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School of Natural Sciences
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October 18, 2010

To: Undergraduate Council

From: Maria Pallavicini, Dean – School of Natural Sciences

Cc: Patricia LiWang, Professor – School of Natural Sciences
Anne Kelley, Professor – School of Natural Sciences
Tammy Johnson, Manager of Instructional Support & Student Affairs - School Of Natural Sciences

Subject: Proposed changes to Chemical Sciences major coursework requirements

The Chemical Sciences faculty have recommended, and the Natural Sciences Curriculum Committee has approved, modifications to the coursework requirements for the major.

The principal change is the elimination of the research requirement for the major and its replacement by an additional four units (two 2-unit courses) of laboratory-based coursework. The reason for elimination of the research requirement is that it has become untenable to find appropriate research labs for the many Chemistry majors that we now have. The School of Natural Sciences is introducing three new laboratory courses, each worth two units, and eliminating two of our existing laboratory courses, one of which has never been taught.

I have reviewed the proposed changes and concur with the modifications recommended by the Chemical Sciences faculty.

Chemical Sciences B.S. Program
School of Natural Sciences, UC Merced

Chemistry is often known as "the central science" because of the key position it occupies in modern science and engineering. Most phenomena in the biological and earth sciences can be described in terms of the chemical and physical behavior of atoms and molecules, and chemical principles also underlie much progress in medicine and engineering. In addition, chemical systems are fascinating and often beautiful in their own right. Recent developments in the chemical sciences are increasingly directed toward the study of phenomena at the nanoscale, the size range intermediate between individual molecules and macroscopic matter. The ability to measure, understand, and control the properties of matter on these size scales allows us to draw conceptual and practical connections between the submicroscopic world of atoms and molecules and the macroscopic world with which we interact.

UC Merced offers an undergraduate major leading to a B.S. degree in the Chemical Sciences. All of our programs are designed to satisfy the requirements for approval by the American Chemical Society. The curriculum is designed to meet the needs of students who plan to end their formal education with a bachelor's degree as well as those who wish to go on for an advanced degree. The UC Merced chemistry B.S. graduate is well prepared to pursue a career in chemistry or an allied field. We offer both a basic chemistry program and three emphasis tracks in biological chemistry, environmental chemistry, and materials chemistry, which allow students to pursue interdisciplinary areas within a degree program that is still focused on chemistry.

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A degree in the chemical sciences opens the door to a wide variety of careers in industry or government service, forensic chemistry in crime laboratories, commercial fields such as patent law and scientific writing, and high school science teaching. Many chemistry majors go on to graduate study to prepare for careers in teaching and/or research at the college or university level, or research positions in the chemical, pharmaceutical, electronics or other high-tech industries. A major in chemistry is also an excellent foundation for medical school or other careers in the health sciences.

Requirements for the Chemical Sciences (CHEM) Major

In addition to adhering to the UC Merced and School of Natural Science requirements, the additional requirements that must be met to receive the B.S. in Chemical Sciences at UC Merced are:

Chemical Sciences Requirements (61-71 units): The Chemical Sciences major consists of 20-22 courses (7 lower division and 13-15 upper division, depending on emphasis track) designed to give all students a common foundation of core knowledge specific to the discipline.

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Lower Division Major Requirements (28 units):

BIO 1: Contemporary Biology [4]
CHEM 8: Principles of Organic Chemistry [4]
CHEM 10: General Chemistry II [4]
MATH 22: Calculus of a Single Variable II [4]
MATH 23: Multivariable Calculus [4]
MATH 24: Linear Algebra and Differential Equations [4]
PHYS 9: Introductory Physics II [4]

Upper Division Major Requirements (28 units):

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CHEM 100: Organic Synthesis and Mechanism [3]
CHEM 101L: Advanced Synthetic Laboratory [2]
CHEM 111/BIO 101: Biochemistry I [4]
CHEM 112: Quantum Chemistry and Spectroscopy [3]
CHEM 113: Chemical Thermodynamics and Kinetics [3]
CHEM 153: Physical Chemistry Laboratory [2]
CHEM 115: Instrumental Analysis and Bioanalytical Chemistry [3]
CHEM 155: Instrumental Analysis Laboratory [2]
CHEM 120: Inorganic Chemistry [3]
CHEM 150: Inorganic and Materials Chemistry Laboratory [2]
CHEM 194: Ethics and Communication in Chemistry [1]

Deleted: CHEM 114L: Physical Chemistry and Instrumental Analysis Laboratory [2]¶

Emphasis Track Requirements:

Requirements for Chemistry emphasis track

Any two of the following in-depth course electives:
- Any other 3- or 4-unit CHEM course numbered 100-189 [3 or 4]
- Any 200-level CHEM course (instructor approval required) [3]
- ESS 100: Environmental Chem [4]
- MSE 110: Solid State Materials Properties [4]
- MSE 118: Introduction to Nanotechnology and Nanoscience [3]

Deleted: CHEM 95/195: Research [at least 4 units total]¶

Deleted: BIO 102/CHEM 122: Biochem & Molecular Bio [4]¶
CHEM 130: Organic spectroscopy and computation [3]¶
CHEM 131: Molecular spectroscopy [3]¶
CHEM 133: Biophysical Chemistry [3]¶
CHEM 140: Nanoscale Materials Chemistry [3]¶

Requirements for Materials Chemistry emphasis track

ENGR 45: Introduction to Materials [4]
One of the following materials electives:
- CHEM 140: Nanoscale Materials Chemistry [3]
- ENGR 170: Introduction to Electron Microscopy [3]
- MSE 110: Solid State Materials Properties [4]
- MSE 113: Materials Characterization [4]
- MSE 114: Polymeric Materials [4]
- MSE 115: Ceramic Materials [3]
- MSE 116: Composites [3]
- MSE 118: Introduction to Nanotechnology and Nanoscience [3]
- MSE 119: Materials Modeling [3]

One of the following in-depth course electives:
- Any other 3- or 4-unit CHEM course numbered 100-189 [3 or 4]
- Any 200-level CHEM course (instructor approval required) [3]
- ESS 100: Environmental Chemistry [4]

Deleted: CHEM 147: Materials Chemistry Laboratory [3] ¶
CHEM 95/195: Research [at least 2 units total]¶

Requirements for Biological Chemistry emphasis track

BIO 102/CHEM 122: Biochemistry and Molecular Biology [4]
Two other upper division biology courses
One of the following in-depth course electives:
- Any other 3- or 4-unit CHEM course numbered 100-189 [3 or 4]

Deleted: BIO 140: Genetics [4]¶

Deleted: CHEM 95/195: Research [at least 4 units total]¶
One

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Deleted: BIO 110: The Cell [4] ¶
BIO 120: General Microbiology [4]¶
BIO 127: General Virology [4]¶
BIO 141: Evolution [4] ¶
BIO 151: Molecular Immunology [4]¶

Any 200-level CHEM course (requires instructor approval) [3]
ESS 100: Environmental Chemistry [4]
MSE 118: Introduction to Nanotechnology and Nanoscience [3]

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CHEM 131: Molecular spectroscopy [3]¶
CHEM 133: Biophysical Chemistry [3]¶

Requirements for Environmental Chemistry emphasis track

ESS 100: Environmental Chemistry [4]
Two of the following environmental course electives:
ESS 102: Chemical Processes in the Soil Environment [3]
ESS 103: Geochemistry of Earth Systems [3]
ESS 106: Spectroscopic and Microscopic Methods [3]
ESS 108: Surface and Colloid Chemistry of Earth Materials [3]
ENVE 171: Environmental Organic Chemistry [3]

Deleted: CHEM 95/195: Research [at least 3 units total]¶

Transfer students. Transfer students who wish to major in Chemical Sciences should complete two semesters of general chemistry with laboratory, two semesters of organic chemistry with laboratory, one year of calculus-based physics with laboratory, and mathematics through multivariable calculus. Students should consult the Information for Prospective Students link on the School of Natural Sciences website http://naturalsciences.ucmerced.edu for more information.

Sample Plan of Study for Chemical Sciences degree, Chemistry emphasis

Semester 1		Semester 2	
MATH 21 Calculus I	4	MATH 22 Calculus II	4
		PHYS 8 Physics I	4
CHEM 2 General Chemistry I	4	CHEM 10 General Chemistry II	4
CORE 1 The World at Home	4	Free elective	4
CSE 20 Introduction to Computing I	2		
Semester units	14	Semester units	16

Semester 3		Semester 4	
MATH 23 Multivariable Calculus	4	CHEM 100 Organic Synthesis and Mechanism	3
CHEM 8 Principles of Organic Chemistry	4	MATH 32 Probability & Statistics	4
PHYS 9 Physics II	4	MATH 24 Differential Eqs and Linear Algebra	4
WRI 10 College Reading and Composition	4	General Education elective	4
Semester units	16	Semester units	15

Semester 5		Semester 6	
BIO I Contemporary Biology	4	CHEM 113 Chemical Thermodynamics and Kinetics	3
CHEM 112 Quantum Chemistry and Spectroscopy	3	General Education elective	4
General Education elective (w/emphasis on communication)	4	CORE 100 The World at Home	4
CHEM 101L Advanced Synthetic Lab	2	In-depth course elective	3-4
CHEM 195 Research	2	CHEM 153 Physical Chemistry Lab	2
Semester units	15	Semester units	16-17

Semester 7		Semester 8	
CHEM 111 Biochemistry I	4	CHEM 150 Inorganic Lab	2
CHEM 120 Inorganic Chemistry	3	Free elective	4
Free elective	4	General Education elective	4
CHEM 115 Instrumental Analysis and Bioanalytical Chemistry	3	In-depth course elective	3-4
CHEM 155 Instrumental Lab	2	CHEM 194 Ethics and Communication	1
Semester units	16	Semester units	14-15
		Total Program Units	122-124

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Sample Plan of Study for Chemical Sciences degree, Materials emphasis

Semester 1		Semester 2	
MATH 21 Calculus I	4	MATH 22 Calculus II	4
		PHYS 8 Physics I	4
CHEM 2 General Chemistry I	4	CHEM 10 General Chemistry II	4
CORE 1 The World at Home	4	Free elective	4
CSE 20 Introduction to Computing I	2		
Semester units	14	Semester units	16

Semester 3		Semester 4	
MATH 23 Multivariable Calculus	4	CHEM 100 Organic Synthesis and Mechanism	3
CHEM 8 Principles of Organic Chemistry	4	MATH 32 Probability & Statistics	4
PHYS 9 Physics II	4	MATH 24 Differential Eqs and Linear Algebra	4
WRI 10 College Reading and Composition	4	General Education elective	4
Semester units	16	Semester units	15

Semester 5		Semester 6	
BIO I Contemporary Biology	4	CHEM 113 Chemical Thermodynamics and Kinetics	3
CHEM 112 Quantum Chemistry and Spectroscopy	3	General Education elective	4
General Education elective (w/emphasis on communication)	4	CORE 100 The World at Home	4
CHEM 101L Advanced Synthetic Lab	2	CHEM 153 Physical Chemistry Lab	2
ENGR 45 Introduction to Materials	4	CHEM 195 Research	2
Semester units	17	Semester units	15

Semester 7		Semester 8	
CHEM 111 Biochemistry I	4	CHEM 150 Inorganic Lab	2
CHEM 120 Inorganic Chemistry	3	Free elective	4
CHEM 115 Instrumental Analysis and Bioanalytical Chemistry	3	General Education elective	4
Materials elective	3-4	In-depth course elective	3-4
CHEM 155 Instrumental Lab	2	CHEM 194 Ethics and Communication	1
Semester units	15-16	Semester units	14-15
		Total Program Units	122-124

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Sample Plan of Study for Chemical Sciences degree, Biological emphasis

Semester 1		Semester 2	
MATH 21 Calculus I	4	MATH 22 Calculus II	4
		PHYS 8 Physics I	4
CHEM 2 General Chemistry I	4	CHEM 10 General Chemistry II	4
CORE 1 The World at Home	4	General Education elective	4
CSE 20 Introduction to Computing I	2		
Semester units	14	Semester units	16

Semester 3		Semester 4	
MATH 23 Multivariable Calculus	4	CHEM 100 Organic Synthesis and Mechanism	3
CHEM 8 Principles of Organic Chemistry	4	MATH 32 Probability & Statistics	4
PHYS 9 Physics II	4	MATH 24 Differential Eqs and Linear Algebra	4
WRI 10 College Reading and Composition	4	General Education elective	4
Semester units	16	Semester units	15

Semester 5		Semester 6	
BIO I Contemporary Biology	4	CHEM 113 Chemical Thermodynamics and Kinetics	3
CHEM 112 Quantum Chemistry and Spectroscopy	3	Upper division biology course	4
General Education elective (w/emphasis on communication)	4	CORE 100 The World at Home	4
CHEM 101L Advanced Synthetic Lab	2	CHEM 111 Biochemistry I	4
General Education elective	4	CHEM 153 Physical Chemistry Lab	2
Semester units	17	Semester units	17

Semester 7		Semester 8	
CHEM 115 Instrumental Analysis and Bioanalytical Chemistry	3	CHEM 150 Inorganic Lab	2
CHEM 120 Inorganic Chemistry	3	Free elective	4
In-depth course elective	3-4	General Education elective	4
CHEM 122 Biochemistry & Molecular Biology	4	Upper division biology course	4
CHEM 155 Instrumental Lab	2	CHEM 194 Ethics and Communication	1
Semester units	15-16	Semester units	15
		Total Program Units	125-126

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Sample Plan of Study for Chemical Sciences degree, Environmental emphasis

Semester 1		Semester 2	
MATH 21 Calculus I	4	MATH 22 Calculus II	4
		PHYS 8 Physics I	4
CHEM 2 General Chemistry I	4	CHEM 10 General Chemistry II	4
CORE 1 The World at Home	4	Free elective	4
CSE 20 Introduction to Computing I	2		
Semester units	14	Semester units	16

Semester 3		Semester 4	
MATH 23 Multivariable Calculus	4	CHEM 100 Organic Synthesis and Mechanism	3
CHEM 8 Principles of Organic Chemistry	4	MATH 32 Probability & Statistics	4
PHYS 9 Physics II	4	MATH 24 Differential Eqs and Linear Algebra	4
WRI 10 College Reading and Composition	4	General Education elective	4
Semester units	16	Semester units	15

Semester 5		Semester 6	
BIO I Contemporary Biology	4	CHEM 113 Chemical Thermodynamics and Kinetics	3
CHEM 112 Quantum Chemistry and Spectroscopy	3	ESS 100 Environmental Chemistry	4
General Education elective (w/emphasis on communication)	4	CORE 100 The World at Home	4
CHEM 101L Advanced Synthetic Lab	2	General Education elective	4
CHEM 195 Research	1	CHEM 153 Physical Chemistry Lab	2
Semester units	14	Semester units	17

Semester 7		Semester 8	
CHEM 111 Biochemistry I	4	CHEM 150 Inorganic Lab	2
CHEM 120 Inorganic Chemistry	3	Free elective	4
Environmental course elective	3	General Education elective	4
CHEM 115 Instrumental Analysis and Bioanalytical Chemistry	3	Environmental course elective	3
		CHEM 195 Research	2
CHEM 155 Instrumental Lab	2	~~CHEM 194 Ethics and Communication~~	1
Semester units	15	Semester units	16
		Total Program Units	123

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Course requirements for ACS accreditation

<u>2008 ACS guidelines require:</u>
Introductory chemistry
1 semester (at least 3 units) or equivalent in each of:
- Analytical
- Biochem
- Inorganic
- Organic
- Physical

4 additional semesters of "in-depth" courses, which may include the second semesters of year-long sequences in organic or physical
400 hours of lab work beyond the introductory chemistry lab

Correspondence between new (F10) proposed requirements and ACS

Course	**Chem track**	**Bio track**	**Materials track**	**Environ. track**
Intro chem	CHEM 2, 10	CHEM 2, 10	CHEM 2, 10	CHEM 2, 10
Analytical (1 sem)	CHEM 115	CHEM 115	CHEM 115	CHEM 115
Biochem (1 sem)	CHEM 111	CHEM 111	CHEM 111	CHEM 111
Inorganic (1 sem)	CHEM 120	CHEM 120	CHEM 120	CHEM 120
Organic (1 sem)	CHEM 8	CHEM 8	CHEM 8	CHEM 8
Physical (1 sem)	CHEM 112	CHEM 112	CHEM 112	CHEM 112
In-depth courses (4 sem)	CHEM 100 CHEM 113 2 in-depth electives	CHEM 100 CHEM 113 CHEM 122 1 in-depth elective	CHEM 100 CHEM 113 materials elective 1 in-depth elective	CHEM 100 CHEM 113 2 envir. electives
Additional track requirements		2 BIO electives	ENGR 45	ESS 100
Lab work (400 hours)	CHEM 8 (45) CHEM 101L (90) CHEM 153 (90) CHEM 155 (90) CHEM 150 (90) *Total 405*	CHEM 8 (45) CHEM 101L (90) CHEM 153 (90) CHEM 155 (90) CHEM 150 (90) CHEM 122 (15) *Total 420*	CHEM 8 (45) CHEM 101L (90) CHEM 153 (90) CHEM 155 (90) CHEM 150 (90) ENGR 45 (30) *Total 435*	CHEM 8 (45) CHEM 101L (90) CHEM 153 (90) CHEM 155 (90) CHEM 150 (90) ESS 100 (45) *Total 450*