Operational Plan for the Chemistry Program

Section A

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Welcome to the Chemistry Program

The Department of Biology & Chemistry has a longstanding commitment to excellence as demonstrated by providing an academically demanding curriculum integrated with Christian commitment. Our first chemistry major, George H. Coleman (1915), obtained a Ph.D. in chemistry from the University of Illinois. The first "long term" chemistry faculty member was Dr. H.J. Long who served the college from 1927-1962, during which time he served as president from 1936-1962. The Department of Biology & Chemistry offers a B.A. in chemistry. For more than 35 years biology majors could add chemistry as a second major through the substitution of specific course requirements. The Department of Biology & Chemistry is part of the College of Arts and Sciences and is committed to producing well prepared graduates in the chemical sciences.

As indicated by our Chemistry Program mission statement, the Department of Biology & Chemistry remains committed both to the liberal arts in the context of a Christian setting and to the development of graduates who are well prepared in the chemical sciences. To this end, the Department plays an integral role in the general education curriculum at Greenville University through the interdisciplinary,

junior/senior level Science and Christianity (UNIV301). The course introduces students to some of the paradigm-shifting ideas in science and examines their impact on the relationship to the Christian faith.

The Department of Biology & Chemistry is committed to research, scholarship and keeping abreast of pedagogical issues in the sciences. In addition to regular semester research, the Department has provided paid, full-time summer research experiences for 25 of our majors over the last five years. The majority of the funding for this research has come from science alumni who give annually to the Catalyst Fund.

Graduates from the Department of Biology & Chemistry are prepared to enter various disciplines subsumed under the umbrella of the chemical sciences. Included under this umbrella are professional programs (e.g., medicine, dentistry, veterinary science, physical therapy, pharmacy, etc.) and graduate programs in science, as well as laboratory and environmental occupations. The relatively small number of chemistry courses (30 credits) required for the B.A. in Chemistry allows our students the luxury of taking courses in other departments. (This is on the low end of credits required for a B.A. Chemistry.) It is not unusual for our students to major or minor in other disciplines (e.g., biology, mathematics and physics).

Program Mission Statement

The Department of Biology & Chemistry is committed to excellence in chemical science education. It assumes that through the study of chemistry one can understand unique aspects concerning the nature of God and His creation. The following quote from Johannes Kepler exemplifies the Department's position and teaching philosophy concerning the motivation for the pursuit of scientific knowledge.

“Scientists are the priests of the highest God in regard to the book of nature. It befits us to be thoughtful not for ourselves but for the glory of God.” Consequently, chemistry becomes a part of the University’s concept of Christian education.

Programmatic Faith Integration

The Department of Biology & Chemistry have worked to incorporate faith into the chemistry program through two approaches: stewardship and humility. Really, these approaches only work with a foundational view of faith in the students’ science education. We train students to look at science with a starting point of faith. With this lens, students can better discover their specific vocation, understand how to be a Christian scientist, and understand how to avoid scientific idolatry while still appreciating the natural world that God left for us to study. With a foundational view of religion, we avoid auxiliary faith exercises that might lead students to think that faith only applies to certain parts of our subjects. We seek out challenging questions by approaching EVERY part of chemistry through faith.

Stewardship: Chemistry with no bounds would tell us that it is fine to exploit natural resources for our own personal benefit. That would be a natural thought in our fallen world. Students would be able to focus on their experiment more if they were to just dump their waste down the sink. Their grade might even improve; yet we need to ask more of them at Greenville University. Environmental stewardship is promoted through various ways in the chemistry program. All of our laboratory courses challenge students to properly manage their chemical waste, not for themselves, but to maintain God’s creation. This expectation is promoted, in part, by the Chemical Safety Assistant, a senior chemistry student who engages with chemistry teaching assistants to train them to promote responsible waste management in chemistry labs. Focusing on environmental responsibility promotes character and allows students to see the chemistry through a Christian perspective.

Stewardship of God's creation is a theme of chemistry in other areas as well. God gives us all unique skills to carry out our vocation. These skills are a resource that should be prudently utilized. The chemistry program often approaches topics that are seemingly unrelated to faith by seeking historical perspectives where scientists didn't fully utilize their unique knowledge, to the detriment of others. For example, in organic chemistry, many chemistry programs will discuss the awful history of a drug called thalidomide after introducing the concept of chirality. Instead of introducing thalidomide simply as an example of a chiral drug, we examine the duty of the chemists involved to constantly critique (constructively) other chemists' works. This not only teaches students in the chemistry program to be good scientists but also to be good students and citizens, all in the name of God.

Humility: In order to avoid personal conflict with your faith as a scientist, a certain degree of humility is needed. Science seeks to answer all of the questions. Without humility, it is easy to think that we know more than we actually do about God's complex world. The idea of humility is approached throughout the curriculum in the chemistry program. We are careful to teach many concepts in the form of theories, not facts. Many think science is based in facts, but we are vigilant to teach that most of the facts are based upon theories. In general chemistry we embrace the usefulness of theories when we teach about acids and bases. We teach three separate, conflicting theories. All of the theories are useful in their own way, but all are ultimately inadequate in describing acids and bases on their own. We embrace this by teaching students how to productively use different theories in different situations. Understanding the limitations of chemistry allows students to build chemistry on a foundation of their faith. This is even more evident in our approach to evolution in courses such as Biochemistry. We teach students to embrace the science, but also embrace their faith. Seeing evidence of evolution shouldn't diminish our faith in God. Ignoring evidence of evolution is ignoring an aspect of God's creation. Understanding science in terms of theory allows for our students to build their understanding of chemistry on top of their foundation of faith.

Program/Major Objectives:

At the close of their degree, students should be able to:

1. Demonstrate an understanding of major concepts, theoretical principles and experimental findings in chemistry. (SLO 2)
2. Demonstrate a knowledge and understanding of the proper procedures and regulations for safe handling and use of chemicals. (SLO 2)
3. Understand how to properly carry out experiments, and appropriately record and analyze the results. (SLO 1)
4. Demonstrate an ability to solve problems in chemistry using the tools, techniques, and data available. (SLO 2, SLO 5)
5. Demonstrate effective writing and oral communication of concepts and experimental results. (SLO 4)
6. Discuss development of major scientific ideas and relate chemistry to and integrate chemistry with other areas of knowledge including issues of public concern. (SLO 3, SLO 6)

Chemistry Program Fulfillment of the SLOs

Institutional SLO 1 (Critical Self-Awareness) is fulfilled through Chemistry Program Objective 3. Designing and setting up an experiment requires that a student be aware of their own strengths and also that they are critical of their own results, otherwise, bias will be introduced into their results.

Institutional SLO 2 (Knowledge and Skill) is fulfilled through Chemistry Program Objectives 1, 2, and 4. Demonstrating understandings of chemistry concepts is in line with developing knowledge of a subject. To be able to safely handle chemicals, students must have knowledge of what they are using and skill with handling chemicals. Knowledge and skill are also needed in order to employ problem

solving strategies. Without an understanding of chemistry, students wouldn't be able to use the appropriate tools for problem solving within the subject.

Institutional SLO 3 (Collaboration and Cooperation Across Disciplines) is fulfilled through Chemistry Program Objective 6. Effective integration of chemistry with other areas of knowledge requires collaboration and understanding of other disciplines.

Institutional SLO 4 (Communication) is fulfilled through Chemistry Program Objective 5. The chemistry department focuses heavily on written and oral communication skills to satisfy SLO 4.

Institutional SLO 5 (Cultural and Aesthetic Values) is fulfilled through Chemistry Program Objective 4. Contributions from diverse cultures is recognized in the sciences through the problem-solving strategy described in Chemistry Program Objective 4.

Institutional SLO 6 (Character and Application of Christian Virtues) is fulfilled through Chemistry Program Objective 6. Chemistry Program Objective 6 discusses integrating chemistry into other areas of knowledge. As described in the faith integration statement, the chemistry program trains students to integrate faith into their chemistry education.

Chemistry Program Connections to Greenville University as a Whole

The Chemistry Program relies heavily upon the general education curriculum. The successful chemistry major needs to be able understand and reflect on both their strengths and weaknesses. As our majors work through the general education curriculum, they must learn to develop critical inquiry skills including how to correctly determine appropriate library and web resources. The general education

curriculum also provides both oral and written communication skills, without which our majors would not be able to communicate their experimental findings. The integration of faith and learning is also a key component that UNIV301 provides for our majors. Specifically to the major, the Chemistry Program requires students to take courses outside of the Department of Biology & Chemistry, including Calculus I (MATH 115), Calculus II (MATH 116), Multivariable Calculus (MATH 217), Differential Equations (MATH 218), University Physics I (PHYS 200), and University Physics II (PHYS 210). This mathematics sequence (MATH 115, MATH 116, MATH 217, and MATH 218) is utilized to allow chemistry students to be successful in Physical Chemistry I (CHEM 321) and Physical Chemistry II (CHEM 322). The physic courses (PHYS 200 and PHYS 210) are important for our physical chemistry sequence, but also to allow general and organic chemistry students (CHEM 111, CHEM 112, CHEM 201, and CHEM 301) to connect the curriculum to other disciplines (satisfying chemistry program objective 6).

Section C

Program Learning Objectives	Required CHEM Courses								Substitutions		
	111	112	201	301	305*	321**	322**	409	314**	315**	342*
1	I		D			M	M		M	M	
2		I	D	M							
3	I		D		M						M
4		I		D	M						M
5	I	D						M			
6	I			D				M			
Key: I = Introduced, D = Developed, M = Mastered											

Program Learning Objectives	Required Non-CHEM Courses					
	MATH 115	MATH 116	MATH 217	MATH 218	PHYS 200	PHYS 210
1	I	I	I	I		
2						
3						
4						
5						
6					D	D
Key: I = Introduced, D = Developed, M = Mastered						

Section D

SLOs	Program Objective	Level of Mastery (IDM)	Term	Course number	Learning Activity	Benchmark	Assessment method
Year One							
SLO 2	1	I	Fall	111	Exam Scores	>70%	Average Exam Scores
		D	Fall	201	Exam Scores	>70%	Average Exam Scores
		M	Fall	321	Exam Scores	>70%	Average Exam Scores
		M	Fall	322	Exam Scores	>70%	Average Exam Scores
		M	Fall	314	Exam Scores	>70%	Average Exam Scores
		M	Fall	315	Exam Scores	>70%	Average Exam Scores
Year Two							
SLO 2	2	I	Spring	112	Laboratory Notebook	>70%	Laboratory Notebook Rubric
		D	Fall	201	Laboratory Exam	>70%	Laboratory Exam Score
		M	Spring	301	Laboratory Exam	>70%	Laboratory Exam Score
SLO 1	3	I	Fall	111	Laboratory Notebook	>70%	Laboratory Notebook Rubric
		D	Fall	201	Laboratory Notebook	>70%	Laboratory Notebook Rubric
		M	Spring	305	Laboratory Notebook	>70%	Laboratory Notebook Rubric
		M	Spring	342	Laboratory Notebook	>70%	Laboratory Notebook Rubric
Year Three							
SLO 2, 5	4	I	Spring	112	Exam Scores	>70%	Average Exam Scores
		D	Spring	301	Exam Scores	>70%	Average Exam Scores
		M	Spring	305	Exam Scores	>70%	Average Exam Scores
		M	Spring	342	Exam Scores	>70%	Average Exam Scores
Year Four							
SLO 4	5	I	Fall	111	Laboratory Report	>70%	Laboratory Report Score
		D	Spring	112	Laboratory Report	>70%	Average of Laboratory Report Scores
		M	Fall/Spring	409	Final Paper	>70%	Final Paper Score
SLO 3, 6	6	I	Fall	111	Faith Reflection	>70%	Faith Reflection Score
		D	Spring	301	Faith Reflection	>70%	Faith Reflection Score
		M	Fall/Spring	409	Faith Reflection	>70%	Faith Reflection Score

Description of Assessment Processes

Program Objective 1 will be assessed through exam scores in General Chemistry I (Introductory), Organic Chemistry I (Developmental), Physical Chemistry I (Mastery), and Physical Chemistry II (Mastery). Students who are enrolled as a Chemistry/Biology double major are allowed to substitute Biochemistry I (CHEM 314) or Biochemistry II (CHEM 315) in place of Physical Chemistry I or II. Due to this, we will also assess Program Objective 1 for Biochemistry I and II (also through exam scores).

Program Objective 2 will be assessed early in the students' education through General Chemistry I (Introductory), Organic Chemistry I (Developmental), and Organic Chemistry II (Mastery). This assessment is done so early since we expect students to quickly get up to speed with laboratory safety. This assessment will be evaluated through laboratory notebooks (CHEM 111) and laboratory exams (CHEM 201 and CHEM 301).

Program Objective 3 will be assessed through laboratory notebooks in General Chemistry I (Introductory), Organic Chemistry I (Developmental), and Quantitative Chemical Analysis (Mastery). As a substitution, students are allowed to take Instrumental Analysis (CHEM 342) instead of Quantitative Chemical Analysis (CHEM 305). Due to this, we will also assess Program Objective 3 for Instrumental Analysis (also through laboratory notebooks).

Program Objective 4 will be assessed through exam scores in General Chemistry II (Introductory), Organic Chemistry II (Developmental), and Quantitative Chemical Analysis (Mastery). Again, students are allowed to take Instrumental Analysis (CHEM 342) instead of Quantitative Chemical Analysis (CHEM 305). Due to this, we will also assess Program Objective 4 for Instrumental Analysis (also through exam scores).

Program Objective 5 will be assessed through laboratory reports in General Chemistry I (Introductory) and General Chemistry II (Developmental). The mastery level for program objective 5 will be assessed through the final paper in Seminar in Chemistry (CHEM 409).

Program Objective 6 will be assessed through Faith Reflections in General Chemistry I (Introductory), Organic Chemistry II (Developmental), and Seminar in Chemistry (Mastery).

Assessment Timetable

During the first year of assessment we will be assessing Program Objective 1 (1. Demonstrate an understanding of major concepts, theoretical principles and experimental findings in chemistry). The department chair will collect data from each faculty member's FCAR and student evaluations to determine if we are meeting the benchmarks.

During the second year of assessment we will be assessing Program Objectives 2 and 3 (2. Demonstrate a knowledge and understanding of the proper procedures and regulations for safe handling and use of chemicals; 3. Understand how to properly carry out experiments, and appropriately record and analyze the results). The department chair will collect data from each faculty member's FCAR and student evaluations to determine if we are meeting the benchmarks.

During the third year of assessment we will be assessing Program Objective 4 (4. Demonstrate an ability to solve problems in chemistry using the tools, techniques, and data available). The department chair will collect data from each faculty member's FCAR and student evaluations to determine if we are meeting the benchmarks.

During the last year of the four-year assessment cycle we will assessing Program Objectives 5 and 6. (5. Demonstrate effective writing and oral communication of concepts and experimental results; 6. Discuss development of major scientific ideas and relate chemistry to and integrate chemistry with other areas of knowledge including issues of public concern) The department chair will collect data from each faculty member's FCAR and student evaluations to determine if we are meeting the benchmarks.