



**SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS**

New Baccalaureate Degree Minor

UNIVERSITY:	SDSU
TITLE OF PROPOSED MINOR:	Bioprocessing Sciences
DEGREE(S) IN WHICH MINOR MAY BE EARNED:	Any
EXISTING RELATED MAJORS OR MINORS:	None
INTENDED DATE OF IMPLEMENTATION:	2019-2020 Academic Year
PROPOSED CIP CODE:	14.4501
UNIVERSITY DEPARTMENT:	College of Agriculture, Food and Environmental Sciences
UNIVERSITY DIVISION:	College of Agriculture, Food and Environmental Sciences

University Approval

To the Board of Regents 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.

President of the University

5/13/2019

Date

- 1. Do you have a major in this field?** Yes No

- 2. If you do not have a major in this field, explain how the proposed minor relates to your university mission.**

South Dakota State University (SDSU) requests authorization to offer a baccalaureate minor in Bioprocessing Sciences. Bioprocessing is a broad term encompassing the research, development, manufacturing, and commercialization of products prepared from or used by biological systems, including food, feed, fuels, and biopharmaceuticals, as well as remediation of environmental waste. The minor in Bioprocessing Sciences will provide students with knowledge and skills that supplement their major field of study to serve the large bioprocessing industries in South Dakota and the region. The minor will support SDSU's mission of providing engaging instruction that contributes to workforce development in South Dakota and the region.

The Bioprocessing Sciences Minor supports the mission of SDSU as provided in SDCL 13-58-1: *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, aviation, education, engineering, human sciences, nursing, pharmacy, and other courses or programs as the Board of Regents may determine. Bioprocessing industries are expanding in South Dakota, and a skilled labor force is required to support the development and manufacturing of bio-based products, such as biofuels, soy-based food products, and feed for farm-based aquaculture.

SDSU does not request new state resources.

3. What is the nature/purpose of the proposed minor?

The proposed minor is intended to provide students with a general understanding of principles and development of skills in bioprocessing technologies such as fermentation, bioseparation, and energy transfer. Principles of quality control, operational efficiency, safety, and project management are also important components of the minor. Students will learn how to apply these principles and technologies in commercial product bio-based manufacturing and environmental services.

This is an interdisciplinary minor that utilizes existing courses from agriculture, natural sciences, and engineering. It supports workforce development in manufacturing industries, such as renewable fuels and food/drink products, and in environmental services, such as waste remediation and management.

4. How will the proposed minor benefit students? What are the majors/degree programs from which students would likely enroll in the minor?

Several majors at SDSU in agriculture, natural sciences, and engineering, require students to take one or more courses with content related to bioprocessing. However, these students might not be aware of complementary course offerings in other disciplines or the breadth of outstanding career opportunities in the bioprocessing industries. The minor in Bioprocessing Sciences will provide students in these majors with additional coursework to better prepare them for a career related to bioprocessing, and will bring to their attention career opportunities that they otherwise might not have considered. The additional credential will make students more competitive in the job marketplace.

The minor is expected to have particular appeal to students majoring in Agricultural and Biosystems Engineering, Agricultural Systems Technology, Biotechnology, Dairy Manufacturing, Food Science, Mechanical Engineering, Microbiology, and Operations Management.

5. Describe the workforce demand for graduates in related fields, including national demand and demand within 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.

Bioprocessing technologies are used in a variety of industries ranging from renewable fuels, food and drink products, pharma- and nutraceuticals, and environmental remediation of wastes. This minor will combine courses from several disciplines to enhance the student's knowledge of these technologies and provide hands-on experiences with their applications,

thus helping to prepare students for career opportunities in the bioprocessing industries. The SD Department of Labor has projected strong growth (12.1 to 14.8%) in industry employment for the period 2016 to 2026 in the areas of professional, scientific and technical services; chemical manufacturing; and waste management and remediation services.¹ Students majoring in disciplines related to agriculture, engineering, and other STEM areas are particularly encouraged to work towards a minor in Bioprocessing Sciences to enhance their preparation and employability for a career related to bioprocessing.

Bioprocessing is integral to several large industries in South Dakota and the region. South Dakota and the neighboring states of Minnesota, Iowa, and Nebraska account for four of the top six states in the U.S. for ethanol production capacity.² Additionally, bio-based processing significantly enhances the value of and demand for some of the most economically important commodities produced in South Dakota, including corn and soybeans.

Future employees and their employers in the bioprocessing industries will benefit from this certificate. Students will have an enhanced skill-set that combines basic knowledge of how bioprocessing technologies work and how to apply them in the commercial manufacturing of bio-based products. Students completing the minor will have a clearer understanding of how their chosen major can fill workforce needs in the bioprocessing industries.

6. Provide estimated enrollments and completions in the table below and explain the methodology used in developing the estimates.

The estimates below are based on approximately 5% of the students majoring in Agricultural and Biosystems Engineering, Agricultural Systems Technology, and Microbiology and 2.5% of the students majoring in Biotechnology, Dairy Manufacturing, Food Science, Mechanical Engineering, and Operations Management will enroll in the minor.

<i>Estimates</i>	Fiscal Years*			
	1st	2nd	3rd	4th
	FY 20	FY 21	FY 22	FY 23
Students enrolled in the minor (fall)	10	15	20	25
Completions by graduates	0	0	3	5

*Do not include current fiscal year.

7. What is the rationale for the curriculum? Demonstrate/provide evidence that the curriculum is consistent with current national standards.

There is no existing academic program in the state designed specifically to address the workforce needs of the bioprocessing industries. SDSU offers courses in several departments with relevant content, but there is limited depth of bioprocessing content in any given major, and there is no structure or obvious academic pathway that helps students identify an appropriate set of courses for career preparation in bioprocessing. The proposed minor is designed to provide a pathway for students from several majors to significantly enhance their preparation to enter the bioprocessing workforce. The proposed minor is comprised of courses

¹ SD Dept. of Labor & Regulation (2018). *2017 Annual Workforce Report*. Available at https://dlr.sd.gov/lmic/menu_publications.aspx

² US Energy Information Administration. (June, 2017). *Today in Energy*. Available at: <https://www.eia.gov/todayinenergy/detail.php?id=31832>.

selected from programs in the Departments of Agricultural and Biosystems Engineering, Biology and Microbiology, Construction and Operations Management, Dairy and Food Science, Health and Nutritional Sciences, and Mechanical Engineering. Students completing the minor will gain well-rounded knowledge of several aspects of the bioprocessing industries to complement their fields of study and strengthen their employability.

There is not a national accrediting body or educational organization.

8. Complete the tables below. Explain any exceptions to Board policy requested.

A. Distribution of Credit Hours

Bioprocessing Sciences Minor	Credit Hours	Percent
Requirements in minor	14-15	72%
Electives	3-4	28%
Total	18	100%

B. Required Courses in the Minor

Prefix	Number	Course Title	Credit Hours	New (yes, no)
MICR OR MICR	231-231L 233-233L	General Microbiology and Lab (4) Introductory Microbiology and Lab (4)	4	No
ABE	444-444L	Unit Operations of Biological Materials Processing and Lab	3	No
ABE OR ME OR ME	343-343L 311 314	Engineering Properties of Biological Materials and Lab (3) Thermodynamics I (3) Thermodynamics (3)	3	No
AST OR FS OR ME OR MICR	443-443L 351-351L 416 450	Food Processing and Engineering Fundamentals (3) Principles of Food Processing (3) Renewable Energy Systems (3) Applications of Microbiology and Biotechnology (3)	3	No
ABE XXX XXX	411 or 494 or 498	Design Project III (2) Internship Undergraduate Research	1-2	No
Subtotal			14-15	

C. Elective Courses in the Minor: List courses available as electives in the program. Indicate any proposed new courses added specifically for the minor.

Select 3-4 credits from the following list:

Prefix	Number	Course Title	Credit Hours	New (yes, no)
GE	425	Occupational Safety/Health Management	3	No
MICR	311-311L	Food Microbiology and Lab	4	No
MICR	332	Microbial Physiology	2	No
MICR	332L	Microbial Physiology Lab	2	No
MNET	231-231L	Manufacturing Processes I and Lab	3	No
NUTR	426-426L	Production of Wine Beer Spirits and Lab	3	No
OM	240	Decision Making Processes in Management	3	No
OM	425	Production Operations/Management ³	3	No

D. List any prerequisites for the courses above.

The following courses include prerequisite requirements:

Course Title	Prerequisite
FS 351-351L Principles of Food Processing	FS 251 + CHEM 106 [SGR #6] or CHEM 114 [SGR #6]
ME 311 Thermodynamics I	PHYS 211 [SGR #6] + EM 215
ME 314 Thermodynamics	PHYS 211 [SGR #6] + MATH 125 [SGR #5]
ME 416 Renewable Energy Systems	ME 311, ME 314, or PHYS 341
MICR 231-231L General Microbiology & Lab	CHEM 106 [SGR #6] or CHEM 112 [SGR #6]
MICR 233-233L Introductory Microbiology & Lab	BIOL 151 [SGR #6] + 6 credits of CHEM [SGR #6]
MICR 311-311L Food Microbiology & Lab	MICR 231 [SGR #6] or MICR 233
MICR 332 Microbial Physiology	MICR 231 [SGR #6] or MICR 233
MICR 450 Applications of Microbiology and Biotechnology	MICR 231 [SGR #6] or MICR 233
NUTR 426-426L Production of Wine, Beer and Spirits and Lab	Registration Restriction - Participants must be 21 years of age or older to enroll
OM 240 Decision Making Processes in Management	MATH 121 [SGR #5]
OM 425 Production & Operations Management	STAT 281 [SGR #5] or STAT 381

E. Minors typically consist of 18 credit hours, including prerequisite courses. Proposals to establish new minors as well as proposals to modify existing minors must recognize and address this limit. If the minor includes more than 18 credit hours (including prerequisites), provide justification below.

The minor consists of existing courses. Several of the courses have prerequisites; however, the prerequisites in question are typically taken during students' general education coursework and will have little effect on the students pursuing the minor. In addition, the elective courses align closely to the program requirements for the primary audience. It is likely those electives would be completed by students in majors in which they would already be taking the prerequisites. These majors include Agricultural and Biosystems

³ Minor course modification will revise OM 425 Production and Operations Management to remove MNET 367-367L Production Strategy & Lab as prerequisite effective fall 2019.

Engineering, Agricultural Systems Technology, Biotechnology, Dairy Manufacturing, Food Science, Mechanical Engineering, Microbiology, and Operations Management.

All students in the minor will have to complete ABE 444-444L and the experiential learning requirement (ABE 411 or XXX 494 or XXX 498) which do not require prerequisites. It is anticipated all students pursuing the minor are expected to be from majors for which the prerequisites for either MICR 231-231L or MICR 233-233L are already required. Either of these lower-level MICR courses fulfills the prerequisite requirement for all higher level MICR courses in the minor.

Other requirements for the minor have course alternatives to meet the program learning outcomes such that most students can choose a course for which the prerequisite requirement will have been met by other requirements in their respective major.

9. What are the learning outcomes expected for all students who complete the minor? How will students achieve these outcomes?

Students completing the minor in Bioprocessing Sciences will be able to:

- Understand how cells or cellular components of biomaterials can be grown to produce commercial quantities of desired raw products (upstream bioprocessing).
- Understand and use biomass separation techniques to extract desired product from cell debris (downstream bioprocessing).
- Apply bioprocessing principles (e.g., fermentation, heat, mass, and energy transfer) to manufacturing of renewable energy and commercial bioproducts or to management of environmental waste.
- Apply principles of quality control, operations efficiency, project management, and safety to manufacturing of bio-based products.
- Demonstrate understanding and applications of operational protocol used in a bioprocessing discipline.
- Demonstrate a working knowledge of one or more industries that utilize bioprocessing technologies.

The attached curriculum map (Appendix A) shows where students achieve these outcomes in the curriculum.

10. What instructional approaches and technologies will instructors use to teach courses in the minor? *This refers to the instructional technologies and approaches used to teach courses and NOT the technology applications and approaches expected of students.*

The coursework associated with this minor is delivered in a face to face learning environment with considerable hands-on class laboratory experiences. The experiential learning requirement consisting of either an internship (XXX 494), undergraduate research (XXX 498), or design project (ABE 411) will give students an opportunity to integrate knowledge and laboratory skills from other classes in the minor into applied production and/or processing of biomaterials.

11. Delivery Location⁴

⁴ The accreditation requirements of the Higher Learning Commission (HLC) require Board approval for a university to offer programs off-campus and through distance delivery.

A. Complete the following charts to indicate if the university seeks authorization to deliver the entire program on campus, at any off campus location (e.g., UC Sioux Falls, Capital University Center, Black Hills State University-Rapid City, etc.) or deliver the entire program through distance technology (e.g., as an online program)?

	Yes/No	Intended Start Date
On campus	Yes	2019-2020 Academic Year

	Yes/No	If Yes, list location(s)	Intended Start Date
Off campus	No		

	Yes/No	If Yes, identify delivery methods ⁵	Intended Start Date
Distance Delivery (online/other distance delivery methods)	No		

B. Complete the following chart to indicate if the university seeks authorization to deliver more than 50% but less than 100% of the certificate through distance learning (e.g., as an online program)?⁶

	Yes/No	If Yes, identify delivery methods	Intended Start Date
Distance Delivery (online/other distance delivery methods)	No		

The courses in the Bioprocessing Minor are not available online at SDSU.

12. Does the University request any exceptions to any Board policy for this minor? Explain any requests for exceptions to Board Policy. If not requesting any exceptions, enter "None."

None.

13. Cost, Budget, and Resources: 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 operations and maintenance, facilities, etc., needed to implement the proposed minor. Address off-campus or distance delivery separately.

All courses are currently being taught. SDSU does not require any additional resources to offer this minor.

14. New Course Approval: New courses required to implement the new minor may receive approval in conjunction with program approval or receive approval separately. Please check the appropriate statement (place an "X" in the appropriate box).

⁵ Delivery methods are defined in [AAC Guideline 5.5](#).

⁶ This question responds to HLC definitions for distance delivery.

YES,

the university is seeking approval of new courses related to the proposed program in conjunction with program approval. All New Course Request forms are included as Appendix C and match those described in section 7.

NO,

the university is not seeking approval of all new courses related to the proposed program in conjunction with program approval; the institution will submit new course approval requests separately or at a later date in accordance with Academic Affairs Guidelines.

Appendix A
Minor in Bioprocessing Sciences – Student Learning Outcomes

	Required	Required	Must Complete One of These Courses			Must Complete One of These Courses			
	MICR 231/L or MICR 233/L	ABE 444/L	ABE 343/L	ME 311	ME 314	FS 351/L	AST 443/L	ME 416	MICR 450
Student Outcomes									
1. Understand how cells or cellular components of biomaterials can be grown to produce commercial quantities of desired raw products (upstream bioprocessing).	X								X
2. Understand and use biomass separation techniques to extract desired product from cell debris (downstream bioprocessing).	X	X	X						X
3. Apply bioprocessing principles (e.g., fermentation, heat, mass, and energy transfer) to manufacturing of renewable energy and commercial bioproducts or to management of environmental waste.		X	X	X	X	X	X	X	X
4. Apply principles of quality control, operations efficiency, project management, and safety to manufacturing of bio-based products.						X	X		
5. Demonstrate understanding and applications of operational protocol used in a bioprocessing discipline.		X					X	X	
6. Demonstrate a working knowledge of one or more industries that utilize bioprocessing technologies.						X	X	X	X

Appendix A (continued)
Minor in Bioprocessing Sciences – Student Learning Outcomes

Student Outcomes	Must Complete One of These Courses			Electives					
	ABE 411	XXX 494	XXX 498	GE 425	MICR 311-311L	MICR 332-332L	MNET 231-231L	NUTR 426-426L	OM 425
1. Understand how cells or cellular components of biomaterials can be grown to produce commercial quantities of desired raw products (upstream bioprocessing).						X			
2. Understand and use biomass separation techniques to extract desired product from cell debris (downstream bioprocessing).						X		X	
3. Apply bioprocessing principles (e.g., fermentation, heat, mass, and energy transfer) to manufacturing of renewable energy and commercial bioproducts or to management of environmental waste.	X	X	X		X		X	X	
4. Apply principles of quality control, operations efficiency, project management, and safety to manufacturing of biobased products.		X	X	X	X		X	X	X
5. Demonstrate understanding and applications of operational protocol used in a bioprocessing discipline.	X	X	X					X	
6. Demonstrate a working knowledge of one or more industries that utilize bioprocessing technologies.	X	X	X					X	