

Program Purpose/Program Benefits (Supporting Information)

Department of Chemistry
College of Science
Illinois Institute of Technology

New Bachelor of Science Degree Programs

Approved by UGSC on Nov 23, 2016

BS in Bioanalytical Chemistry

BS in Environmental Chemistry

BS in Forensic Chemistry

BS in Medicinal Chemistry

Curriculum Revision suggested by UGSC

BS in Computational Chemistry and Biochemistry

HIGHLIGHTS

- The First and Unique BS Programs in the nation, the state of Illinois, and/or the city of Chicago
- No Change in BS Degree Requirement (127-128 credits)
- American Chemical Society (ACS)-Accredited BS Degree Programs
- Credit hours required for ACS-Approved BS program (120)
- Credit hours required for all Peer Chemistry Programs in the Chicago area (120)
- MUST Present Benefits and Compelling Reasons for Enrollment in Illinois Tech Chemistry
- Use 18 Elective Credits (6 Chemistry and 12 Free Electives) for Recruiting and Advanced Training in a Specialized Area of Chemistry.
- Create Attractive, Diverse, and Marketable New BS Programs
- Highly Affordable Programs that can be designed and taught by the Chemistry Department
- Chemistry Faculty anticipate creation of several T/TT faculty lines in the near future
- The Area-Focused and Affordable Programs.
- Sufficient Lead Time for Preparation of New Course Offering (Fall 2020)

I. BACKGROUND

In 2005, the Chemistry Division at the Department of Biological, Chemical, and Physical Sciences (BSPS) launched the following Optional BS degree programs in Chemistry.

- BS Chemistry with emphasis in Biological Chemistry
- BS Chemistry with emphasis in Chemical Education
- BS Chemistry with emphasis in Chemical Physics
- BS Chemistry with emphasis in Material Chemistry
- BS Chemistry with emphasis in Pharmaceutical Chemistry
- BS Chemistry with emphasis in Polymer Chemistry

However, enrollment in the optional degree programs has been extremely low. Over the past 10 years, only less than a total of 5 chemistry majors have been enrolled in the optional degree programs. One of the main reasons for such low enrollment is a very demanding curriculum including all standard-lecture based courses (15-18 credits) required for the optional BS degrees. As such, the optional degree programs present no clear benefit and have not been successful in recruiting students and improving visibility of Illinois Tech Chemistry

The Chemistry faculty now propose to **i)** Cancel the Optional BS Degree Programs and **ii)** Launch *New Viable and Marketable* BS programs to *significantly* increase undergraduate enrollment in Chemistry.

II. STRATEGY and DIRECTION: Systematic Review of Peer Chemistry Programs

As the first step to set a strategic direction to create successful new BS programs in Chemistry, the chemistry undergraduate program committee has conducted extensive search and review of American Chemical Society (ACS)-accredited chemistry programs offered by the peer institutions in USA. Our key findings are summarized below.

Figure 1. Search for ACS-Approved BS Programs in USA



More Affordable Peer Chemistry Programs (120 vs 128 credits): While ACS-approved chemistry programs at the major and local academic institutions require 120 credit hours, Illinois Tech Chemistry offers BS degree in Chemistry requiring higher credit hours (127-128 with 58 chemistry credits). Other peer chemistry programs at the academic institutions in the city of Chicago also require 120 credits (Table 1). Illinois Tech has provided students with a rigorous and high quality education in Chemistry as evidenced by the requirement of credits and chemistry courses. However, the demanding credit requirement in compliance with Illinois Tech's educational goal constitutes Illinois Tech Chemistry program the least affordable, at least in the Chicago land.

Table 1. Credits required for BS in Chemistry Degree in Peer Programs

	UIC	Loyola	DePaul	Illinois Tech
Credits Required for BS Degree	120	120	120	128
Credits for Required Chemistry Courses	46	45	48	58
Enrollment (Fall 2016)		> 440	> 130	27

Diverse, Specialized, Customized, and Area-Focused Undergraduate Programs: Many chemistry departments at US academic institutions offer diverse BS degree programs in addition to the traditional BS degree in Chemistry and have crafted specialized and area-focused BS programs with a good overlap in curriculum (Table 2). For instance, the department of chemistry at University of South Florida offers three medical-related BS degree programs, and one of the programs, BS in Biomedical Science has an unusually high undergraduate enrollment (> 3,000 majors).

Table 2. BS Programs in Chemistry Departments and Current Enrollment

	Ohio University	UC Davis	U. of South Florida	Michigan Tech U
Program	BS-Chem	BS-Chem	BS-Chem	BS in Chemistry
	BS-Biochemistry	BS in Chemical Physics	BS-Biomedical Sci	BS-Pharm Chem
	BS-Pre-Dentistry	BS in Pharm Chem	BS-Medical Technology	BS-Biochem/Mol Biol
	BS-Environmental Chem	BS-Environ Chem track	BS-Interdisc Natural Sci	BS-ChemInformatics
	BS-Forensic Chem	BS-Forensic Chem track		
Enrollment	> 400	~ 800	> 3,000	~ 100

III. JUSTIFICATION and CRITERIA: New BS Programs at Illinois Tech Chemistry

At Illinois Tech, the Chemistry Department has provided a rigorous and high quality education in Chemistry. Unlike other local peer programs based on 120 credit hours, the traditional Illinois Tech BS degree in Chemistry requires a minimum of 127/128 credits. We are proposing to use the extra demanding credits for advanced training in specialized areas. We anticipate that in the new BS programs, students will be trained as viable candidates with good entry-level skills in job market and for entrance to graduate programs including medical and pharmacy school. The students will have learning opportunities to gain various hands-on techniques by taking the lab courses customized for industrial need in addition to the standard lecture-based courses. The students are expected to develop good basic understanding of the subject matter and sound knowledge of chemical applications to the specialized fields. This in-depth and crafted training approach will benefit students in the specialized programs with requisite educational background to develop their competitive career paths.

We first identified the core areas for creation of new BS programs: Bio, Medicine, Data, Analytics, Environment, and Safety (Figure 2 and Table 3). We then selected the proposed BS degree programs based on our review of various factors: **i)** Unique BS degree programs, at least in the Chicago area; **ii)** Major areas attractive to high school and undergraduate students; **iii)** Specialized degrees in high demand from Industry; **iv)** Undergraduate programs in high growth and enrollment

at peer institutions; v) Affordable programs that can be taught and designed by Illinois Tech Chemistry faculty; vi) Curriculum in good overlap for area-focused multi-degree programs.

Figure 2. Identification of the Core Areas for new BS programs

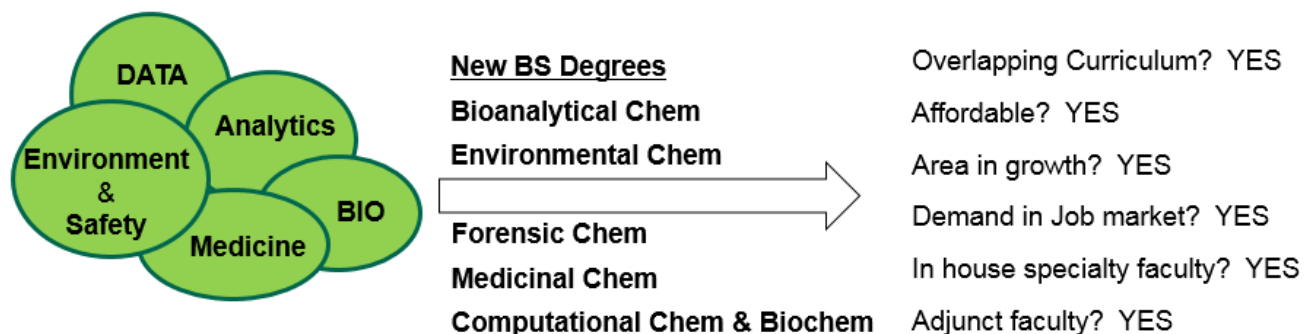


Table 3. Overlapping Curriculum

Program	Analytical	Data Analytics	Biological	Computational Modeling and Design
Bioanalytical Chemistry	X	X	X	X
Environmental Chemistry	X	X	X	X
Forensic Chemistry	X	X	X	X
Medicinal Chemistry	X	X	X	X
Computational Chem & Biochem		X	X	X

IV. MARKET ANALYSIS and IMPACT on CHEMISTRY ENROLLMENT

We anticipate that the new BS degree program should make a significant impact on undergraduate enrollment in Illinois Tech Chemistry. The proposed new BS programs are unique, marketable, and attractive to high school and undergraduate students. No peer local institutions offer any of the new BS programs. Illinois Tech will be the FIRST institution to offer the Bioanalytical Chemistry program and will be one of 6 institutions to train students in Medicinal/Pharmaceutical Chemistry BS programs and will be the only institution to offer Forensic and Environmental Chemistry and Computational Chemistry and Biochemistry degrees in the city of Chicago.

Employment of Chemists is predicted to be in slow growth (3%, Figure 3, US BLS, 2014-24). However, jobs related to the new BS Chemistry programs including Environmental and Forensic Chemistry are projected to be in high demand with 8-21% projected employment growth rate, US BLS).

In-depth coursework in Analytical Chemistry is emphasized in the proposed curriculum of the new degree programs (Bioanalytical, Environmental, Forensic, and Medicinal Chemistry). Industrial demand for analytical chemists remains very high. Particularly, R&D analytical chemists and technicians for analytical method development and quality control and quality analysis (QC/QA) is

in a growing demand. There are over 200 biotech and pharmaceutical and life science companies in the Chicago areas.

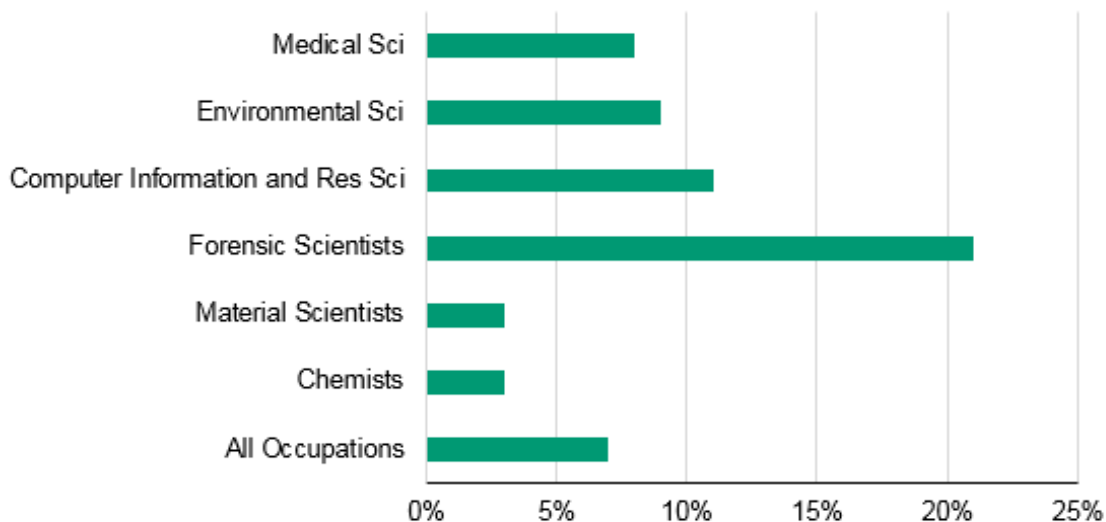
A brief job search in *LinkedIn* using the two key words indicate the high employment population in bioanalytical and medicinal chemistry:

Chemist-2,276; Bioanalytical Chemist-408 (18% of chemist jobs); Medicinal/Pharmaceutical Chemist-462 (20% of chemist jobs).

Employment projection for Environmental and Forensic Chemists is reported to be promising. Forensic chemists and environment chemists can find numerous positions in US federal, state, and county labs. If successfully offered, Illinois Tech Environmental and Forensic Chemistry programs will be well linked to US Drug Enforcement Agency (DEA), Chicago Division, and Food & Drug Administration (FDA)/National Forensic Chemistry Center (FCC) and IL Environmental Protection Agency through internship programs.

Computational Chemistry and Information and Data Science have been continuously expanding and successfully applied to societal needs. Particularly, the area of data science and big data analytics is in a fast growth. The new BS program in Computational Chemistry and Biochemistry is suited to create the curriculum for education in molecular and data analysis in the areas of Medicinal, Environmental, and Forensic Chemistry.

Figure 3. Employment Projection (2014-2024, US Bureau of Labor Statistics)



Bachelor Science in Chemistry

Semester 1		Credits
CHEM 124	General Chemistry I	4
CS 105 or CS110	Intro to Programming Computing Principles	2
MATH 151	Calculus I	5
Humanities-200 level course		3
		14
Semester 2		
CHEM 100	Introduction to Profession	2
CHEM 125	General Chemistry II	4
MATH 152	Calculus II	5
PHYS 123	General Physics I	4
Social Sciences Elective		3
		18
Semester 3		
CHEM 237	Organic Chemistry I	4
BIOL 107 or BIOL 115	General Biology Lectures Human Biology	3
MATH 251	Multivariate	4
PHYS 221	General Physics II	4
Humanities or Social Sciences Elective		3
		18
Semester 4		
CHEM 239	Organic Chemistry II	3
CHEM 240*	Organic Chemistry Lab	2
CHEM 247	Analytical Chemistry	3
MATH 252	Introduction to Differential Equation	4
Humanities Elective (300+)		3
		15
Semester 5		
CHEM 321*	Instrumental Analysis	4
CHEM 343	Physical Chemistry I	3
I PRO Elective I		3
Chemistry Elective*		3
Social Sciences Elective (300+)		3
		16
Semester 6		
CHEM 344	Physical Chemistry II	4
CHEM 434	Spectroscopic Methods	4
CHEM 485	Chemistry Colloquium	1
Free Elective		3
Humanities Elective (300+)		3
		15
Semester 7		
CHEM 415	Inorganic Chemistry	3
BIOL 401	Introduction to Biochemistry	4
OR		
BIOL 403	Biochemistry	3
CHEM 451*	Undergraduate Seminar	3
Free Elective		3
Free Elective		3
		15/16

Semester 8		
CHEM 416*	Inorganic Chemistry Lab	3
Chemistry Elective*		3
CHEM 485*	Chemistry Colloquium	1
I PRO Elective II		3
Free Elective		3
Social Sciences Elective (300+)		3
		16
Total Credit Hours		127-128
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Chemistry Requirements		54
CHEM100, 124, 125, 237, 239, 240, 247, 321, 343, 344, 415, 416, 434, 451, 485		48
Chemistry Electives		6
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Biology Requirements		6-7
BIOL107 or 115, BIOL 401 or 403		
Mathematics Requirements		18
MATH 151, 152, 251, 252		
Physics Requirements		8
PHYS 123, 221		
Computer Science Requirements		2
CS 105 or 110		
Humanities and Social Sciences Requirements		21
Interprofessional Projects (I PRO)		6
Free Electives		12

*The courses may be replaced with courses required for the new BS programs.