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

David L. Chicoine
President of the University

May 6, 2015

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.

1. What is the general nature of the proposed program? What is the expected demand for graduates in South Dakota? What is the need for the proposed program?

South Dakota State University (SDSU) requests permission to plan a Bachelor of Science degree in Biochemical Engineering. The general nature of the proposed Bachelor of Science (B. S.) program in biochemical engineering (working title) is to ground students in understanding of chemistry, biochemistry, biology, microbiology, molecular and synthetic biology, and apply engineering principles to systems and processes enabled by information science to produce high value products, through use of cellular or sub-cellular systems (Bio-manufacturing). Students will be prepared to work in a broad range of bioprocessing industries. Biochemical engineers design and manage bio-manufacturing unit operations including fermentation, filtration, evaporation, distillation, extraction, crushing and screening in an appropriate series and under stringent operating conditions to produce bio-manufactured products such as antibiotics, vaccines, biofuels including ethanol and biodiesel, bio-based green industrial chemicals, industrial enzymes, antioxidants, probiotics and food and feed products, supplements and additives.

The intent is to study, with corporate development partners, the demand for an undergraduate program specific to the broad bio-manufacturing sector as an interdisciplinary collaboration between the Departments of Agricultural and Biosystems Engineering, Chemistry and Biochemistry, Biology and Microbiology, and Mechanical Engineering. It is expected that a substantial portion of the course work can come from existing courses. Some new specific course work may be needed. This will be determined by the analysis undertaken with the authorization of the intent to plan done collaboratively with the corporate development partners.
No new state funding will be requested. The funding model for the interdisciplinary degree will be developed within the planning and analysis framework enabled by the approval of the intent to plan, working with the corporate development partners. It is expected the funding model may include redirected state general funds, tuition and fee revenues paid by students and private resources.

The expected demand for biochemical engineering graduates in South Dakota is strong and growing, reflecting national trends. The national employment increase in biochemical engineering is estimated to be 3% to 7% annually through 2022 with projected annual openings expected to average 2,950 per year between 2012 and 2022. With a median salary of $94,240 per year, biochemical engineering graduates will enter a robust job market.  

The I-29 corridor regional growth strategy, *Pressing the Advantage*, June, 2010\(^2\) identified renewable energy, biotechnology/life sciences and agribusiness, all with significant advanced manufacturing capabilities, as major clusters that will produce more high quality jobs, more wealth and more economic opportunities. *2020 Vision: The South Dakota Science and Innovation Strategy*, April, 2013\(^3\), call out the comparative advantage of value-added agriculture and agribusinesses, energy including renewable fuels and human health and nutrition as sectors that have the potential of advancing the economic growth and development of South Dakota above the mean, if fully exploited.

South Dakota companies in these sectors have a demand for the skills and know-how of graduates from an interdisciplinary biochemical engineering program. The corporate development partners joining South Dakota State in this intent to plan request are noted in Appendix C. These include MedGene Labs, Profile by Sanford, Nelson Engineering, Poet and Poet Nutrition, DD Innovations, Novita Nutrition, Prairie AquaTech, SAB Biotherapeutics, SD Soybean Processors, Valley Queen Cheese, and Sanford Applied Biosciences. Joining the corporate development partners will be the SD Biotechnology Industry Organization (SD Bio). Appendix D includes letters of support from a number of corporate partners that represent a good cross section of the South Dakota biotechnology industry ranging from innovative new startups to large well established employers.

The Batelle/BIO report for South Dakota\(^4\), provided through SD Bio, provides detailed evidence that South Dakota is home to a growing and diverse bioscience industry with over 6,000 jobs in over 370 firms that they organize into five major subsectors. Agricultural feed stocks and chemicals, nutrition and bioenergy are leading advances in biosciences and engineering and rely on the insight and innovations coming from biochemical engineering capabilities.

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The University of Georgia and the University of California-Davis, the 1862 land grant institutions in George and California, are the only two universities in the nation that offer a B.S. in biochemical engineering program. With appropriate analyses and planning authorized by the intent to plan, South Dakota State University may fill a critical need in America’s heartland.

2. What is the relationship of the proposed program to the University’s mission as provided in South Dakota statute and Board of Regents Policy?

The statutory mission of South Dakota State University 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, located at Brookings, in Brookings County, shall be under the control of the Board of Regents and shall provide undergraduate and graduate programs of instruction in the liberal arts and sciences and professional education in agriculture, education, engineering, human sciences, nursing and pharmacy, and other courses 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 proposed baccalaureate major in Biochemical Engineering meets the mission of South Dakota State University by directly providing undergraduate instruction in science and engineering.

The proposed baccalaureate major in Biochemical Engineering supports the goals stated in the South Dakota Board of Regents Strategic Plan 2014-2020:

Priority One – Student Success
- Increase total undergraduate degrees awarded
  - The new program would be only the third program offered in the United States, and would allow SDSU to attract students from South Dakota and across the nation.
- Improve retention and graduation rates
  - The new program would foster increased recruitment as well as retention by expanding the suite of majors available to students at SDSU. The first to market advantage in the Midwest would position SDSU as a leader in a field that garners significant student interest.

Priority Two – Academic Quality and Performance
- Grow the number of students participating in experiential learning through undergraduate research experiences and/or industry internships.
  - The new program’s interdisciplinary nature would increase student’s exposure to hands-on, experiential learning with appropriate internship opportunities in many different occupational specialties.
Priority Three – Research and Economic Development

- STEM Education
  - The new program would foster an increase in enrollment in the STEM fields.
- Economic Development

The proposed baccalaureate major in Biochemical Engineering supports the four goals of IMPACT 2018, South Dakota State University’s Strategic Plan.

Goal 1: Promote academic excellence through quality programs, engaged learners and an innovative teaching and learning environment

- Number of accredited, certified or approved programs.
  - ABET accreditation would be sought for the biochemical engineering program
- Number of graduates per year
  - Biochemical Engineering would attract new students to SDSU which would ultimately result in more graduates per year
- Enrollment
  - Biochemical Engineering would attract new students to SDSU
- Enrollment of honors eligible students
  - The known rigor and challenge of Biochemical Engineering would attract more honors eligible students to SDSU
- Number of STEM graduates

Goal 2: Generate new knowledge, encourage innovations and promote artistic and creative works that contribute to the public good and result in social, cultural, or economic development for South Dakota, the region, the nation and the world.

The additional expertise added to campus by new faculty in biochemical engineering would add to all of the Goal 2 performance indicators.

- Research spending
- Research spending in private sector partnerships and collaborations
- Interdisciplinary bioscience and engineering initiative
- Invention disclosures
- Royalty-bearing IP licenses
- Start-ups
- Start-up companies and collaborating businesses

Goal 3: Extend the reach and depth of the university by developing strategic programs and collaborations.

- Active agreements with universities, community colleges and technical institutes
  - Biochemical engineering will provide another accredited major for attracting collaboration with in-state and out-of-state institutions.
  - Biochemical engineering will expand the reach of SDSU through numerous opportunities for collaborations with industry through internships, sponsored research agreements, and faculty consulting.

http://sdstate.edu/impact2018/
Goal 4: Secure human and fiscal resources to ensure high performance through enhanced financial, management and governance systems

Biochemical engineering would expand the talent pool for the growing and diverse bioscience industry in South Dakota. Industry partners would be sought to fund:

- Endowed faculty positions
- University endowment
- Scholarships for students

3. Are there any related programs in the regental system? If there are related programs, why should the proposed program be added? If there are no related programs within the system, enter “None.”

The SDSMT’s Chemical and Biological Engineering is a related program. This major covers the traditional Chemical Engineering curriculum, such as thermodynamics, heat and mass transport, fluid dynamics, chemical reaction kinetics and reactor design, separations and unit operations, and process design and control. A student has the option of choosing an emphasis in one of these areas: advanced materials (nano materials, polymers, ceramics, materials processing, corrosion, or solid state/semi-conductors), biochemical engineering, energy technology, environmental engineering, and petroleum engineering. SDSMT is also developing a graduate certificate in petroleum systems focusing on graduate-level training as part of the Energy Resources Initiative to respond to the growing interest and need for additional expertise in the oil and gas sector associated with the Bakken Formation development in North Dakota and the fossil fuel energy development in Wyoming and Montana.

Biochemical engineering at SDSU can tap into the existing campus synergy in biological sciences, chemistry/biochemistry, and health professions. Over 200 tenure track faculty members on the SDSU campus are involved in teaching and research in one of the many branches of health and biological sciences. Biochemical engineering at SDSU would differ from traditional chemical engineering programs by focusing on biological examples as students learned basic engineering principles in thermodynamics, material and energy balances, separations, transport phenomena, reactor design, and process control. Students could choose from a rich diversity of elective course work in biological sciences. The large research portfolio on campus provides many opportunities for students to gain additional hands-on experience in projects tied to the biological sciences.

Biochemical engineering faculty on campus would expand the reach of SDSU expertise in bioprocessing of agricultural products, food processing engineering, human health and nutrition, pharmaceuticals, animal health and disease prevention, and animal nutrition. If the program is developed following the analyses and planning authorized by the intent to plan, it would provide a stream of graduates well prepared to contribute to the growth and development of South Dakota’s bioscience sector.
4. Are there related programs at public colleges and universities in Minnesota, North Dakota, Montana, and Wyoming? If there are related programs in these states list below under each state and explain why the proposed program is needed in South Dakota. If there are no related programs in a state, enter “None” for that state.

Minnesota

University of Minnesota, Twin Cities, has a Chemical Engineering program with a focus on processing of traditional non-renewable metals, chemicals, petro-polymer, nanomaterials, pulp, paper, and other forest products.

University of Minnesota, Duluth has a Chemical Engineering program with a focus on traditional chemical engineering of metal, petro-plastic, coal chemical processing.

North Dakota

The University of North Dakota, Grand Forks has a Chemical Engineering undergraduate program with a focus on explosive chemicals and traditional petroleum refinery processes.

Montana

Montana State University has a Chemical and Biological Engineering program with a focus on petroleum and coal based products.

Wyoming

The University of Wyoming has a Chemical and Petroleum Engineering program with a focus on petroleum and other traditional chemicals and petro-polymers.

5. Are students expected to be new to the university or redirected from other programs? How many majors are expected in the first years of the program? How many graduates are expected?

It is expected that students for this new major will be both new to the University and redirected from other programs. A portion of the students currently enrolled in Mechanical Engineering, Agricultural and Biosystems Engineering, Biochemistry, Biotechnology, or Microbiology may be interested in the new major. The major should attract new students to the university since the major opens up a whole new career path for students that is not easily accessible through the existing degree programs.

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6 This question addresses opportunities available through Minnesota Reciprocity and the Western Undergraduate Exchange in adjacent states. List only programs at the same degree level as the proposed program. For example, if the proposed program is a baccalaureate major, then list only related baccalaureate majors in the other states and do not include associate or graduate programs.
About 1,300 students visit or inquire about engineering programs in the Jerome J. Lohr College of Engineering at SDSU each year. Only about 600 of those students actually complete the admission process with about 400 new students actually arriving on campus to enroll in one of the existing engineering programs. Many of these students and parents ask about how to best prepare for engineering careers associated with various companies that are part of the expanding bio-manufacturing sector. Providing the option of choosing biochemical engineering in the Jerome J. Lohr College of Engineering will help expand the number of engineering students that enroll at SDSU. A conservative estimate for the initial cohort is 15 students, including junior and senior level students who change their major to Biochemical Engineering.

<table>
<thead>
<tr>
<th>Academic Years</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Enrollment Target</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students in the major (fall)</td>
<td>15</td>
<td>32</td>
<td>49</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td>Completions by graduates</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>7</td>
<td>12</td>
</tr>
</tbody>
</table>

6. Does the university intend to seek authorization to deliver this entire program at any off-campus locations? If yes, enter location(s) and intended start date(s). Does the university intend to seek authorization to deliver this entire program by distance technology? If yes, identify delivery method(s) and intended start date(s).

- Off-campus: No
- Distance delivery: No

7. What are the University’s plans for obtaining the resources needed to implement the program? Indicate “yes” or “no” in the columns below.

<table>
<thead>
<tr>
<th>Development/Start-up</th>
<th>Long-term Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reallocate existing resources</td>
<td>Yes</td>
</tr>
<tr>
<td>Apply for external resources</td>
<td>Yes</td>
</tr>
<tr>
<td>Ask Board to seek new State resources</td>
<td>No</td>
</tr>
<tr>
<td>Ask Board to approve new or increased student fee</td>
<td>No</td>
</tr>
</tbody>
</table>

* A student fee for biochemical engineering commensurate with the other engineering programs on campus would be requested. The fee is currently $80 per credit hour.

SDSU is requesting to engage in the planning process to determine the actual cost to deliver an accredited program. If the intent to plan is approved, SDSU would retain the services of a consultant to perform a robust complete supply-demand feasibility assessment for a program in biochemical engineering. The proposed industry partners listed in the appendix will be an important resource in making an accurate determination of the future demand for biochemical engineers as well as the financial support available from industry.

8. Curriculum Example: Provide (as Appendix A) the curriculum of a similar program at another college or university. The Appendix should provide the required and elective courses in the program. Catalog pages or web materials may be used. Identify the college or university
and explain why the program may be used as one model when the proposed program is developed.

Only two baccalaureate majors in biochemical engineering are offered in the United States. The curriculum of both programs is listed to provide a more complete representation of curriculum that might be included in a biochemical engineering program at SDSU.
Appendix A

The University of California–Davis

<table>
<thead>
<tr>
<th>Courses</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower Division Composition</strong> Select ONE of the following courses:</td>
<td></td>
</tr>
<tr>
<td>UWP 1, 1V, or 1Y Expository Writing</td>
<td>4</td>
</tr>
<tr>
<td>ENL 3 Introduction to Literature</td>
<td></td>
</tr>
<tr>
<td>COM 1 Bks of West Civ/Ancient World</td>
<td></td>
</tr>
<tr>
<td>COM 2 Bks of West Civ/MidAge-Enligh.</td>
<td></td>
</tr>
<tr>
<td>COM 3 Bks of West Civ/Modern Crisis</td>
<td></td>
</tr>
<tr>
<td>COM 4 Bks of Contemporary World</td>
<td></td>
</tr>
<tr>
<td>NAS 5 Intro to Native American Lit.</td>
<td></td>
</tr>
<tr>
<td><strong>Upper Division Composition (0 or 4 units) Select ONE of the following courses</strong></td>
<td></td>
</tr>
<tr>
<td>UWP 102E or 102F Writing in the Disciplines</td>
<td>4</td>
</tr>
<tr>
<td>UWP 104A, 104E, or 104T Writing in the Professions</td>
<td></td>
</tr>
<tr>
<td>MAT 21A Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MAT 21B Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MAT 21C Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MAT 21D Vector Analysis</td>
<td>4</td>
</tr>
<tr>
<td>MAT 22A Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>MAT 22B Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>PHY 9A Classical Physics</td>
<td>5</td>
</tr>
<tr>
<td>PHY 9B Classical Physics</td>
<td>5</td>
</tr>
<tr>
<td>PHY 9C Classical Physics</td>
<td>5</td>
</tr>
<tr>
<td>CHE 2A General Chemistry</td>
<td>5</td>
</tr>
<tr>
<td>BIS 2A Introductory Biology</td>
<td>5</td>
</tr>
<tr>
<td>or BIT 1 Introduction to Biotechnology</td>
<td>4</td>
</tr>
<tr>
<td>ECM 5 BioChem/Materials Analysis</td>
<td>3</td>
</tr>
<tr>
<td>ECM 6 Computational Methods</td>
<td>4</td>
</tr>
<tr>
<td>ECH 51 Material Balances</td>
<td>4</td>
</tr>
<tr>
<td>ECH 80 Chemical Engineering Professionalism (SS GE3 credit)</td>
<td>1</td>
</tr>
<tr>
<td>CHE 128A Organic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHE 129A Organic Chemistry</td>
<td>2</td>
</tr>
<tr>
<td>CHE 128B Organic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHE 110A Quantum Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>BIS 102 Struc &amp; Func Biomolecules</td>
<td>3</td>
</tr>
<tr>
<td>MIC 101 Intro Microbiology</td>
<td>5</td>
</tr>
<tr>
<td>ECH 140 Mathematical Methods</td>
<td>4</td>
</tr>
<tr>
<td>ECH 141 Fluid Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>ECH 142 Heat Transfer</td>
<td>4</td>
</tr>
<tr>
<td>ECH 143 Mass Transfer</td>
<td>4</td>
</tr>
<tr>
<td>ECH 145A Chemical Engineering Thermodynamics Lab</td>
<td>2</td>
</tr>
</tbody>
</table>
Biochemical Engineering Electives (9 units)
Choose at least one laboratory course from the Laboratory Elective list; additional courses may be chosen from either list. You may receive biochemical engineering elective credit up to a maximum of two units of an internship (192) or independent study (199), or Biotechnology 189L with the approval of a petition, provided that the course is a laboratory-based experimental project, related to the biological and/or biochemical engineering sciences, and the student submits a written report that demonstrates proficiency in laboratory skills, techniques, or method. Research does not replace the required lab elective.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECH 145B</td>
<td>Chemical Engineering Transport Lab</td>
<td>2</td>
</tr>
<tr>
<td>ECH 148A</td>
<td>Chemical Kinetics and Reaction Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ECH 152A</td>
<td>Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>ECH 152B</td>
<td>Thermodynamics</td>
<td>4</td>
</tr>
<tr>
<td>ECH 157</td>
<td>Process Dynamics</td>
<td>4</td>
</tr>
<tr>
<td>ECH 158A</td>
<td>Process Economics and Green Design (SS GE3 credit)</td>
<td>4</td>
</tr>
<tr>
<td>ECH 158C</td>
<td>Plant Design Project</td>
<td>4</td>
</tr>
<tr>
<td>ECH 161A</td>
<td>BiochemE Fundamentals</td>
<td>4</td>
</tr>
<tr>
<td>ECH 161B</td>
<td>Bioseparations</td>
<td>4</td>
</tr>
<tr>
<td>ECH 161C</td>
<td>Biotech Facility Design (SS GE3 credit)</td>
<td>4</td>
</tr>
<tr>
<td>ECH 161L</td>
<td>Bioprocess Engineering Lab</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIS 2B</td>
<td>Introductory Biology</td>
<td>5</td>
</tr>
<tr>
<td>BIS 2C</td>
<td>Introductory Biology</td>
<td>5</td>
</tr>
<tr>
<td>BIS 101</td>
<td>Genes &amp; Gene Expression</td>
<td>4</td>
</tr>
<tr>
<td>BIS 103</td>
<td>Bioenergetics &amp; Metabolism</td>
<td>3</td>
</tr>
<tr>
<td>BIS 104</td>
<td>Regulation of Cell Function</td>
<td>3</td>
</tr>
<tr>
<td>BIM 102</td>
<td>Quantitative Cell Biology</td>
<td>4</td>
</tr>
<tr>
<td>BIM 109</td>
<td>Biomaterials</td>
<td>4</td>
</tr>
<tr>
<td>BIM 117</td>
<td>Molecular and Cellular Networks</td>
<td>4</td>
</tr>
<tr>
<td>BIM 140</td>
<td>Protein Engineering</td>
<td>4</td>
</tr>
<tr>
<td>BIM 161A</td>
<td>Biomolecular Engineering</td>
<td>4</td>
</tr>
<tr>
<td>BIM 162</td>
<td>Quantitative Biomolecular Eng.</td>
<td>4</td>
</tr>
<tr>
<td>BIT 160</td>
<td>Principles of Plant Biotechnology</td>
<td>3</td>
</tr>
<tr>
<td>BIT 188</td>
<td>Undergraduate Research: Proposal</td>
<td>3</td>
</tr>
<tr>
<td>CHE 130A</td>
<td>Pharmaceutical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHE 130B</td>
<td>Pharmaceutical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>EBS 165</td>
<td>Bioinstruments and Control</td>
<td>4</td>
</tr>
<tr>
<td>ECH 144</td>
<td>Rheology and Polymer Processing</td>
<td>3</td>
</tr>
<tr>
<td>ECH 166</td>
<td>Catalysis</td>
<td>3</td>
</tr>
<tr>
<td>ECH 170</td>
<td>Introduction to Colloid and Surface Phenomena</td>
<td>3</td>
</tr>
<tr>
<td>FST 102A</td>
<td>Malting and Brewing Science</td>
<td>4</td>
</tr>
<tr>
<td>FST 104</td>
<td>Food Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>FST 123</td>
<td>Intro. to Enzymology</td>
<td>3</td>
</tr>
<tr>
<td>MIC 140</td>
<td>Bacterial Physiology</td>
<td>3</td>
</tr>
<tr>
<td>Course Code</td>
<td>Title</td>
<td>Credits</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>MIC 150</td>
<td>Bacterial Genetics</td>
<td>3</td>
</tr>
<tr>
<td>MCB 123</td>
<td>Enzymes and Receptor Systems</td>
<td>3</td>
</tr>
<tr>
<td>NPB 101</td>
<td>Systemic Physiology</td>
<td>4</td>
</tr>
<tr>
<td>NPB 107</td>
<td>Cell Signaling in Health and Disease</td>
<td>3</td>
</tr>
<tr>
<td>PLB 111</td>
<td>Plant Physiology</td>
<td>3</td>
</tr>
<tr>
<td>PLB 112</td>
<td>Plant Growth &amp; Development</td>
<td>3</td>
</tr>
<tr>
<td>PLS 100A</td>
<td>Metabolic Processes of Cultivated Plants</td>
<td>3</td>
</tr>
<tr>
<td>PLS 152</td>
<td>Plant Genetics</td>
<td>4</td>
</tr>
<tr>
<td>STA 120</td>
<td>Probability and Random Variables for Engineers</td>
<td>4</td>
</tr>
<tr>
<td>STA 130A</td>
<td>Mathematical Statistics: Brief Course</td>
<td>4</td>
</tr>
<tr>
<td>STA 131A</td>
<td>Introduction to Probability Theory</td>
<td>4</td>
</tr>
<tr>
<td>VEN 123</td>
<td>Analysis of Musts and Wines</td>
<td>2</td>
</tr>
<tr>
<td>BIM 161L</td>
<td>Biomolecular Eng. Lab</td>
<td>3</td>
</tr>
<tr>
<td>BIT 161A</td>
<td>Genetic Biotech Lab</td>
<td>6</td>
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<td>BIT161 B</td>
<td>Plant Genetic Biotech Lab</td>
<td>4</td>
</tr>
<tr>
<td>FST 102 B</td>
<td>Practical Malting &amp; Brewing</td>
<td>4</td>
</tr>
<tr>
<td>FST 104 L</td>
<td>Food Microbiology Lab</td>
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<td>FST 123 L</td>
<td>Enzymology Lab</td>
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<tr>
<td>MCB 120L</td>
<td>Biochemistry Lab</td>
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<td>MCB 160L</td>
<td>Principles of Genetics Lab</td>
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<tr>
<td>NPB 101L</td>
<td>Systemic Physiology Lab</td>
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</tr>
<tr>
<td>NPB 104L</td>
<td>Cellular Physiology/Neurobio Lab</td>
<td>4</td>
</tr>
<tr>
<td>VEN 123L</td>
<td>Analysis of Musts &amp; Wines Lab</td>
<td>2</td>
</tr>
<tr>
<td>VEN 124L</td>
<td>Wine Production Lab</td>
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</tr>
</tbody>
</table>
Appendix B

University of Georgia [http://www.engineering.uga.edu/bs-biochemical-engineering](http://www.engineering.uga.edu/bs-biochemical-engineering)

The curriculum includes courses in basic sciences, engineering sciences, engineering design, social sciences and the humanities. The curriculum is a 130 credit hour, four-year course of study. The curriculum has 47 hours in Math and the Basic Sciences, 56 hours in the Engineering Sciences and Design and 27 hours in the Social Sciences and Humanities. (In ABE department)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ENGR 1120 Engineering Graphics</td>
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<tr>
<td>MATH 2250 Calculus I Sci Engr</td>
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<tr>
<td>CHEM 1211 &amp; L Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 1103 Basic Concepts Biology</td>
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<tr>
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<tr>
<td>ENGR 1140 Comp Methods</td>
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<tr>
<td>MATH 2260 Calculus II Sci Engr</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 1212 &amp; L Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>ENGL 1101 English Comp I</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 1251 Physics for Engineers I</td>
<td>3</td>
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<tr>
<td>BCHE 2910 Engineering Design</td>
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<tr>
<td>MATH 2500 Multivariable Calculus</td>
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</tr>
<tr>
<td>CHEM 2211 &amp; L Organic Chemistry</td>
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<tr>
<td>PHYS 1252 Physics for Engineers II</td>
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<tr>
<td>BIOL 1104 Organismal Biology</td>
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<tr>
<td>ENGL 1102 English Comp. II</td>
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<tr>
<td>ENGR 2120 Statics</td>
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<tr>
<td>MCHE 3140 Engr Thermodynamics I</td>
<td>3</td>
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<tr>
<td>MATH 2700 Differential Equations</td>
<td>3</td>
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<tr>
<td>HIST 2111/2112 American History</td>
<td>3</td>
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<tr>
<td>POLS 1101 American Government</td>
<td>3</td>
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<tr>
<td>BCHE 3145 Equil Thermodynamics</td>
<td>2</td>
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<tr>
<td>World Language and Culture</td>
<td>3</td>
</tr>
<tr>
<td>MIBO 3500 Intro Microbiology</td>
<td>3</td>
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<tr>
<td>ENGR 3520 Mass Rate</td>
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<tr>
<td>BCMB 3100 Intro Biochemistry</td>
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<tr>
<td>ENGR 3160 Fluid Mechanics</td>
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<tr>
<td>Social Science Elective</td>
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<tr>
<td>ENGR 4510 Biochemical Engineering</td>
<td>3</td>
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<tr>
<td>BCHE 3180 Engineering Lab</td>
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<tr>
<td>BCHE 3420 Kinetics/Reactor Design</td>
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<tr>
<td>ENGR 2110 Engr Decision Making</td>
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<tr>
<td>ENGR 3150 Heat Transfer</td>
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<td>ENGINEERING ELECTIVE</td>
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<tr>
<td>World Language and Culture</td>
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</tr>
<tr>
<td>ENGINEERING ELECTIVE</td>
<td>3</td>
</tr>
</tbody>
</table>
COMM 1100 Speech Communication 3
World Language and Culture 3
BCHE 4920 Capstone Design 4
BCHE 4360 Biochem Process Ctrl 3
BCHE 4710 Bio- Electrochemical Engr 3
BCHE 4180 Adv Biochem Engr Lab 3
ENGINEERING ELECTIVE 3

**BS BchE Electives**

Choose 3 classes from the following list:

- BCHE 4350 Bioprocess Quality Control
- BCHE 4460 Biorefinery Engineering
- BCHE 4625 Tissue Engineering
- BCHE 4645 Biocatalysis & Protein Engineering
- BCHE 4655 Metabolic Engineering & Synthetic Biology
- ENGG 4615 Soft Materials
- ENGR 4450 Environmental Engineering Remediation Design
- ENGR 4490 Renewable Energy Engineering
- ENGR 4520 Design of Biochemical Separations Processes

**Major Requirements:**

All students must earn a grade of "C" (2.0) or better in the following courses: ENGR 1120, ENGR 2110, ENGR 2120, MCHE 3140, ENGR 3150, ENGR 3160, ENGR 3520, MATH 2250, MATH 2260, MATH 2500 or MATH 2300H, MATH 2700, PHYS 1251, PHYS 1252, BIOL 1103, BIOL 1104, CHEM 1211, CHEM 1211L and CHEM 1212, CHEM 1212L. Except for those courses requiring a grade of "C" (2.0) or better, a maximum of two ENGR or BCHE prefix courses with grades of "D" (1.0) may be used to satisfy graduation requirements. Competency in a computer programming language is expected and may be satisfied with ENGR 1140.

**Transfer Entrance Requirements into Intended Major:**

Overall GPA 2.7 for Transfer Students.

THE FUNDAMENTALS OF ENGINEERING & PRE-FE EXAMS ARE A GRADUATION REQUIREMENT FOR THIS DEGREE PROGRAM.
Appendix C

Potential Industry Partners for a Biochemical Engineering Program

Alltech
Dr. Pearse Lyons
Founder & President
3031 Catnip Hill Pike
Nicholasville, KY 40356

Alumend
Ryan Hanson, President
4800 N. Career Avenue
Sioux Falls, SD 57107

Bel Brands USA
Cyril Cledelin, VP of Operations
1313 34th Avenue
Brookings, SD 57006

Dakota Ethanol
Scott Mundt, CEO
P.O. Box 100
Wentworth, SD 57075

MedGene Labs
Mark Luecke, CEO
1006 32nd Avenue, Suite 104
Brookings, SD 57006

Nelson Engineering
Jerry Baker, Vice President of Operations
500 West Hanger Street
Sioux Falls, SD 57104

Novita Nutrition, LLC
Don Endres, CEO and Co-Founder
2301 Research Park Way, Suite 226
Brookings, SD 57006

Poet, LLC
Poet Nutrition, Inc.
Jeff Broin, Executive Chairman
4615 N. Lewis Avenue
Sioux Falls, SD 57104

Prairie AquaTech
Mark Luecke, CEO
South Dakota State University
Intent to Plan: B.S. in Biochemical Engineering

705 32nd Avenue South
Brookings, SD 57006

Profile by Sanford
Nate Malloy, COO
1305 W 18th Street/PO Box 5039
Route 5725
Sioux Falls, SD 57117

Redfield Energy, LLC
Tom Hitchcock, CEO
38650 171st Street
PO Box 111
Redfield, SD 57469

RTI
Christopher Chase, DVM, Ph.D.
CEO/President
801 32nd Avenue
Brookings, SD 57006

SAB Biotherapeutics, Inc.
Eddie Sullivan, Ph.D.
President and CEO
2301 E. 60th Street, North
Sioux Falls, SD 57104

Sanford Applied Biosciences
Dr. Eddie Sullivan,
Vice-President of Business Development and Government Relations
2301 E. 60th Street, North
Sioux Falls, SD 57104

SD Biotechnology Association
Joni Johnson, Executive Director
2329 N. Career Avenue, Ste. 115
Sioux Falls, SD 57107

SD Soybean Processors
John Prohaska, Operations Manager
100 Caspian Avenue, Box 500
Volga, SD 57107

Sterling Technology
Randy Kjelden, President
133 32nd Avenue South
Brookings, SD 57006
South Dakota State University
Intent to Plan: B.S. in Biochemical Engineering

UAS Labs
S.K. Dash, Ph.D.
Chairman & Founder
President, DD Innovations, Inc.
7300 France Avenue South, Suite 208
Edina, MN 55435

Valley Queen Cheese Factory, Inc.
Mark Leddy, CEO
200 E Railway Avenue
Drawer 35
Milbank, SD 57252
Appendix D

Industry Support Letters

April 30, 2015

Van C. Kelley, Department Head
Agricultural & Biosystems Engineering
South Dakota State University
Brookings, SD 57007

Dear Dr. Kelley,

We wish to extend our support for the proposed Biochemical Engineering major at South Dakota State University and are interested in learning more about how Sanford Profile can be involved in the planning process.

We believe that a Biochemical Engineering major at SDSU would be a game changer for advancing healthcare in the region. There are many important applications for such a program, including nutrition. Future graduates may find careers producing Profile’s nutrient-rich meal replacement products, both in determining proper formulation for the best outcomes for unique individuals and in developing optimal ingredient processing methods.

Thank you for including us in this opportunity. We look forward to working with you in the future.

Sincerely,

Nate Malloy, COO
Profile by Sanford
1305 W. 18th Street, PO Box 5039
Sioux Falls, SD 57117-5039
Ph: 605-312-7706
Fax: 605-312-7701
April 21, 2015

Van C. Kelley, Ph.D., Head
Department of Agricultural & Biosystems Engineering
Agricultural Engineering (SAE)
Box: 2120
South Dakota State University
Brookings, SD 57007

Dear Dr. Kelley,

I wish to express my support for a new major in biochemical engineering at South Dakota State University (SDSU), and am enthusiastic about engaging in the planning and feasibility study process for this program.

A biochemical engineering major at SDSU would have tremendous potential to positively impact innovation and commercialization of new products here in South Dakota and the surrounding region. The university is uniquely positioned to marry several strengths in engineering, biology, microbiology, chemistry, and biochemistry, to produce a talented workforce that is prepared to address the challenges of integrated systems and fill staffing needs for companies like UAS Laboratories, LLC and DD Innovations, Inc.

Thank you for your leadership in this endeavor. I hope to hear of a favorable decision from the South Dakota Board of Regents in the near future.

Sincerely,

S.K. Dash, Ph.D.
Chairman & Founder, UAS Laboratories, LLC
President, DD Innovations, Inc.
April 17, 2015

Van C. Kelley, Department Head
Agricultural & Biosystems Engineering
South Dakota State University
Brookings, SD 57007

Dear Van,

I enthusiastically support the development of a new major in biochemical engineering at South Dakota State University and accept the opportunity to assess the needs of industry for a biochemical engineering degree.

SAB Biotherapeutics, Inc. (SAB), is a biopharmaceutical company on the leading edge of innovation, developing natural technologies that have the potential to transform the treatment and prevention of a wide range of diseases. Utilizing the most advanced antibody science in the world, SAB is delivering the world’s first large scale platform to create fully human, polyclonal antibodies. If approved, this new major would fulfill a critical need for highly trained graduates to produce mass quantities of pharmaceutical products, developed by SAB and other companies, for a growing global population with increasing healthcare needs. I am encouraged by this proposal by the university, and the possibility of added capacity for growing the pharmaceutical industry in the Midwest.

Thank you for the opportunity to be involved with this project. I look forward to providing insight for this new program.

Sincerely,

Eddie J. Sullivan, Ph. D.
President/CEO
SAB Biotherapeutics, Inc.

Personal Impact + Global Influence

2301 E 60th N, Sioux Falls, SD 57104
P 605/679.6980

6701 Democracy Blvd, Ste 300, Bethesda, MD 20817
P 301/214.4046 • F 301/564.9619
April 27, 2015

Van C. Kelley, Department Head
Agricultural & Biosystems Engineering
South Dakota State University
Brookings, SD 57007

Dear Dr. Kelley,

I would like to offer you my complete support for the creation of a Biochemical Engineering program at South Dakota State University (SDSU). I have been involved in the biotechnology industry for over 30 years, primarily working in industrial sites, and can confirm first-hand the growing need for skilled professionals in this discipline.

The creation of a Biochemical Engineering major at SDSU will fuse a strong engineering school with the life science disciplines of the university which include microbiology, chemistry and biochemistry. The university is already recognized as a regional seed for agricultural and veterinary science industries and a specialized biotechnology related engineering program will further reinforce these strengths. It is my experience and opinion that the future stability of our region will be determined not just by those who have good ideas, but by those who are able to bring those ideas to fruition while solving meaningful opportunities. The Biochemical Engineering program could become a bridge to this future.

Thank you for your commitment spearheading the development of this Biochemical Engineering program and please do not hesitate to reach out to me if I can be of additional help.

Sincerely,

Steve Berger, MBA
Vice President, Operations and General Manager
Medgene Labs
April 20, 2015

Van C. Kelley, Department Head
Agricultural & Biosystems Engineering
South Dakota State University
Brookings, SD 57007

Dear Dr. Kelley,

I wish to express my support for a new major in biochemical engineering at South Dakota State University (SDSU), and am enthusiastic about engaging in the planning and feasibility study process for this program.

A biochemical engineering major at SDSU would have tremendous potential to positively impact innovation and commercialization of new products here in South Dakota and the surrounding region. The university is uniquely positioned to marry several strengths in engineering, biology, microbiology, chemistry, and biochemistry, to produce a talented workforce that is prepared to address the challenges of integrated systems and fill staffing needs for companies like Novita.

Thank you for your leadership in this endeavor. I hope to hear of a favorable decision from the South Dakota Board of Regents in the near future.

Sincerely,

[Signature]

Don Endres
CEO
Novita Nutrition, LLC
April 20, 2015

Van C. Kelley, Department Head
Agricultural & Biosystems Engineering
South Dakota State University
Brookings, SD 57007

Dear Van,

Thank you for asking SD Biotech to be in support of Biochemical Engineering at SDSU. Absolutely I will help you in any way that I can. With the state’s growing biotechnology industry, a skilled workforce is in high demand. This degree has great timing!

As the Executive Director of South Dakota Biotech, one of my main roles is to foster industry partnerships. I am happy to help you expand your list of industry leaders. The new major will strengthen the business environment and help South Dakota expand the bio-based economy in all areas of the life sciences including human health, food and agriculture, and renewable energy biotechnology.

Please let me know how I can be of further assistance.

Sincerely,

Joni Johnson
Executive Director
South Dakota Biotech
April 21, 2015

Van C. Kelley, Department Head
Agricultural & Biosystems Engineering
South Dakota State University
Brookings, SD 57007

Dear Dr. Kelley,

I wish to express my support for a new major in biochemical engineering at South Dakota State University (SDSU), and am enthusiastic about engaging in the planning and feasibility study process for this program.

A biochemical engineering major at SDSU would have tremendous potential to positively impact innovation and commercialization of new products here in South Dakota and the surrounding region. The university is uniquely positioned to marry several strengths in engineering, biology, microbiology, chemistry, and biochemistry, to produce a talented workforce that is prepared to address the challenges of integrated systems and fill staffing needs companies in the state. Biochemical engineering allows for students to find career across multiple disciplines, as their skill set is adaptable and broad to fit a variety of areas. It is important to give our state the tools to advance multiple industries and elevate our workforce.

Thank you for your leadership in this endeavor. I hope to hear of a favorable decision from the South Dakota Board of Regents in the near future. Please let me know if there is anything additional I can do to help with this effort.

Sincerely,

Sue Lancaster
Corporate Development
South Dakota Innovation Partners
From: TP Lyons [mailto:tplyons@Alltech.com]
Sent: Thursday, April 23, 2015 2:41 PM
To: Kephart, Kevin
Subject: RE: Biochemical Engineering degree planning study

Dear Kevin,

I note your interest in the Biochemical Engineering degree, and in my opinion, we really need this in our industry. We had 18 people take distance learning courses for biochemistry and biotechnology, and this has resulted in them obtaining a master's degree, and in some cases, a Ph.D.

You mention a Biochemical Engineering program at UC-Davis. Some of the large agriculture companies have put a lot of money into this as they see it to be fulfilling. Why a Biochemical Engineering degree? Because it gives you processes, such as: distilling, recovery, fermentation, and separation.

I salute South Dakota State University on their initiative.

Regards,
Pearse Lyons

Alltech
Dr. Pearse Lyons
Founder & President
3031 Catnip Hill Pike
Nicholasville, KY 40356

Alltech
700 32nd Ave. South
Brookings, SD 57006

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April 24, 2015

Van C. Kelley, Ph.D., Head
Department of Agricultural & Biosystems Engineering
Agricultural Engineering
Box 2120
South Dakota State University
Brookings, SD 57007

Dear Dr. Kelley,

On behalf of RTI, I wish to express my support for a new major in biochemical engineering at South Dakota State University (SDSU), and am enthusiastic about engaging in the planning and feasibility study process for this program.

A biochemical engineering major at SDSU would have tremendous potential to positively impact innovation and commercialization of new products here in South Dakota and the surrounding region. The university is uniquely positioned to marry several strengths in engineering, biology, microbiology, chemistry, and biochemistry, to produce a talented workforce that is prepared to address the challenges of integrated systems and fill staffing needs for companies like RTI. In particular, our business involves the use of good manufacturing practices (GMP) processes for pharmaceutical and vaccine development and production. A person with these skill sets learned from this major would be invaluable to our company.

Thank you for your leadership in this endeavor. I hope to hear of a favorable decision from the South Dakota Board of Regents in the near future.

Sincerely,

Christopher Chase, DVM, PhD, Diplomate, American College of Veterinary Microbiologists
President/Chief Executive Officer
April 21, 2015

Van C. Kelley, Department Head
Agricultural & Biosystems Engineering
South Dakota State University
Brookings, SD 57007

Dear Dr. Kelley,

This letter is to express my support for the Biochemical Engineering major at South Dakota State University (SDSU).

As you know, with the growing ag and biotechnology industry in South Dakota there is a need for a workforce who is diverse in their skill set and thinking. The Biochemical Engineering major would provide students with an understanding across multiple disciplines that would not only be beneficial to the student, but also the State of South Dakota.

I am happy to support the program in anyway that I can. Please do not hesitate to let me know if you need anything additional from me.

Sincerely,

Dennis Harstad
Vice President of Operations and General Manager
Prairie AquaTech
April 14, 2015

Van C. Kelley, Department Head
Agricultural & Biosystems Engineering
South Dakota State University
Brookings, SD 57006

Dear Dr. Kelley,

We are interested in joining in the planning and investigation process to discover the market demand and financial feasibility of SDSU offering the new major in biochemical engineering.

Valley Queen Cheese has relied on the SDSU Dairy Science Department for many years to provide talented individuals for our management team. As our business grows, we also need to expand our internal engineering capabilities to be able to effectively work with large complex processing equipment in a non-stop manufacturing environment. Valley Queen Cheese processes over four million pounds of milk every day and turns it into 400,000 pounds of cheese. Our cheese manufacturing process also generates over 3.5 million pounds of liquid whey, which is dried into lactose and whey protein concentrate to be used as ingredients for baby formula, candy and nutritional supplements. Even though thousands of tons of product pass through our plant, producing quality cheese products is a delicate and precise process. We need engineers to help us design, refine, and optimize our equipment and processes to keep us at the cutting edge of efficiency while maintaining industry-leading quality.

Valley Queen Cheese is a major employer in the I-29 corridor. Growing and expanding our business depends on meeting the needs of national food marketers that require quality cheese and whey products to bring their own products to life. Additional engineering expertise would strengthen our ability to react quickly as we modify our processes and production to meet every-changing consumer trends.

I am looking forward to hearing the Regent’s decision on the intent to plan for a new major in biochemical engineering.

Sincerely,

Mark Leddy
CEO
May 11, 2015

Van C. Kelley, Ph.D.
Department Head
Agricultural & Biosystems Engineering
South Dakota State University
Brookings, SD 57007

Dear Dr. Kelley,

I am delighted to hear about the prospect of offering a major in biochemical engineering at South Dakota State University. POET would be pleased to be involved in the evaluation and planning process further if you believe this would be helpful.

POET is one of the largest producers of ethanol and other biorefined products in the world. As we continue to expand our original business model to include the production of renewable food sources and petrochemical alternatives, our groundbreaking endeavors depend on a talented team of scientists and engineers. A new major in biochemical engineering at South Dakota State University would definitely help support our goal of attracting bright new employees into the future that will help fuel our development programs.

Please let me know if I can provide further assistance. I look forward to the new biochemical engineering major at SDSU and the opportunity to partner and lend support.

Sincerely,

W. Wade Robey, Ph.D.
Chief Technology Officer
POET LLC.