



2014-2015 CSCI EETF Assessment Year End Report, June, 2015

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[NOTE: Items A, B, C, and D are identical to your Page 2 on your Annual Report for CAPR. Please simply cut and paste from there. Item E is unique to the CSCI EETF.]

A. Program Student Learning Outcomes

Students graduating with a Biochemistry B.A./B.S. from Cal State East Bay will

1. demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry.
2. work effectively and safely in a laboratory environment to perform experimental procedures and operate modern chemical/biochemical instruments.
3. use quantitative reasoning to analyze chemical problems and evaluate chemical data.
4. write and speak clearly on chemical or biochemical issues.
5. work collaboratively in teams to solve chemical problems.

B. Program Student Learning Outcome(s) Assessed

2. Work effectively and safely in a laboratory environment to perform experimental procedures and operate modern chemical/biochemical instruments

C. Summary of Assessment Process

As stated in our five-year assessment plan, in 2014-2015 we specifically concentrated on Program Learning Outcome #2 which concerns assessing laboratory performance. In addition we continued to assess program content through Program Learning Outcome #1 (Demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, and biochemistry).

The laboratory assessment was conducted through capstone laboratory exercises and the ability to critically analyze experimental results in CHEM 3303 and CHEM 4430. The assessment for content was focused on specific course learning outcomes in the areas of organic (CHEM 3301-02-03), physical (CHEM 3511-12-13), inorganic (CHEM 4161 and 4162), and biochemistry (CHEM 4411-12) through the use of standardized national exams and embedded exam questions.

D. Summary of Assessment Results

CHEM 4430 General Biochemistry Laboratory

Students who successfully complete this course should:

- 1) know buffer theory and how to prepare a laboratory buffer.
- 2) know how to perform protein and enzyme activity assays and how to calculate results from laboratory-derived data.
- 3) know how to calculate data commonly found in Protein Purification Tables and how to interpret this information.
- 4) know how to perform enzyme kinetic data analysis and how to present this data in graphical format.
- 5) know theory and practical details of chromatographic procedures --including gel filtration chromatography, ion-exchange chromatography, and high performance liquid chromatography (HPLC).
- 6) know the theory and practical details of electrophoresis of proteins and DNA.
- 7) know how to develop a well-written laboratory notebook.

Fall 2014 BS Biochemistry Majors: 12 students

Goal	Assessment tool	Number of correct answers*	Percentage
1	Q7	9	75%
1	Q8	9	75%
2	Analysis in lab notebook	12	100%
3	Q9	10	83%
3	Analysis in lab notebook	10	83%
4	Analysis in lab notebook and report	10	83%
4	Q10	4	33%
5	Q11	8	66%
5	Q12	12	100%
6	Q14	11	92%
6	Q15	5	42%
6	Gel photograph	10	83%
7	Final lab notebook score	12	100%

*Partial credit was applied to exam questions and lab notebook grading. If 75% off all possible

points were earned, the answer was counted as correct.

Winter 2015 BS Biochemistry Majors: 12 students

Goal	Assessment tool	Number of correct answers*	Percentage
1	Q7	4	44%
1	Q8	6	67%
2	Q10	4	44%
3	Q9	4	44%
4	Analysis in lab notebook and report	5	56%
4	MC 5-10	2	22%
5	Q11	2	22%
5	Q12	8	89%
6	Q14	4	44%
6	Q15	2	22%
6	Gel photograph	9	100%
7	Final lab notebook score	8	89%

*Partial credit was applied to exam questions and lab notebook grading. If 75% off all possible points were earned, the answer was counted as correct.

CHEM 3303 Organic Chemistry

Students who successfully complete the year-long series of organic chemistry should:

1. be able to predict bonding, nomenclature, chemical properties and some physical properties of organic compounds if the molecular structure is known.
2. be able to identify common organic functional groups and show a knowledge of the chemistry and reactivity of each functional group.
3. be able to use the results of the common spectroscopic methods (NMR, IR, UV and mass spectroscopy) to determine the structures of simple organic compounds.
4. know and understand the common reaction mechanisms of organic reactions, and be able to indicate the mechanism and type of intermediate involved in the reactions.
5. be able to safely carry out standard laboratory techniques for the purification of organic compounds, including distillation, recrystallization, column chromatography, thin layer chromatography, and extraction.
6. be able to measure the infrared spectrum of an unknown solid or liquid and be able to identify the functional groups present.
7. be able to carry out standard functional group transformations of organic compounds, and

isolate and characterize the resulting products.

The outcomes criteria for objectives 1-4 are based on the average percentile obtained on the American Chemical Society standardized Organic Chemistry exam. The exam is given as the final exam in CHEM 3303. The outcomes criteria for objectives 5-7 are based on a capstone assignment for CHEM 3303 laboratories. Students will identify two unknown organic compounds, one solid and one liquid. This will require purification by distillation, the knowledge of chemical reactivities and classification tests, the ability to obtain spectroscopic data, especially FT-IR, and the ability to interpret the results. The synthesis of derivatives of each unknown is required, requiring a chemical transformation and purification and characterization of the product.

American Chemical Society Standardized Organic Chemistry Exam Spring 2015 Data

	Average Percentile	# of students above 40 percentile	% of students above 40 percentile	# of students above 70 percentile	% of students above 70 percentile
Chemistry and Biochemistry Majors (28)	34	10	29%	4	12%
All Students in Class (112)	26	25	22%	10	9%

American Chemical Society Standardized Organic Chemistry Exam Spring 2015 Analysis

The ACS standardized exam test student learning outcomes 1-4 for the year-long Organic Chemistry series and allows us to compare our students' performance to students nationwide who have completed a year-long undergraduate series of courses in organic chemistry. Our goal is for our students to be at or above the 40th percentile in the nation. In 2015, 10/28 of our Chemistry and Biochemistry accomplished this goal. 4/28 of our majors were at or above the 70th percentile which we consider outstanding. Analysis of the most frequently missed questions by our chemistry and biochemistry students determined that the most problematic areas were in recognizing intermediates of reactions and putting together multi-step reaction sequences. The instructors of the course will keep this in mind during the next year and give more emphasis to the theory and application of these areas.

Unknown Lab Assessment Spring 2015 Data

Correct identification of two unknown compounds during the Organic Chemistry Capstone

Experience for 2015 is shown in the following table:

	# of students	Both correct	At least one correct	None correct	% Both correct	% One or more correct
Chemistry and Biochemistry Majors	28	16	27	1	57 %	96 %
All Students in Class	114	66	103	11	58 %	90 %

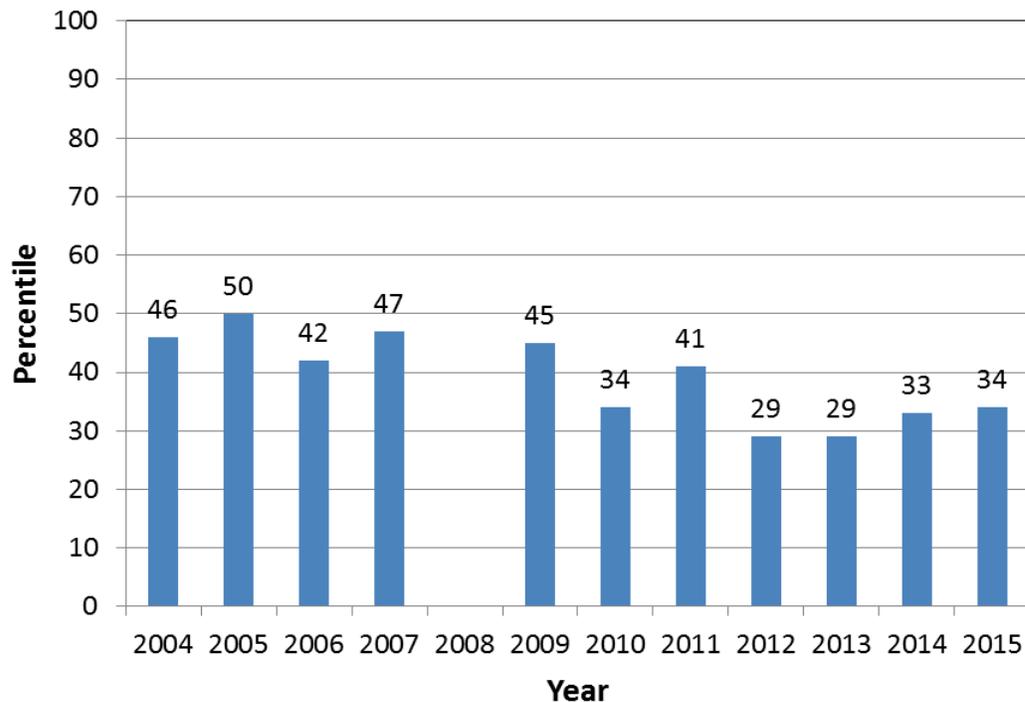
Unknown Lab Assessment Spring 2015 Analysis

Of all students completing the lab, 90 % identified at least one of the two unknowns and 58 % identified both. Of the 28 chemistry and biochemistry majors who finished the lab, 96 % identified at least one of the two unknowns and 57 % identified both. In order to accomplish the identification of their unknowns, students must use the knowledge they gained in the theory and practice of organic chemistry during the year-long Organic Chemistry series. They must first come up with a plan for identification and then look up the experimental procedures to carry it out. At each stage they need to critically analyze their results and make decisions for the next experiments based on those results. At defined stages in the process students meet privately with the lab instructor to orally defend their process and conclusions, at which point they also get feedback from the instructor. At the end of the experiment students write a lab report which includes a substantial analysis of the data they collected to explain how their results support their conclusions. Having 96 % of the chemistry and biochemistry majors able to satisfactorily complete the process and identify at least one of their unknowns leads us to believe that student learning objectives in the Organic Chemistry lab are being met.

Comparison to Previous Years

In an on-going effort to improve our students' success in meeting the student learning outcomes, we compare the results of this year's assessment data with previous years. As shown in the following graph and table, the results of this year's lecture assessment is an improvement over the most recent years, although not the best that we have achieved. The results of this year's laboratory assessment are better in all measures than the average of the last 11 years.

Results of Capstone Organic Lecture Assessment during 2004 – 2015 for Chemistry and Biochemistry Majors



Results of Capstone Organic Laboratory Assignment during 2004 – 2015 for Chemistry and Biochemistry Majors

Year	# of Chem/Biochem Majors	# with both correct	% Both Correct	# with at least one correct	% At least one correct
Sp 2004	18	13	72	17	94
Sp 2005	22	9	41	22	100
Sp 2006	22	18	82	22	100
Sp 2007	12	5	42	10	83
Sp 2008	10	7	70	9	90
Sp 2009	17	10	74	14	95
Sp 2010	25	12	48	21	84
Sp 2011	26	15	58	23	88
Sp 2012	25	13	52	21	84
Sp 2013	32	21	66	29	91
Sp 2014	24	11	46	22	93
Sp 2015	28	16	57	27	96

CHEM 4411, 4412, 4413 General Biochemistry

Students who successfully complete this course should:

- 1) understand buffer theory and the preparation of laboratory buffers.
- 2) know the structures and properties of the twenty amino acids.
- 3) know the unique properties and chemistry of the peptide bond.
- 4) recognize the common structural motifs found in proteins - including the alpha-helix, the beta-sheet, and other structural features.
- 5) know the properties of enzymes and the basics of enzyme kinetics-- including the Michaelis-Menten equation, Lineweaver-Burke equation and graphs, and the basics of enzyme inhibition. understand the basic principles of bioenergetics - including standard and actual free energy changes and the calculation of these energy changes in biochemical reactions.
- 6) understand the unique chemistry of Adenosine Triphosphate (ATP) - including standard and actual free energy change values for ATP hydrolysis.
- 7) know the structure and properties of biologically-important carbohydrates.
- 8) understand the basic details of the major metabolic pathways found in the cell --including glycolysis, gluconeogenesis, glycogen metabolism, the citric acid cycle, electron transport system, oxidative phosphorylation, and fatty acid oxidation.
- 9) know the basics of protein and amino acid metabolism - including amino acid catabolism and anabolism and the urea cycle.
- 10) know the structure and properties of the purine and pyrimidine nucleotides.
- 11) know the structural details of the DNA molecule and how it is able to replicate.
- 12) know the structural details of the RNA molecule and how RNA synthesis and processing occurs in the cell.
- 13) know how proteins are synthesized in the cell using ribosomes, tRNA, and mRNA.

CHEM 4411 - General Biochemistry I (Lecture course) Comparison of student performance in 2013 and 2014

Undergraduate Program SLO-1: Demonstrate knowledge in the various areas of chemistry, including inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry and biochemistry.

Assessment Tool: Embedded exam questions

Selected Specific Biochemistry I Learning Goals:

- 2) Know the structures and properties of the twenty amino acids found in proteins.
- 4) Recognize the common structural motifs found in proteins, e.g. alpha helix, beta-sheet,

supersecondary structures.

5) Know the properties of enzymes, including regulatory mechanisms, and the basics of enzyme kinetics (e.g. Michaelis-Menton equation, Lineweaver-Burk analysis, types of enzyme inhibition).

Results:

Assessment of SLO 1 for this course was conducted using either 19 (2013) or 21 (2014) embedded exam questions covering three biochemistry-specific learning outcomes. Where partial credit was given for an embedded question the answer was scored as correct if 70 % of the possible points were earned. Performance of 21 Biochemistry and 13 Chemistry majors was assessed in 2013 and the results tabulated separately. In 2014 performance of 2 Chemistry majors and 15 Biochemistry majors was assessed. Because the number of Chemistry majors was small in 2014, the performances for both majors were tabulated together. Since assessment had been done separately for the two types of majors in 2013, the separate values obtained for the Chemistry and Biochemistry majors were re-worked and normalized for a mixture of the Chemistry and Biochemistry majors. This allowed a more reasonable comparison of the performances for 2013 and 2014. The data presented below represent averages obtained for three or four embedded questions for each biochemistry-specific learning outcome. The same or very similar questions were used in 2013 and 2014. As a general goal we are aiming for percentages above 75% for each of the biochemistry learning outcomes.

Assessment Data for Chemistry and Biochemistry Majors: Fall 2013 and Fall 2104

Biochemistry Learning Outcome	% Students with Correct Answer - Fall 2013	% Students with Correct Answer - Fall 2104
2 - Amino Acid Structure	59	75
4 - Protein Structural Motifs	67	56
4 - Protein Regulatory Mechanisms	72	75
5 - Properties Enzymes	51	65
5 - Enzyme Kinetics	58	55

Analysis:

Performance improvement is noted for 2014 over 2013 for three of the five specific areas assessed and the 2014 value for a fourth area (enzyme kinetics) shows only a slight decrease from 2013, probably not very significant. These are encouraging results. Over the past year we placed special emphasis on Outcome 5 where student achievement was lowest in Fall 2013. From the table it can be seen that the performance for "properties of enzymes" improved in 2014

but "enzyme kinetics" remained weak. The latter is a difficult topic. Whereas the decrease in performance for 2014 is probably not significant, still 55% for "enzyme kinetics" is way below our goal of 75%. To approach this weakness we will assign some special exercises on enzyme kinetics in the upcoming year and again make a special effort to spend extra time on this topic. Attention will also be given to protein motifs, where a dip in performance can be noted in the table.

CHEM 4412 - General Biochemistry II (Lecture course)

Student learning outcomes specifically assessed were #6, 7, and 8 based on embedded questions in the final exam in CHEM 4412.

Exam Question	Learning Outcome	No. of Students	No. with correct answer	% with correct answer*
1	8	14	7	50
2	7	14	9	64
3	6	14	5	36
4	8	14	8	57
7	8	14	4	29
MC10	6	14	10	71
MC14	6	14	11	79

*Where partial credit was given the answer was counted as correct if at least 75% of the total possible points were awarded.

In this quarter, a significant portion of Biochemistry majors were unable to answer key questions associated with the learning goals of the course. Notably, two out of the 14 assessed students failed the course with the letter grade F and are currently repeating the course in the spring quarter 2015.

CHEM 3511, 3512, 3513 Physical Chemistry

Students who successfully complete this series of courses should:

- 1) understand the properties of the gas phase and the relationship to energy.
- 2) be able to correlate bond energies with macroscopic energy determinations.
- 3) recognize the driving force for chemical reactions.
- 4) understand the concept of equilibrium as it is applied to various reactions.
- 5) be able to explain the origin of quantum theory.
- 6) be able to describe the nature of the electron in the hydrogen atom.
- 7) be able to describe the building up of the periodic table by electron configuration.

- 8) be able to correlate the changes observed in spectroscopic methods in terms of quantum theory.
- 9) understand the importance of rates of chemical reactions in the overall scheme of chemistry.
- 10) be able to calculate reaction order from the time dependence on concentration.
- 11) be able to understand and describe transition state theory.
- 12) understand the nature of solids in terms of their nature, bonding, and properties.
- 13) understand how statistics and probability can be used to develop thermodynamic concepts.

For CHEM 3511, Student Learning Outcomes 1, 3, and 4 were assessed through the use of eight embedded questions in the final exam, three free response, two multiple choice, and three true-false type questions. The results were sorted by major.

BS Chemistry (16 students)

Question	Number (Percent) of students receiving at least			
	25%	50%	75%	100%
Q1	14 (87.5%)	11 (68.8%)	2 (12.5%)	2 (12.5%)
Q2	16 (100%)	15 (93.8%)	3 (18.8%)	3 (18.8%)
Q3	13 (81.3%)	10 (62.5%)	6 (37.5%)	1 (6.3%)
MC13				12 (75.0%)
MC15				4 (25.0%)
TF8				9 (56.3%)
TF9				9 (56.3%)
TF10				9 (56.3%)

BS Biochemistry (14 students)

Question	Number (Percent) of students receiving at least			
	25%	50%	75%	100%
Q1	10 (71.4%)	8 (57.1%)	3 (21.4%)	2 (14.3%)
Q2	14 (100%)	13 (92.9%)	6 (42.9%)	4 (28.6%)
Q3	8 (57.1%)	6 (42.9%)	2 (14.3%)	0 (0%)
MC13				11 (78.6%)
MC15				3 (21.4%)
TF8				5 (35.7%)
TF9				10 (71.4%)
TF10				11 (78.6%)

The fraction of students receiving at least 75% of the points on questions 1-3 is disappointing. Question 3 was particularly challenging to the class. This will be addressed in future sections by

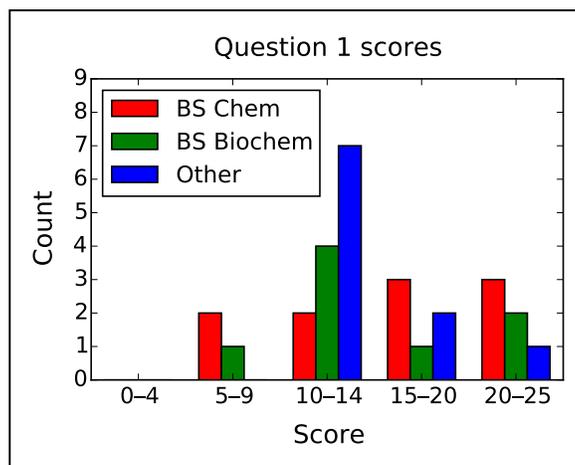
providing more examples of gas-phase equilibrium problems in lecture. Additionally, the results for question 15 indicate that students struggled with the concept partial pressures in gas-phase equilibrium problems.

CHEM 3512 provides an introduction to molecular quantum mechanics and takes place in the second quarter of a three-quarter sequence in Physical Chemistry. The course begins with the fundamental principles of quantum mechanics followed by examples involving simple model potentials. These basic concepts are applied to develop the electronic structure theory of atoms and chemical bonding theory for molecules.

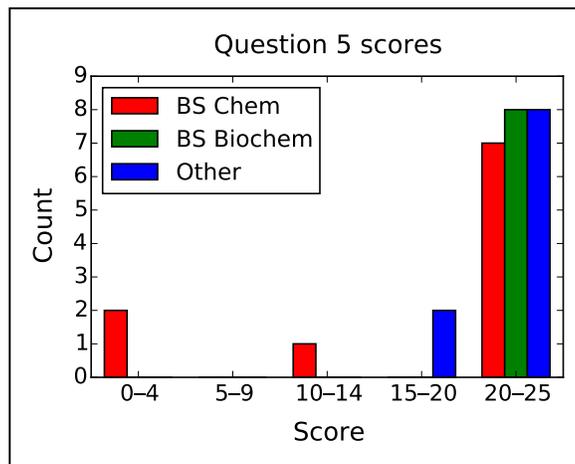
The total course enrollment is 36; however, 8 of these did not begin the course with the required prerequisites (1 year of calculus and 1 year of physics with a C- grade or higher). Therefore, only the 28 students with the necessary preparation are considered here. The breakdown of these 28 students by degree program is: 10 B.S. Chemistry, 8 B.S. Biochemistry, 6 M.S. Chemistry, 3 B.S. Biology, and 1 cross-enrollment (from Mills College).

Several specific learning outcomes are assessed using embedded questions in the final exam. The learning outcomes and the corresponding distribution of scores are shown below, broken down by degree program (red is B.S. Chemistry, green is B.S. Biochemistry, blue is other).

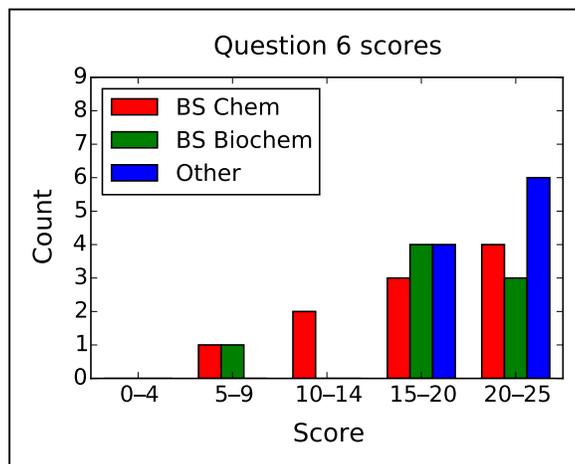
Learning outcome: *Formulate the mathematical description for the quantum mechanical motion of a particle: translations, vibrations, and rotations.*



Learning outcome: Depict orbital angular and radial distribution functions.



Learning outcome: Classify molecular orbitals by their nodal structure, shape, and symmetry; quantify bonding in terms of the bond order.



E. Suggestions and Recommendations for the CSCI EETF in the Future

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