This assessment review, which began last fall, is to examine whether the current First Level Exam design accurately allows for evaluation of how well students meet the course learning goals. Learning goals 1-3 below were defined in February, 2011 and have been expanded upon in detail below.

**Goal 1.** Knowledge, comprehension, and application of information in core areas of biochemistry.

**Goal 2.** Analysis and synthesis of information in core areas of biochemistry, using oral and written communication.

**Goal 3.** Analysis, synthesis, and evaluation in a specific area of original biochemical research that is substantial.

**The learning goals that are assessed in the First Level Exam Parts I and II include the following subject matter.**

Students are expected to learn:

1. Basic facts about the structure and functions of biological macromolecules: nucleic acids, peptides and proteins including structural and binding proteins, and enzymes; enzyme kinetics theory and measurements
2. Structures and properties of organic molecules involved in metabolic pathways and the names and functions of the enzymes in the pathways (in item 3).
3. Design of key metabolic pathways including glycolysis, the TCA cycle, fatty acid/lipid biosynthesis and breakdown, pentose phosphate pathway, cholesterol biosynthesis and metabolism, nucleic acid subunit biosynthesis; glycogen metabolism; hormone action; regulation of metabolic pathways.
4. Molecular biology topics including mechanisms of DNA replication, modification; RNA (all types) structure and function; ribozyme structure and function; polymerases, nucleasea, gyrases; comparison of eukaryotic and prokaryotic systems throughout.
5. Mechanism of protein biosynthesis: transcription and translation; ribosome structure and function; the genetic code.
6. Membrane structure; receptor function; membrane proteins, transporters, ion channels.
7. Cell signaling; protein trafficking
8. Bioorganic chemistry: the chemical properties of organic molecules relevant to biological systems; mechanisms of chemical reactions in which these molecules participate; corollaries with enzyme mechanisms.
9. Physical biochemistry: chemical thermodynamics; chemical equilibrium and reaction free energy; application of modern techniques for the analysis of macromolecular structure and function including spectroscopic methods, separation methods, measurement of physical properties of macromolecules.

The First Level exam has two components, one given at the end of the fall semester and the second at the end of the spring semester. Students must pass all components to remain in good standing and move to Level II with 30 credits completed. The fall exam has three sub-sections: protein structure and function, metabolism and bioorganic chemistry (the last only since 2013).
Most of the factual subject matter for the fall exam is readily tested with standard exam questions designed as explain and/or define questions, graphical analyses, and requiring quantitative analysis of real or hypothetical experimental data. The assessment of student performance in the first (fall) component involves mostly “remembering” and “understanding” skills with some “applying” and “analyzing” skills (according to Bloom’s taxonomy*).

Assessment of whether students are meeting learning goals is straightforward in that exams are based on course material and questions are designed to test their knowledge, comprehension and interpretation (Goal 1) of core biochemistry facts and concepts given in items 1-9 above. Grading is done by the instructors teaching the course and final decisions about Pass/Fail grades are made at a meeting of the program’s Curriculum and Examination Committee consisting of four doctoral faculty members and three senior students. Decisions are also made about requiring students who failed any component to be re-tested on that material, or requiring them to repeat the course and re-take the exam after that. Re-examination usually occurs in August and the same design and assessment criteria apply to that exam as for the earlier one.

The spring exam (First Level Part II) for the past several years was designed to have two components; one was a traditional exam designed to assess students’ ability to analyze course material in Bioenergetics/Lipids/Membrane subjects. The second component was a grant-writing exercise based on a hypothesis/biochemical problem in Molecular Biology provided by the instructor on the day of the exam, derived from material covered in the Advanced Biochemistry II course and original publications from current scientific literature. Students were required in a single extended exam session to produce a complete grant proposal document in the style of NIH grants. This second component assessed student performance in higher order “analysis”, “evaluation” and “creativity”* skills but was quite difficult to grade objectively and no grading rubric existed. The hypothesis presented was usually narrowly focused on a specific cellular process or function but had to be addressed broadly enough such that students demonstrated their understanding of molecular biology, some protein biochemistry, and control/regulation of cellular functions. Also incorporated into the written exam was a requirement to include the design of experiments utilizing methods such as mass spectrometry, these methods having been taught in the Physical Biochemistry course taken in spring. The design of part II of the First Level exam allowed assessment of Goals 2 and 3 (from 2011).

Failure rates on the First Level Exam Parts I and II ranged from a high of 67% in one component (fall 2011) to 0% over the past four years. Over the four year period, a greater passing rate in the Metabolism component of Part I was accomplished by narrowing the scope of some of the lecture material rather than eliminating topics or relaxing examination standards. Part of the variability reflects the varied past experiences and training of students entering the program.

During the fall semester 2014, the Curriculum and Examination Committee deliberated about the structure of the Molecular Biology component of the First Level Exam Part II and decided that it should be redesigned to allow for better assessment of student learning. The decision was made to eliminate the extended grant writing exercise, which for many students required more than 10 hours to complete, was difficult to grade and was an exercise that provided some new learning or skills not necessarily closely aligned with learning goals. An exam with guided writing exercises was considered to be a more valuable design, as assessment could be better based on students’ demonstration of factual knowledge and higher order synthesis and evaluation skills. This new design (to be administered in a 6 hour exam in two sessions) will be implemented at the end of spring semester 2015. A grading rubric will be produced by the instructors and for future reference.

It should be noted here that grant writing skill is considered to be very valuable for Biochemistry doctoral students and such an exercise is still required in a Seminar course (Seminar in Biochemistry BICM81000) taken in the spring term of the first year.

**Second Level Exam**
The learning goals for the Second Level exam are not specifically defined as each one is individualized according to student’s thesis research projects. The goals are centered on developing skills in analysis, evaluation and synthesis of knowledge as it currently exists in some area of biochemical science and the design of new approaches to advance knowledge in that area. The exam consists of a written proposal outlining a research project, followed by an oral defense of this proposal. It is developed in close cooperation with the research mentor and is defended before the thesis committee. The committee’s evaluation is based upon an assessment of the written and oral exam components which are expected to reveal the student’s ability to clearly present the state of knowledge in their field, their identification/analysis of where advancements are needed, and the design and potential interpretation of experiments to produce that knowledge. The doctoral program relies upon the judgment of the thesis committee for evaluation. A rudimentary grading rubric has been designed and will be used in the future to aid committee members in assessment of student performance. This rubric/form will serve as a record for the program and the student as to whether the written proposal and the oral defense are satisfactory or not, and which components must be improved and repeated. It was decided by the Curriculum and Examination Committee last fall that the general design continues to be optimal for assessment of students’ skills in higher order learning and skills aligned with learning goals, and does not need to be modified.

<table>
<thead>
<tr>
<th>Year</th>
<th>Proteins</th>
<th>Metab</th>
<th>BioOrg</th>
<th>MolecBio</th>
<th>BioEnergs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>12</td>
<td>67</td>
<td>25</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>33</td>
<td>50</td>
<td>33</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>12</td>
<td>41</td>
<td>21</td>
<td>25</td>
<td>17</td>
</tr>
<tr>
<td>2014</td>
<td>0</td>
<td>23</td>
<td>36</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>2015</td>
<td>15</td>
<td>15</td>
<td>17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
February 26, 2015

Dear Rick,

I am writing to welcome the new track in Molecular Biophysics that you are proposing for the Ph.D. Program in Biochemistry. Given the interdisciplinary nature of cutting-edge scientific research, there is a pressing need for cross-disciplinary training of our doctoral students. As you are aware, the Chemistry Ph.D. Program has a Molecular Biophysics Subdiscipline that trains students with traditional chemical backgrounds in the fields of biochemistry and biophysics. The Chemistry Program is fully supportive of the Biochemistry Program's efforts to train students with traditional biochemistry backgrounds in this area as we envision it as an excellent synergy between our two programs.

According to your design, the Molecular Biophysics track requires two course offerings from the Chemistry Program which were previously electives, namely Chem 87901 (Molecular Biophysics, 3 credits) and Chem 80541 (Advanced Seminar in Molecular Biophysics, 1 credit). Both of these courses are offered with sufficient frequency so as to include students from the Biochemistry Program without issue. The Chemistry Program views this service to the Biochemistry Program as reciprocation for our requirement that Molecular Biophysics students in the Chemistry Program take the Biochemistry Program course BICM 77000 (Physical Biochemistry, 3 credits).

Sincerely,

Brian R. Gibney
Executive Officer
Ph.D. Program in Chemistry