Chemistry emphasis B.S.** degree and include the following:

- 40 upper division credits (level 3000/4000)
- 69 required major core credits
- Completion of Core Curriculum credits (Minnesota Transfer Curriculum [MnTC] Goal Areas 1-10) - required for all baccalaureate degrees
- Completion of BSU Focus and Nisidotaading Course Requirements

Dual Degrees

Students wishing to complete two degrees concurrently, (example: Bachelor of Science and Bachelor of Arts) must complete a minimum of an additional 30 credits above the required 120 credits.

Multiple Credentials
Any additional major, minor or certificate in a degree must have at least 6 credits of course work not used to meet the requirements of another major, minor or certificate in the degree.

Required Credits: 69
Required GPA: 2.25

I REQUIRED COURSES

SELECT 1 OF THE FOLLOWING COURSES:

- CHEM 1111 General Chemistry I (4 credits)
- CHEM 2211 Principles of Chemistry I (4 credits)

COMPLETE THE FOLLOWING COURSES:

- CHEM 2212 Principles of Chemistry II (4 credits)
- CHEM 3100 Journal Club (1 credit)
- CHEM 3311 Organic Chemistry I (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- CHEM 3371 Organic Chemistry Laboratory I (1 credit)
- CHEM 3372 Organic Chemistry Laboratory II (1 credit)
- CHEM 3507 Analytical Chemistry (3 credits)
- CHEM 3570 Analytical Chemistry Laboratory (1 credit)
- CHEM 4510 Instrumental Methods of Analysis (3 credits)
- CHEM 4571 Instrumental Analysis Laboratory I (1 credit)
- CHEM 4572 Instrumental Analysis Laboratory II (1 credit)
- MATH 2471 Calculus I (5 credits)
- PHYS 2101 University Physics I (4 credits)

II REQUIRED EMPHASIS

COMPLETE ONE OF THE FOLLOWING COURSES:

- CHEM 4110 Environmental Chemistry (3 credits)
  or ENVR 4110 Environmental Chemistry (3 credits)

COMPLETE 4 SEMESTER CREDITS FROM THE FOLLOWING COURSE:

- CHEM 4970 Internship (3-4 credits)

II REQUIRED EMPHASIS

Select 3 semester credits of electives from CHEM 3100 or above. (CHEM 3100 may be repeated with 1 credit applying to this area.)

SELECT 24 SEMESTER CREDITS FROM THE FOLLOWING COURSES:

- BIOL 2610 General Ecology (3 credits)
- BIOL 3361 Limnology (4 credits)
- CHEM 3140 Chemical Toxicology (3 credits)
- CHEM 3150 Standard Methods of Water Analysis (3 credits)
  or ENVR 4220 Sampling and Analysis (4 credits)
- CHEM 4411 Biochemistry I (3 credits)
- CHEM 4412 Biochemistry II (3 credits)
- CHEM 4471 Biochemistry Laboratory I (1 credit)

- ENVR 4050 Geochemistry (3 credits)
- ENVR 4200 Wastewater Treatment (3 credits)
- ENVR 4240 Waste Management (4 credits)
- ENVR 4260 Risk, Resilience and Sustainable Community Development (3 credits)
- ENVR 4400 Environmental Microbiology (3 credits)
- ENVR 4500 Environmental Toxicology (4 credits)
- GEOL 3211 Environmental Hydrology (3 credits)

Program Learning Outcomes | Chemistry, B.S.

1. Use the structure of atoms and their subatomic particles to explain chemical and physical properties.

2. Explain how atoms interact via chemical bonds and the energy changes associated with making and breaking bonds.

3. Relate the three dimensional geometric structures of chemical compounds to their chemical and physical behaviors.

4. Evaluate how intermolecular forces dictate the physical behavior of matter.

5. Categorize and analyze the chemical reactions involved in transforming matter into products with new chemical and physical properties.

6. Evaluate the energy changes that accompany chemical reactions.

7. Assess the various ways that affect how reaction rates vary with time.

8. Analyze the various factors that affect the equilibrium of chemical reactions.

9. Perform laboratory experiments that involve collecting and analyzing data and practicing chemical safety.

10. Evaluate chemical constructs at the particulate and macroscopic levels using models, graphs to visualize data, and mathematical equations.

11. Develop written reports and oral presentations that effectively communicate scientific principles and processes.

Chemistry, B.S. *major*
Forensic Science Emphasis

A total of 120 semester credits are needed for the **Chemistry, Forensic Science emphasis B.S.** degree and include the following:

- 40 upper division credits (level 3000/4000)
- 78 required major core credits
- Completion of Core Curriculum credits (Minnesota Transfer Curriculum [MnTC] Goal Areas 1-10) - required for all baccalaureate degrees
- Completion of BSU Focus and Nisidotaading Course Requirements

Dual Degrees
Students wishing to complete two degrees concurrently, (example: Bachelor of Science and Bachelor of Arts) must complete a minimum of an additional 30 credits above the required 120 credits.

Multiple Credentials
Any additional major, minor or certificate in a degree must have at least 6 credits of course work not used to meet the requirements of another major, minor or certificate in the degree.

Required Credits: 78
Required GPA: 2.25

I REQUIRED COURSES

Select 1 of the following courses:

- CHEM 1111 General Chemistry I (4 credits)
- CHEM 2211 Principles of Chemistry I (4 credits)

Complete the following courses:

- CHEM 2212 Principles of Chemistry II (4 credits)
- CHEM 3100 Journal Club (1 credit)
- CHEM 3311 Organic Chemistry I (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- CHEM 3371 Organic Chemistry Laboratory I (1 credit)
- CHEM 3372 Organic Chemistry Laboratory II (1 credit)
- CHEM 3507 Analytical Chemistry (3 credits)
- CHEM 3570 Analytical Chemistry Laboratory (1 credit)
- CHEM 4510 Instrumental Methods of Analysis (3 credits)
- CHEM 4571 Instrumental Analysis Laboratory I (1 credit)
- CHEM 4572 Instrumental Analysis Laboratory II (1 credit)
- MATH 2471 Calculus I (5 credits)
- PHYS 1101 General Physics I (4 credits)
  or PHYS 2101 University Physics I (4 credits)

II REQUIRED EMPHASIS

Complete the following courses:

- BIOL 1400 Cellular Principles (4 credits)
- BIOL 2360 Genetics (4 credits)
- CHEM 2210 Forensic Science (3 credits)
- CHEM 2270 Forensic Science Laboratory (1 credit)
- CHEM 4411 Biochemistry I (3 credits)
- CHEM 4471 Biochemistry Laboratory I (1 credit)
- CHEM 4412 Biochemistry II (3 credits)
- CHEM 4472 Biochemistry Laboratory II (1 credit)
- CRJS 1120 Criminal Justice and Society (3 credits)
- CRJS 3359 Criminal Investigation (3 credits)
- CS 1310 Computational Problem Solving & Society (3 credits)
- CS 2750 Introduction to Data Analysis (3 credits)
- STAT 2610 Applied Statistics (4 credits)
  or PSY 3401 Basic Statistics for Research (4 credits)

Complete two of the following course electives:

- BIOL 3074 Molecular Techniques (2 credits)
- BIOL 3075 Cellular Techniques (2 credits)
- BIOL 3380 Molecular Genetics (3 credits)
- BIOL 3590 Cell Biology (3 credits)
- CHEM 3140 Chemical Toxicology (3 credits)
- CHEM 4476 Techniques in Biotechnology and Biochemistry (2 credits)
- CS 2321 Computer Science I (4 credits)
- CRJS 3355 Drugs and Criminal Justice (3 credits)
- CRJS 3358 Criminal Law (3 credits)
- CRJS 3360 Criminal Procedure and Evidence (3 credits)
- JUST 3377 Forensic Victimology (3 credits)

Select 1 of the following courses:

- CHEM 3811 Intermediate Inorganic Chemistry (3 credits)
- CHEM 4711 Physical Chemistry I (3 credits)

Program Learning Outcomes | Chemistry, B.S.

1. Use the structure of atoms and their subatomic particles to explain chemical and physical properties.

2. Explain how atoms interact via chemical bonds and the energy changes associated with making and breaking bonds.

3. Relate the three dimensional geometric structures of chemical compounds to their chemical and physical behaviors.

4. Evaluate how intermolecular forces dictate the physical behavior of matter.

5. Categorize and analyze the chemical reactions involved in transforming matter into products with new chemical and physical properties.

6. Evaluate the energy changes that accompany chemical reactions.

7. Assess the various ways that affect how reaction rates vary with time.

8. Analyze the various factors that affect the equilibrium of chemical reactions.

9. Perform laboratory experiments that involve collecting and analyzing data and practicing chemical safety.

10. Evaluate chemical constructs at the particulate and macroscopic levels using models, graphs to visualize data, and mathematical equations.

11. Develop written reports and oral presentations that effectively communicate scientific principles and processes.

Science Education, B.S. *major*
Chemistry Specialty (Teacher Licensure)

A total of 120 semester credits are needed for the **Science Education, Chemistry specialty (Teacher Licensure) B.S.** degree and include the following:

- Completion of a minimum of 40 upper division credits (level 3000/4000)
- Completion of all required major credits
- Completion of Core Curriculum credits (Minnesota Transfer Curriculum [MnTC] Goal Areas 1-10 with a minimum of 40 credits) required for all baccalaureate degrees
- Completion of BSU Focus and Nisidotaading Course Requirements

Dual Degrees
Students wishing to complete two degrees concurrently, (example: Bachelor of Science and Bachelor of Arts) must complete a minimum of an additional 30 credits above the required 120 credits.

Multiple Credentials
Any additional major, minor or certificate in a degree must have at least 6 credits of course work not used to meet the requirements of another major, minor or certificate in the degree.

Required Credits: 78
Required GPA: 2.50

Core Courses for Science Teaching in Grades 5-8

Complete the following courses:

- BIOL 1400 Cellular Principles (4 credits)
  *or*BIOL 1110 Human Biology (4 credits)
- BIOL 1500 Diversity of Life (4 credits)
  *or*BIOL 1120 General Biology: Evolution And Ecology (3 credits)
- CHEM 2211 Principles of Chemistry I (4 credits)
  *or*CHEM 1111 General Chemistry I (4 credits)
- CHEM 2212 Principles of Chemistry II (4 credits)
  *or*CHEM 1112 General Chemistry II (4 credits)
- GEOL 1110 Physical Geology (4 credits)
- SCI 3100 Integrative Science for Teachers (4 credits)
- SCI 3450 Science Methods For Grades 5-8 (4 credits)
  or ED 3410 Secondary Science Methods (4 credits)

REQUIRED PROFESSIONAL EDUCATION COURSES

Complete the following courses with a minimum 2.50 GPA:

- ED 3100 Introduction to the Foundations of Public School Education (3 credits)
- ED 3110 Educational Psychology (3 credits)
- ED 3140 Human Diversity and Educational Equity (3 credits)
- ED 3350 Principles and Strategies of Teaching (3 credits)
- ED 3780 Inclusive Teaching and Classrooms (3 credits)
- ED 4737 Content Area Reading (3 credits)
- ED 4799 The Professional Teacher (1 credit)

Complete the following course:

- HLTH 3400 Drug Education, Stress and the Mind (2 credits)

Complete 12 credits of student teaching:

- ED 4830 Student Teaching - Secondary (1-12 credits)

CHEMISTRY SPECIALTY

Complete the following courses:

- CHEM 3110 Laboratory Management and Safety (2 credits)
- CHEM 3311 Organic Chemistry I (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- CHEM 3371 Organic Chemistry Laboratory I (1 credit)
- CHEM 3372 Organic Chemistry Laboratory II (1 credit)
- CHEM 3507 Analytical Chemistry (3 credits)
- CHEM 3570 Analytical Chemistry Laboratory (1 credit)
- CHEM 3980 Research (1-2 credits)

Select 1 of the following courses:

- CHEM 3811 Intermediate Inorganic Chemistry (3 credits)
- CHEM 4411 Biochemistry I (3 credits)

Chemistry *minor*

Multiple Credentials
Any additional major, minor or certificate in a degree must have at least 6 credits of course work not used to meet the requirements of another major, minor or certificate in the degree.

Required Credits: 24

Required GPA: 2.00

REQUIRED COURSES

Select 1 of the following courses:

- CHEM 1111 General Chemistry I (4 credits)
- CHEM 2211 Principles of Chemistry I (4 credits)

Complete the following courses:

- CHEM 2212 Principles of Chemistry II (4 credits)
- CHEM 3311 Organic Chemistry I (3 credits)
- CHEM 3312 Organic Chemistry II (3 credits)
- CHEM 3371 Organic Chemistry Laboratory I (1 credit)
- CHEM 3372 Organic Chemistry Laboratory II (1 credit)

REQUIRED SPECIALIZATION Select 1 of the following specializations: A, B OR C

A. ANALYTICAL CHEMISTRY

Complete the following courses:

- CHEM 3507 Analytical Chemistry (3 credits)
- CHEM 3570 Analytical Chemistry Laboratory (1 credit)
- CHEM 4510 Instrumental Methods of Analysis (3 credits)
- CHEM 4571 Instrumental Analysis Laboratory I (1 credit)

B. BIOCHEMISTRY /BIOTECHNOLOGY

COMPLETE THE FOLLOWING COURSES:

- CHEM 4411 Biochemistry I (3 credits)
- CHEM 4412 Biochemistry II (3 credits)
- CHEM 4471 Biochemistry Laboratory I (1 credit)

Select one of the following courses:

- CHEM 4472 Biochemistry Laboratory II (1 credit)
- CHEM 4476 Techniques in Biotechnology and Biochemistry (2 credits)

C. FORENSIC SCIENCE

COMPLETE THE FOLLOWING COURSES:

- CHEM 2210 Forensic Science (3 credits)
- CHEM 2270 Forensic Science Laboratory (1 credit)
- CHEM 3507 Analytical Chemistry (3 credits)
- CHEM 3570 Analytical Chemistry Laboratory (1 credit)
- CRJS 1120 Criminal Justice and Society (3 credits)

Biochem, Cellular & Molecular Biology Courses

BCMB 1000 Biochemistry, Cell and Molecular Biology Careers (BCMB Careers) (1 credit)
An introduction to biochemistry, cell and molecular biology careers and curriculum planning for BCMB majors or students considering pursuing a BCMB degree.

BCMB 3000 Biochemistry, Cell and Molecular Biology Research (BCMB Research) (1 credit)
An introduction to biochemistry, cell and molecular biology research available at BSU and professionally. Covers the basics of research and medical ethics. Identifying a research mentor for senior research projects and preparing a preliminary research proposal. Prerequisite(s): BCMB 1000.

BCMB 3074 Molecular Techniques (2 credits)
This is a hybrid lecture and lab-based course and is an introduction to several common molecular-based techniques. Students will learn basic pipetting, protein assays, electrophoresis, PCR, and other molecular genetic techniques. Prerequisite(s): BIOL 1400, BIOL 2360, CHEM 2211, CHEM 2212; or consent of instructor.

BCMB 3075 Cellular Techniques (2 credits)
This course is the one of two options for completion of techniques core requirement for the BCMB major and for specific Biology majors. Includes an introduction to cell culture, cell imaging, cell-based assays, and stem cell biology. Prerequisite(s): BIOL 3074 or BCMB 3074.

BCMB 4476 Techniques in Biotechnology and Biochemistry (2 credits)
This course is one of two options for completion of the techniques core requirement for the BCMB major. The structure of the course consists of a combined lecture and lab. The course provides students with opportunities to learn advanced laboratory techniques in biotechnology and biochemistry. Prerequisite(s): CHEM 4471 or BCMB 3074 or BIOL 3074. (Also offered under CHEM 4476)

BCMB 4917 DIS Tchg Assoc | (1-2 credits)
Directed Independent Study | Teaching Associate

All-University Courses

The course numbers listed below, not always included in the semester class schedule, may be registered for by consent of the advisor, instructor, or department chair, or may be assigned by the department when warranted. Individual registration requires previous arrangement by the student and the completion of any required form or planning outline as well as any prerequisites.

1910, 2910, 3910, 4910 DIRECTED INDEPENDENT STUDY
1920, 2920, 3920, 4920 DIRECTED GROUP STUDY
1930, 2930, 3930, 4930 EXPERIMENTAL COURSE
1940, 2940, 3940, 4940 IN-SERVICE COURSE
1950, 2950, 3950, 4950 WORKSHOP, INSTITUTE, TOUR
1960, 2960, 3960, 4960 SPECIAL PURPOSE INSTRUCTION
1970, 2970, 3970, 4970 INTERNSHIP
1980, 2980, 3980, 4980 RESEARCH
1990, 2990, 3990, 4990 THESIS

Chemistry Courses

CHEM 1100 Consumer Chemistry (3 credits)
Chemistry as viewed through illustrations taken from common substances, objects, and processes in the world around us. Topics range from table salt to perception-altering drugs, and from drinking water to nuclear power. Intended for nonscience majors. [Core Curriculum Goal Area 3]

CHEM 1110 Chemistry for Allied Health (3 credits)
Survey of concepts in general and organic chemistry and biochemistry. Laboratory component introduces techniques, methods, and instrumentation. Intended for students majoring in Nursing and other allied health disciplines.

CHEM 1111 General Chemistry I (4 credits)
A survey of chemistry covering basic concepts of inorganic chemistry. The laboratory component introduces techniques, methods, and instrumentation. [Core Curriculum Goal Area 3 (LC)]

CHEM 1112 General Chemistry II (4 credits)
A continuation of the survey begun in chemistry 1111 covering basic concepts of organic, and biochemistry. The laboratory component introduces techniques, methods, and instrumentation. Prerequisite: CHEM 1111 or CHEM 2211. [Core Curriculum Goal Area 3 (LC)]

CHEM 1171 General Chemistry I Lab (0 credit)
A survey of chemistry covering basic concepts including inorganic, organic, and biochemistry. The laboratory component introduces techniques, methods, and instrumentation. [Core Curriculum Goal Area 3 (LC)] If on-campus student must register for CHEM 1111 (Lecture) and CHEM 1171 (Lab).

CHEM 1172 General Chemistry II Lab (0 credit)
A survey of chemistry covering basic concepts including inorganic, organic, and biochemistry. The laboratory component introduces techniques, methods, and instrumentation. [Core Curriculum Goal Area 3 (LC)] If on-campus student must register for CHEM 1111 (Lecture) and CHEM 1171 (Lab).

CHEM 1921 Directed Group Study (3 credits)
Arranged group study.

CHEM 2130 Chemistry of Drugs (3 credits)
Introduction to the pharmacology of the more common drugs and toxic substances.

CHEM 2210 Forensic Science (3 credits)
Introduction to the theory and practice of crime scene evidence analysis. Topics include, but are not limited to: bloodstain analysis, toxicology, DNA evidence, forensic entomology, fingerprint analysis, biological evidence, arson, and explosives. [Core Curriculum Goal Area 3]

CHEM 2211 Principles of Chemistry I (4 credits)
Principles of inorganic, physical, solution, and gas phase chemistry. The laboratory component introduces techniques, methods, and instrumentation. Intended for chemistry majors and minors, biology majors, preprofessional students, and open to any student meeting the prerequisites wishing to fulfill their Core Curriculum requirement. [Core Curriculum Goal Area 3 (LC)] If on-campus student must register for CHEM 2211 (Lecture) and CHEM 2271(Lab).

CHEM 2212 Principles of Chemistry II (4 credits)
Continuation of the development of principles of inorganic, physical, solution, and gas phase chemistry begun in CHEM 2211. The laboratory component introduces techniques, methods, and instrumentation. Intended for chemistry majors and minors, biology majors, preprofessional students, and open to any student meeting the prerequisites wishing to fulfill their Core Curriculum requirement. Prerequisite: CHEM 1111 or CHEM 2211. [Core Curriculum Goal Area 3 (LC)] Student must register for CHEM 2212 (Lecture) and CHEM 2272 (Lab).

CHEM 2270 Forensic Science Laboratory (1 credit)
Introduction to techniques in Forensic Science. These techniques include, but are not limited to: Bloodstain analysis, HPLC, GC-MS, PCR, and microscopic analysis of biological and physical evidence. [Core Curriculum Goal Area 3]

CHEM 2271 Principles of Chemistry I Lab (0 credit)
Principles of inorganic, physical, solution, and gas phase chemistry. The laboratory component introduces techniques, methods, and instrumentation. Intended for chemistry majors and minors, biology majors, preprofessional students, and open to any student meeting the prerequisites wishing to fulfill their Core Curriculum requirement. [Core Curriculum Goal Area 3 (LC)] If on-campus student must register for CHEM 2211 (Lecture) and CHEM 2271(Lab).

CHEM 2272 Principles of Chemistry II Lab (0 credit)
Continuation of the development of principles of inorganic, physical, solution, and gas phase chemistry begun in CHEM 1211. The laboratory component introduces techniques, methods, and instrumentation. Intended for chemistry majors and minors, biology majors, preprofessional students, and open to any student meeting the prerequisites wishing to fulfill their Core Curriculum requirement. Prerequisite: CHEM 1111 or CHEM 2211. [Core Curriculum Goal Area 3 (LC)] Student must register for CHEM 2212 (Lecture) and CHEM 2272 (Lab).

CHEM 2925 People of the Environment: Chemistry Perspective (3 credits)
A study of the chemical processes important in maintaining a clean environment.

CHEM 3100 Journal Club (1 credit)
Oral and written presentations of special topics in chemistry. May be repeated with 2 semester credits allowed toward chemistry major. Prerequisite: CHEM 3312.

CHEM 3110 Laboratory Management and Safety (2 credits)
Laboratory management concepts, safety information concerning chemical substances. Prerequisite: Junior or Senior standing.

CHEM 3140 Chemical Toxicology (3 credits)
Chemical principles in toxicology. Design of environmentally safer chemicals; quantitative analysis of the toxicity of various molecules. Prerequisite: CHEM 3311.

CHEM 3150 Standard Methods of Water Analysis (3 credits)
Introduction to techniques of analysis of natural and effluent water samples using standard analytical techniques. Prerequisite: CHEM 1112 or CHEM 2212.

CHEM 3210 Interpretation of Spectral Data (2 credits)
Systematic identification of chemical structures utilizing data from mass spectrometry, infrared spectroscopy, and nuclear magnetic resonance spectroscopy. Prerequisites: CHEM 3312 or CHEM 3372 (may be co-requisite).

CHEM 3311 Organic Chemistry I (3 credits)
A study of the properties of aliphatic and aromatic compounds and the theories and mechanisms to account for those properties. Prerequisite: CHEM 1112 or CHEM 2212.

CHEM 3312 Organic Chemistry II (3 credits)
Continuation of study of the properties of functional groups and the theories and mechanisms to account for those properties. Prerequisite: CHEM 3311.

CHEM 3371 Organic Chemistry Laboratory I (1 credit)
Laboratory study of the reactions of organic compounds. Prerequisites: CHEM 1112 or CHEM 2212; Corequisite CHEM 3311.

CHEM 3372 Organic Chemistry Laboratory II (1 credit)
Laboratory study of the reactions of organic compounds. Prerequisite: CHEM 3371; Corequisite CHEM 3312.

CHEM 3507 Analytical Chemistry (3 credits)
A study of equilibrium processes and the experimental methods and instruments used for quantitative analysis of samples. Prerequisite: CHEM 1112 or CHEM 2212.

CHEM 3570 Analytical Chemistry Laboratory (1 credit)
Laboratory applications of analytical instrumentation to chemical analysis. Prerequisites: CHEM 1112 or CHEM 2212, CHEM 3507 (may be corequisite).

CHEM 3811 Intermediate Inorganic Chemistry (3 credits)
Theoretical approach to the principles of inorganic chemistry. Integration of theory and descriptive chemistry. Corequisite: CHEM 2212.

CHEM 3980 Research (1-2 credits)
This research experience will develop essential skills needed to be a chemist. Student researchers will participate in scholarly projects based on appropriate methodology and scholarship. Work will culminate in a presentation or paper. Course may be repeated for 6 credits.

CHEM 4110 Environmental Chemistry (3 credits)
Intensive study of biogeochemical cycles of natural and man-made pollutants including transformations, transport, fate and persistence mechanisms. Environmental effects, long-term impacts, and methods of treatment/ prevention are discussed. Prerequisites: CHEM 1112 or CHEM 2212 or consent of instructor.

CHEM 4320 Special Topics in Organic Chemistry (1-3 credits)
Selected topics such as advanced synthesis, advanced reaction mechanisms, polymers, and natural products. May be repeated when topic is changed. Prerequisite: CHEM 3312. Might not be offered every year.

CHEM 4411 Biochemistry I (3 credits)
Chemical principles governing metabolic functions and genetics. Prerequisites: CHEM 3312 or consent of instructor.

CHEM 4412 Biochemistry II (3 credits)
Continuation of CHEM 3411. Chemical principles governing metabolic functions and genetic materials. Prerequisite: CHEM 4411.

CHEM 4420 Special Topics in Biochemistry (1-3 credits)
Selected topics such as carbohydrates, lipids, proteins, enzymology, nucleic acids, metabolism, toxicology, and biochemical lab techniques. May be repeated when topic is changed. Prerequisite: CHEM 3312. Might not be offered every year.

CHEM 4471 Biochemistry Laboratory I (1 credit)
Laboratory techniques pertaining to biochemistry. Prerequisites: CHEM 3312 and CHEM 3372, Corequisite: CHEM 4411.

CHEM 4472 Biochemistry Laboratory II (1 credit)
Continuation of laboratory techniques pertaining to biochemistry. Prerequisites: CHEM 4411; Corequisite: CHEM 4412.

CHEM 4476 Techniques in Biotechnology and Biochemistry (2 credits)
This course is one of two options for completion of the techniques core requirement for the BCMB major. The structure of the course consists of a combined lecture and lab. The course provides students with opportunities to learn advanced laboratory techniques in biotechnology and biochemistry. Prerequisite(s): CHEM 4471 or BCMB 3074 or BIOL 3074. (Also offered under BCMB 4476)

CHEM 4510 Instrumental Methods of Analysis (3 credits)
Theory and applications of instrumental methods of chemical analysis. Prerequisite: CHEM 3507 and CHEM 3570.

CHEM 4520 Special Topics in Analytical Chemistry (1-3 credits)
Selected topics such as mass spectrometry, NMR, electrochemistry, chemical separations, and computerized instrument interfaces. Prerequisite: CHEM 3507. Might not be offered every year.

CHEM 4571 Instrumental Analysis Laboratory I (1 credit)
Experimental applications of instrumental methods of chemical analysis. Corequisite: CHEM 4510.

CHEM 4572 Instrumental Analysis Laboratory II (1 credit)
Continuation of CHEM 4571. Experimental applications of instrumental methods of chemical analysis. Prerequisite: CHEM 4510.

CHEM 4614 Medicinal Chemistry: Drug Design (3 credits)
This course focuses on drug design and development, as well as the absorption, distribution, metabolism and excretion of drug molecules. Organic chemistry principles vital to drug synthesis and case studies of clinically relevant drugs will be incorporated. Prerequisite(s): CHEM 3312.

CHEM 4615 Medicinal Chemistry: Drug Action (3 credits)
This course focuses on drug targets such as enzymes, receptors, and nucleic acids and the mechanisms by which pharmaceuticals alter the normal cellular activity. Common classes of pharmaceuticals (antibacterial, antiviral, anticancer, opioids, etc) will be explored. Progress in pharmaceutical development will be highlighted through the incorporation of current literature article and drugs undergoing clinical trials. Prerequisite(s): CHEM 4411.

CHEM 4711 Physical Chemistry I (3 credits)
Fundamental understanding of chemical and physical properties of atoms and molecules through quantum mechanical and classical approaches. Prerequisites: CHEM 2212 and PHYS 2101.

CHEM 4712 Physical Chemistry II (3 credits)
Fundamental understanding of chemical and physical properties of atoms and molecules through quantum mechanical and classical approaches. Prerequisites: CHEM 4711 or consent of instructor.

CHEM 4720 Special Topics in Physical Chemistry (1-3 credits)
Selected topics such as kinetics, thermodynamics, quantum chemistry, and molecular modeling. Prerequisite: CHEM 3312. Might not be offered every year.

CHEM 4771 Physical Chemistry Laboratory I (1 credit)
Physical chemistry laboratory applications. Prerequisites: CHEM 3570; Corequisite: CHEM 4711.

CHEM 4772 Physical Chemistry Laboratory II (1 credit)
Physical chemistry laboratory applications. Continuation of 3771. Prerequisites: CHEM 3570; Corequisite: CHEM 4712.

CHEM 4812 Advanced Inorganic Chemistry II (3 credits)
Continuation of the study of the theoretical approaches to the principles of inorganic chemistry. Prerequisite: CHEM 4712 and CHEM 4811.

CHEM 4820 Special Topics in Inorganic Chemistry (1-3 credits)
Selected topics such as organometallics, catalysis, bioinorganic chemistry, and materials chemistry. Prerequisite: CHEM 3312. Might not be offered every year.

CHEM 4871 Inorganic Chemistry Laboratory I (1 credit)
Laboratory oriented approach emphasizing techniques and theories of preparative inorganic chemistry. Prerequisite: CHEM 4711.

CHEM 4872 Inorganic Chemistry Laboratory II (1 credit)
Laboratory oriented approach emphasizing techniques and theories of preparative inorganic chemistry. Prerequisite: CHEM 4871.

CHEM 4894 Research I (2 credits)
This research experience in chemistry will develop essential skills needed to be a chemist. Student researchers will utilize literature, record, and analyze experimental results, and report findings in papers and presentations. Course may be repeated for 4 credits.

CHEM 4895 Research II (2 credits)
This second course in a two course research sequence in chemistry will continue to develop essential skills needed to be a chemist. Student researchers will utilize literature, record and analyze experimental results, and report findings in papers and presentations. Course may be repeated for 4 credits.

CHEM 4917 DIS Tchg Assoc | (1-2 credits)
Directed Independent Study | Teaching Associate

CHEM 4970 Internship (3-4 credits)
Graded Satisfactory/Unsatisfactory only. Student internships may be either full-time or part-time in a public or private agency appropriate to the degree objective. Internships consist of closely supervised periods of service that are arranged in advance of the course registration. Students should consult their advisor concerning prerequisites.

CHEM 4980 Research (1-3 credits)
This research experience will develop essential skills needed to be a chemist. Student researchers will participate in scholarly projects based on appropriate methodology and scholarship. Work will culminate in a presentation or paper. Course may be repeated for 6 credits.

All-University Courses

The course numbers listed below, not always included in the semester class schedule, may be registered for by consent of the advisor, instructor, or department chair, or may be assigned by the department when warranted. Individual registration requires previous arrangement by the student and the completion of any required form or planning outline as well as any prerequisites.

1910, 2910, 3910, 4910 DIRECTED INDEPENDENT STUDY
1920, 2920, 3920, 4920 DIRECTED GROUP STUDY
1930, 2930, 3930, 4930 EXPERIMENTAL COURSE
1940, 2940, 3940, 4940 IN-SERVICE COURSE
1950, 2950, 3950, 4950 WORKSHOP, INSTITUTE, TOUR
1960, 2960, 3960, 4960 SPECIAL PURPOSE INSTRUCTION
1970, 2970, 3970, 4970 INTERNSHIP
1980, 2980, 3980, 4980 RESEARCH
1990, 2990, 3990, 4990 THESIS