HIGHER EDUCATION COORDINATING COMMISSION
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Docket Item:

University Program Approval: Oregon State University, Bachelor of Science (B.S.) in Biological Data Science.

Summary:

Oregon State University proposes a new degree program leading to a B.S. in Biological Data Science. The statewide Provosts' Council has unanimously recommended approval. Higher Education Coordinating Commission (HECC) staff completed a review of the proposed program. After analysis, HECC staff recommends approval of the program as proposed.

Materials:

Academic program information.

Staff Recommendation:

Staff recommends the Commission move to approve the University Program Approval: Oregon State University, Bachelor of Science (B.S.) in Biological Data Science.

HECC Docket Submission

Oregon State University seeks the Oregon Higher Education Coordinating Commission approval to offer an instructional program leading to a Bachelor of Science in Biological Data Sciences.

Program Description and Justification

1. *Identify the institution, degree, and title of the program.*

   Oregon State University is proposing to offer a new Bachelor of Science degree program in Biological Data Sciences beginning in summer 2020.The program will be located in the College of Agricultural Sciences. The proposed program will be delivered face-to-face on the OSU-Corvallis campus.

2. *Describe the purpose and relationship of the proposed program to the institution's mission and strategic plan.*

   The Biological Data Sciences program is structured to help meet the state of Oregon's 40-40-20 goal, specifically that 40% of Oregonians will complete a four-year degree. The Biological Data Sciences program does this by diversifying OSU's portfolio of academic programs into an area where there is substantial job growth. The program will include early academic advising, research opportunities and peer-to-peer learning to promote student success and retention. Access to research opportunities on the undergraduate level has been shown to increase retention and provide greater access to graduate school for under-represented students. The transdisciplinary curriculum of Biological Data Sciences is expected to attract a student population with diverse academic backgrounds, interests, and career goals. The structure of the program ensures distributed learning and an interdependent learning community designed to help reduce achievement gaps between diverse groups of students and first-generation college students.

   Graduates of the Biological Data Sciences program will be prepared to engage in work that addresses timely issues such human health, food security, global climate change and social progress that directly reflect OSU's signature areas of focus and strategic priorities.

3. *What evidence of need does the institution have for the program?*

   A 2014 industry association report from the Coalition of State Bioscience Institutes stated that workers with degrees in subject areas that prepare them for data analytics are in exceptional demand.

   Past analyses and present-day assessment indicate that demand for scientists qualified to analyze big data outstrips supply. Oregon's STEM Investment Council has set as one of their goals to double the number of students who earn a postsecondary degree with proficiencies in the STEM field. Biological Data Scientists fill an existing void state-wide and nationally.

4. *Are there similar programs in the state? If so, how does the proposed program supplement, complement, or collaborate with those programs?*

   To our knowledge, there are currently no post-secondary institutions in Oregon that offer an undergraduate degree in Biological Data Sciences.

All appropriate University committees and the Statewide Provosts Council have approved the proposed program. The Oregon State University Board of Trustees approved the program on October 17, 2019.

Recommendation to the Commission

The Statewide Provosts Council recommends that the Oregon Higher Education Coordinating Commission authorize Oregon State University to establish an instructional program leading to a Bachelor of Science in Biological Data Sciences, effective summer 2020**.**

Proposal for a New Academic Program

Institution: Oregon State University
College/School: College of Agricultural Sciences
Department/Program Name: Botany and Plant Pathology
Degree and Program Title: Biological Data Sciences (BDS)

1. PROGRAM DESCRIPTION

a. Proposed Classification of Instructional Programs (CIP) number.

CIP Code 26.1199
Title: Biomathematics, Bioinformatics, and Computational Biology, Other.
Definition: Any instructional program in biomathematics, bioinformatics, and computational biology not listed above.

b. Brief overview (1-2 paragraphs) of the proposed program, including its disciplinary foundations and connections; program objectives; programmatic focus; degree, certificate, minor, and concentrations offered.

We propose a new undergraduate major and minor that combines education and practical training in biological data sciences (**BDS**), a new paradigm in the life sciences that couples large-scale data collection with advanced computational and analytical methods for data analyses. Data are currently being collected at speeds and scales that were previously unimaginable and modern research programs addressing issues of human health, energy, the environment, and food security are heavily dependent on scientists with the skills to work large and complex datasets. The training of undergraduate students in the life sciences, however, has not been contemporized to meet these needs. The BDS undergraduate program outlined here addresses that deficit by providing transdisciplinary education that intersects the life sciences, computer science, statistics, and mathematics. The BDS academic program is designed to make use of existing course curricula in life and earth sciences, chemistry, mathematics, computer science, and statistics to provide a core knowledge base for all BDS students. Each student also chooses an academic program of particular interest to pursue an in-depth option that is part of the 180 credits required for their degree. This breadth of academic training is one special feature of the BDS degree. The other unique feature is the series of BDS cohort classes that emphasize the following: 1) active learning, application, and integration of the core knowledge base, 2) working in teams, and 3) communicating across disciplines. These learning experiences will foster undergraduate engagement and provide skills that are needed for success in graduate or professional school and the workplace.

BDS will be based in the College of Agricultural Sciences (CAS) and administered by Department of Botany and Plant Pathology (BPP), but the program is designed to be collaborative and to integrate courses and faculty across units representing multiple disciplines, including all of the life sciences departments, Chemistry, the School of Life Sciences, School of Electrical Engineering and Computer Science, the departments of Statistics and Mathematics, and the College of Earth, Ocean, and Atmospheric Sciences.

<u>The outcome of the BDS program will be graduates that</u>:

1. are trained in core knowledge and competencies across the *diversity* of disciplines;
2. have domain expertise in an area of one disciplinary field;
3. understand the process of scientific investigation;

4. understand the appropriate use of a variety of quantitative methods;
5. communicate effectively across disciplines; and
6. function collaboratively in transdisciplinary teams.

c. **Course of study**

General features of the program:

1. Students will learn the fundamentals of the life sciences, computer science, mathematics, and statistics.
2. Students choose an option to study a particular area of BDS at a deeper and more rigorous level.
3. The foundational and advanced classes are drawn from existing OSU academic programs in various colleges and departments.
4. Five new BDS courses are designed to educate the students as a cohort to integrate the various disciplinary approaches, and to use case studies, and capstone projects to learn skills necessary for functioning in teams.
5. Each student completes an independent experiential learning activity and learns to capture that experience in professional writing and oral presentation skills.

Core concepts and competencies that define the BDS degree:

1. Fundamentals of the life sciences: ecology/evolution, structure/function, information flow, energy and matter transformation, and systems.
2. Fundamentals of statistics: statistical inference, probability distributions, and commonly used statistical models.
3. Fundamentals of mathematics: derivatives and integrals and their applications; basic notions in linear algebra including matrix manipulations, eigenvalues and eigenvectors and their applications.
4. Fundamentals of computer science: programming skills, data structures, design and analysis of algorithms, and data mining.
5. Effective communication with researchers within and across disciplines; functioning effectively in teams to accomplish a common goal.
6. Appropriate and sensible use of quantitative methods and tools to effectively manage, summarize, visualize, manipulate, and make accurate inference from large biological datasets.
7. Process of scientific investigation: hypothesis generation, experimental design, and data generation, data analysis and evaluation.
8. Knowledge of principles in the life sciences to generate biological datasets.
9. Knowledge of theories and principles in the life sciences to develop testable hypotheses.
10. How to apply methods of mathematics to model biological systems.
11. Knowledge of principles in statistics, mathematics, and computer science to use and adapt quantitative-based methods for research needs.
12. Knowledge of theories and principles in statistics, mathematics, and computer science to design computer-based systems and new approaches for research needs.

d. Anticipated start date.

Fall, 2020

2. Relationship to Mission and Goals

a. Manner in which the proposed program supports the institution's mission, signature areas of focus, and strategic priorities.

OSU has set goals to raise the standards in teaching, research, and outreach to meet the mission of promoting economic, social, cultural, and environmental progress in the three signature areas of sustaining Earth ecosystems, improving human health, and promoting economic growth. Solutions to many of the most complex problems relevant to these signature areas require the integration of large and

diverse data sets and the linked development of computational models encompassing multiple levels of scale.

The proposed BDS program is designed to address the mission of OSU. The rigorous program will recruit the top domestic and international students. As part of the learning experience, students will be required to participate in an experiential learning activity and a senior capstone course. At OSU, there are many research programs across the life science departments that generate and use big data to address timely issues in human health, food security, global climate change, and social progress. In mathematics, statistics, and computer science, research programs are innovating approaches for processing, analyzing, and modeling large datasets. These research programs offer multiple opportunities for students to learn to use large and real-world datasets to address societal issues relevant to OSU's three signature areas.

To provide students a transformative educational experience, BDS is structured for cohort learning and promotes the integration of domain knowledge from multiple disciplines and teaches skills necessary for effectiveness in teams. The learned skills will prepare students for careers in research and development in academic, private, and government sectors, which are increasingly seeking graduates who are capable of adapting to and bridging multiple disciplines, and who are comfortable with diverse quantitative and computational methods necessary for success in trans-disciplinary collaborations.

b. Manner in which the proposed program contributes to institutional and statewide goals for student access and diversity, quality learning, research, knowledge creation and innovation, and economic and cultural support of Oregon and its communities.

The proposed BDS program values the importance of diversity in enriching the research, teaching and outreach missions of OSU. Because of the trans-disciplinary nature of the BDS major, we will attract a student population with very diverse academic backgrounds, interests, and career goals. To promote inclusivity and retention, students in the BDS program will be constantly engaged in tasks and projects that require work in small trans-disciplinary teams. The program will also be structured to have moderate to high levels of active learning exercises in its courses and a cohort that meets annually in BDS core courses. This structure ensures quality, a distributed learning, and an interdependent learning community, all of which help reduce achievement gaps between diverse groups of students and first-generation college students (5).

BDS requires its students to work with data generated by researchers who engage in collaborative research and participate in activities to generate knowledge, innovate approaches, and contribute to discoveries that have the potential to benefit Oregon and its communities. BDS will be administered by a department that has a strong culture of high-quality, interdisciplinary, collaborative research and teaching. The coupling of the two missions provides students direct access to research opportunities, many of which directly address the signature areas of sustainable Earth ecosystems and food security/human health. Moreover, because BDS uses foundational courses offered by other units and has core courses taught by faculty outside of BPP, students will have direct access to the various research programs across OSU. Last, BDS will have the synergistic effect of furthering the integration of researchers at OSU and innovating the research missions of OSU.

c. Manner in which the program meets regional or statewide needs and enhances the state's capacity to:

i. improve educational attainment in the region and state;

By implementing the 40-40-20 education goal, the state of Oregon has raised the standards for educational attainment. To help meet the goals of 40% Oregonians completing a 4-year degree, the BDS program will include early academic advising, strong learning experiences, and peer-to-peer learning to promote student success. BDS will also emphasize early academic achievement and ensure students have strong skills in writing and math. The cohort learning establishes a distributed learning environment, contributes to cultural awareness, all of which have been shown to benefit historically under-served students (6). Most importantly, research experience and skills, like those provided by the BDS capstone

project and courses, are becoming increasingly necessary for successful post-undergraduate career plans. Students are also more likely to stay in a STEM field and express interest in an advance degree if given opportunities to conduct independent undergraduate research (7). This retention seems to be particularly evident in historically under-represented students (8-10). The research experiences make faculty and staff more approachable, another factor that positively influence student success. In addition, the director of BDS will be involved in teaching and developing program portfolios and will be approachable to students. Last, students have greater successes in courses that incorporate active learning (4). Improved grades and increased rate of completion of STEM courses can reduce course repetition, the time for degree attainment and the cost of college for the students while leading to a higher graduation rate. Thus, by integrating active learning throughout the BDS program we are maximizing the likelihood that students who start the degree will successfully complete the program.

ii. respond effectively to social, economic, and environmental challenges and opportunities; and

Finding solutions for some of the most pressing societal challenges requires a "new biology for the 21st century" that is dependent on integration within biology and collaboration with other sciences (11). Innovative technologies and the scale in which data can be collected are transforming key sectors such as agriculture, research on climate change, and the health industry, especially in the area of personalized medicine. For example, employment in Oregon bioscience-based industries grew by nearly 31% in 2001-2010 and personalized medicine is expected drive 27% growth of biomedical engineering employment in Oregon in the next decade. BDS is designed to address the need to prepare students for skills in working large datasets and collaborating across disciplines and will thus supply skilled professionals who can help the state respond effectively to challenges and opportunities.

iii. address civic and cultural demands of citizenship.

Cohort learning promotes the sharing of experiences and interactions and group commitment to achieving a common educational goal. Evidence has suggested that such learning models improve academic achievements. Importantly, cohort learning gives students opportunities to practice cooperation, in contrast to competition, and provides more support for students as they progress towards their goals. Members of cohorts are exposed to more diverse ideas and perspectives, which contribute to a greater sense of inclusivity and better cultural awareness. This learned sense of cooperation will translate to informed professionals who are more aware of the responsibilities of citizenship.

3. Enrollments

a. Anticipated fall term headcount and FTE enrollment over each of the next five years.

The following projections assume students will graduate in four years and increased enrollment as the program matures.

Year 1: 15~25 Year 2: 35~50 Year 3: ~75 Year 4: 100~115 Year 5: ~125

b. Expected degrees/certificates produced over the next five years.

Year 1: 0 Year 2: 0 Year 3: 5 (we expect transfer students) Year 4: 20-30 Year 5: 20-30

c. Characteristics of students to be served (resident/nonresident/international; traditional/ nontraditional; full-time/part-time, etc.).

Students pursing the BDS major will be resident, nonresident, and international full-time traditional students. Bioinformatics is a highly sought-after skill and the BDS major is expected to attract a more diverse demographic of students, including non-resident and international students.

d. Evidence of market demand.

As expected of an explosion of data richness, there has been a corresponding increase in demand for trans-disciplinary trained scientists, and a variety of career opportunities. Analysis of employment advertisements from 2003-2008, revealed a substantial and steady increase in opportunities (12). In fact, past analyses and present-day assessment indicate that demand for qualified scientists outstrips supply (13,14). It has been estimated that the United States faces a shortage of individuals with analytical skills necessary for analyzing big data (15). An analysis of current and future computer science needs showed that the largest need for faculty is in the area of "big data" (16). Locally, more than 20% of the jobs in Oregon fall into the STEM (Science, Technology, Engineering, and Math) categories (17). Based on projected job openings, 82% require a doctoral or professional degree while 55% require a bachelor's degree. The STEM fields are recognized as being key to economic well-being. Yet, there is concern that demand outstrips supply and the Oregon's STEM Investment Council has set as one of their goals to double the number of students who earn a postsecondary degree with proficiencies in a STEM field.

4. Outcomes and Quality Assessment

a. Expected learning outcomes of the program.

The learning outcomes of BDS are:

1. Apply the process of scientific investigation to real world biological datasets.
2. Use appropriate quantitative and visual methods in scientific investigation.
3. Demonstrate proficiency in using appropriate methods to organize and manipulate large datasets.
4. Demonstrate effective communication and functioning in trans-disciplinary teams.
5. Adhere to the standards of ethical behavior (honesty and integrity in all stages of scientific practice to produce unbiased scientific knowledge).
6. Apply the core concepts in the biological sciences, mathematics, statistics, and computer science to scientific investigation.

5. Program Integration and Collaboration

a. Closely related programs at other Oregon colleges and universities.

There are no closely related programs, as no Oregon public university offers an undergraduate Bachelor of Science degree in Bioinformatics and Data Science. However, University of Oregon has a Bioinformatics and Genomics Master's Program. Portland State University and Oregon Health & Sciences University have a Biomedical Informatics Program, which combines a computer science degree and a Master's degree in Biomedical Informatics. At OSU, several undergraduate programs offer options that are related to BDS. For example, EECS offers a bioinformatics option. Mathematics offers a Mathematical Biology option. Biochemistry and Biophysics offers a Computational and Molecular Biology option. BioResource Research has a Genomics/Bioinformatics option. However, BDS will be a degree-granting program and is unique in being a transdisciplinary program that requires students to have disciplinary foundations in biology, mathematics, computer science, and statistics. Last, BDS provides a cohort learning experience that ensures integration of knowledge and skills across the disciplines.

Proposal References Available in a separate document upon request

Institution: Oregon State University
Program: BS in Biological Data Sciences

Action: At the **November 21, 2019** meeting, the Statewide Provosts Council approved a new program for **Oregon State University, BS in Biological data Sciences,** Policy to move forward to the Oregon Higher Education Coordinating Commission for its review and approval. The **Oregon State University** Board of Trustees approved the program at its **October 17, 2019** meeting.

Eastern Oregon University
Sarah Witte, provost
_X_ Approved
__Opposed
__Abstained

Oregon State University
Ed Feser, provost
_X_ Approved
__Opposed
__Abstained

Portland State University
Susan Jeffords, provost
_X_ Approved
__Opposed
__Abstained

University of Oregon
Patrick Phillips, provost
_X_ Approved
__Opposed
__Abstained

Oregon Health & Science University
Elena Andresen, interim provost
_X_ Approved
__Opposed
__Abstained

Oregon Tech
Joanna Mott, provost
_X_ Approved
__Opposed
__Abstained

Southern Oregon University
Susan Walsh, provost
_X_ Approved
__Opposed
__Abstained

Western Oregon University
Rob Winningham, provost
_X_ Approved
__Opposed
__Abstained