South Dakota Board of Regents

New Graduate Degree Program

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| **University:** | **South Dakota State University** |
| **Proposed Graduate Program:** | **Ph.D. in Biochemistry** |
| **Degree:** | **Ph.D.** |
|  **Existing or New Degree(s):** | **New Degree** |
| **Intended Date of Implementation (term):** | **Summer 2013** |
| **Proposed CIP code:** | **26.0202**  |
| **University Department**  | **Chemistry & Biochemistry** |
| **University Division** | **Arts and Sciences** |

#### **University Approval**

To the Board and the Executive Director: I certify that I have read this proposal, that I believe it to be accurate, and that it has been evaluated and approved as provided by university policy.

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| President of the University |  | Date |

After approval by the President, a signed copy of the proposal should be transmitted to the Executive Director. Only after Executive Director review should the proposal be posted on the university web site and the Board staff and the other universities notified of the URL.

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| **1. What are the purposes of the proposed program?** |

*Purpose of the Program*

South Dakota State University (SDSU) proposes the creation of a Ph.D. in Biochemistry within the Department of Chemistry and Biochemistry. Adding a Ph.D. in Biochemistry will strengthen the University’s ability to attract excellent students at both undergraduate and graduate, enhance the quality and scope of teaching and expand the breadth, depth and economic impact of the institution’s research.

The proposed degree will prepare students for careers in research, teaching, and in the South Dakota biosciences industry. The degree will make SDSU more competitive when recruiting faculty and graduate students, and when applying for grants and contracts. The University does not request new State resources. The program would be implemented through redirections of existing resources and with external funds.

SDSU also recognizes that complex problems require innovative and interdisciplinary solutions which will only be realized by innovative and interdisciplinary approaches. Collaboration with the Governor’s Research Center for the Biological Control and Analysis by Applied Photonics (BCAAP), Sanford Research and Avera Research Institute will create novel, intellectually-charged research groups and will prepare students for academic and industrial careers in biochemistry.

*Expected Demand for Graduates*

The South Dakota Governor’s Office of Economic Development has identified the “biosciences” as a targeted sector for economic development.[[1]](#footnote-1) “Bioscience” or “biotechnology” related areas also represent at least three of the five targeted research sectors that are under consideration in the South Dakota State Science and Technology Plan.

The growth of bioscience employers in South Dakota has outpaced the national growth, showing a rate of state growth between 2001 and 2009 of 55% with an employment growth rate during this period reaching 42% and the creation of over 1,000 new jobs.2 There are currently more than 100 organizations and industries engaged in bioscience research in South Dakota.1 By 2018 it is projected that there were will be an ~12% increase in new STEM jobs created in the biosciences industry in South Dakota with 10% requiring a doctoral degree.[[2]](#footnote-2)

The growing bioscience industry in South Dakota provides numerous opportunities for graduates of the program. For example, both Sanford Health and Avera are increasing their research efforts and have demonstrated herein a strong interest in having their research investigators participate. Numerous bioscience companies such as Hematech, Monsanto, Alphagenix, Chronix BioMedical, OmegaQuant, Permara, pharmaCline have established a presence in South Dakota. Providing quality graduates for these programs is critical to the companies’ long-term success in South Dakota. The presence of these companies and strong university research infrastructure will also strengthen the ability of the state to grow this targeted economic development sector.

*“…I believe that the PhD program in Biochemistry will provide excellent classroom and research training....”*

*Dr. David Pearce, Vice President, Sanford Research, Sioux Falls, SD*

*“We believe that the proposed Ph.D. program will serve an emerging need in South Dakota. With the interest in biomedical research, the need for trained scientists will only continue to strengthen. These new opportunities within our service area will help in our recruitment of professionals by providing an employment opportunity for the partners of our staff. This program will certainly contribute to the South Dakota economy by bringing opportunities typically only found in larger metropolitan areas. Such economic vibrancy is certainly beneficial*

*to the population that Avera serves.”*

*Dr. Dave Kapaska, Regional President, Avera McKennan Hospital & University Health Center*

*Expected Student Demand*

Employment of biochemists and biophysicists is projected to increase by 31 percent from 2010 to 2020, much faster than the average for all occupations, as more biochemists and biophysicists will be needed to use the knowledge they have gained from basic research to develop biological products and processes that improve our lives.[[3]](#footnote-3) Recent graduates of SDSU’s biochemistry major have gone on to graduate school at the University of Michigan.

The South Dakota State University Ph.D. in Chemistry has had a biochemistry track since 2005. Graduates have been successful in higher education and in industry. There are 8 Ph.D. students in the track (spring 2013). It has been difficult to recruit students who want a Biochemistry degree to a Chemistry program. The new Ph.D. will make it much easier to recruit students and faculty interested in Biochemistry.

*University Mission*

The statutory mission of South Dakota State University is provided in SDCL 13-58-1:

*Designated as South Dakota’s land-grant university, South Dakota State University, formerly the state college of agriculture and mechanical arts, shall be under the control of the Board of Regents and shall provide undergraduate and graduate programs of instruction in the liberal arts and science and professional education in agriculture, education, engineering, home economics, nursing and pharmacy, and other course or programs as the Board of Regents may determine.*

Board Policy 1:10:2 South Dakota State University Mission Statement provides:

*The legislature established South Dakota State University as the Comprehensive Land Grant University to meet the needs of the State and region by providing undergraduate and graduate programs of instruction in the liberal arts and sciences and professional education in agriculture, education, engineering, human sciences, nursing, pharmacy, and other courses or programs as the Board of Regents may determine (SDCL 13-58-1).*

*The Board implemented SDCL 13-58-1 by authorizing South Dakota State University to serve students and clients through teaching, research, and extension activities. The University’s primary goal is to provide undergraduate and graduate programs at the freshman through the doctoral levels. The university complements this goal by conducting nationally competitive strategic research and scholarly and creative activities. Furthermore, South Dakota State University facilitates the transference of knowledge through the Cooperative Extension Service with a presence in every county and through other entities, especially to serve the citizens of South Dakota.*

*South Dakota State University is unique within the South Dakota System of Higher Education because of its comprehensive land grant mission. The mission is implemented through integrated programs of instruction, the Cooperative Extension Service, the Agricultural Experiment Station, and numerous auxiliary and laboratory services.*

SDSU currently offers 12 Ph.D. programs. SDSU has offered a B.S. in Biochemistry since 2004 and a Biochemistry track within the Ph.D. in Chemistry since 2005.

*University Strategic Plan and Priorities*

The institutional mission states that “*South Dakota State University will create a prosperous future for the people of South Dakota and their communities, and for the region and the nation, through excellence in education, in innovation and new knowledge creation and in putting knowledge to work*.”

The program is specifically aligned with, or highly likely to promote, the following items in SD BOR Policy 1:21:

1. Academic Quality & Performance
* Encourage student engagement in research and service.
* Expand use of technology to enhance learning.
1. Economic Development & Quality of Life
* Promote growth of research initiatives.
* Expand graduate education.
* Contribute to economic development through technology transfer & incubation of new commercial ventures.
* Contribute to workforce development & quality of life by expanding academic programs to meet our future workforce needs, offering off-campus and online programs, and creating corporate training partnerships.
* Encourage entrepreneurship.

The proposed program is also aligned with the following objectives of Goal 2 of the new SDSU Strategic Plan “Impact 2018:

* Provide an expanded venue for frontier research. This proposal builds on prior state investment in the Center for the Biological Control and Analysis by Applied Photonics (BCAAP), a state-funded Governor’s Research Center that has supported infrastructure development in biochemistry within the Department of Chemistry and Biochemistry,
* Develop a Ph.D.-trained workforce to complement the undergraduate-level training already provided by the Department through its Bachelor of Science in Biochemistry and,
* Expand graduate education and connect SDSU to state economic development efforts in the expanding bioscience industry.

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| **2. Rationale** |

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| **A. If a new degree is proposed, what is the rationale?** |

A new degree is not proposed. South Dakota State University offers twelve Ph.D. programs.

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| **B. What is the rationale for the curriculum?** |

A core coursework curriculum (18 credits) will provide disciplinary breadth and a foundation for a student’s plan of study. Elective courses (9 credits) will be chosen by the student, their faculty research advisor and graduate advisory committee to support the interdisciplinary nature of the planned dissertation research project. The elective courses will provide depth in a subspecialty within the field. The remaining credits (63 credits) will be for dissertation research reflecting the knowledge-creation nature of the degree.

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| **C. Demonstrate that the curriculum is consistent with current national standards**. Complete the tables below and explain any unusual aspects of the proposed curriculum. |

There are no national standards for a Biochemistry PhD program. The program curriculum proposed by the Department of Chemistry & Biochemistry aligns well with those of the leading national research institutions (University of California San Francisco (UCSF), University of Minnesota, and University of Wisconsin) offering graduate program in Biochemistry and similarly titled graduate programs. A central objective of the curriculum of these programs is determination of the molecular mechanisms of biological functions through an an integrated, interdisciplinary approach bridging biochemistry, biophysics, molecular biology, cell biology, bioinformatics, and structural biology. For example, the UCSF biochemistry graduate program curriculum (<http://biochemistry.ucsf.edu/programs.html>) includes an array of disciplinary and interdisciplinary content areas including Biochemistry, Molecular Biology, Cell Biology, Developmental Biology, and Biophysics, similar to that being proposed here and substantial original research requirements. Such research-based graduate programs typically involves coursework in the first year followed by candidacy examinations within the first two years to test a student’s preparedness for the graduate education. This is often followed by rotations through research laboratories to learn techniques and investigate possible research topics. During their program of study biochemistry graduate students are involved in journal clubs, seminar presentations, attending local/national/international scientific meetings, career counseling, publishing research findings as well as training in ethical conduct of research. The plan of study proposed by SDSU for this degree contains similar elements.

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| **D. Summary of the Degree** *(modify table as needed)* |

For students entering with a baccalaureate degree, the proposed curriculum will consist of 90 credits total:

* 13 credits of core courses that are listed in Section D. These provide a broad foundation covering basic graduate concepts in biochemistry and research ethics.
* 3 credits of seminar (literature, research progress report and final oral presentation of the dissertation).
* 2 credits of laboratory rotation to provide students with an introduction to a range of laboratory experiences.
* 9 credits of elective coursework. These will provide students with the opportunity for depth in a topical area that will be directly related to their dissertation research topic.
* 63 credits of dissertation credit.

For students entering with a master’s degree, the proposed curriculum will consist of 60 credits total. The student’s graduate advisory committee will assess the academic transcripts and approve a combination of coursework and dissertation credit that ensures that the all degree requirements are met.

The table assumes a student is entering with a baccalaureate degree.

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| Ph.D. in Biochemistry | Credit Hours | Percent |
| Required courses, all students | 18 | 20% |
| Required option or specialization, if any | 0 | 0% |
| Electives | 9 | 10% |
| Dissertation | 63 | 70% |
| Total required for the degree | 90 | 100% |

 Required Courses

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| --- | --- | --- | --- |
| Prefix & Num | Course Title | Credit Hours | New (yes, no) |
| CHEM xxx | Laboratory Rotations | 2 | yes |
| CHEM 705 | Principles of Biochemistry | 3 | no |
| CHEM 767 | Biophysical Chemistry | 3 | no |
| CHEM 790 | Seminar | 3 | no |
| BIOS 662 | Advanced Molecular and Cell Biology | 6 | no |
| GSR 601 | Research Regulations Compliance | 1 | no |
| CHEM 898D | Dissertation | 63 | no |

**Elective Courses in the Program**: **List courses that may be taken as electives in the program. Indicate any new courses to be added specifically for the major.**

Elective courses are chosen by the student, their faculty research advisor and graduate advisory committee to support the interdisciplinary nature of the planned dissertation research project. Nine (9) credits of elective courses are required and may be chosen from STEM disciplines (e.g., BIOL-, BIOS-, CHEM-, MATH-, or STAT- prefixed courses). For that reason the list below is for illustrative purposes and is not intended to restrict the graduate advisory committee’s discretion.

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| --- | --- | --- | --- |
| Prefix & Number | Course Title | Credit Hours | New (yes, no) |
| BIOL 645/645L | Microimaging Techniques | 4-6 | no |
| BIOS 663 | Advanced Concepts in Infectious Disease | 6 | no |
| BIOS 793 | Epigenetics | 2 | no |
| CHEM 703 | Advanced Physical Chemistry | 3 | no |
| CHEM 706 | Advanced Analytical Chemistry | 3 | no |
| CHEM 736 | Chromatography and Separations | 3 | no |
| CHEM 742/742L | Structural Determination of Organic Molecules | 4 | no |
| CHEM 766 | Biochemistry II | 3 | no |
| CHEM 781 | Bioorganic Chemistry | 3 | no |
| CHEM xxx | Principles of Biophysical Microscopy | 3 | no\* |
| CHEM xxx | Macromolecular Structural Determination | 3 | yes |
| CHEM xxx | Systems Biology and Pathway Modeling | 3 | yes |
| CHEM xxx | Biochemical Methods | 1 | yes |
| CHEM 792 | Special Topics | variable | no |
| MICR 539 | Medical/Veterinary Immunology | 3 | no |
| PS 792 | Regulatory RNA | 3 | no |
| STAT 541 | Statistical Methods II | 3 | no |
| STAT 736 | Bioinformatics | 3 | no |

 \* has been offered once as a special topics course

A novel aspect of the electives proposed for this program are a set of highly-focused, one-credit courses that will provide the theory and practice of a research methods needed to undertake the research that we anticipate will be supported by the participating faculty. In the table above, these are identified as “Biochemical Methods” courses. Examples of areas that will be developed as the program matures are: flow cytometry, antibody production, genetics of human disease, molecular basis of pediatric disease, redox biology, neurochemistry, and protein trafficking.

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| **3. Student Outcomes & Demonstration of Individual Achievement** |

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| **A. What specific knowledge and competencies, including technology competencies, will all students demonstrate be able to demonstrate before graduation?** *The knowledge and competencies should be specific to the program and not routinely expected of all university graduates.* **Complete Appendix A – Outcomes using the system form.** *Outcomes discussed below should be the same as those in Appendix A.* |

Appendix A identifies the student outcomes which are intended to ensure that students are adequately prepared to enter employment in industry, government service or continue in an academic career track.

Through seminar, coursework and laboratory experiences graduates are expected to demonstrate the ability to critically evaluate the literature within the discipline (Outcomes 3 & 5). Students will demonstrate the ability to plan and implement an original research project through the successful completion of their dissertation (Outcomes 1 & 2). Through formal coursework and interactions with their graduate mentor and advisory committee graduates will demonstrate an understanding of the requirements of the ethical conduct of research (Outcome 6). The program also identifies strong communications skills as an important student outcome (Outcome 4). These skills will be developed through formal coursework, student seminar presentations within the program and at professional meetings, and the written dissertation.

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| **B. What national instruments (examinations) are available to measure individual student achievement in this field?** |

There are none.

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| **C. How will mastery by individual students be demonstrated? Describe the specific examinations or processes to be used. This is to include external measures. What will be the consequences for students who do not demonstrate mastery?** |

Mastery will be demonstrated by assessing the Outcomes identified in Appendix A and adherence to the existing policies of the SDSU Graduate School’s Doctor of Philosophy Degree Requirements (refer to the 2011-2012 SDSU Graduate Catalog).

Mastery of individual course content will be demonstrated, in part, through traditionally graded courses. Learning must also be demonstrated outside the traditional lecture/laboratory classroom. For example admission into candidacy for the degree will be granted only upon successful completion of a series of cumulative examinations (3 reflective of the core requirements to ensure depth of knowledge and 2 in supporting areas to ensure breadth of knowledge). These examinations are both written and oral ensuring the student has not only mastered the material but can communicate effectively in a variety of formats. To complete the degree, the student must present and defend their research, again, in both written and oral formats. The written and oral candidacy exams and the written and oral final examinations are overseen by the student’s Graduate Advisory Committee. Completion of the seminar requirements, the final oral presentation of the dissertation, and the dissertation itself will be assessed using the department’s institutionally-approved doctoral program assessment rubrics. The outcomes of these assessments are reported as a part of the department’s regular Academic Assessment and Evaluation reporting activities.

In accordance with SDSU Graduate School policy, students who fail to meet minimum performance standards on their first attempt are generally given a second chance to demonstrate mastery. The department as well as the Graduate School ensures the student has every opportunity for success. However, students who ultimately fail to demonstrate mastery of the content and skills necessary for admission to candidacy or fail to successfully defend their dissertation are given the option to complete a Master of Science degree. The Department has a M.S. in Chemistry to accommodate these students. For these students, the academic rigor of completing a Master of Science degree is applied.

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| **4. What instructional approaches and technologies will be used to teach courses in the program?**  |

Standard contemporary classroom lecture and laboratory technologies as well as Access Grid or the Digital Dakota Network (DDN) will be used.

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| **5. Did the University engage any developmental consultants to assist with the development of the curriculum? Were any professional or accrediting associations consulted during the development of the curriculum? What were the contributions of the consultants and associations to the development of curriculum? See also section 11 below.** |

No developmental consultants were engaged in developing this proposal.

The curriculum was developed with reference to those of the University of Minnesota, University of Wisconsin and the University of California-San Francisco. A specific inquiry was made to the University of California-San Diego that has a similar Ph.D. program that involves a partnership with a private research organization.

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| **6. Are students in the program expected to be new to the university, redirected from other programs or both? Complete the table and explain how the estimates were developed.** |

It is expected that during the first year of the new program (FY14 in the table below) the 8 graduate students currently in the biochemistry track within the existing Ph.D. in Chemistry will transfer to the Ph.D. in Biochemistry. Students are recruited for this track as a part of the department’s graduate student recruiting efforts. The FY 14 incoming class currently has 3 students who have expressed the intent to follow the biochemistry track and accepted assistantship offers to enroll in Fall 2013.

New student admissions in the program will increase over the next 3 years of the program initiation (FY15, FY16 & FY17) until a target of 10 students per year is achieved in FY17. On-going new graduate student admission at this level will result in an annual total program enrollment of 40-50 graduate students with the goal of graduating an average of 10 students per year once the program enrolment stabilizes.

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|  | Fiscal Years\* |
|  | 1rst | 2nd | 3rd | 4th |
| Estimates | FY14 | FY15 | FY16 | FY17 |
| Students new to the university | 3 | 6 | 8 | 10 |
| Students from other university programs | 8 | 0 | 0 | 0 |
| = Total students in the program (fall) | 11 | 16 | 22 | 29 |
| Program credit hours (major courses)\*\* | 209 | 304 | 418 | 551 |
| Graduates | 1 | 2 | 3 | 5 |

\* Does not include current fiscal year.

\*\* Assumes students are registered for 9 credit hours in the fall and spring terms and 1 credit in summer (19 credits total per year). This is the total number of credit hours generated by students in the program in the required or elective program courses. The same numbers are used in Appendix B – Budget.

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| **7. If program accreditation is available, identify the organization and explain whether accreditation is required or optional, the resources required, and the University’s plans concerning the accreditation of this program.** |

There is no accrediting organization for this program.

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| **8. Does the University request any exceptions to any Board policy for this program? Explain any requests for exceptions to Board Policy.** |

No.

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| **9. Program Delivery** |

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| **A. Does the University request authorization to deliver this entire program at any off-campus locations?**  |

No.

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| **B. Does the University request authorization to deliver this entire program by distance technology?**  |

No.

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| **C. Include off-campus tuition and site or delivery costs in the next section and in Appendix B***.*  |

Not applicable.

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| **10. Costs, Budget and Resources** |

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| **A. Explain the amount and source(s) of any one-time and continuing investments in personnel, professional development, release time, time redirected from other assignments, instructional technology & software, other O&M, facilities, etc needed to implement the proposed program. Address off-campus or distance delivery separately.** |

The program Budget is provided in Appendix B.

Most of the infrastructure and resources necessary to offer this degree are in place because the degree is, in effect, already offered via the biochemistry track in the Ph.D. in Chemistry degree program. This is includes most faculty FTEs, core program coursework core instrumentation facilities, graduate student recruiting expenses and departmental support staff. These items are identified in Appendix B.

Additional resources will be added via adjunct faculty members who will teach elective coursework that currently does not exist in the SDSU Graduate School catalog. These courses will be taught as a responsibility within their existing appointments at their primary institution and will result in no net cost to the department. This item is identified in Appendix B.

New elective coursework that will be created as a part of this proposal will replace existing coursework within the department’s graduate course offerings. Existing courses that will be modified or deleted from the current departmental offerings to redirect the necessary resources to the proposed program are CHEM 728, 742, 753, 781.

Some coursework and seminars may be delivered via Access Grid or DDN.

Dissertation research expenses will be borne by grants and contracts awarded to participating faculty members. Some students will perform their research activities at the home institution of adjunct faculty participating in the program.

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| **11. Board Policy 2:1: “*Proposals for new graduate programs shall be evaluated by independent consultants retained by the Board.”*  Provide the names, telephone numbers, and URLs of professional organizations, accrediting bodies, and journals (editors) who may be able to assist the Board staff with the identification of consultants.**  |

The American Society for Biochemistry and Molecular Biology, <http://www.asbmb.org>

Biophysical Society, <http://www.biophysics.org>

American Association for the Advancement of Science, Research Competitive Service,

<http://www.aaas.org/spp/rcp/capabilities/proposal_review.shtml>

University of California – Berkeley

University of California – San Francisco

Scripps Research Institute

University of Wisconsin - Madison

University of California – San Diego

**Appendix A**

**Individual Student Outcomes and Program Courses**

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|  | Program Courses that Address the Outcomes |
| Individual Student Outcome | #Laboratory  Rotations | \*CHEM 705 | \*CHEM 767 | \*BIOS 662 | \*GSR 601 | \*CHEM 790 | \*CHEM 792 | \*BIOL 663 | \*BIOL 605 | BIOS 792 | STAT 541 | MICR 531 | #Systems Biology | #Macromolecular Structures | #Biochemical Approaches | #Molecular Basis of Ped. Disease | #Redox Biology | #Neurochemistry | #Protein Trafficking | #Biochemical  Methods | CHEM 898 |  |
| 1. Acquire and apply the knowledge and skills to make an original contribution to the biochemical field. | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |  |
| 2. Conduct independent research within a supportive framework. | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  |
| 3. Understand and critically evaluate the biochemical literature. | X | X | X | X |  | X | X | X | X | X |  | X | X | X | X | X | X | X | X | X | X |  |
| 4. Communicate relevant biochemical principles and theories by written, oral, and visual means. | X |  |  |  |  | X |  | X | X |  |  |  | X | X | X | X | X | X | X | X | X |  |
| 5. Apply biochemical principles and procedures to the recognition, interpretation, and understanding of prior and current knowledge in the field. | X | X | X | X |  | X | X | X | X | X |  | X | X | X | X | X | X | X | X |  | X |  |
| 6. Exhibit an appropriate awareness of and commitment to the ethical conduct of research. | X |  |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  |

#### \* required course

#### # proposed course which does not currently exist

Appendix C

University Response to External Review

1. South Dakota Bioscience Industry, Governor’s Office of Economic Development, <http://www.sdreadytowork.com/Key-Industries-Biotech.aspx> [↑](#footnote-ref-1)
2. <http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stemsouthdakota1.pdf> [↑](#footnote-ref-2)
3. U.S. Bureau of Labor Statistics, Occupational Outlook Handbook, <http://www.bls.gov/ooh/Life-Physical-and-Social-Science/Biochemists-and-biophysicists.htm>, accessed Feb. 10, 2013. [↑](#footnote-ref-3)