

Section 2: Program Summary Chemistry (DC): Secondary Minor and Major

The University Detroit Mercy (UDM), a Catholic institution whose mission flows from the educational traditions of the Sisters of Mercy of the Americas and the Society of Jesus, exists to provide excellent student-centered undergraduate and graduate education in an urban context. A UDM education seeks to integrate the intellectual, spiritual, ethical, and social development of students. It emphasizes the worth of the individual. Further, the University expects its diverse graduates to be distinguished world citizens, community members, and leaders who:

- Reflect on the meaning of their lives.
 - Think and communicate clearly, imaginatively, and effectively.
 - Process the skills and competencies of a college education.
 - Understand diverse cultural heritages.
 - Have a sense of social responsibility and a desire to serve society.
- (2003-2005 Undergraduate Catalog, 89-91)*

UDM's Core Curriculum consists of a set of requirements (48 hours) based on six objectives that express, in further detail, this academic purpose. The list of approved core courses is published in the *Schedule of Classes* issued for each term. Education students taking their majors in the College of Engineering and Science (CES) must complete the same Core Curriculum as all UDM students with specific recommendations from Core options in Objectives 1, 2, 3, 5 and 6; Objective 4 remains the same as the general core outline requirements. The specific CES recommendations are:

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| Objective 1 | Communication Skills—Take CST 101 Fundamentals of Speech and ENL 131 Academic Writing. |
| Objective 2 | Mathematical and Computer Skills—Take MTH 140 (or MTH 141/142 depending on the program) and Computer Science (Required course depends on program). |
| Objective 3 | Scientific Literacy—At least two courses must be in Natural Science. In some programs, all courses may be selected from Natural Science. |
| Objective 5 | Diverse Human Experience—Two courses from 5A (History and Religious Studies), 5B (Literary Experiences), and 5C (Aesthetic Experiences). Take one course from 5D (Comparative Experiences). |
| Objective 6 | Social Responsibility— (Education students choose one course from any of the Ethics courses.) |

Contemporary Socio-Political Problems—(Education students choose one course from the general core outline--depending on the program.) *CHM 429, CHM 474 and EDU 440 are included in the list of courses that fulfill this UDM core objective. (Class Schedule on WEB site)*

The Chemistry Major and Minor for Secondary Teacher Education is offered by the Chemistry and Biochemistry Department in the College of Engineering and Science. The Department of Education, housed in the College of Liberal Arts and Education (CLAE), offers baccalaureate, post-degree, and master's degree teacher education programs with State of Michigan certification in three areas: Elementary Education, Secondary Education, and Special Education. Each program requires the completion of coursework in three areas:

- University core curriculum.
- A teaching major and minor in approved academic areas.
- Professional education, including student teaching.

In addition to these programs, UDM Education Department delivers the same graduate and postgraduate certification programs to cohorts of K-12 Detroit Archdiocese teacher candidates through Experience Plus. All programs may be completed on a full or part-time basis either during the day, late afternoon, evening, or weekend. UDM majors and minors in Elementary, Special Education, and/or secondary education are completed in the following colleges and appropriate departments:

- College of Business Administration
- College of Engineering & Science (Includes Mathematics) and
- College of Health Professions
- College of Liberal Arts

The Department of Education, therefore, works closely with the faculty members throughout the University to ensure that each student is effectively advised and assisted to complete her/his Education program with a quality major and/or minor.

UDM offers teacher certification in Chemistry (DC) for students who wish to teach in secondary schools. The Chemistry minor is a program of 20-23 required hours with a core of 17-20 hours and 3 hours of electives, which is completed in the College of Engineering and Science. The Chemistry major is a program of 33-36 required credit hours, including a core of 30-33 hours, and 3 hours of electives. The *Michigan Curriculum Framework* for Chemistry specifies the guidelines for integrating basic concepts and scientific inquiry skills into real-world contexts throughout a secondary Chemistry program. Those concepts include the areas of properties of matter; energy, chemical bonds, and chemical reactions; and organic, biochemical, nuclear, and environmental chemistry. UDM students take classes that give them an in depth knowledge of these concepts and the appropriate chemistry inquiry skills to become a secondary education teacher.

A. Philosophy, Rationale, and Objectives

Philosophy: The Chemistry faculty members, housed in the Chemistry and Biochemistry Department in College of Engineering and Science, and the Education Department faculty work together to prepare teacher education candidates for the Chemistry teacher certification. The philosophies of these two departments are complementary. They both state the belief that theory and scholarly research need to be placed in the proper historical, social and political context. They seek to integrate laboratory and field experience into the learning process so that students

not only learn about their discipline but also construct knowledge in a real and tangible manner. Students, thus, have the advantage of developing a knowledge and skill base which empowers them to be active, positive contributors to the local, national and global societies. In order to teach students from diverse backgrounds, socio-economic status, and abilities in urban, suburban, and rural settings, UDM Education and Chemistry faculty believe that a strong pedagogy program must be a full partner with academic knowledge.

Rationale: The role of science in today's complex and highly technological society is considered as a critical determinant to our future as a global community. With this in mind, the faculties of the Chemistry and Biochemistry and of the Education Departments strive to provide an education which integrates the intellectual, spiritual, moral and social development of their students. This integration requires a solid base of discipline knowledge which demonstrates the interrelationships within the discipline as well as those relationships with other disciplines. It is through this kind of study that students learn and practice the knowledge and skills required to be inquiring, reflective, ethical and value-driven educators. Preparation for the Chemistry secondary teacher certification enables teacher candidates to use this knowledge and skill base to make knowledgeable, practical and creative applications of theory as well as to identify issues and solve problems which challenge our ability to create a better world.

In today's complex world, Chemistry teachers need to use the skills of the art and science of teaching to teach their students to learn how science can help them to be productive members of society. Current developments such as environmental impact of chemicals, increased production of pollutants, uses of radioactivity in modern society, nuclear power, and the application of biochemical principles in recombinant DNA technology requires ethical, caring, responsive citizens capable and willing to make knowledgeable decisions. The Chemistry program of studies is designed to provide the knowledge, skills, and practice that Teacher Education students need in order to be competent educators in this regard.

Objectives: The general objectives for the preparation of all secondary teacher education candidates, including those with secondary Chemistry Majors and Minors, are delineated in the "Education Department's Conceptual Framework," which is published annually along with the "Education Department's Code of Ethics" in its *Teacher Education Handbook*. This "Framework," which complements the Michigan Department of Education's Standards for the Secondary Physical Science programs and the Entry-Level Standards for Michigan Teachers (ELSMT), identifies three dimensions of the role of teacher:

- A *scholar* who uses the research-knowledge base for teaching integrated with the liberal arts and sciences disciplines.
- An *inquirer* who is skilled in decision-making based on ethical, critical, and reflective thinking.
- A *moral agent* who values and acts according to the UDM values and the "Department of Education Professional Code of Ethics."

These general objectives, in addition to complementing the University mission and the Chemistry department's philosophy, reflect the key ideas expressed by the Michigan State Board of Education-January 2002 Content Guidelines/Standards (SBE Standards) and the "*Michigan Curriculum Framework Content Standards for Physics*". Additionally, they are aligned with the Michigan Test for Teacher Certification (MTTC).

These content categories have been reviewed by the Chemistry and Education faculty, who believe that the Chemistry program of studies effectively prepares candidates for certification as teachers of Chemistry in the secondary classroom as follows:

Sub area	Approximate Percentage Of Questions on Test
Constructing and Reflecting on Scientific Knowledge	27%
Properties of Matter	23%
Energy, Chemical Bonds, and Chemical Reactions	35%
Organic, Bio-, Nuclear, and Environmental Chemistry	15%

Constructing and Reflecting on Scientific Knowledge

- Understand the history of modern chemistry.
- Understand relationships among chemistry, technology, and society.
- Understand procedures and principles related to scientific research and experimental design.
- Apply knowledge of methods and equipment used in measurement to solve problems.
- Apply procedures for gathering, organizing, interpreting, evaluating, and communicating data.
- Apply procedures for the safe, proper, and legal use of tools, equipment, and materials (including chemicals) related to laboratory investigations.
- Analyze the nature of scientific thought and inquiry.

Properties of Matter

- Identify chemical and physical properties of matter.
- Understand quantum theory and atomic structure.
- Understand the organization of the periodic table.
- Understand chemical notation and nomenclature.
- Understand the mole concept and its relationship to chemical formulas.
- Apply knowledge of the kinetic molecular theory to the states of matter and to the gas laws.

Energy, Chemical Bonds, and Chemical Reactions

- Understand how to balance chemical equations.
- Solve stoichiometry problems.
- Understand energy and energy changes in chemical processes.
- Understand types and characteristics of molecular structure.
- Understand the nature of solids.
- Apply knowledge of ions, solutions, and solubility to explain the formation and properties of homogeneous mixtures.
- Understand chemical equilibrium and factors that affect reaction rates.
- Understand acid-base reactions.
- Understand oxidation-reduction reactions.

Organic, Bio-, Nuclear, and Environmental Chemistry

- Understand organic compounds, their structures, their reactions, and their importance.
- Understand biochemical compounds and their function.
- Understand the basic principles of radioactivity and nuclear reactions and applications of nuclear chemistry.
- Understand the application of chemistry to environmental concerns.

B. Sequence of Courses and/or Experiences

UDM's College of Liberal Arts and Education offers baccalaureate, post-degree, and master's degree teacher education programs with State of Michigan certification in three areas: Elementary Education, Secondary Education, and Special Education.

Each program requires the completion of coursework in these areas:

- University core curriculum.
- A teaching major and a teaching minor in approved academic subject areas.
- Professional education, including field experiences and student teaching.

The UDM 48 Hour Core Curriculum is explained in the *2003-2005 Undergraduate Catalog* (89-91) and is published, with a list of approved courses for each of the six objectives, in the *Class Schedule* for each of the three terms (16-18 Term I 2003-2005). Education students are encouraged to select courses that will complement their certification as well as their major and minor areas of study. For example: Chemistry students would be encouraged to select courses in the Math, Science, Social Studies, Literature, and the Fine Arts that would complement their Chemistry major or minor as well as their other area of study. Those objective areas are:

1. Communication Skills (6 hours; 2 courses—Speech and Academic Writing).
2. Mathematical and Computer Skills (6 hours—choices in Mathematics and Computer).

3. Scientific Literacy (9 hours—choices from the Social Sciences and Natural Sciences. *CHM 387 Quantitative Analysis is taken by all Chemistry students, regardless of their career choices.*).
4. Meaning and Value (9 hours—choices from Philosophy, Religious Studies).
5. Diverse Human Experience (12 hours—choices from Historical, Literary, Aesthetic, Comparative Experiences and Languages).
6. Social Responsibility (6 hours—choices from Ethics and Contemporary Social Problems, ranging from Philosophy, Health Services, Religious Studies across Social and Natural Sciences, Criminal Justice, Communication, Women's Studies.)

The sequence of courses listed in Form XX for the Chemistry majors and minors provides a systematic study of the fundamental knowledge of the Chemical Sciences and their methods of inquiry. A foundation is thereby established for students' future pursuits, including a career in secondary education. The core courses in the Chemistry sequence develop the students' understanding of the fundamental concepts that comprise the content of Chemistry and the methods used to create knowledge in this discipline. Teacher education students engage in both constructing and reflecting on scientific knowledge as they engage in both theory and laboratory courses involving inorganic and organic chemistry, thermodynamics, nuclear reactions, energy, chemical bonds and reactions as well as societal issues related to biochemistry. General principles and concepts of organic and inorganic chemistry are learned initially in CHM 107 General Chemistry I and CHM 108 General Chemistry II and their laboratory classes, CHM 110 and CHM 111. The acquisition continues in CHM 227 Organic Chemistry I and CHM 229 Organic Chemistry II and their laboratory classes, CHM 228 and CHM 230. These principles and concepts are developed more extensively for Chemistry majors in CHM 333 Physical Chemistry Lab I and CHM 334 Physical Chemistry Lab II. Analysis skills for majors are explored in CHM 341 Chemical Thermodynamics and Applications and CHM 342 Chemical Dynamics and Quantitative Chemistry. Students may take CHM 471 Biochemistry I and CHM 472 Biochemistry II as a sequence (6 credits), or they may take CHM 470 Basic Biochemistry (3 credits). Both choices provide opportunities for majors and minors to acquire knowledge about biochemical concepts, principles, and inquiry skills. An additional opportunity exists for Chemistry majors to practice their analytical skills in the UDM Core Curriculum class for the College of Engineering and Science, CHM 387 Quantitative Analysis. Chemistry minors seeking a teaching certification have their major in another college and do not take CHM 387 as part of their Chemistry minor. Both majors and minors must select one elective that provides opportunities to explore chemical interactions within societal contexts from: CHM 103 Chemistry and Society, CHM 429 Industrial Chemistry Societal Issues, and CHM 474 Biochemical Social Issues.

The relationship of Chemistry to the other scientific and mathematical disciplines is addressed in the UDM Core Curriculum Requirement, particularly Objective 3—Scientific Literacy. In addition, there are science and mathematics courses which are

either required of all Chemistry majors or are prerequisites or co-requisites to Chemistry courses in the planned program of study.

C. Varied Instructional Approaches

The Chemistry faculty and the Education faculty prepare students to utilize a variety of instructional approaches by modeling creative, logical, and effective teaching practices in their classes. A review of the Chemistry course syllabi reveals the range of teaching methods used by that faculty to instill the skills and knowledge of the discipline: lectures, discussion, study guides, textbooks, laboratory experiments and reports, films, quizzes, use and review of web sites, critical analysis of articles from scholarly journals, essays, and examinations. A review of the Education Syllabi on the UDM WEB reveals a similar range of teaching methods practiced by the Education faculty. Educators also include group/team/collaborative activities, building a community of learners, both non-fiction and fiction analysis, field observations and research, written and oral presentations enhanced with electronic equipment/programs, and other education projects and assessment tools. A review of the Education Courses listed in Form XXX, the "Course Descriptions," and the course syllabi on the WEB link explicates the wide range of instructional methods taught to Secondary and Special Education teacher candidates. EDU 401/402 Introduction to Elementary and Secondary Education I provides a semester long initial field experience with the "Field Research/Case Study" where students observe and work with a teacher in their major and/or minor areas. This project allows them to observe a variety of instructional strategies and to reflect upon their effectiveness and appropriateness for their developing teaching style. In EDU 469 Curriculum and Methods of Teaching in Secondary Schools I, students are introduced to secondary level curriculum and instructional methods. Topics include methods of instruction, classroom leadership/management, lesson designs, assessment, evaluation, and reporting of student progress. In EDU 475 Curriculum and Methods of Teaching in Middle and Secondary Schools II: Science, they are asked to consider Chemistry as they concentrate on learning the theory behind instructional methods uniquely effective for teaching and learning science. They also have opportunities to observe and reflect about learning in grade 9-12 classrooms as well as to practice methods within the college classroom and in grade 9-12 classrooms. EDU 478/578 Reading in the Content Areas provides instruction in a variety of methods for teaching reading to secondary students across the curriculum. In addition to a variety of technology methods used and demonstrated in all the Education courses, EDU 459 Instructional Technology and EDU 600 Computer Use in Education teach a variety of instructional approaches for using many kinds of technology to assess various learning styles of students and to accommodate those learning styles. These courses also develop the candidates' knowledge, skills, and attitudes for applying technology in education settings. As the candidates develop their assignments, the science candidates focus on their majors and minors. These courses were developed to address the Seventh Standard of the Entry Level Standards for Michigan teachers. Student teaching, EDU 490, for secondary (7-12 grades), as well as SED 474 and SED 489 (Special Education candidates), provides students with a full semester of grade 9-12 real teaching experiences with both

grade 9-12 cooperating teachers and college supervisors. Observations early in those courses and eight seminars complement their experiences and encourage self reflection and feedback about their instructional methods in collaboration with grade 9-12 Co-operating Teachers and UDM College Supervisors. Candidates with Chemistry major are assigned to secondary teachers who teach Chemistry. If at all possible, the Co-operating Teacher to whom the majors are assigned also teaches a class in the candidate's minor area. The same effort is made to assign Chemistry minors to a Co-operating Teacher for their major area who also teaches Chemistry.

D. Elementary and Secondary Level Preparation Differences

Chemistry minors and majors are only offered for secondary level teaching.

E. Gender Equity, Multi-cultural, and Global Perspectives

Chemistry minors and majors learn to incorporate issues of gender equity, multicultural and global perspectives which are addressed within their University Core Curriculum courses. Objective IV- Meaning and Value (9 hours), Objective V- Diverse Human Experience (9 hours) and Objective VI-Social Responsibility (5-6 hours) require all students to select classes from Philosophy, Religious Studies, History, English, Human Services, and/or the Fine Arts. Instructors in the courses of the Chemical Science programs take care to provide a comfortable learning environment for those whose voices have traditionally been stifled in the physical sciences and mathematics. The College's success is documented by the National Science Foundation's recognition that the College of Engineering and Science has a highly favorable rate for admission and graduation of women. The College was sought out for recipients of Clare Boothe Luce Scholarships in Physical Sciences and Engineering; it will have two Luce Scholars in programs beginning in fall 2005. The Education Courses continue the infusion of equity issues throughout the program.

E. Multiple Methods of Student Assessment

Chemistry minors and majors learn a variety of assessment tools from personal experience in every Chemistry course, which are then adaptable to their own teaching. All Chemistry courses rely on regular quizzes and examinations to assess the students' knowledge. For example, quizzes and exams in CHM 107 General Chemistry I and CHM 108 include objective type questions and problems that are evaluated using rubrics that connect the students' theoretical knowledge to practical, real life situations involving principles of Chemistry. In the complementary laboratories, students keep permanent notebook lab notes about experiments and write lab reports that are assessed regularly. They are taught how to assess their work in laboratories and how to write standard laboratory reports according to specific guidelines. Homework assignments and problem sets are also included as a percentage of the students' grade in courses such as: CHM 111, 227, 228, 229, 230, 341, 342, 470, and 471. In addition to such assignments and assessments in CHM 387, 470, and 471, students are also required to make oral presentations about topics that involve research which are evaluated according to objectives explicated in the assignment and on the assessment rubric. The Education courses continue to model and to teach a variety of assessment processes, including authentic models and/or

other alternative assessments procedures. In methods EDU 469, portfolio assignments must include assessments appropriate to the lesson's or unit's objectives and the specific content being taught. Students become familiar with a variety of assessment tools and practices. They are also taught how to construct student-led conferences and demonstrate their ability to the peers in the class. EDU 475 (Science Methods) teaches students a variety of evaluative strategies for use in dealing with specific problems in science instruction; students demonstrate their acquisition of assessment skills through written and oral presentations. They also develop a "science and management kit" that is composed of a series of folders, one of which must include articles about a variety of assessment processes and their plans for assessing their future students. The evaluation forms used by the grade 9-12 Co-operating Teachers and the University Supervisors in Student Teaching (490 General Education and 474 and 478 Special Education) include evaluation of the assessment practices use by the student teachers to evaluate the performances of their grade 9-12 students.