2016 Assessment Plan- Chemistry

I. Mission of the Major:

The major in chemistry provides students the opportunity and the guidance to build a foundation in the chemical sciences. Students engage in active learning as they apply the scientific method towards understanding chemistry. Students **think critically and reason wisely** when evaluating data and issues related to chemistry in society. Students from this program are equipped with the tools needed to **understand new technologies**, **communicate effectively about science and scientific issues**, and **form collaborations to tackle a variety of projects**. Ultimately, upon leaving the department students are prepared for graduate school, a variety of careers, and become lifelong learners.

Chemistry Program Goals:

The chemistry program at Wells:

1. Provides students the opportunity and the guidance to learn the fundamental principles and technology needed to be successful in the chemical sciences.
2. Challenges students to think critically, quantitatively, and reason wisely in evaluating data and working through problem sets. Students should be able to apply these skills to issues arising in the world around them, including ethical conflicts surrounding particular scientific theories, technologies, or applications.
3. Train students to communicate scientific work in a clear, coherent manner in both written and oral form.
4. Engages students in practicing the process of science – planning, executing, evaluating, self-reflection, collaborating and communicating. It also involves helping students understand the importance of diversity in the practice of science through collaborative learning where different perspectives are valued and evaluated.

Alignment of Chemistry Goals with the Wells College's Student Goals:

	Chemistry Program Goals			
	1	**2**	**3**	**4**
Content 1	X			
Content 2	X			
Content 3			X	X
Skills 1		X	X	
Skills 2		X		
Skills 3			X	
Skills 4		X		X
Skills 5				X
Skills 6				X

II. Program Goals, Learning Objectives and Measurable Learning Outcomes

1. Program Goal: *Provides students the opportunity and the guidance to learn the fundamental principles and technology needed to be successful in the chemical sciences.*

a. **Learning Objective**: Upon completion of the program students will possess a working knowledge of major principles in the chemical sciences.

- **Measurable Learning Outcome**: In class quizzes and exams are used to measure the mastery of concepts and principles taught in lecture and lab.
- **Measurable Learning Outcome**: take-home exams and projects will test a students' mastery of information and will demonstrate if a student can build upon acquired knowledge independently.

b. **Learning Objective**: Students will be able to utilize a variety of chemistry equipment and technology used in the chemical sciences.

- **Measurable Learning Outcome**: Students learn how to use technology (equipment and software) needed in the chemical sciences. To assess if the use of the equipment has been mastered students are asked to hand in post-lab questions and lab reports that are dependent on their understanding of the technology.
- **Measurable Learning Outcome**: These technologies are also continually used throughout the semester with the expectation the student can use the equipment independently.

2. **Program Goal**: *Challenges students to think critically, reason wisely, and quantitatively in evaluating data and to apply that skill to issues arising in the world around them, including ethical conflicts surrounding particular scientific theories, technologies, or applications.*

a. **Learning Objective**: Students will be able to think critically, quantitatively, and reason wisely about data collected in lab and problem sets worked through for class.

- **Measurable Learning Outcome**: Students participate in inquiry-based lab activities and independent projects. Lab write-ups from these activities are used to monitor whether students can efficiently analyze the data collected in lab.
- **Measurable Learning Outcome**: Problem sets and case studies are used in classes to measure how well students can apply their reasoning and critical thinking skills outside of lab.

b. **Learning Objective**: Students will apply critical thinking and reasoning skills to current issues arising in the world around them, including ethical conflicts surrounding particular scientific theories, technologies, or applications.

- **Measurable Learning Outcome**: Case studies and paper discussions are used to bring relevant real world topics into the classroom. This outcome is usually assessed through the completion of reflection pieces, question sets or discussion sessions.

3. **Program Goal**: *Train students to communicate scientific work in a clear, coherent manner in both written and oral form.*

a. **Learning Objective**: Students are able to *write* about scientific work in a clear, coherent manner.

- **Measurable Learning Outcome**: Lab reports are used to assess whether a student can write and describe their own scientific work obtained from experiments conducted in the lab.
- **Measurable Learning Outcome**: Students are also asked to summarize the work carried out in a specific field of chemistry by other scientists. These involve students writing review articles and literature reviews.

b. **Learning Objective**: Students are able to *speak* about scientific work clearly and coherently.

- **Measurable Learning Outcome**: Students present their results or research to their peers. This requires them to not only think critically about their data but also figure out a way to efficiently convey their results.
- **Measurable Learning Outcome**: Throughout a variety of Chemistry courses (Inorganic, Instrumental, Bioinorganic, Biochemistry and Biochemical Pathways) students are also asked to read, digest and present work from the primary literature.
- **Measurable Learning Outcome**: In addition to formal class presentation students are encouraged to talk about chemistry in a more informal setting (such as small group or class discussions). This is measured using group assignments and projects.

4. **Program Goal**: *Engages students in practicing the process of science – planning, executing, evaluating, collaborating and communicating. It also involves helping students understand the importance of diversity in the practice of science through collaborative learning where different perspectives are valued and evaluated.*

a. **Learning Objective**: Students are effective in practicing the process of science – planning, executing, and evaluating.

- **Measurable Learning Outcome**: In many chemistry lab courses students are required to keep a lab notebook. This exercise requires students to come up with a purpose of the experiment, draw out the protocol, collect data, analyze results and draw conclusions.
- **Measurable Learning Outcome**: Once skills have been mastered students are asked to carry out independent or research projects. Success of these projects requires them to not only know the material but also stay organized independent of the instructor. Successfully completing an independent project involves independently designing the experiment, setting up and running the experiment, followed by writing up the results or presenting findings to the class.

b. **Learning Objective**: Students will appreciate the importance of *diversity* in the practice of science through collaborative learning where different perspectives are valued and evaluated.

- **Measurable Learning Outcome**: Students work in groups, allowing them to appreciate the different perspectives needed to complete scientific problem set or laboratory exercises.
- **Measurable Learning Outcome**: Students are asked to provide constructive peer evaluation on class presentations and papers.

III. Utilizing Assessment Data

Student work will be collected throughout the academic year by the faculty member teaching the courses. Each faculty member will evaluate if the students learned what was expected, based on each assignment. Percentages of how well the student answered/ completed the activity will be calculated, and students will be considered proficient if 70% or more of the students demonstrated a passing grade on the assessed activity. Throughout the year the chemistry faculty will assess the progress in each of their classes and make adjustments to meet the learning needs of the students.

IV. Specific Course Objectives, Correlation to Program Goals and Objectives, and Specific Measurable Learning Outcomes

Chris Bailey was on sabbatical during the Spring semester so, most of the outcomes analyzed this year in the attached assessment report were from courses taught by Lindsay Burwell (Organic Chemistry, Biochemistry and Biochemical Pathways). This was her first year teaching these courses and therefore, assessment for these courses needed to be updated. General Chemistry, Chemical Analysis, Instrumental Analysis, and Inorganic Chemistry were the focus of the assessment report submitted by Chris Bailey last year. One goal for the 2016-2017 school year is to analyze more outcomes for the other Chemistry courses. All examples below can be found in the faculty's files.

CHEM 107L -General Chemistry

1. Think about/understand nature at the atomic and molecular level. (**learning goals- 1,3,4**)
   See, for example, answer key to Exam #1 (28 September, 2006), questions 3 & 6
   See, for example, answer key to Final Exam (December 11, 2006), questions 3, 4 &7
2. Understand and use the mathematics of chemistry. (**learning goals- 1,3,4**)
   See, for example, answer key to Exam #1 (28 September, 2006), questions 1, 2, 4 & 5
   See, for example, answer key to Final Exam (December 11, 2006), questions 1, 5 & 6
3. Understand the role of energy (heat and electromagnetic radiation) in determining the properties of atoms and molecules. (**learning goals- 1,3,4**)
   See, for example, answer key to Final Exam (December 11, 2006), questions 1, 2 &7
4. Effectively perform laboratory experiments and then clearly communicate the goals and results of these experiments to an outside audience. (**learning goals- 1,2,3,4**)
   See, for example, "Writing for General Chemistry Laboratories"; handout shows what is expected of students.
   See, for example, "Slake, Smelt & Slake, Ltd."; example of letter from client, plus lab instructions

See, for example, "GenChemCo Industries" letters; first letter shows a well written student letter with my comments; second letter is example of a less well written student letter (no comments are given on this one as this letter is used during peer editing exercise)

CHEM 108L - Chemical Analysis

1. Continue to work on the goals from Chem107L (**learning goals- 1,2,3,4**)
2. Understand the dynamic and predictive properties of chemistry. (**learning goals- 1,3,4**)
   See, for example, Chem108L Exam #1 (8 March 2007), questions 1, 2, 3, 4 & 5

CHEM213L and CHEM214L Organic Chemistry I+II.

Examples Highlighted in yellow were analyzed in the attached assessment report.

1. Understand the underlying principles of Organic Chemistry by learning structures of organic compounds and understanding how a molecule's structure contributes to its reactivity. (**learning goals- 1, 2**)
   – see for example, Post-lab questions Sn1 Reaction kinetics activity
2. Understand the concepts of acid/ base and nucleophile/ electrophile chemistry to draw basic mechanisms and predict products of reactions. (**learning goals- 1, 2**)
   – see for example, 2016 Organic Chemistry II Exam III predict the product and draw mechanism question 1 (Friedel-Crafts reaction)
3. Master lab techniques needed to isolate, purify, identify and quantify organic compounds. (**learning goals- 1, 2, 4**)
   – see for example, Marvin Sketch Activity
4. Practice a variety of professional skills: keeping a lab notebook, effectively communicating findings in a formal lab report, and using online sources to support your work. (**learning goals- 3, 4**)
   – see for example, 2015-2016 Organic Chemistry Lab notebook
   – see for example, 2016 Organic Chemistry I Isolation of beta-carotene lab report and rubric
5. Be able to design, set up, and carry out an independent group experiments and clearly communicate the results to their peers. (**learning goals- 2, 4**)
   – see for example, 2016 Organic Chemistry II independent project lab report and presentation

CHEM323L Biochemistry and CHEM 326 Biochemical Pathways

1. Understand how proteins, carbohydrates and lipids are organized and function in a living system. (**learning goal- 1, 2**)
   – see for example, 2016 Biochemical Pathways Exam I Short answer questions 1+2
2. Understand how biochemical pathways work and are regulated. (**learning goals- 1, 2**)
   – see for example, 2015 Biochemistry Midterm Question 6
3. Utilize a variety of biochemical techniques and analyze biochemical laboratory results. (**learning goals- 1, 2, 4**)
   – see for example, 2015 Biochemistry Lab 2- titration of amino acid post-lab questions
4. Analyze primary literature and present your findings in a review article and class presentation. (**learning goals- 1, 2, 4**)
   – see for example, 2016 Biochemical Pathways mini-review article and presentation.
5. Practice a variety of professional skills: keeping a lab notebook, collaborating with peers, writing a formal lab report, and delivering a public presentation based on experimental results. (**learning goals- 3, 4**)
   – see for example, 2015 Biochemistry Independent Enzyme Kinetic Lab Report, Presentation, and Rubric