

Chemistry

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Description of the Major. Chemistry investigates the composition, properties, and changes of properties in substances and various elementary forms of matter. The study of chemistry gives students an opportunity to develop necessary modern knowledge and techniques with instrumentation.

The chemistry program at Westmont provides a broad knowledge of the field and includes eight tracks.

The professional track leads to graduate study in chemistry and prepares students for challenging careers in teaching and research, industrial chemistry research and development, energy development, medicinal and pharmaceutical chemistry and related areas.

The general track, is more flexible and allows students to go directly into laboratory work or to take additional courses in other disciplines for careers in environmental control, industrial chemistry, medical technology, food chemistry and agricultural chemistry.

The biochemistry track provides the basis for pre-medical, pre-pharmacy and pre-dental training or for graduate study in biochemistry, molecular biology, biomedical research or genetic engineering.

The chemical physics track allows students to combine chemistry with a strong emphasis in physics and engineering. This track prepares students for graduate work in chemical physics or chemical engineering, or teaching chemistry and physics at the secondary level. All four tracks lead to the B.S. degree.

For students desiring a broader curriculum or a double major, the B.A. degree track allows the most flexibility. A four-year Fast-Track plan for obtaining a secondary teaching credential in chemistry is available using this track. With careful planning and two extra classes over the summer, it is possible to complete both the general track B.A. requirements and the teaching credential in four years.

Students interested in chemical engineering have the option of the 3-2 program in which they receive a degree from the engineering school and a B.A. from Westmont. The benefits of receiving a liberal arts and sciences background and the more specialized training from a formal engineering school can be beneficial for both the student and the employer. Since the 3-2 program has strict requirements, interested students must meet with a faculty of the department to plan the class schedules consistent with their goals. The program often takes six years to complete.

Distinctive Features. Chemistry students at Westmont have many opportunities to use state-of-the-art instrumentation such as atomic absorption spectrometers, 400 MHz Fourier transform nuclear magnetic resonance spectrometers, FT infrared and ultraviolet-visible spectrometers, fluorimeter, mass spectrometer, pulsed dye laser, automated gel electrophoresis and gas and high performance liquid

chromatographs. They learn analytical chemical techniques, and advanced organic synthesis techniques.

Most of our students participate in undergraduate research. Each student in the B.S. program is *required* to do independent research with a faculty member.

Participating in an off-campus program is encouraged of all chemistry majors. The student may choose to do so during the fall of either the junior or senior year. The student should consult his or her academic advisor so that the required courses can be scheduled ahead of that off-campus semester.

Career Choices. A degree in chemistry can lead to many interesting and challenging careers, including: biochemist, chemical engineer, industrial or clinical chemist, college instructor, dentist, dietician, high school teacher, marine scientist, pharmacologist, physician, radiologic technician, nuclear medicine technician, forensic serologist, toxicologist, technical writer, patent lawyer, industrial hygienist, and industrial management.

B.A. Degree Major Requirements: 46-66 units

A. General Track

Required Lower-Division Courses: 25-26 units

CHM 005, 006 General Chemistry I, II (4,4)

MA 009, 010 Elementary Calculus I, II (4,4)

One of the following combinations (9-10)

PHY 011, 013 Physics for Life Sciences I, II (4,4)

PHY 014 Physics for Life Sciences Laboratory (1)

OR

PHY 021, 023 General Physics I, II (4,4)

PHY 022, 024 General Physics Laboratory I, II (1,1)

Required Upper-Division Courses: 21 units

CHM 101, 102 Organic Chemistry I, II (4,4)

CHM 121 Introductory Analytical Chemistry (4)

CHM 195 Seminar (1)

One of the following combinations: (4)

CHM 130 Physical Chemistry I (3)

CHM 132 Physical Chemistry Laboratory I (1)

OR

CHM 135 Introductory Physical Chemistry (3)

CHM 132 or 133 Physical Chemistry Laboratory I or II (1)

Upper-Division CHM Elective (4)

B. General Track with Teaching Credential

Required Lower-Division Courses: 25-26 units

CHM 005, 006 General Chemistry I, II (4,4)

MA 009, 010 Elementary Calculus I, II (4,4)

One of the following combinations (9-10)

PHY 011, 013 Physics for Life Sciences I, II (4,4)

PHY 014 Physics for Life Sciences Laboratory (1)

OR

PHY 021, 023 General Physics I, II (4,4)

PHY 022, 024 General Physics Laboratory I, II (1,1)

Required Upper-Division Courses: 68 units

CHM 101, 102 Organic Chemistry I, II (4,4)

CHM 121 Introductory Analytical Chemistry (4)

CHM 195 Seminar (1)

One of the following combinations: (4)

CHM 130 Physical Chemistry I (3)

CHM 132 Physical Chemistry Laboratory I (1)

OR

CHM 135 Introductory Physical Chemistry (3)

CHM 132 or 133 Physical Chemistry Laboratory I or II (1)

Upper-Division CHM Elective (4)

ED 101 Explorations in Teaching (4)

ED 105 Perspectives on Cultural Diversity and Education (4)

ED 111 Educational Psychology (4)

ED 125 Curriculum and Planning (4)

ED 130 Special Education (2)

ED 151 Curriculum, Management, Instruction (2)

ED 161 Technology for the Classroom Teacher (2)

ED 171 Content Area Literacy (4)

ED 191 Student Teaching (12)

ED 196 Student Teaching Seminar (3)

ENG 106 Language Acquisition (4)

KNS 156 Health Education for the Classroom Teacher (2)

C. Chemical Engineering 3-2/3-3 Program Track

Required Lower-Division Courses: 34 units

CHM 005, 006 General Chemistry I, II (4,4)

MA 009, 010 Elementary Calculus I, II (4,4)

MA 019 Multivariable Calculus (4)

PHY 021, 023 General Physics I, II (4,4)

PHY 022, 024 General Physics Laboratory I, II (1,1)

PHY 040 Differential Equations (4)

Required Upper-Division Courses: 23 units

CHM 101, 102 Organic Chemistry I, II (4,4)

CHM 121 Introductory Analytical Chemistry (4)

CHM 122 Advanced Methods in Chemistry (3)

CHM 125 Analog and Digital Instrumental Analysis (4)

CHM 130 Physical Chemistry I (3)

CHM 132 Physical Chemistry Laboratory I (1)

Highly Recommended Courses:

MA 020 Linear Algebra (4)

CS 010 Design and Implementation of Solutions to Computational Problems (4)

D. Biochemistry Track

Required Lower-Division Courses: 33-34 units

CHM 005, 006 General Chemistry I, II (4,4)

BIO 005, 006 General Biology 1, 11 (4,4)

Two of the following three: (8)

MA 005 Introduction to Statistics (4)

MA 009 Elementary Calculus I (4)

MA 010 Elementary Calculus II (4)

One of the following combinations: (9-10)

PHY 011, 013 Physics for Life Sciences I, II (4,4)

PHY 014 Physics for Life Sciences Laboratory (1)

OR

PHY 021, 023 General Physics I, II (4,4)

PHY 022, 024 General Physics Laboratory I, II (1,1)

Required Upper-Division Courses: 31-32 units

CHM 101, 102 Organic Chemistry I, II (4,4)

CHM 113 Biochemistry (4)

CHM 115 Advanced Biochemistry (4)

CHM 121 Introductory Analytical Chemistry (4)

CHM 195 Seminar (1)

One of the following two: (3)

CHM 130 Physical Chemistry I (3)

CHM 135 Introductory Physical Chemistry (3)

Two of the following three: (7-8)

CHM 131 Physical Chemistry II (3)

BIO 102 Physiology (4)

BIO 114 Genetics (4)

B.S. Degree Major Requirements: 55-71 units

A. Professional Track

Required Lower-Division Courses: 30 units

CHM 005, 006 General Chemistry I, II (4,4)

MA 009, 010 Elementary Calculus I, II (4,4)

MA 019 Multivariable Calculus (4)

PHY 021, 023 General Physics I, II (4,4)

PHY 022, 024 Introductory Physics Laboratory I, II (1,1)

Recommended Lower-Division Courses:

BIO 005 General Biology I (4)
 CS 010 Design and Implementation of Solutions to Computational Problems (4)
 PHY 040 Differential Equations (4)
 GER 001, 002 Elementary German I, II (4,4)

Required Upper-Division Courses: 40-41 units

CHM 101, 102 Organic Chemistry I, II (4,4)
 CHM 104 Advanced Inorganic Chemistry (4)
 CHM 113 Biochemistry (4)
 CHM 121 Introductory Analytical Chemistry (4)
 CHM 122 Advanced Methods in Chemistry (3)
 CHM 130, 131 Physical Chemistry I, II (3,3)
 CHM 132, 133 Physical Chemistry Laboratory I, II (1,1)
 CHM 195 Seminar (1)

One of the following (4)

CHM 198 Chemical Research (4)
 CHM 199 Major Honors (4)

One of the following (4-5)

PHY 142/143 Circuits and Electronics/Electronics Laboratory (4,1)
 CHM 115 Advanced Biochemistry (4)
 CHM 150 Special Topics (4)
 CHM 160 Advanced Organic Chemistry (4)

All graduating majors in the professional track are required to take the Graduate Record Exam in their senior year.

B. General Track**Required Lower-Division Courses: 25-26 units**

CHM 005, 006 General Chemistry I, II (4,4)
 MA 009, 010 Elementary Calculus I, II (4,4)
One of the following combinations: (9-10)
 PHY 011, 013 Physics for Life Sciences I, II (4,4)
 PHY 014 Physics for Life Sciences Laboratory (1)

OR

PHY 021, 023 General Physics I, II (4,4)
 PHY 022, 024 General Physics Laboratory I, II (1,1)

Required Upper-Division Courses: 30 units

CHM 101, 102 Organic Chemistry I, II (4,4)
 CHM 121 Introductory Analytical Chemistry (4)
 CHM 122 Advanced Methods in Chemistry (3)
 CHM 195 Seminar (1)
One of the following (2)
 CHM 198 Chemical Research (2)
 CHM 199 Major Honors (4)

One of the following combinations: (4)

CHM 130 Physical Chemistry I (3)

CHM 132 Physical Chemistry Laboratory I (1)

OR

CHM 135 Introductory Physical Chemistry (3)

CHM 132 or 133 Physical Chemistry Laboratory I or II (1)

Upper-Division CHM Electives (8)

C. Biochemistry Track

Required Lower-Division Courses: 33-34 units

CHM 005, 006 General Chemistry I, II (4,4)

BIO 005, 006 General Biology I, II (4,4)

MA 009, 010 Elementary Calculus I, II (4,4)

One of the following combinations: (9-10)

PHY 011, 013 Physics for Life Sciences I, II (4,4)

PHY 014 Physics for Life Sciences Laboratory (1)

OR

PHY 021, 023 General Physics I, II (4,4)

PHY 022, 024 General Physics Laboratory I, II (1,1)

Required Upper-Division Courses: 34 units

CHM 101, 102 Organic Chemistry I, II (4,4)

CHM 113 Biochemistry (4)

CHM 115 Advanced Biochemistry (4)

CHM 121 Introductory Analytical Chemistry (4)

CHM 195 Seminar (1)

One of the following (1)

CHM 198 Chemical Research (1)

CHM 199 Major Honors (4)

One of the following combinations: (4)

CHM 130 Physical Chemistry I (3)

CHM 132 Physical Chemistry Laboratory I (1)

OR

CHM 135 Introductory Physical Chemistry (3)

CHM 132 or 133 Physical Chemistry Laboratory I or II (1)

Two of the following three: (8)

CHM 131 Physical Chemistry II (3) **and** CHM 133 Physical Chemistry Laboratory II (1)

BIO 102 Physiology (4)

BIO 114 Genetics (4)

Those interested in graduate school in biochemistry should choose CHM 130 and 131 and take additional courses in advanced biochemistry, molecular biology, inorganic and organic chemistry.

D. Chemical Physics Track

Required Lower-Division Courses: 39 units

CHM 005, 006 General Chemistry I, II (4,4)
 PHY 021, 023 General Physics I, II (4,4)
 PHY 022, 024 General Physics Laboratory I, II (1,1)
 PHY 025 Modern Physics (4)
 PHY 026 Modern Physics Laboratory (1)
 PHY 040 Differential Equations (4)
 MA 009, 010 Elementary Calculus I, II (4,4)
 MA 019 Multivariable Calculus (4)

Required Upper-Division Courses: 27-28 units

CHM 101 Organic Chemistry I (4)
 CHM 130, 131 Physical Chemistry I, II (3,3)
 CHM 132, 133 Physical Chemistry Laboratory I, II (1,1)
 CHM 195 Seminar (1)
One of the following (2)
 CHM 198 Chemical Research (2)
 CHM 199 Major Honors (4)
 *CHM Electives (4)
 *PHY Electives (8 or 9)
 PHY 142/143 Circuits & Electronics with lab (4,1) recommended
 *Department Chair approval required.

Recommended Course

MA 140 Complex Analysis (4)

Requirements for a Minor: 20 units

Required Lower-Division Courses: 8 units

CHM 005, 006 General Chemistry I, II (4,4)

Required Upper-Division Courses: 12 units

CHM 101, 102 Organic Chemistry I, II (4,4)
Upper-Division CHM Elective (4)

Preparation for Teaching Chemistry at the Secondary Level

Students wishing to teach at the high school or junior high level should complete the requirements for a B.A. major, following the general track. In order to complete a fifth-year Credential Program at Westmont, students should also complete four or more of the following (minimum of 12 units) prior to applying to the program.

KNS 156 Health Education for the Classroom Teacher (2)

- ENG 106 Language Acquisition (4)
- ED 101 Explorations in Teaching: Secondary (4)
- ED 105 Perspectives on Cultural Diversity and Education (4)
- ED 130 Special Education for the Classroom Teacher (2)
- ED 161 Technology for the Classroom Teacher: Secondary (2)

In many cases, it is possible to complete requirements for the major and the Westmont Credential Program in four years. Such a “fast-track” schedule requires early planning, ideally beginning in the first year. Students wishing to complete such a program should refer to more specific advising materials available on the department web-page.

All students wishing to explore secondary teaching are also strongly encouraged to consult with faculty advisors in the Department of Education as early in their undergraduate program as possible, in addition to their major advisor.

Lower-Division Course Descriptions

- CHM 001 Introductory General Chemistry** (4) Three lectures and one four-hour laboratory per week. The periodic table, atomic structure, and other fundamentals of chemistry, including laboratory.
- CHM 004 Chemistry, Culture and Society** (4) Survey course that teaches the basic concepts of chemistry. Key episodes in the history of chemistry are used to develop an understanding of how science functions and describe modern ideas about matter, including atomic-molecular theory, energy, chemical periodicity, chemical bonding, and molecular structure. This understanding is then used to describe the chemistry of petroleum derivatives, plastics, living systems, food, drug action, chemically-intensive agriculture, the environment, and contemporary energy technologies. The course also considers the impact of chemical technology on society by exploring chemistry’s benefits and environmental, human health, and social risks associated with the development, manufacture, and use of chemicals. As part of this exploration students are urged to consider the relationships between science, technology, and Christian thought and practice.
- CHM 005 General Chemistry I** (4) Prerequisites: Admissions math requirement (see Applying to Westmont)). Corequisite: CHM 005L. Three lectures and one four-hour laboratory per week. Covers basic concepts of physical, inorganic, organic, analytical and nuclear chemistry.
- CHM 006 General Chemistry II** (4) Prerequisites: CHM 005. Corequisite: CHM 006L. Three lectures and one four-hour laboratory per week. Covers basic concepts of physical, inorganic, organic, analytical and nuclear chemistry.
- CHM 005H, 006H General Chemistry I, II: Honors** (4,4) Prerequisites: By invitation only and Admissions math requirement (see Applying to Westmont). Three lectures and one four-hour laboratory per week. A survey of concepts in physical, inorganic, organic, analytical and nuclear chemistry. Examines each topic with more rigor than CHM 005, 006.
- CHM 014 Scientific Glassblowing** (1) Practical construction and repair of glass apparatus. One three-hour laboratory per week.

Upper-Division Course Descriptions

- CHM 101, 102 Organic Chemistry I, II** (4,4) Prerequisite: CHM 006. Three lectures and one four-hour laboratory per week. Preparation and properties of aliphatic and aromatic compounds, reaction mechanisms, organic synthesis, and qualitative organic analysis in theory and laboratory.
- CHM 104 Advanced Inorganic Chemistry** (4) Prerequisite: CHM 101. Recommended: CHM 102 and CHM 130/131 or CHM 135. The structure, spectroscopy, and reactivity of main group and transition metal compounds will be presented and systematized in terms of current bonding models, particularly molecular orbital and group theory. The results of these studies will then be applied to problems in bioinorganic, materials, environmental, and organometallic chemistry. Three lectures per week.
- CHM 113 Biochemistry** (4) Prerequisites: BIO 005 and CHM 101, 102. Introduction to metabolism through a consideration of protein structure-function relationships, enzyme action and regulation, and catabolic and anabolic pathways, emphasizing the metabolism of carbohydrates. Laboratory work emphasizes enzyme isolation and characterization.
- CHM 115 Advanced Biochemistry** (4) Prerequisite: CHM 113. Examination of biochemical processes with a focus on the metabolism of lipids, amino acids, and nucleotides, and the biochemistry of nucleic acids. Central pathways are considered in detail, including regulatory mechanisms and hormonal signaling. Other selected processes and the integration of mammalian metabolism is explored.
- CHM 121 Introductory Analytical Chemistry** (4) Prerequisites: CHM 006. Suggested pre- or co-requisite: CHM 101. Three lectures and one four-hour laboratory per week. Provides a theoretical and practical introduction to the analytical process with an emphasis on problem definition, method selection and validation, sampling and sample preparation, analysis, the communication of warranted results, and quality assurance. Course topics include statistics, spectroscopic methods, gas and liquid chromatography, gravimetric analysis, titrimetry, and electromechanical methods. The laboratory portion of the course emphasizes the development of scientific writing proficiency.
- CHM 122 Advanced Methods in Chemistry** (3) Prerequisites: CHM 101 and CHM 121 or consent of instructor. Two lectures and one four-hour laboratory per week. An advanced integrated course that develops students proficiency with the use of advanced synthetic and instrumental methods and their application to small molecule, metallurgical, polymeric, nanoscale, food, and environmental systems. Laboratory work focuses on the selection, design and implementation of syntheses and instrumental and wet chemical analysis methods with the aim of developing problem solving, troubleshooting, scientific information literacy, and professional communication skills.
- CHM 125 Analog and Digital Instrumental Analysis** (4) A laboratory course in analog and digital electronics: assembly language and microprocessors, computer interfacing, data acquisition by analog to digital conversion, and stepping motors. Two lectures and two three-hour laboratories per week.

- CHM 130 Physical Chemistry I** (3) Prerequisites: MA 010. Corequisite: CHM 132. Postulates in quantum mechanics and application of the Schrodinger's equation to translation, rotation and vibration. Angular momentum, approximation methods, group theory, atomic and molecular structure, spectroscopy, and electric and magnetic properties, chemical kinetics.
- CHM 131 Physical Chemistry II/PHY 160** (3) Prerequisites: MA 010 and CHM 130 or PHY 025. Corequisite: CHM 133. Classical equilibrium thermodynamics: applications of the first, second, and third laws to condensed and gas phases. Principles and applications of statistical thermodynamics.
- CHM 132, 133 Physical Chemistry Laboratory I, II** (1,1) Corequisites: CHM 130 or 131 or 135. One three-hour laboratory per week. Emphasizes thermodynamics, kinetics, electrochemistry, spectroscopy, quantum chemistry, and computer applications. Oral and written presentations of laboratory results are required.
- CHM 135 Introductory Physical Chemistry** (3) Prerequisite: MA 010. Corequisite: CHM 132 or 133. Applications of physical chemistry to the life sciences. Thermodynamics, energy and the first law, entropy and the second law, free energy and bioenergetics, solar energy. Chemical and biochemical kinetics, biochemical spectroscopy, transport properties, macromolecules.
- CHM 150 Special Topics** (1/2-4) Prerequisites: CHM 102 (and others possible, depending on topic). Topics include advanced biochemistry, biophysical chemistry, materials chemistry, bioinorganic chemistry, advanced spectroscopy, organometallic chemistry of the transition elements, and electroanalytical chemistry.
- CHM 160 Advanced Organic Chemistry** (4) Prerequisites: CHM 102 and CHM 131 or CHM 135. Advanced topics in kinetics and mechanisms of organic reactions, stereochemistry, molecular orbital theory, photochemistry, organometallic chemistry, polymers, and natural products. Three lectures and one four-hour laboratory per week.
- CHM 190 Chemistry** Internship(1) Supervised experiences in the chemistry department or in community and industrial facilities such as clinical or research laboratories. Generally one unit of credit per semester.
- CHM 195 Seminar** (1) Prerequisite: Chemistry major and junior standing. Examination of the relationship between chemistry and Christianity with special emphasis given to the role of matter and matter theory in Christian thought, practice, and aspiration; chemical creativity as an expression of the Imago Dei; and the development of philosophies of ministry that support Christian chemists' responsible lifelong engagement with the church and their profession. Weekly reading assignments will address the historical interplay between natural philosophy and religion, the doctrines of creation and the imago dei, the nature of scientific knowledge, environmental stewardship, scientific responsibility, and the scientific vocation. A written report is submitted at the conclusion of research activities.
- CHM 198 Chemical Research** (1-4) Prerequisites: CHM 102, 125 or 131. Students work closely with a faculty person on original research projects. The results may be reported in research conferences and journal form for publication.

CHM 199 Major Honors (4-6) In consultation with their faculty mentor the Major Honors candidate will develop and execute an advanced level independent research project, produce a fully documented research paper, and pass an oral examination on the research before a committee.