



SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS
Intent to Plan for a New Program

UNIVERSITY:	USD and SDSM&T
DEGREE(S) AND TITLE OF PROGRAM:	B.S. in Biomedical Engineering
INTENDED DATE OF IMPLEMENTATION:	Fall 2018

University Approval

To the Board of Regents 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.

President of the University

Date

1. What is the general nature/purpose of the proposed program?

The University of South Dakota and South Dakota School of Mines & Technology request permission to plan a Joint Bachelor of Science degree in Biomedical Engineering (BME). The intent is that both USD and SDSM&T will offer the joint degree program. The Joint Degree capitalizes on an inter-institutional model by bridging the medical and engineering disciplines to produce well prepared BME graduates to advance human health and wellbeing. The purpose of the proposed program are listed in the objectives below:

Graduates will:

- a. Learn with hands-on laboratory experience, experimental design and data analysis tools, and effective team-work strategies.
- b. Acquire the problem-solving skills required to start a business in the growing regional biomedical market.
- c. Acquire the expertise needed to drive the success of regional biotechnology, biomaterial development, or biomedical research companies.
- d. Demonstrate critical-thinking, creativity, effective communication, and leadership skills.
- e. Acquire the foundational skills in engineering and medicine needed to advance research and innovation development domestically and globally.

2. What is the need for the proposed program (e.g., Regental system need, institutional need, workforce need, etc.)? What is the expected demand for graduates nationally and in South Dakota (provide data and examples; data sources may include but are not limited to the South Dakota Department of Labor, the US Bureau of Labor Statistics, Regental system dashboards, etc.)?

The Bureau of Labor Statistics reports that growth in the national job outlook for biomedical engineers for 2016-2026 will be as fast as average and that the median annual salary in 2016 was \$85,620.¹ In 2016 the Coalition of State Bioscience Institutes (CSBI) reported on

¹ Bureau of Labor Statistics Occupational Outlook Handbook for Biomedical Engineers, <https://www.bls.gov/ooh/architecture-and-engineering/biomedical-engineers.htm>

workforce trends.² Their report separates the United States into seven geographic regions, with South Dakota assigned to Region 4. In 2015, Region 4 had 18,803 job postings.

Locally, SAB Biotherapeutics, Sanford Health, and Alumend (all based in Sioux Falls) have pharmaceutical products and medical devices that are in FDA-approved trials and ImMutrix (based in Rapid City) is quickly approaching that stage in development. Also, the Governor's Office of Economic Development is actively recruiting companies in the medical product space, including naming "bioscience" as one of the "key industries" for the state.³ These observations, coupled with the active research in biomaterials and biomedical devices occurring at SDSMT and USD, led Dr. Christoph Bausch in his report on a South Dakota Unified Bioscience Strategy, to conclude that the biomaterial and medical device spaces should be a cornerstone of the SD bioscience economic development strategy.⁴

There is a strong national and regional need for biomedical engineers. The medical device and pharmaceutical product industry in South Dakota is young and rapidly growing. The BME Graduate Program has produced graduate and student led companies that are partaking in the biotech growth as shown in their participation and Governor's Giant Vision Business Plan awards from the SD Chamber of Commerce and Industry. To support that growth, the industry will need a skilled biomedical engineering workforce that can be uniquely provided by the Board of Regents through USD and SDSMT.

3. How would the proposed program benefit students?

The B.S. in Biomedical Engineering is an interdisciplinary degree that offers a span of job opportunities both in South Dakota and nationally. The diverse education in BME, which combines life science and engineering courses, will prepare the students to work in many professional fields (medical device, health care, animal health, agriculture, biotechnology, pharmaceutical industries, etc.). BME students have access to the vast resources of the University of South Dakota, GEAR Center, and SDSMT, which provides extensive and diverse opportunities for collaboration with faculty, clinicians, and students.

Students will be prepared to go directly into well-paying industries where biomedical products are designed and manufactured. Biomedical Engineering graduates bring a unique knowledge of life sciences, engineering design, and analysis skills to an employer. The undergraduate Biomedical Engineering degree can also help advance students to further their education into professional studies.

The programs will go up for Accreditation Board for Engineering and Technology, Inc. (ABET) accreditation. The students will also be a stakeholder in the biomedical engineering program and will be included in ongoing review of program educational objectives for continued success and continued improvement in the BME program.

² The Coalition of State Bioscience Institutes (CSBI): 2016 Life Science Workforce Trends Report http://docs.wixstatic.com/ugd/dd6885_941eb22598f7465a84b4db3386dc29c6.pdf

³ South Dakota Governor's Office of Economic Development, Key Industries, "Bioscience in South Dakota," available from <http://www.sdreadytowork.com/Key-Industries/Bioscience.aspx>.

⁴ South Dakota Unified Bioscience Strategy, Confidential. Report is on File at USD BME.

4. How does the proposed program relate to the university's mission as provided in South Dakota Statute and Board of Regents Policy, and to the current Board of Regents Strategic Plan 2014-2020?⁵

The statutory mission of the University of South Dakota is provided in SDCL 13-57-1⁶:

Designated as South Dakota's liberal arts university, the University of South Dakota, established and located at Vermillion, in Clay 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 business, education, fine arts, law and medicine, and other courses or programs as the Board of Regents may determine.

The statutory mission of the South Dakota School of Mines & Technology is provided in SDCL 13-60-1:

The South Dakota School of Mines and Technology, formerly the State School of Mines, located at Rapid City, in Pennington County, shall be under the control of the Board of Regent and shall provide undergraduate and graduate programs of instruction in engineering and the natural science and other courses or programs as the Board of Regents may determine.

Biomedical Engineering exists at the intersection of biomedical science, engineering science, and human health care. Accordingly, a program that is jointly offered by The University of South Dakota and the South Dakota School of Mines & Technology will support the missions of each university.

The SD Board of Regents strategic plan puts forth four major goals to attain by 2020; the proposed B.S. in Biomedical Engineering will help address each of these four goals:

1. Student Success – Grow degree production to 7,450 per year by 2020:

As highlighted earlier in this Intent to Plan, there is tremendous and growing demand for biomedical engineers in the workforce both nationally and regionally. This growth makes biomedical engineering an attractive option for students.

2. Academic Quality and Performance – Document that academic programs are of the highest quality:

Both USD and SDSMT will seek accreditation of their programs from the Accreditation Board for Engineering and Technology, Inc. (ABET) which periodically reviews all accredited programs to be certain they are compliant with rigorous and industry-relevant standards.

3. Research and Economic Development – Increase annual system research and contract expenditures to \$150M by 2020 to advance knowledge, enhance technology transfer, commercialization, and catalyze economic development:

In the Unified Bioscience Strategy, Dr. Christoph Bausch identified biomaterials and biomedical Devices as target areas for economic growth in South Dakota. Both of these areas fall within the domain of biomedical engineering. Further, the existing graduate-level biomedical engineering program (which is also jointly offered between USD and SDSMT) has been actively participating in technology transfer, commercialization, and economic development. Antimicrobial

⁵ South Dakota statutes regarding university mission are located in SDCL 13-57 through 13-60; Board of Regents policies regarding university mission are located in Board Policies 1:10:1 through 1:10:6. The Strategic Plan 2014-2020 is available from https://www.sdbor.edu/the-board/agendaitems/Documents/2014/October/16_BOR1014.pdf.

⁶ http://legis.sd.gov/Statutes/Codified_Laws/DisplayStatute.aspx?Type=Statute&Statute=13-57-1

Materials, Inc. and Tailored Medical Devices, Inc.; companies founded by BME graduate students, are currently licensing university technologies (AMI directly, and TMDI through a sub-license from Sanford Health). Furthermore, the SD Chamber of Commerce and Industry has awarded four Governor's Giant Vision Business Plan awards to companies that are led by BME graduates or students (BME graduates or students are underlined):

2016 BlueDop Medical (Patrick Kelly and Tyler Remund)

2014 AgriVax (Sue Lancaster)

2014 Antimicrobial Materials Inc. (Greg Bertsch)

2013 Tranzderm Solutions (Sue Lancaster)

4. *Affordability and Accountability – Reduce SD tuition and fees ranking to the regional average by 2020:*

While a single program can do little to influence the tuition and fees charged by the university, the program can provide a good value to its students. The high market need for biomedical engineering graduates will help to support that value. Accountability is a key element of the ABET accreditation process and programs are required by ABET to have stakeholder advisory boards and the boards include students, program graduates, and industry representation.

5. Do any related programs exist at other public universities in South Dakota? If a related program already exists, explain the key differences between the existing programs and the proposed program, as well as the perceived need for adding the proposed new program. Would approval of the proposed new program create opportunities to collaborate with other South Dakota public universities?⁷

Since 2006, USD and SDSMT have offered graduate programs in Biomedical Engineering. As highlighted in question #4, graduates from these programs are contributing to the growing medical product industry in South Dakota. The proposed B.S. in Biomedical Engineering will complement these successful graduate programs.

SDSMT offers a B.S. in Chemical and Biological Engineering. This program focuses on bioproduction (including pharmaceuticals). This does not overlap with the medical device and drug delivery focus of the planned B.S. in Biomedical Engineering. It is likely that elective courses will be shared between the programs, similar to the co-listed Immuno-Engineering course at the graduate level.

SDSU offers a minor in Biomedical Engineering. SDSU also offers a B.S. in Agriculture and Biosystems Engineering. This major is focused in the agricultural area and has little overlap with the human health emphasis of the planned B.S. in Biomedical Engineering.

⁷ Lists of existing system programs are available through university websites and the RIS Reporting: Academic Reports database available from <http://apps.sdbor.edu/ris-reporting/AcademicProgramReports.htm>.

6. Do related programs exist at public colleges and universities in Minnesota, North Dakota, Montana, and/or Wyoming?

	Institution	Program Title
Minnesota	University of Minnesota (Twin-Cities, Duluth)	Department of Biomedical Engineering, Bachelor of Biomedical Engineering, B.Bm.E.
North Dakota	None	(Joint Graduate Program: UND, NDSU)
Montana	Montana State University	Biological Engineering
Wyoming	None	(Minor in Biomedical Engineering @ University of Wyoming)

7. Are students enrolling in this program expected to be new to the university or redirected from other existing programs at the university?

USD’s Department of Biomedical Engineering is housed in USD’s Graduate Education and Applied Research (GEAR) Center, which is on the University Center site in Sioux Falls. Also, many of the prospective employers are based in Sioux Falls. Therefore, we believe this will position the B.S. in Biomedical Engineering to attract students that are new to the university.

The B.S. in Biomedical Engineering will also be offered on-campus at USD and SDSMT. We expect students at these locations to be a combination of new students and students that redirect from other programs.

8. What are the university’s expectations/estimates for enrollment in the program through the first five years? What are the university’s expectations/estimates for the annual number of graduates from the program after the first five years? Provide an explanation of the methodology the university used in developing these estimates.

In Fall 2017, USD began offering its A.S. in Integrated Science at the University Center in Sioux Falls. The A.S was designed to be stackable into the planned B.S. in Biomedical Engineering. There are currently six students enrolled in the A.S. and at least five of them hope to pursue the B.S. in Biomedical Engineering.

Biomedical Engineering graduate students recently started a student chapter of the Biomedical Engineering Society (BMES) at SDSMT; there meetings are routinely attended by 15-20 undergraduate students. SDSMT has 1,530 prospective students in their recruitment database for Fall 2018 who have indicated an interest in a BS in Biomedical Engineering.

Based on these anecdotal data, we believe that USD/SDSMT combined enrollment in the first year will be 20 students (including current A.S. students). Given the anticipated growth in workforce demand, we expect to graduate 30 students per year (combined).

9. Complete the following charts to indicate if the university intends to seek authorization to deliver the entire program on campus, at any off campus location or deliver the entire program through distance technology (e.g., as an on-line program)?⁸

	Yes/No	Intended Start Date
On campus	Yes	Fall 2018

	Yes/No	If Yes, list location(s)	Intended Start Date
Off campus	Yes	University Center – Sioux Falls	Fall 2018

	Yes/No	If Yes, identify delivery methods ⁹	Intended Start Date
Distance Delivery (online/other distance delivery methods)	Yes	DDN; D2L Collaborate	Fall 2018

10. What are the university’s plans for obtaining the resources needed to implement the program?

	Development/Start-up	Long-term Operation
Reallocate existing resources	Yes	Yes
Apply for external resources ¹⁰	No	No
Ask Board to seek new State resources ¹¹	No	No
Ask Board to approve a new or increased student fee	No	No

11. Curriculum Example: Provide (as Appendix A) the curriculum of a similar program at another college or university. Identify the college or university and explain why the selected program is a model for the program under development.

The Curriculum Example is from the Joint Department of Biomedical Engineering from UNC Chapel Hill and NC State University. UNC Chapel Hill undergraduates receive a liberal arts education. NC State University is a land grant college that also provides a liberal education with historical strengths in engineering, statistics, agriculture, life sciences, textiles, and design. Both programs are ABET accredited. From the Joint Department of Biomedical Engineering at UNC Chapel Hill and NC State University: “The mission of the UNC/NC State Joint Department of Biomedical Engineering is to unite engineering and medicine to improve lives. The work and culture of the Joint Department are built on three core values: innovate, collaborate, and translate. The Joint Department is a unique collaboration between North Carolina’s two flagship universities: The University of North Carolina at Chapel Hill and North Carolina State University. The nationally ranked UNC Hospitals and School of Medicine at UNC-Chapel Hill provide an excellent clinical environment for students to gain experience in medicine, while the College of Engineering at NC State, one of the finest engineering and computer science schools in the world, offers state-of-the-art facilities for students and faculty engaged in vital areas of research and technology transfer.”

See the attached Example Curriculum in Appendix A.

⁸ The Higher Learning Commission (HLC) and Board of Regents policy requires approval for a university to offer programs off-campus and through distance delivery.

⁹ Delivery methods are defined in [AAC Guideline 5.5](#).

¹⁰ If checking this box, please provide examples of the external funding sites identified

¹¹ Note that requesting the Board to seek new State resources may require additional planning and is dependent upon the Board taking action to make the funding request part of their budget priorities. Universities intending to ask the Board for new State resources for a program should contact the Board office prior to submitting the intent to plan.

Appendix A

Undergraduate Biomedical and Health Sciences Engineering Curriculum University of North Carolina at Chapel Hill 2016-2017

Students may declare the Biomedical and Health Sciences Engineering major as early as their first year. However, students who enter UNC fall 2016 or later and wish to complete the Biomedical and Health Sciences Engineering major must apply for admission to the program. Admission to the university does not guarantee admission to the program. Students will apply for admission to the program in the fall, spring or summer of their first year. Rising juniors may also apply, but admission to rising juniors will only be granted on a limited basis if space is available. Students who are not accepted to the program must select a different major.

In order to apply, students must complete or receive credit (transfer, AP or IB) for core courses (see notes 2 and 3 below). More information about this process is available on the department Web site.

First year

BMME	101	Frontiers of Biomedical Engineering ¹	1
MATH	231	Calculus of Functions of One Variable ²	3
MATH	232	Calculus of Functions of One Variable II ²	3
PHYS	116/118	Mechanics ²	4
CHEM	101, 101L	General Chemistry I and Lab ²	4
CHEM	102, 102L	General Descriptive Chem and Lab	4
ENGL	105 / 105I	English Composition and Rhetoric ³	3
		Foreign Language 3	3

1. Strongly recommended, but not required. Course provides an introduction to biomedical engineering tools and topics and information about the curriculum.
2. Students must earn a C or better in this course in order to apply for the major.
3. Students must earn a C- or better in this course in order to apply for the major.

Sophomore year

Fall or Spring:

MATH	233	Calculus of Functions of Several Variables	3
MATH	383, 383L	Linear Algebra and Differential Equations	4
PHYS	117/119	Electromagnetism and Optics	4
BMME	210	BME Design and Manufacturing I	2
BIOL	101, 101L	Principles of Biology with Lab	4
BIOL	202	Molecular Biology and Genetics	4
COMP		Introductory Programming Elective (COMP 116 highly)	3

recommended, but you can choose from COMP 116, 401, PHYS 331 or, in summer, BMME 201)

Fall only:

BMME	160	Statics	3
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Spring only:

BMME	150	Introduction to Materials Science	3
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Junior year

Fall or Spring:

BMME	310	BME Design and Manufacturing II	2
BIOL	252	Fund. Of Hum. Anatomy and Physiol.	4
MATH	528	Mathematical Methods for the Physical Sciences I (lab section is optional)	3
STOR		Statistics Elective (choose from STOR 435 or STOR 455)	3
		BME Specialty Elective 1	3

Fall only:

BMME	350	Fundamentals of Biomedical Electronics	4
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Spring only:

BMME	351	Human Physiology and Biological Measurements	4
BMME	465	Biomedical Instrumentation	4
BMME	410	Signals and Systems	3

Senior year

Fall or Spring:

BME Specialty Elective 2	3
BME Specialty Elective 3	3
BME Specialty Elective 4	3

Choose ONE of the following (additional courses taken count as a BME Specialty Elective)

BMME	341	Thermodynamics (fall)	3
BMME	455	BioFluid Mechanics (fall)	3
BMME	475	Transport Processes (spring)	3
BMME	405	Biomechanics of Movement (spring)	3
BMME	505	Skeletal Biomechanics (fall)	3

Fall only:

BMME	697	Senior Design Project	3
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Spring only:

BMME	698	Senior Design Project	3
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Any semester⁵

Approaches class: Historical Analysis (HS) ⁴	3
Approaches class: Social and Behavioral Science (SS,HS) ⁴	3
Approaches class: Social and Behavioral Science (SS,HS) ⁴	3
Approaches class: Philosophical and Moral Reasoning (PH)	3
Approaches class: Literary Arts (LA)	3
Approaches class: Visual and Performing Arts (VP)	3
Lifetime Fitness	1

Approaches classes must also meet connections⁵ no additional credit hours

US Diversity (US) North
Atlantic World (NA)
Beyond the North Atlantic World (BN)
World Before 1750 (WB)
Global Issues (GL)

4. Social and Behavioral Science or Historical Analysis classes must come from two different departments
5. Other approaches and connections requirements are met by required courses

BME electives offered in fall (this list is subject to change):

BMME 445: Systems Neuroscience
BMME 485: Biotechnology
BMME 510: Biomaterials
BMME 550: Medical Imaging
BMME 580: Microcontroller Applications I
PHYS 405: Biological Physics
BMME 490: Topics vary. Check listings.
BMME 495: Undergraduate Research in BME as a Technical Elective

BME electives offered in spring (this list is subject to change):

BMME 420: Introduction to Synthetic Biology
BMME 425: Biomedical Applications of Electromagnetics
BMME 470: Tissue Engineering
BMME 576: Mathematics for Imaging Computing
BMME 490: Topics vary. Check listings.
BMME 495: Undergraduate Research in BME as a Technical Elective