New Degree Program Proposal
Biological Data Sciences

Status: Pending Review - Faculty Senate Exec Committee (Previous Version)

Hide All Reviews

1. Review - College Approver - Agricultural Sciences

Approved by Penelope Diebel Assistant Dean / College of Ag Admin, *March 25, 2019 12:40pm*

Comments

Penelope Diebel (College Approver - Agricultural Sciences) March 25, 2019 12:40pm
The College of Agricultural Sciences supports the addition of this new degree program. The originators have gone through extensive liaison processes to determine the best curriculum internal to the Department, as well as those courses listed from outside the department.

2. Review - Curriculum Coordinator

Approved by Janice Nave-Abele Curriculum Coordinator / University Accreditation, *April 1, 2019 1:42pm*

Comments

Janice Nave-Abele (Curriculum Coordinator) April 1, 2019 1:42pm
This application proposes to establish a new undergraduate degree program in Biological Data Sciences. This program will be delivered at the main OSU Corvallis campus.

This new undergraduate program has three Options included: Computational Biology (CB), Ecological and Environmental Informatics (EEI), Genomics Option (GEN).

The CIP number for this program is 26.1101.

3. Review - Graduate School

Approved by Janice Nave-Abele Curriculum Coordinator / University Accreditation, *April 1, 2019 1:45pm*

Comments

Janice Nave-Abele (Graduate School) April 1, 2019 1:45pm
This proposal is for an Undergraduate program and does not need to be reviewed by the Graduate School. The proposal is being moved forward for consecutive review by the Budgets and Fiscal Planning Committee and by the Faculty Senate Curriculum Council.

4. Review - Budgets and Fiscal Planning Committee

Approved by Andrew Ibarra Dir-Physical Activity Program / Sch of Bio/Pop Hlth Sci, *May 15, 2019 9:34am*

Comments

Andrew Ibarra (Budgets and Fiscal Planning Committee) April 26, 2019 3:17pm
Committee reviewed and had further questions, will contact Jackie Thorsness for further clarification

5. Review - Graduate Council Chair

Approved by Janice Nave-Abele Curriculum Coordinator / University Accreditation, *May 17, 2019 7:52am*

Comments

Janice Nave-Abele (Graduate Council Chair) May 17, 2019 7:52am
This is an undergraduate degree and does not require Graduate Council review.

Materials linked from the June 13, 2019 Faculty Senate agenda.

6. Review - Curriculum Council Chair

Sent Back by Allen Thompson Associate Professor / Philosophy Department, *June 3, 2019 10:47am*

Comments

Allen Thompson (Curriculum Council Chair) June 3, 2019 10:47am
Members of the Council were concerned that this program depended on several required courses from other colleges which were already very difficult to get into. Council member asked that letters of support be obtained from admin in relevant Colleges and that the originator provide a letter addressing how students would receive suitable advising for an interdisciplinary program across several colleges.

7. Originator Response

Janice Nave-Abele Curriculum Coordinator / University Accreditation, *June 10, 2019 9:20am*

Comments

Janice Nave-Abele June 10, 2019 9:20am
Sending proposal back to Curriculum Council Chair per his request.

8. Review - Curriculum Council Chair

Approved by Allen Thompson Associate Professor / Philosophy Department, *June 10, 2019 11:11am*

9. Review - Faculty Senate Exec Committee

Pending Review

More Queued Reviews (4)

Faculty Senate; Provost /Academic Affairs; Academic Programs; Catalog Coordinator

Proposal

Proposal ID:106498
Type:New Degree Program
Submission Date:June 10, 2019 9:20am
Comments:
This application proposes to establish a new undergraduate degree program in Biological Data Sciences. This program will be delivered at the main OSU Corvallis campus.

This new undergraduate program has three Options included: Computational Biology (CB), Ecological and Environmental Informatics (EEI), Genomics Option (GEN).

History

Active Version - Submitted June 10, 2019 9:20am
Version 1 - Submitted March 18, 2019 7:16pm

Originators

NAME	TITLE	DEPARTMENT/SCHOOL
Jeffrey Chang	Associate Professor	Ag Botany / Plant Path

Contacts

NAME	TITLE	DEPARTMENT/SCHOOL
Joseph Spatafora	Distinguished Professor	Ag Botany / Plant Path

Proposal Details

College:College of Agricultural Sciences
Department/School:Botany and Plant Pathology
Program Type:Undergraduate Major

Materials linked from the June 13, 2019 Faculty Senate agenda.

New Degree Name:Biological Data Sciences

Supporting Documents

DOCUMENTS
*** Signed Transmittal Sheet**
transmittal_sheet16.603_signed.pdf (114.55 Kb added Jun 03, 2019 10:47 am)
*** Executive Summary**
Executive_summary.pdf (74.13 Kb added Jun 03, 2019 10:47 am)
*** Proposal**
BDS_proposal_ver10.pdf (278.85 Kb added Jun 10, 2019 10:30 am)
*** Letters of Support**
Siobhan Brady, UC Davis Brady_Chang_LOS.pdf (103.00 Kb added Jun 03, 2019 10:47 am)
Reinhard Laubenbacher; UConn Health Laubenbacher_Chang_OSU.pdf (204.91 Kb added Jun 03, 2019 10:47 am)
Blake Meyers; Danforth Plant Sci. Center Meyers_Chang_LOS.pdf (184.52 Kb added Jun 03, 2019 10:47 am)
Brett Tyler; OSU Tyler_ACTF.pdf (229.82 Kb added Jun 03, 2019 10:47 am) For use of ACTF.
Brett Tyler; OSU Tyler_BLDS.pdf (224.16 Kb added Jun 03, 2019 10:47 am) For use of BDS designator.
*** Accessibility Form**
accessibility_form16.426_BDS.pdf (127.22 Kb added Jun 03, 2019 10:47 am)
*** Library Evaluation**
Library_evaluation.pdf (262.37 Kb added Jun 03, 2019 10:47 am)
*** Faculty CVs**
Faculty_involvement.pdf (106.89 Kb added Jun 03, 2019 10:47 am)
Other Attachments
ug_assessment_apa_reporting_BDS.xlsx (42.38 Kb added Jun 03, 2019 10:47 am) Curriculum map
Outcomes and Quality Assessment.pdf (25.46 Kb added Jun 03, 2019 10:47 am) Recommendations and response to outcomes and quality assessment
Space_BDS.pdf (148.74 Kb added Jun 03, 2019 10:47 am) Space Evaluation
LIAISONS

Materials linked from the June 13, 2019 Faculty Senate agenda.

*** Liaisons**

see response document
Request: Request_document.pdf (54.99 Kb added Jun 03, 2019 10:47 am)
Response: Response_document.pdf (43.30 Kb added Jun 03, 2019 10:47 am)
Please see response document that was uploaded. It lists all the individuals and units that we contacted prior to officially submitted the CAT I proposal. The document presents their comments and our responses/actions.

Michael Lerner; michael.lerner@oregonstate.edu
Request: *None*
Response: *None*
Please see attached document for comments and our response.

John Bailey; john.bailey@oregonstate.edu
Request: *None*
Response: *None*

Mina Ossiander; ossiand@math.oregonstate.edu
Request: *None*
Response: *None*
Provided valuable comments and met with BPP to discuss. Please attached document for comments and our response.

Robert Mason; robert.mason@oregonstate.edu
Request: *None*
Response: *None*
We have discussed, both formally and informally, this proposal with Bob. He has verbally expressed support for the proposed program.

Brock Mcleod; Brock.McLeod@oregonstate.edu
Request: *None*
Response: *None*
Brock has been exceptionally helpful with the design of the curriculum, and navigating the OSU curriculum system.

Virginia Weis; weisv@oregonstate.edu
Request: *None*
Response: *None*

Jerri Bartholomew; barthoje@oregonstate.edu
Request: *None*
Response: *None*

Andrew Karplus; Andy.Karplus@oregonstate.edu
Request: *None*
Response: *None*
Andy provided valuable suggestions. Please see attached document and our response.

Theresa Filtz; theresa.filtz@oregonstate.edu
Request: *None*
Response: *None*

Lisa Ganio; lisa.ganio@oregonstate.edu
Request: *None*
Response: *None*
We discussed the proposal with the heads and chairs of COS. Lisa was present. Prior to her appointment as head of Stats, we had worked more closely with her predecessors, Dr. Schafer and Dr. Lesser, in developing this proposal.

Tom Weller; tom.weller@oregonstate.edu
Request: *None*
Response: *None*
We met with Tom and his colleagues. We also met with their curriculum committee. Please see attachment for a more detailed description of our conversations.

Mike Rosulek; rosulekm@engr.orst.edu
Request: *None*
Response: *None*
We met with Mike on two separate occasions. Please see response for a more detailed description. He indicated the CAT I proposal should be sent to him, as he is the chair of their curriculum committee.

Bill Bogley; bogleyw@science.oregonstate.edu
Request: *None*
Response: *None*
Math has provided important feedback, via their curriculum committee and also via Bill. Please see attachment for details.

Selina Heppell; selina.heppell@oregonstate.edu
Request: *None*
Response: *None*
We met with Selina very early in the process and received support.

Norman Hord; norman.hord@oregonstate.edu
Request: *None*
Response: *None*

Jack Barth; barth@coas.oregonstate.edu
Request: *None*
Response: *None*

Larry Becker; beckerla@geo.oregonstate.edu
Request: *None*
Response: *None*

Adam Kent; adam.kent@geo.oregonstate.edu
Request: *None*
Response: *None*

Roy Haggerty; Roy.Haggerty@oregonstate.edu
Request: *None*
Response: *None*
We shared a version with Dr. Haggerty, who shared it broadly within COS. We also met with Dr. Haggerty on two separate occasions to discuss BDS.

Penny Diebel; penelope.diebel@oregonstate.edu
Request: *None*
Response: *None*

Kate Field; kate.field@oregonstate.edu
Request: *None*
Response: *None*
Kate was on a committee to help develop the curriculum.

Lisbeth Goddik; Lisbeth.goddik@oregonstate.edu
Request: *None*
Response: *None*

Alan Sams; Alan.Sams@oregonstate.edu
Request: *None*
Response: *None*

Mark Leid; mark.leid@oregonstate.edu
Request: *None*
Response: *None*

Scott Ashford; scott.ashford@oregonstate.edu
Request: *None*
Response: *None*

BUDGET INFORMATION

*** Budget Year 1**

osubudget_worksheet_BDS Major Minor.101518.to submit.xlsx (139.10 Kb added Jun 03, 2019 10:47 am)
The narrative will be uploaded in year 2 and the worksheet will be repeated for years 3 and 4.

*** Budget Year 2**

BDS Budget Narrative.101518.to submit.pdf (87.49 Kb added Jun 03, 2019 10:47 am)

*** Budget Year 3**

osubudget_worksheet_BDS Major Minor.101518.to submit.xlsx (139.10 Kb added Jun 03, 2019 10:47 am)

*** Budget Year 4**

osubudget_worksheet_BDS Major Minor.101518.to submit.xlsx (139.10 Kb added Jun 03, 2019 10:47 am)

Proposal Transmittal Sheet

Full Category I and Abbreviated Category I Proposals

Submit proposals to: Office of Academic Programs, Assessment, and Accreditation
314 Waldo Hall – Oregon State University

Attach Transmittal Sheet; Proposal; Library Evaluation (performed by the Library for Full Category I proposals), Letters of Support (external to OSU); Liaison Correspondence (internal to OSU), External Review (new graduate program proposals), and Budget Information (both OSU and HECC budget sheets for Full Category I proposals and OSU budget sheets for Abbreviated Category I proposals)

Full Category I Proposals: New Programs

Final Approval--for new degrees, extension to OSU's branch campus, and substantive changes:
Higher Education Coordinating Commission (HECC)

Final Approval-- for new certificate programs: OSU Provost

Check one:

- [X] **New Degree Program**
- [ ] **New Certificate Program**
- [ ] **Extend Program to OSU Branch Campus**
- [ ] **Substantive Change**

Abbreviated Category I Proposals: Other Proposals

Final Approval--for new academic units, renames, reorganizations, and, suspensions: OSU Provost

Final Approval-- for terminations: OSU Board of Trustees

Check one:

- [X] **Establish:** new college, school, department or program
- [ ] **Rename**: change the name of an existing academic program or academic unit
- [ ] **Reorganization:** move the responsibility of an academic program from one academic unit to another; reorganize existing academic unit(s), including mergers and splits
- [ ] **Suspension (or Reactivation):** suspend an academic program (maximum period: three years)
- [ ] **Termination:** terminate an academic program or academic unit

Title of Proposal: Biological Data Sciences

Proposed Effective Term: Fall, 2020

School/Department/Program: Botany and Plant Pathology

College: CAS

I certify that the above proposal has been reviewed by the appropriate Program, Department, School, and College administrators and committees. I approve this proposal.

	12/11/18	Jeff Chang (director)
Sign (Department/School Chair/Head; Director)	***Date***	**Print (Chair/Head; Director)**
	2/26/19	Dr. Alan Sams (Dean)
***Sign* (College Dean)**	***Date***	**Print (College Dean)**

Source: Office of Academic Programs, Assessment and Accreditation (2-10-15; rev 1-8-16)

EXECUTIVE SUMMARY

A new undergraduate program in Biological Data Sciences (BDS)

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. 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. However, the training of undergraduate students in the life sciences has not been contemporized to meet these needs.

In response to the need for improved training of 21st century biologists, in July 2013, a Task Force was commissioned by Deans Daniel Arp and Mark Zabriskie to develop a strategic plan for coordinated graduate and undergraduate curricula in bioinformatics and computational biology. The task force, chaired by Center for Genome Research and Biocomputing (CGRB) Director Brett Tyler, included 20 faculty from the Colleges of Science, Agricultural Sciences, Pharmacy, Veterinary Medicine, Forestry, Engineering, Public Health and Human Sciences, and Earth, Ocean and Atmospheric Sciences. A report was released recommending the establishment of a new major to deliver undergraduate transdisciplinary training in the quantitative and life sciences. Detailed feedback was collected from the community through small group discussions, email, and three town hall meetings. A BDS committee was assembled to represent expertise necessary for developing an undergraduate transdisciplinary program. The BDS committee used recommendations of the undergraduate sub-task force and community feedback as a foundation for the BDS program. The committee also conducted a thorough analysis of pre-existing and related programs to understand the curricular landscape.

The BDS undergraduate program outlined here provides transdisciplinary education that intersects the life sciences, computer science, statistics, and mathematics. 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. In addition, to provide students a transformative educational experience, the BDS program will offer six new classes that are structured for cohort learning, promoting the integration of domain knowledge from multiple disciplines, and learning skills necessary for effectiveness in teams. As part of the learning experience, students will be required to participate in an experiential learning activity and a senior capstone course. The proposed BDS program will foster undergraduate engagement and provide foundational knowledge and skills in biological data sciences that are needed for success in graduate or professional school, and the workplace.

HIGHER EDUCATION COORDINATING COMMISSION

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. However, the training of undergraduate students in the life sciences 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 knowledgebase 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.

Proposal Summary Table

- CIP (Classification of Instructional Program)#: **26.1199**
- CPS#: **106498**
- College Code: **01**
- Degree Types: **Bachelor of Science**
- Program Level: **Undergraduate**
- Academic Home: **Botany and Plant Pathology; College of Agricultural Sciences**
- Contact: **Jeff Chang (7-5278; changj@science.oregonstate.edu)**
- Options: **Genomics; Ecological and environmental informatics; Computational biology**
- Areas of Concentration: **NA**
- Minors: **BDS**
- Program Total Credit Hours: 1**80**
- Pre-Professional/Professional Model: **NA**
- Thesis or Non-Thesis: **NA**
- Location: **Main Campus; Corvallis, OR**
- Course Designator: **BDS**
- Delivery Mode: **On-campus (face-to-face); some courses available via Ecampus**
- Enrollment Limitations: **None**
- Accreditation: **NA**
- Proposed Effective Date: **Fall, 2020**
- Program Unique to Public Higher Education Institutions in Oregon: **Yes**
- Embedded Proposals: **NA**

c. Course of study – proposed curriculum, including course numbers, titles, and credit hours.

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.

Course Requirements:

Core courses: Students will share a common core of foundational courses. These are existing courses that teach core knowledge and skills, and that are offered by units that administer degrees in the life sciences, chemistry, computer science, statistics, and mathematics (**Table 1**). Some core requirements can be satisfied by choosing from a menu of courses offered by various units at Oregon State University. The courses required for BDS were identified on the basis of their sufficiency in satisfying prerequisites for upper division courses relative to this discipline. The core will also require six new courses (BDS) that are structured to promote cohort learning and the development of competencies that potential employers seek. These are analytical thinking, effective communication, organization, and functioning within transdisciplinary teams.

Table 1: Core foundational courses

Discipline	**Course Name**	**Course Number**	**Cr**
Biological Science 5 classes; 19 credits	Introductory Biology Genetics Evolution	BI 211*, 212*, 213* or BI 204*, 205*, 206* BI 311 BI 445	12 4 3
Chemistry 1 class + lab; 5 credits	General Chemistry	CH 231*, 261 (lab and lecture)	5
Mathematics 5 classes; 19 credits	Calculus Discrete Math Vector Calculus Linear Algebra I	MTH 251*, 252 MTH 231 MTH 254 MTH 341	8 4 4 3
Statistics 3 classes; 12 credits	Intro Stats Methods data analysis	ST 351 ST 411, 412	4 8
Computer Science 3 classes; 12 credits	Intro to Comp. Sci. Data structures	CS 161, 162 CS 261	8 4

Biological Data Sciences 5 classes; 13 credits	Critical Thinking Comp Approaches Biol Data Special Projects Case Studies of Biol Data Capstone in BDS I Capstone in BDS II	BDS 211 BDS 311 BDS 406 BDS 411^ (WIC) BDS 491 BDS 492	3 3 1 3 3 3
Experiential Learning	Independent projects Equivalent to at least 60 hours work	May be taken as 401 or 410 or not for credit	

*Bacc Core Course
^ Writing Intensive Course

Options: Each BDS student selects an option, of which the credits are incorporated into the 180 credits of the degree, to provide deeper understanding and expertise in a life science area or related data science skills. Options include Genomics (GEN; **Table 2**), Ecological and Environmental Informatics (EEI; **Table 3**), and Computational Biology (CB; **Table 4**). Elective credits that satisfy the options are listed in tables 2-4.

Table 2. Genomics option (GEN; 35-37 option elective credits; 28-30 general elective credits)
Students in the GEN option complete course series in general and organic chemistry and biochemistry. They take at least one advanced course in molecular biology, and two courses in genomics. It is recommended that BOT 476 be taken as the first genomics course. Because molecular biology and genomics courses have increased markedly over recent years, the course lists may go out of date quickly. Therefore, BDS advisors may approve new courses to meet these requirements at their discretion.

Chemistry 4 classes + 2 labs; 18 credits	CH 232*, CH 233*, CH 262, CH 263. General Chemistry (4, 4, 1, 1) CH 331, CH 332. Organic Chemistry (4, 4)
General Biochemistry 2 classes: 7 credits	BB 450, 451. General Biochemistry (4, 3)
Molecular Biology 1 class: 4 credits	BB 314. Cell and Molecular Biology (4)
Advanced Molecular, Cell, Organismal or physiology Choose 1 class; 3-4 credits	BOT 331. Plant Physiology (4) BB 460. Advanced Cell Biology (3) BB 484. Chromatin and Epigenetics (3) BB 493. Biochemistry Lab (3) MB 302. General Microbiology (3) MB 303. General Microbiology lab (2) Z 425. Embryology and Development (5) Z 437. Vertebrate Endocrinology (4) Z 438. Behavioral Neurobiology (3) ***OR*** other course with advisor approval
Two Genomics class Choose 2 class; 3-4 units	BOT 476. Introduction to Computing Life Sciences (3) (recommended as first course for MG option) BOT 458. Ecosystems Genomics† (3) BOT 460. Functional Genomics† (3)

	BOT 475. Comparative Genomics† (4) BB 485. Applied Bioinformatics (3) MB 420. Microbial Genomes, Biogeochemistry, and Diversity (3) ST 415. Design and Analysis of Planned Experiments (3) ***OR*** other class with advisor approval

†The Department of Botany and Plant Pathology will submit Category II proposals to change prerequisites from BI311 *and* BI314 (BB314) to BI311 *or* BB314.

Table 3: Ecological and environmental informatics (EEI; 32-37 option elective credits; 28-33 general elective credits)

Students in the EEI option take classes in general, population and community ecology. They also take a course in physical environmental science and two courses in environmental informatics. EEI students also take Applied Differential Equations, and one of three other MTH/ST courses that apply to quantitative modeling and analysis of ecosystems. Courses in ecology and environmental analysis have proliferated in recent years, so, BDS advisors may approve new courses to meet these requirements at their discretion.

Mathematics/ Statistics **2 classes; 7 credits**	MTH 256. Applied Differential Equations (4) **AND** one of the following: MTH 420. Models and Methods of Applied Mathematics (3), MTH 427. Introduction to Mathematical Biology (3), ***OR*** ST 415. Design and Analysis of Planned Experiments (3)
General Ecology **1 class: 3 credits**	BI 370. Ecology (3)
Molecular Ecology **1 class: 3 credits**	BOT458. Ecosystem Genomics† (3)
Population, Community, and Ecosystem Ecology **Choose 3 class; 9-12 credits**	at least one of the following: BI 351. Marine Ecology (3), BI 358. Symbioses and the Environment (3), BI 481. Biogeography (3), BI 495. Disease Ecology (3), BOT 341. Plant Ecology (4), BOT 413. Forest Pathology (3), BOT 440. Field Methods in Plant Ecology (4), FES 341. Forest Ecology (3), FW 321. Applied Community and Ecosystem Ecol (3), FW 456. Freshwater Ecology and Conservation (5), FW 479. Wetlands and Riparian Ecology (3), **AND** at least one of the following: BI 483. Population Biology (3), ***OR*** BOT 442. Plant Population Ecology (3) ***OR*** FW 320. Introductory Population Dynamics (4) ***OR*** other class with advisor approval
Physical Environmental Sci **Choose 1 class; 3-4 credits**	CSS 205. Soil Science* (4) ATS 201. Climate Science* (4) GEO 202. Earth Systems Science* (4) OC 201. Oceanography* (4) OC 332. Costal Oceanography (3) OC 440. Biological Oceanography (4) GEO 221. Environmental Geology (4) ***OR*** other class with advisor approval

Environmental Informatics **Choose 2 classes; 7-8 credits**	GEOG 201. Foundations of Geospatial Science and GIS* (4) ***OR*** FE 209. Forest Photogrammetry and Remote Sensing (4) ***OR*** FE 257. GIS and Forest Engineering Applications (4) AND one of the following: GEOG 360. GIscience I: Geographic Information Systems and Theory (4) ***OR*** GEOG 480. Remote Sensing I: Principles and Applications (4) ***OR*** FW 303. Survey of Geographic Information Systems in Natural Resources (3) ***OR*** CROP/HORT 414. Precision Agriculture (4) ***OR*** other class with advisor approval

†The Department of Botany and Plant Pathology will submit Category II proposals to change prerequisites from BI311 *and* BI314 (BB314) to BI311 *or* BB314.

Table 4: Computational Biology (CB: 29-33 option elective credits; 32-36 general elective credits)

Students in the CB option take Analysis of Algorithms and three additional classes in computer science. They also take at least three courses (with at least one class in each of the two categories) in bioinformatics and statistics. Last, CB students take Applied Differential Equations and Introduction to Mathematical Biology.

Mathematics 2 classes; 7 credits	MTH 256. Applied Differential Equations (4), MTH 427. Introduction to Mathematical Biology (3)
Biology/Bioinformatics and Statistics Choose at least 3 class with at least one from Biology/Bioinformatics and one from Statistics; 9-10 credits	BOT 460. Functional Genomics† (3), ***OR*** BOT 458. Ecosystem Genomics† (3), ***OR*** BOT 475. Comparative Genomics† (3), ***OR*** CS 446. Networks in Computational Biology (3), **AND** one of the following: ST 413. Methods of Data Analysis (4), ***OR*** ST 415. Design and analysis of planned experiments (3), ***OR*** ST 431. Sampling Methods (3),***OR*** other class with advisor approval
Computer Science 1 class; 4 credits	CS 325. Analysis of Algorithms (4)
Advanced Computer Science Choose at least 3 classes (9-12 credits)	CS 331. Introduction to Artificial Intelligence (4) CS 361. Software Engineering I (4), CS 362. Software Engineering II (4), CS 420. Graph Theory (3), CS 434. Machine Learning (4), CS 458. Intro Info. Visual (4), CS 475. Intro Parallel Program (4), ***OR*** other class with advisor approval

†The Department of Botany and Plant Pathology will submit Category II proposals to change prerequisites from BI311 *and* BI314 (BB314) to BI311 *or* BB314.

The BDS major satisfies all University and CAS degree requirements, with at least 180 credits, 51 credits of Bac Core courses (19 overlap with those of the major), at least 60 upper division courses and at least 36 credits in the major with 24 upper division credits. A general curriculum 4-year plan and examples of 4-year curricula for the GEN, EEI, and CB options are given in **Tables 8**, **9, 10** at the end of this document.

Requirement for Experiential Learning:

Numerous studies have found that experiential learning activities increase student engagement and improve long-term success. Every BDS undergraduate is required to have an experiential learning (EL) component in their curriculum that is not part of a scheduled academic course. It may or may not involve academic credit. Paid and voluntary positions are both acceptable. Following the EL project, a student is required to participate in a 1-credit seminar to reflect on the project and to build professional communication skills. The EL component can take many forms but must involve a minimum of 60 hours of work (about 2-credit equivalent) and must have a substantial educational objective that is related to the BDS degree. To meet the requirement, the student and the EL supervisor must make a written agreement that is approved by a BDS advisor. After completion of the EL project, the student is required to participate in a 1-credit student seminar (BDS 406), to reflect on the EL project and to incorporate it into future career planning activities.

Minor (27 credits)

Courses in the life sciences, computer science, and statistics are core to the minor, with 8-11 credits of upper division courses. Students are required to choose two to three additional classes (at least 8 credits, with at least one being an upper division course) in bioinformatics, statistics, mathematics, and/or computer science. Students pursing a minor are also required to take at least one BDS course.

Table 5. Minor in BDS

Biology 1 class; 4 credits	BI 311. Genetics (4); requires BI 211*, BI212*, BI213* Principles in Biology (4, 4, 4); requires CH 231*, CH 261 (4, 1)
Computer Science 2 classes: 8 credits	CS 161, CS 162. Introduction to Computer Science (4, 4)
Statistics 1 classes: 4 credits	ST 411. Methods of Data Analysis (4); requires ST 351 (4)
BDS Choose 1 class; 3 credits	BDS 211. Critical Thinking (3) BDS 311. Comp Approaches Biol Data (3) BDS 411. Case Studies of Biol Data^ (3) BDS 491. Capstone in BDS I (3); with instructor approval
Upper division electives Choose 2-3 class; need at least 8 credits with at least one class being an upper division class, necessary to satisfy requirements for 12 upper division credits	BOT 476. Introduction to Computing in the Life Sciences (3) BOT 458. Ecosystems Genomics† (3) BOT 460. Functional Genomics† (3) BOT 475. Comparative Genomics† (4) ST 412. Intro to Stats Methods (4) ST 415. Design and Analysis of Planned Experiments (3) MTH 341. Linear Algebra (3); requires MTH 254 MTH 427. Introduction to Mathematical Biology (3); requires MTH 256 CS 261. Data Structures (4) CS 325. Analysis of Algorithms (4); requires CS 261

†The Department of Botany and Plant Pathology will submit Category II proposals to change prerequisites from BI311 *and* BI314 (BB314) to BI311 *or* BB314.

New courses to be developed: BDS cohort courses

The design of the BDS courses was informed by multiple studies of undergraduate employment readiness that were conducted by the Association of American Colleges and Universities (1), the

Engineering and Technology Council (2), the National Science Foundation (NSF) and American Association for the Advancement of Science (AAAS) with support from the Howard Hughes Medical Institute (HHMI) and the National Institutes of Health (NIH) (3). These found that employers desired college graduates with domain-specific knowledge and skills in critical thinking, effective communication across disciplines, applying knowledge, and working in teams with real-world datasets, but college graduates are frequently *not* adequately trained in these skills. The studies also showed that experiential learning experiences are important for long-term career success. BDS cohort classes were designed to help consolidate information from the core curriculum and allow students to develop the skills that future employers seek. Cohort learning programs encourage community, leadership development, and interaction. The courses are built around active and cooperative learning, integration of core information (3, 4), and are structured to build upon another as to develop skills necessary for long-term success and to promote synthesis of knowledge. The breadth and depth of problems addressed increases each year as students expand their repertoire of analytical skills and sophistication of biological thinking.

BDS 211. Use and Abuse of Data: Critical Thinking in Science (3) Spring Freshman Year
As consumers of information presented by teachers, advertisers, mass media, and especially the internet, we are inundated with data that is presented as evidence for choices ranging from what soap to buy to what energy policies to endorse. In this class, students will critically examine how data analysis can support legitimate conclusions and also how deceptive visualizations, misleading comparisons, and spurious reasoning can lead to false conclusions. This class serves as a non-technical introduction to data-analysis and critical thinking skills, where students will begin to actively interpret and discuss the use of data in a collaborative, group-based setting. Active learning activities, such as think-pair-share and one-minute papers, will provide students with low stake opportunities to practice skills central to thinking critically about data. This class establishes the framework for cohort, collaborative learning.

BDS 311. Computational Approaches for Biological Data (3) Spring Sophomore year
Building on the computing fundamentals from the CS prerequisites, this course will cover the theory and practice of computational approaches to biological data. Theoretical concepts will include divide-and-conquer algorithms, and complexity analysis. Students will gain practical experience with writing scripts for interfacing with large biological datasets and participate in a variety of active learning activities designed to advance their understanding of the core concepts of information flow, structure/function, and systems. Curated data sets will provide students with opportunities to understand the process of scientific investigation and characteristics of biological data while they establish an understanding of the appropriate use of computational methods. By having groups of students work cooperatively and review the work of their peers, students will learn how to apply knowledge, improve communication, develop critical thinking and problem-solving skills, and increase effectiveness while working in transdisciplinary, collaborative teams to accomplish a common goal.

BDS 406. Special Projects for Senior Students: Professional Skills (1) Fall Senior year
Following their experiential learning projects, each BDS student will participate in a student seminar to reflect upon their projects and build professional skills. Activities will include: making both an oral and a hard-copy written presentation of the EL project, building a curriculum vitae or resume summarizing the student's academic background and EL skills, preparing job or graduate school application, listening and responding to other student presentations. Through its activities, this course will emphasize cultivation of effective communication between researchers and colleagues within and across disciplines, development of professional skills, and career preparation.

BDS 411. Analysis of Biological Data: Case Studies (3; WIC) Spring Junior Year

In this course, students will build upon the material presented and skills developed in BDS 311 and apply knowledge from computational courses to address well-defined biological data analysis problems in the form of case studies. This course will incorporate active learning to focus on the higher cognitive categories of “analyze”, “evaluate” and “create” through the act of doing. Within each case study, students will be presented with specific dilemmas or questions to be answered about the datasets. Each student, individually and collaboratively in groups, will synthesize previously acquired knowledge in mathematics, statistics, and computer science to implement, in writing, an analysis strategy. Cases studies and in-class activities will permit students to demonstrate the appropriate use of quantitative tools and methods to effectively manage, manipulate, summarize, and make accurate inferences from the case study data sets. Students will also learn and apply methods to visualize biological data. Comparisons of case study solutions and outcomes will be performed in teams and through peer-review to promote effective communication and evaluation of multiple potential solutions. This will be offered as a WIC course and will incorporate activities to meet the WIC-specified learning outcomes. Students will use the skills and tools developed in this course to help frame their capstone project.

BDS 491. Capstone Projects in Biological Data Sciences I (3) Winter Senior year
For their capstone project students will apply quantitative skills and biological thinking to analyze real-world biological datasets. Students will work in small groups to develop a research question and hypothesis. Groups will be expected to leverage large biological datasets to test hypotheses. These data can be retrieved from the public repository, generated by students during experiential learning experiences (with approval from mentor), or obtained from researchers at OSU. Students will synthesize previously acquired skills in mathematics, statistics, computer science, and biology and cultivate their capacity to work and communicate effectively as an interdisciplinary team addressing a common goal. Students are expected to build upon their previous understanding and to demonstrate an ability to apply appropriate quantitative skills and biological thinking to the management and analysis of big and real-world biological datasets.

BDS 492. Capstone Projects in Biological Data Sciences II (3) Spring Senior year
This is the second quarter of the senior capstone series. Student teams will direct their energy towards applying quantitative skills and biological thinking to analyzing and drawing conclusions from real-world biological datasets. Students will apply previously acquired skills in mathematics, statistics, computer science, and biology and cultivate their capacity to work and communicate effectively as an interdisciplinary team addressing a common goal. Students are expected to build upon their previous understanding and to demonstrate an ability to apply appropriate quantitative skills and biological thinking to the management and analysis of big and real-world biological datasets and an ability to clearly and accurately present their findings.

Students will be assessed based on their individual contributions to the course and to their team. Individual assessments will include participation during in-class discussions, creativity, demonstration of core knowledge, ethical conduct, and effectiveness in listening and communicating. With regards to team projects, groups will be assessed based on the project (reports, presentations) and the process (organization and documentation of steps for completing the project). Individuals will also be assessed for their effectiveness in a team, based on the collective evaluations self-reported by the student and via peers within the team. Evaluation criteria will be provided to students and used to guide their ratings for characteristics such as participation (attendance, showing up on time, and degree of contribution to accomplishing team goals), communication (oral and written, level of civility, listening), acceptance of suggestions/criticisms, and level of responsibility (completing assigned tasks on time and to a level of sufficient quality, evidence of leadership).

d. Manner in which the program will be delivered, including program location (if offered outside of the main campus), course scheduling, and the use of technology (for both on-campus and off-campus delivery).

The program will initially be available on the OSU main campus only. Many courses are currently available for E-campus students and we anticipate development of E-campus versions of BDS courses in the near future.

The mathematics, computer science, and statistics courses are fundamental to many majors and are taught multiple quarters during the academic year. So, although there are several course series to complete, there is flexibility in scheduling these courses. The year-long biology series and multiple quarter chemistry series are taught sequentially during the F/W/S terms and are also taught during the summer terms. We anticipate no difficulty for BDS students in scheduling general course requirements in a timely manner.

e. Adequacy and quality of faculty delivering the program.

Botany and Plant Pathology (BPP) will be the administrative home for the BDS program. BPP currently offers a B. S. degree in Botany, and M. S. and PhD in Botany and Plant Pathology, with specialization in a variety of areas of concentration, including Genomics and Computational Biology. BPP has 27 tenure and tenure-track faculty and three instructors. Faculty in BPP is adequate for administrating and delivering this program. BPP faculty teach in multiple academic programs (e.g., Biology, Botany, MCB) and lead diverse research programs that spans from molecular to ecosystem levels, spans terrestrial and marine environments, and has recognized strengths in ecology and a strong nucleus of scientists that use computational biology, modeling, remote sensing, and genomics/transcriptomics/metabolomics. Each of the tenure-track faculty hired since 2005 have research programs in which large datasets are prominent and several tenure-track faculty hired prior to 2005 do so as well. Two of the current faculty members were recruited via the 2005 Computational and Genome Biology and 2010 Systems Biology Provost Initiatives. One new tenure-track faculty will be starting in January of 2020 and BPP will be recruiting one additional tenure-track faculty in the 2018-2019 academic years. These positions are expected to conduct research that generate or leverage large datasets to address important biological questions and required to teach at least one course in the proposed BDS program and will also serve as academic advisor to students. Two faculty members outside BPP have committed to teaching two of the core BDS courses to be developed (see next section).

BPP has also consistently provided leadership to units, programs, and centers at OSU in the life sciences, including the undergraduate environmental sciences, vision on undergraduate and graduate programs in bioinformatics, the graduate MCB program, and the CGRB. Associate Professor Jeff Chang will be the inaugural director of the BDS program with support (equivalent of one-month summer salary + OPE) provided by the Department of Botany and Plant Pathology. He helped transition OSU into the big data era through investments in next generation sequencing technologies, development of computational and statistical methods for data analysis, development of workshops, creation of student-driven practitioner groups, interdisciplinary teaching, and through collaborations with researchers in statistics, mathematics, and computer science. His research program uses bioinformatics and genome-enabled methods to address fundamental questions in plant-microbe interactions. As a member of the OSU cohort that participated in The Partnership for Undergraduate Life Sciences Education (PULSE) and an instructor in the BI21x Principles of Biology series, he is an adopter of active learning methods and has been working with his cohort to restructure and transform biology instruction at OSU. The director will teach BDS 406, the 1-credit professional skills course.

f. Adequacy of faculty resources – full-time, part-time, adjunct.

Faculty from the various departments and of all ranks will be responsible for delivering courses that are foundation to the BDS program. Two faculty members, Assistant Professors Rebecca Hutchinson (EECS and Fisheries and Wildlife) and Maude David (Microbiology and Pharmacy), were recruited via the 2015 “Complex Systems in the Life and Environmental Sciences” Provost Initiative and are required to teach in the interdisciplinary graduate or undergraduate BDS program; both have committed to teaching a core course in BDS.

BPP has many courtesy faculty and faculty located at branch stations. Although these faculty do not formally participate in teaching in undergraduate programs, their research programs can offer experiential learning activities or provide large datasets for the case studies and/or senior capstone courses. Research opportunities are also available across OSU in departments such as Biochemistry & Biophysics, Computer Science, Mathematics, Statistics, Microbiology, Integrative Biology, Chemistry, Physics, School of Biological and Population Health Sciences, Pharmacy, Veterinary Medicine, Animal Science, Forestry, Horticulture, Crop and Soil Sciences, Fisheries and Wildlife, and more.

Table 6: Faculty resources of BPP

Name/Rank	**Affiliations**	**BPP FTE**
Anderson, Jeff/Asst Prof	BPP, MCB	1.0
Behrenfeld, Mike/Prof	BPP	1.0
Busby, Posy/Asst Prof	BPP	1.0
Chang, Jeff/Assoc Prof	BPP, CGRB, MCB	1.0
Cronn, Rich/Asst Prof (Courtesy)	BPP, US Forest Service	-
Curtis, Marc/Instructor	BPP	1.0
Dolja, Valerian/Prof	BPP, CGRB, MCB	1.0
Dung, Jeremiah/Asst Prof	BPP, COARC	1.0
Fowler, John/Prof	BPP, CGRB MCB	1.0
Freitag, Michael/Prof	BB Adjunct, CGRB, MCB	-
Frost, Ken/Asst Prof	BPP, HAREC	1.0
Gent, David/Assoc Prof (Courtesy)	BPP, NFSPRC	-
Goyer, Aymeric/Asst Prof Sr. Research	BPP, CGRB, MCB	
Grevstad, Fritzi/Asst Prof, Sr. Research (Courtesy)	BPP	.60
Grunwald, Niklaus/Prof (Courtesy)	BPP, CGRB, MCB, USDA	-
Hagerty, Christina	BPP, CBARC	1.0
Hardison, Linda	BPP	.50
Ingham, Russ/Prof	BPP	1.0
Jaiswal, Pankaj/Assoc Prof	BPP, CGRB, MCB	1.0
Johnson, Ken/Prof	BPP	1.0
Jones, Andy/Assoc Prof	BPP, CGRB, MCB	1.0
Kaye, Tom/Assoc Prof (Courtesy)	BPP, Institute of Applied Ecology	-
KC, Achala/Asst Prof	BPP, SOREC	1.0
Kentula, Mary/Assoc Prof (Courtesy)	BPP, EPA	-
LeBoldus, Jared/Asst Prof	BPP	1.0 (50/50 Forestry)
Link-Perez, Melanie/Instructor	BPP	1.0
Liston, Aaron/Prof	BPP, CGRB, MCB	1.0
Loper, Joyce/Prof	BPP, CGRB, MCB	-
Mahaffee, Walt/Assoc Prof (Courtesy)	BPP, USDA	-

Martin, Bob/Prof (Courtesy)	BPP, CGRB, MCB, USDA	-
McCune, Bruce/Prof	BPP	.75
Megraw, Molly/Assoc Prof	BPP, CGRB, MCB	1.0
Meinke, Bob/Asst Prof (Courtesy)	BPP, ODA	-
Mundt, Chris/Prof	BPP	1.0
Milligan, Allan	BPP	83.3
Naithani, Sushma	BPP, CGRB, MCB	.75
Ocamb, Cynthia/Assoc Prof	BPP	1.0
Pscheidt, Jay/Prof	BPP	1.0
Putnam, Melodie/Sr. Instructor	BPP	1.0
Pyke, David/Assoc Prof (Courtesy)	BPP, FSL	-
Reichman, Jay/Asst Prof (Courtesy)	BPP, EPA	-
Rothwell, Gar/Prof (Courtesy)	BPP	-
Santamaria, Luisa/Assoc Prof	BPP, NWREC	1.0
Spatafora, Joey/Prof	BPP, CGRB, MCB	.67
Stockey, Ruth/Prof (Courtesy)	BPP	-
Stockwell, Virginia/Assoc Prof (Courtesy)	BPP, USDA	-
Jessie Uehling/Asst Prof (starting 1/2020)	BPP	1.0
Plant Biology (TBD)/Asst Prof		
Tyler, Brett/Prof	BPP, CGRB, MCB	-
Weiland, Jerry/ Asst Prof (Courtesy)	BPP, USDA	-
Wolpert, Tom/Prof	BPP, CGRB, MCB	1.0
Zasada, Inga/Assoc Prof (Courtesy)	BPP, CGRB	-

g. Other staff.

BPP currently employs five office staff to manage the daily activities of the department. Staff assists faculty teaching needs with advertisement, communication, recruiting, outreach, registration, scheduling, ordering and other general needs.

Table 7: Staff of BPP

Name	**Position**
Baker, Blaine	Bioscience Tech
Simpson, Dianne	Office Admin
Kimberly Callahan	Receptionist
Neil McCoy	Information Services
Angela Link-Perez	Human Resources

h. Adequacy of facilities, library, and other resources.

The OSU library system is adequate and provides access to all major journals for the proposed BDS program.

The Advanced Cyberinfrastucture Teaching Facility (ACTF) is a high-performance computing resource hosted by the Center for Genome Research and Biocomputing (CGRB) dedicated to instructional support. The ACTF consists of 300 + CPU cores, 2 + TB of RAM, and 100+ TB of networked, high-speed ZFS file space. This computing resource currently supports education in bioinformatics by providing infrastructure for analyzing biological datasets large and

small and is being improved to generate new and improved learning opportunities in a variety of fields. Last, the CGRB provides one-on-one support for instructors that use the ACTF (see letter; Tyler).

BPP is located in Cordley Hall and is slated for renovation. Renovation of the building is focused around advancement of student success. Classrooms and laboratories, including computational learning environments, will be updated to 21st century standards. There will be ample collaboration spaces for students to interact with one another, promoting peer-to-peer learning, and with graduate students, researchers and faculty. There will also be social spaces, including a Bioasis, to establish a meaningful environment that creates a sense of place and purpose. The "New Cordley" will be a transformative space where students desire to be and will create a sense of excitement about educational and career possibilities in Biological Data Sciences.

i. 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. Accreditation

a. Accrediting body or professional society that has established standards in the area in which the program lies, if applicable.
NOT APPLICABLE

b. Ability of the program to meet professional accreditation standards. If the program does not or cannot meet those standards, the proposal should identify the area(s) in which it is deficient and indicate steps needed to qualify the program for accreditation and date by which it would be expected to be fully accredited.
NOT APPLICABLE

c. If the proposed program is a graduate program in which the institution offers an undergraduate program, proposal should identify whether or not the undergraduate program is accredited and, if not, what would be required to qualify it for accreditation.
NOT APPLICABLE

d. If accreditation is a goal, the proposal should identify the steps being taken to achieve accreditation. If the program is not seeking accreditation, the proposal should indicate why it is not.
NOT APPLICABLE

4. Need

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.

This projected growth in career opportunities in BDS is further underscored by recent calls for more transdisciplinary training and availability of funding opportunities by President's Council of Advisors on Science and Technology, NIH and NSF. NSF announced a $2 million award to design an *undergraduate* curriculum to teach students how to use tools to visualize big datasets. Similar calls for increased training have been made by the private sector. A recent industry association report from the Coalition of State Bioscience Institutes (18) stated that workers with "Advanced/specialization degrees, such as bioinformatics, biostatistics and computational biology, as well as engineers with the ability to manage complex biological process scale-up" as well as "the ability to work across disciplines" are in exceptional demand. A training needs assessment by the Oregon Engineering and Technology Industry Council (19) stated that in the area of Big Data "Access to well-trained employees who can generate, manage and analyze big data is vital to the success of Oregon businesses", and recommended *undergraduate* training focused on developing "Life Science students with computational skills" *and* "Computer science students with a sophisticated understanding of biology". The report further stated, "ETIC encourages Oregon's post-secondary institutions to propose programs that will prepare Oregon students to become the T-shaped professionals increasingly demanded by industry." The T-shape is meant to symbolize an individual that is trained deeply in one discipline and with boundary crossing competencies. Last, results from a 2016 survey of principal investigators supported by NSF indicated that nearly 90% use or soon will analyze big data. Most PIs suggested the most pressing unmet needs are in training in data science skills (20).

In response to the need for improved training of 21st century biologists, in July 2013, a Task Force was commissioned by Deans Dan Arp and Mark Zabriskie to develop a strategic plan for coordinated graduate and undergraduate curricula in bioinformatics and computational biology. The task force, chaired by CGRB Director Brett Tyler, included 20 faculty from the Colleges of Science, Agricultural Sciences, Pharmacy, Veterinary Medicine, Forestry, Engineering, Public Health and Human Sciences, and Earth, Ocean and Atmospheric Sciences.

A report was released recommending the establishment of a new major to deliver undergraduate transdisciplinary training in the quantitative and life sciences. Detailed feedback was collected from the community through small group discussions, email, and three town hall meetings. A BDS committee, led by Jeff Chang was assembled to represent expertise necessary for developing an undergraduate transdisciplinary program (**Table 11**). The BDS committee used recommendations of the undergraduate sub-task force, also led by Jeff Chang, and community feedback as a foundation for the BDS program. The committee also conducted a thorough analysis of pre-existing and related programs to understand the curricular landscape.

e. If the program's location is shared with another similar Oregon public university program, the proposal should provide externally validated evidence of need (e.g., surveys, focus groups, documented requests, occupational/employment statistics and forecasts).

NOT APPLICABLE

f. Estimate the prospects for success of program graduates (employment or graduate school) and consideration of licensure, if appropriate. What are the expected career paths for students in this program?

It is expected that the majority of students completing the proposed BDS program will be successful in finding employment or acceptance into graduate or professional school. Graduates will not only gain diverse domain knowledge but will also meet the core competencies that biology educators identified as high priority (7). These are: applying quantitative reasoning, using models and simulation, tapping into the interdisciplinary nature of science, gaining the ability to communicate and collaborate with other disciplines, and understanding the relationship between science and society. Many of these core competencies are recapitulated in a guideline for curriculum in bioinformatics (21). The competences are expected to prepare undergraduates for success in "New Biology". Students will have opportunities to work in research programs to addresses some of society's grand challenges in, for example, ecosystem and human health. Moreover, large datasets are being generated and used not only in life science research, but also in other fields, such as athletics, social sciences, genetic counseling, advertisement, economics, political science, to name a few, to help guide decision making processes. Hence, students of this program have an unlimited number of career opportunities.

5. 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.

b. Methods by which the learning outcomes will be assessed and used to improve curriculum and instruction.

BPP has developed a curriculum map and assessment plan for its botany major. Because there is substantial overlap in many of the foundational courses, the BDS program has used these plans as templates for its program. Hence, BDS has a strong framework for a curriculum map that relates currently available courses and those under developed to learning outcomes. The curriculum map also serves as a guideline for the future development of courses. The BDS assessment plan includes rubrics for assessment.

In addition, during annual reporting activities for the initial five years of the program, and every fifth year afterwards, the director of the BDS program will develop a "program portfolio" that highlights student work that are related to the specific learning outcomes. The portfolio will be used to assess the learning outcomes and in parallel, used to market the program. A summative BDS senior exam, administered in the proposed BDS412 Senior Capstone course, will be developed to assess whether students are meeting learning outcomes. Proficiency of 75% or more of the students will be used to demonstrate attainment of outcomes. Areas of concern will be identified on the basis of those in which less than 75% of the students are proficient. Attitudinal surveys of graduating students will be conducted to indirectly assess opinions of the program to identify strengths, needs, and areas for improvement. The success rate of students in the job market and graduate/professional school will be used for assessment. The director of the proposed BDS program will form a committee, consisting of faculty in computer science, statistics, mathematics and the life sciences. Assessment information and program portfolios will be provided to this committee, which will be tasked to advise the director on needs of the BDS program, new opportunities such as new courses or disciplinary directions to pursue, as well as unmet needs that the BDS program needs to address. Results will be used to guide decisions on curricular changes to improve delivery of its courses in BDS or for developing new courses to address unmet needs. The BDS program will also work with other programs to develop new courses or modify courses, if there is a common need by both programs.

c. Nature and level of research and/or scholarly work expected of program faculty; indicators of success in those areas.

Indicators of success for research active faculty include, peer-reviewed publications, external grant funding support, and invited talks at departmental, regional, national, and international meetings/conferences. For instructors, indicators of success include evidence of professional growth and innovation in teaching.

6. Program Integration and Collaboration

a. Closely related programs in this or 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.

b. Ways in which the program complements other similar programs in other Oregon institutions and other related programs at this institution. Proposal should identify the potential for collaboration.

The proposed BDS program was developed by a committee of faculty who are associated with programs that have concentrations related to BDS. An example of the potential for collaboration is highlighted by BDS 492. During our liaison process and because of recommendations by EECS, we developed BDS 492 to extend the senior capstone experience to two quarters. The purpose is to develop mechanisms for students in the BDS capstone course to integrate with students in the capstone series offered by EECS. This will be a powerful learning experience for students of different disciplines. Once BDS is offered, it will continue to have potential for collaboration. The program will collaborate with qualified faculty from any department to develop and deliver the curriculum. Student credit hours delivered by a given faculty member will be tracked and communicated at the college level so that appropriate credit will be distributed to the departments of the participating faculty.

With regard to complementarity, the minor offered by BDS will be attractive to students pursuing degrees from any of the life science programs, mathematics, or computer science at OSU.

c. If applicable, proposal should state why this program may not be collaborating with existing similar programs.
NOT APPLICABLE

d. Potential impacts on other programs.

We expect there to be some initial migration of students from other life science programs, computer science, and mathematics to BDS. The future growth of the BDS program is expected to mirror rates of the university. We do not anticipate the numbers to be substantial and are not expected to impact the budgets or facilities in other programs.

7. Financial Sustainability (attach the completed *Budget Outline*)

a. Business plan for the program that anticipates and provides for its long-term financial viability, addressing anticipated sources of funds, the ability to recruit and retain faculty, and plans for assuring adequate library support over the long term.

It is anticipated that the BDS degree will grow to approximately 100 majors within its initial four years. BPP will assume significant new administrative, teaching and advising responsibilities, but other departments will also contribute to the teaching load. The BDS major is designed to be delivered collaboratively across departments. We will welcome other departments' development of BDS courses and commit to distribute financial resources in alignment with student credit hour generation. Added responsibilities associated with the program will include Director of the BDS major, 0.2 FTE of office staff, 2 terms of GTAs, and a minimum of five faculty members with teaching responsibilities in the major.

Director. – BPP will provide one month of summer salary support for the Director of the BDS major. This position will be filled by Dr. Jeff Chang with an initial term of 4 years.

Faculty. – BPP currently has 27 tenure track Faculty, 8 Senior Research Faculty, 3 Instructors, and 17 Adjunct/Affiliated/Courtesy Faculty members. The Department has a history of advancing data science in biological sciences as evidenced by our support of OSU cluster hires in "big data" and faculty hires within the department. Since 2006 BPP has added 9 tenure track positions with an emphasis on big data in biological sciences. These include Dr. Jeff Anderson (1.0 FTE), Dr.

Posy Busby (1.0 FTE), Dr. Jeff Chang (1.0 FTE), Dr. Ken Frost (1.0 FTE), Dr. Christina Haggerty (1.0 FTE), Dr. Pankaj Jaiswal (1.0 FTE), Dr. Andy Jones (1., FTE), Dr. Jared LeBoldus (1.0 FTE) and Dr. Molly Megraw (1.0 FTE). In addition, numerous senior faculty members have advanced biological data science in their research programs. Several of these faculty members teach existing courses that are included in the BDS major (Table 6).

An additional two Assistant Professor tenure track positions have been guaranteed by the College of Agricultural Sciences and both positions will have teaching responsibilities in the BDS major. Advertisement for the first position closes September 1, 2018 with an anticipated start date of April 1, 2019. Advertisement for the second position will commence early 2019 with an anticipated start data of September 1, 2019. Other departments have also contributed teaching FTE to the BDS program including Dr. Maude David (1.0, Microbiology/Pharmacy) and Dr. Rebecca Hutchinson (1.0 FTE, CS/F&W).

Current faculty committed to teaching the five new BDS courses include:

BDS 211: Dr. Rebecca Hutchinson (CS/F&W)
BDS 311: New BPP TT Faculty Hire 1 (BPP)
BDS 406: Dr. Jeff Chang (BPP)
BDS 411: Dr. Jessie Uehling (BPP; starting Jan, 2010)
BDS 491: Dr. Maude David (MB)
BDS 492: Dr. Maude David (MB)

GTAs. – The anticipated growth in the major and the development of 5 new courses will result in a GTA need of 2 terms of GTA support. We do not anticipate a GTA need for BDS 211, 406, 491, and 492. We will provide one GTA for BDS 311 and 411, and BPP will cover the costs of these GTAs through departmental Ecampus revenue generation. We will also pursue development of BDS ECampus courses so that the program develops an ECampus revenue stream that allows it to be more self-sufficient in the future.

Office Staff. – The additional 100 majors will require additional office staff for administrative support. BPP has recently added one additional OS1 position and is searching for another position, which will bring our full complement of office staff to five FTE. The newly hired OS1 position will contribute 0.1 FTE to administrative assistance for the BDS major and the pending OS2 hire will contribute 0.1 FTE to information assistance (e.g., website management, recruiting, etc.).

Advising. – Advising duties will be distributed across faculty who teach in the major with oversight by the BDS Director. Advisors will meet with students on a quarterly basis and provide personalized advising designed to maximize student success, insure progress towards degree completion, and development and advancement of career goals. There are currently five faculty positions identified to teach in the BDS major and we anticipate that the major will grow to approximately 100 students after four years. This will result in an approximately 20:1 ratio of student:advisor. Because the program is designed to welcome collaborative involvement from other departments, we anticipate that this ratio will decrease as more faculty become involved in the major.

Supplies. – There are no significant supplies required by the major and BDS courses will not include any additional lab fees.

b. Plans for development and maintenance of unique resources (buildings, laboratories, technology) necessary to offer a quality program in this field.

Cordley Hall will be remodeled and is envisioned to be a unique resource for life sciences and BDS majors. (See section 1h above.)

c. **Targeted student/faculty ratio (student FTE divided by faculty FTE).**

We anticipate a student/faculty ratio of 10:1 at the onset of the program. As the program matures and enrollment and faculty participation grow, we anticipate a ratio of 15:1 to 20:1.

d. Resources to be devoted to student recruitment.

BPP will devote resources in supporting office staff FTE to developing a website and an electronic brochure and employing social media to recruit students. Faculty FTE will include outreach in the OSU START program, via high school and community college recruitment efforts, as well as participation in Science Olympiad and 4H. We will also work with the college ambassador program to advertise the new program to prospective students.

8. External Review Not applicable

9. References

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OTHER PROPOSAL PIECES

Accessibility Form: attached

Space/Facilities Evaluation (Review by the Office of Capital Planning and Development; see Resource): attached

Ecampus (If program intends to develop an Ecampus offering, obtain an Ecampus Letter of Confirmation): *not applicable*

Library evaluation (see policy): attached

Liaison comments: Internal to OSU

Letters of Support: External to OSU: attached
Budget - All program budgets must be prepared in collaboration with a Business Center. Consult the Budget Preparation Instructions for further details and contact information. Attached
Budget Preparation Instructions [docx] The OSU Budget Narrative Example is on the last page of the instructions. Attached
Forms:

OSU Internal Budget Worksheet Form Excel [xlsx] (to open file please double click "Read Only" to see all three budget pages) i.e. Recurring, One Time, Summary

Curriculum Four-Year Plan attached:

Table 8: Four-year plan by year and quarter for GEN option

Year 1

FALL	WINTER	SPRING
CHEM 231. Gen. Chem* (4)	CHEM 232. Gen. Chem* (4)	CHEM 233. Gen. Chem* (4)
CHEM 261. Lab for Chem (1)	CHEM 262. Lab for Chem (1)	CHEM 263. Lab for Chem (1)
MTH 251. Differ. Calc.* (4)	MTH 252. Integral Calc. (4)	MTH 231. Discrete Math (4)
CS 161. Intro Comp Sci I (4)	CS 162. Intro Comp Sci II (4)	COMM 111. Pub. Speak* (3)
HHS 231. Lifetime Fitness for Health* (2)	WR 121. English Comp.* (3)	BDS 211. Critical Thinking (3)
= **15** credits	= **16** credits	= **15** credits

Year 2

FALL	WINTER	SPRING
BI 211. Gen. Biology* (4)	BI 212. Gen. Biology* (4)	BI 213. Gen. Biology* (4)
MTH 254. Vector Calc. I (4)	Literature and the Arts* (3)	Cultural diversity* (3)
CS 261. Data Structures (4)		PAC any course* (1)
ST 351. Introduction to Statistical Methods (4)	ST 411. Methods of Data Analysis (4)	ST 412. Methods Data Analysis (4)
	WR 327. Technical Writing (3)	BDS 311. Comp Approaches Biol Data (3)
= 16 credits	**= 14** credits	**= 15** credits

Year 3

FALL	WINTER	SPRING
BI 311 Genetics (4)	BI 445. Evolution (3)	GEN elective (Genomics; 3)
MTH 341. Linear Algebra (3)	BB 314. Cell Molec. Biol (4)	Research/Internship (3); e.g., BOT 401
CH 331. Organic Chemistry (4)	CH 332. Organic Chemistry (4)	GEN elective (Adv. mol., cell, organismal/physiology; 4)
Science, Tech. & Society* (3)		BDS 411. Analysis of Biol Data^ (3)
	Western Cultures* (3)	Soc. Proc.& Institutions* (3)
= 14 credits	**= 14** credits	**= 16** credits

Year 4

FALL	WINTER	SPRING
BB 450. Gen Biochem (4)	BB 451. Gen Biochem (4)	GEN elective (Genomics; 3)
BDS 406. Special Projects (1)	BDS 491. Capstone in BDS I (3)	BDS 492. Capstone in BDS II (3)
Contemp. Global Issues* (3)	Diff., Power, Discrim* (3)	
Electives (3)	Electives (3)	Electives (4)
Electives (4)	Electives (3)	
= 15 credits	**= 16** credits	**= 14** credits

Table 9: Four-year plan by year and quarter for EEI option

Year 1

FALL	WINTER	SPRING
BI 211. Gen Biology* (4)	BI 212. Gen Biology* (4)	BI 213. Gen Biology* (4)
CHEM 231. Gen. Chem* (4)	CS 161. Intro Comp Sci I (4)	CS 162. Intro Comp Sci II (4)
CHEM 261. Lab for Chem (1)		
MTH 251. Differ. Calc.* (4)	MTH 252. Integral Calc. (4)	MTH 231. Discrete Math (4)
WR 121. English Comp.* (3)	COMM 111. Pub. Speak* (3)	BDS 211. Critical Thinking (3)
= **16** credits	= **15** credits	= **15** credits

Year 2

FALL	WINTER	SPRING
MTH 254. Vector Calc. I (4)	Electives (3)	MTH 256. Applied Differential Equations (4)
CS 261. Data Structures (4)	EEI elective (Env. Info.; 4)	
ST 351. Introduction to Statistical Methods (4)	ST 411. Methods of Data Analysis (4)	ST 412. Methods Data Analysis (4)
HHS 231. Lifetime Fitness for Health* (2)	WR 327. Technical Writing* (3)	BDS 311. Comp Approaches Biol Data (3)
	PAC any course* (1)	Literature and the Arts* (3)
= 14 credits	**= 15** credits	**= 14** credits

Year 3

FALL	WINTER	SPRING
BI 370. Ecology (3)	EEI elective (Pop., comm; Eco. Ecology; 3)	BI 445. Evolution (3)
BI 311 Genetics (4)	Western Cultures* (3)	EEI elective (Pop., comm; Eco. Ecology; 4)
MTH 341. Linear Algebra (3)	Soc. Proc.& Institutions* (3)	BOT458. Ecosystem Genomics (3)
Cultural diversity* (3)	Diff., Power, Discrim* (3)	BDS 411. Analysis of Biol Data^ (3)
Science, Tech. & Society* (3)	Contemp. Global Issues* (3)	Research/ Internship (3); e.g., BOT 401
= 16 credits	**= 15** credits	**= 16** credits

Year 4

FALL	WINTER	SPRING
EEI elective (Env. Info.; 4)	EEI elective (Pop., comm; Eco. Ecology; 3)	EEI elective (Phys. Env Sci; 4)
BDS 406. Special Projects (1)	Electives (4)	
Electives (4)	BDS 491. Capstone in BDS I (3)	BDS 492. Capstone in BDS II (3)
Electives (4)	Electives (4)	Electives (4)
MTH 427. Introduction to Mathematical Biology (3)		Electives (3)
= 16 credits	**= 14** credits	**= 14** credits

Table 10: Four-year plan by year and quarter for CB option

Year 1

FALL	WINTER	SPRING
BI 211. Gen Biology* (4)	BI 212. Gen Biology* (4)	BI 213. Gen Biology* (4)
CHEM 231. Gen. Chem* (4)	CS 161. Intro Comp Sci I (4)	CS 162. Intro Comp Sci II (4)
CHEM 261. Lab for Chem (1)		
MTH 251. Differ. Calc.* (4)	MTH 252. Integral Calc. (4)	MTH 231. Discrete Math (4)
WR 121. English Comp.* (3)	COMM 111. Pub. Speak* (3)	BDS 211. Critical Thinking (3)
= **16** credits	= **15** credits	= **15** credits

Year 2

FALL	WINTER	SPRING
MTH 254. Vector Calc. I (4)	Electives (3)	MTH 256. Applied Differential Equations (4)
CS 261. Data Structures (4)	Western Cultures* (3)	Electives (3)
ST 351. Introduction to Statistical Methods (4)	ST 411. Methods of Data Analysis (4)	ST 412. Methods Data Analysis (4)
Cultural diversity* (3)	WR 327. Technical Writing* (3)	BDS 311. Comp Approaches Biol Data (3)
	HHS 231. Lifetime Fitness for Health* (2)	PAC any course* (1)
= 15 credits	**= 15** credits	**= 15** credits

Year 3

FALL	WINTER	SPRING
Genetics BI 311 (4)	CB Elective (Bio/Bioinfo/ST; 3)	BI 445. Evolution (3)
MTH 341. Linear Algebra (3)	Electives (3)	Electives (3)
Electives (3)	CS 325. Analysis of Algorithms (4)	CB Elective (Adv. CS; 4)
Soc. Proc.& Institutions* (3)	Science, Tech. & Society* (3)	BDS 411. Analysis of Biol Data^ (3)
Electives (3)	Electives (3)	Research/ Internship (3); e.g., BOT 401
= 16 credits	**= 16** credits	**= 15** credits

Year 4

FALL	WINTER	SPRING
CB Elective (Bio/Bioinfo/ST; 3)	CB Elective (Adv. CS; 3)	CB Elective (Bio/Bioinfo/ST; 3)
BDS 406. Special Projects (1)	Diff., Power, Discrim* (3)	
Contemp. Global Issues* (3)	Literature and the Arts* (3)	Electives (3)
Electives (4)	BDS 491. Capstone in BDS I (3)	BDS 492. Capstone in BDS II (3)
MTH 427. Introduction to Mathematical Biology (3)	Electives (3)	CB Elective (Adv. CS; 4)
= 14 credits	**= 15** credits	**= 13** credits

Table 11: Members of the two planning committees for the undergraduate BDS programs

Name	Year	Affiliations (dept/college)
Committee #1		
Chang, Jeff (Chair)	2015	BPP/CAS
De Leenher, Patrick	2015	IB &Math/COS
Di, Yanming	2015	Stats/COS & CAS
Fern, Xiaoli	2015	EECS/COE
Field, Kate	2015	Micro/COS & CAS (Dir. BRR)
Freitag, Michael	2015	BB/COS
Levi, Taal	2015	FW/CAS
Committee #2		
Chang, Jeff (Chair)	2018	BPP/CAS
David, Maude	2018	Micro & Pharmacy/COS & CAS & Pharmacy
Hutchinson, Rebecca	2018	EECS & FW/COE & CAS
Megraw, Molly	2018	BPP/CAS
Tyler, Brett	2018	BPP/CAS (Dir. CGRB)

UNIVERSITY OF CALIFORNIA, DAVIS

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SANTA BARBARA • SANTA CRUZ

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Dear Dr. Chang,

I am happy to write you a letter of support for the Biological Data Sciences (BDS) program that you are developing for undergraduate students at Oregon State University.

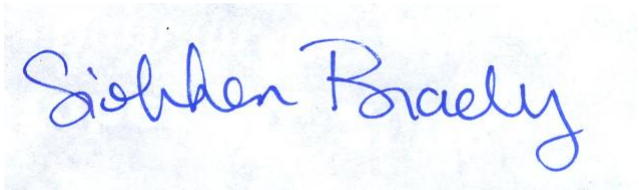
My area of expertise is in plant genomics and plant systems biology. I have been engaged with colleagues in the plant sciences in nation-wide conversations on transforming education and training to enable researchers in leveraging massively large datasets. Our recommendations were published in a commentary in *Plant Physiology* (Friesner et al., 2017).

There is no question that modern plant and life sciences are quantitative and researchers with the necessary skillset are in high demand in the workforce. Timely societal issues in human health, food security, and sustainability of our ecosystem can only be addressed by large transdisciplinary teams. The modern methods used include mathematical modeling, leveraging massive '-omic' datasets, high-throughput phenotyping, and automated sampling, to name a few. These demand biologists who are comfortable working large data, who are familiar with data structures, who are aware of appropriate methods to analyze data, who can communicate effectively and work in large teams, and importantly, who are aware of the limits of the data.

I am in strong support of the proposed BDS program. It is smartly developed to address competencies that we and others have identified as essential for contemporary biology. I am also impressed to see the proposed curricula address the minimal skill sets that we had recommended for plant biology students. I am aware of the challenges in developing an academic program to address the training needs in computational biology. I was excited to see how the proposed BDS program engaged faculty across disciplines and how the program best uses pre-existing courses to address needs. Last, the newly proposed courses are excellent and will help students synthesize knowledge and actively apply knowledge to addressing real datasets.

In summary, the life sciences require more undergraduate programs like BDS. I am in strong support of your proposal.

Sincerely,



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UCONN HEALTH

Center for Quantitative Medicine
Reinhard Laubenbacher, PhD
Professor and Director

September 4, 2018

Professor Jeff Chang
Department of Botany and Plant Pathology
Oregon State University
Corvallis, OR 97331

Dear Professor Chang,
I am happy to provide this letter of support of the superb data science program you are planning to establish at OSU. I have read your detailed proposal outlining the features of the program. While my most immediate experience with data in the life sciences is in the field of biomedicine, I am broadly familiar with developments across the life sciences, and can appreciate the particular challenges that arise in plant biology.

It is by now a truism that the life sciences are becoming more quantitative. In fact, data big and small are now THE driver of much research and practice everywhere. Over time, quantitative, data-based approaches in the life sciences will be as common as they are in engineering, and the term “computational biology” will be largely redundant. The proposed program is an important first step in this direction. Demand for professionals trained in quantitative approaches to the life sciences is skyrocketing, especially since there are now many attractive career opportunities outside the academy for anyone with quantitative training, no matter what domain. Undergraduate data science programs in a variety of fields, from biology to public policy, are being created by many institutions and are meeting exceptional demand. Thus, your proposal is very timely and much needed.

Let me point out what I see as several strengths of your proposed program. Firstly, mathematics and statistics are organically built into the biology training experience. This provides for better motivation on the part of the students and improved skill in applicability. Secondly, your inclusion of advanced linear algebra, up to eigenvectors and eigenvalues, is very important. In my experience, for data problems, especially of the “large” variety, linear-algebra-based methods, such as principal component analysis or various machine learning algorithms, play a larger role than calculus-based approaches. Thirdly, grounding the program in a particular application area, with hands-on experiences, provides students with more directly applicable job skills. And, finally, focusing on communication across fields is crucial for today’s work environment, in whatever setting. Your program will train students that will be well-equipped for both graduate degree programs and professional work environments.

Sincerely,

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September 6, 2018

Prof. Jeff Chang
Dept of Botany & Plant Pathology
Center for Genome Research & Biocomputing
Oregon State University
3098 Cordley Hall
Corvallis, OR 97331

Dear Jeff,

Thank you for sharing your proposal to start a new undergraduate major and minor at Oregon State University entitled 'Biological Data Sciences" (BDS). I will first provide a bit of background about me, to explain why this program is of interest and relevance. I am currently a Member & Principal Investigator at the Donald Danforth Plant Science Center, and I am also a tenured Professor at the University of Missouri, Columbia. Prior to my current appointment, for over 13 years, I was a Professor in the Department of Plant & Soil Sciences at the University of Delaware; I served as the Chair of that department for over six years. I have served on numerous government and industry advisory boards and many editorial boards. My research focuses on the roles of small RNAs, particularly in epigenetic regulation of gene expression, as well as microRNAs and their biogenesis, in various model and crop plants. My lab also works in the field of bioinformatics, developing biology-focused tools for analyzing next-gen transcriptional data. About half of my research group focuses on biological data sciences, focusing on the development and application of bioinformatics tools for RNA and genomic data.

I am excited and supportive about your proposal as it is quite timely. When I was at the University of Delaware ("UD"), going back over a decade ago, I was closely involved with the development of a highly successful graduate program focused on bioinformatics, based in the Center for Bioinformatics & Computational Biology (CBCB). More recently, this has evolved into a "Data Sciences Institute" led by Cathy Wu. I also worked closely with the chair of the statistics program at Delaware. From those experiences, it was clear to me that students and employers, as well as professional and graduate schools, have a strong demand for individuals with experience in working with big data. I also worked closely on the development of a "Genome Sciences" undergraduate major – still in the process of establishment at UD. From the investigations we did into related programs for that work, it was clear that at the undergraduate level, it is critical to establish a foundation to teach students how to work and have familiarity with large datasets, how to treat those data, and both potential and limitations of working with big data. By their very nature, the relatively new fields of computational biology and bioinformatics are transdisciplinary and require students to be sufficiently competent in biology, math, computer science, and statistics. Because is infeasible for someone to be deeply trained in all four of these areas, success is most likely to be found by training individuals deeply in one topic but ensuring they have a high level of comfortable in others.

Generally speaking and in my experience, university programs in biology-focused data sciences can pose some challenges to coordinate or establish because the training is cross-cutting, but degree programs and the units administering them are often separated by departments or even colleges. In the case of your

proposed BDS program, I am impressed that it aims to smartly engaged the campus to build a horizontal structure from a pre-existing vertical structure. This proposed BDS program has an additional strength represented also by its focusing on teaching skills that the students can apply to problems of their interest, and the program will develop their critical thinking abilities; these attributes in your graduates would be applicable for all careers that they might pursue in the future. Finally, I would state that in my opinion, the proposed BDS program represents an exceptionally rigorous academic program that will be attractive to students nationwide. With the BDS program that you are proposing, I anticipating that the graduates you would generate will comprise a future workforce that is well-prepared with quantitative thinking skills.

Sincerely,

Blake C. Meyers, Ph.D.
Member & Professor

Center for Genome Research & Biocomputing
Oregon State University
3021 Ag & Life Sciences Bldg
2750 Campus Way
Corvallis, Oregon 97331-7303
P 541-737-3347
W cgrb.oregonstate.edu

February 25, 2019

Dr. Jeffrey Chang
Department of Botany and Plant Pathology

Dear Jeff,

As Director of the Center for Genome Research and Biocomputing (CGRB), I am pleased to confirm that the CGRB's Advanced Cyberinfrastructure Teaching Facility (ACTF) will be available for any computationally intensive course that forms part of the proposed Biological Data Sciences (BDS) undergraduate major, including BDS 211 and BDS 412.

The ACTF hardware includes:

- 100 TB+ redundant networked storage with regular backup
- 10 Gbps networking backbone
- 10 Gbps networking for all nodes
- 6 high-performance compute nodes supplying:
- 350+ CPU cores
- 2 TB+ RAM
- 4 Nvidia Tesla K80 2xGPU units for general purpose applications
- Enterprise-grade webserver and related hosting resources

The ACTF runs custom software to make it easy for instructors to set up and run classes, and to protect the infrastructure from student errors.

Sincerely,

Brett Tyler, Ph.D.
Director, Center for Genome Research and Biocomputing
Stewart Professor of Gene Research
Director, Graduate Minor in Biological Data Sciences

Center for Genome Research & Biocomputing
Oregon State University
3021 Ag & Life Sciences Bldg
2750 Campus Way
Corvallis, Oregon 97331-7303
P 541-737-3347
W cgrb.oregonstate.edu

February 25, 2019

Dr. Jeffrey Chang
Department of Botany and Plant Pathology

Dear Jeff,

As Director of the Graduate Minor in Biological Data Sciences, you have my support and encouragement to use the name "Biological Data Sciences" for your proposed new undergraduate major that will be hosted by the Department of Botany and Plant Pathology.

The educational goals, disciplinary span, and philosophy of the proposed undergraduate major are closely aligned with those of the graduate minor. Thus, it is entirely logical that they should share the same name, just as undergraduate and graduate majors in, for example Mathematics or Chemistry, share the same name.

Sincerely,

Brett Tyler, Ph.D.
Director, Center for Genome Research and Biocomputing
Stewart Professor of Gene Research
Director, Graduate Minor in Biological Data Sciences

ACCESSIBILITY
New Program Proposal
(Degree or Certificate)
Guidelines for Addressing Accessibility

Sections 503 and 504 of the Rehabilitation Act of 1973, and the Americans with Disabilities Act of 1990 (ADA), as amended by the ADA Amendments Act of 2008 prohibits discrimination on the basis of disability. The Rehabilitation Act and the ADA require that no qualified person shall, solely by reason of disability, be denied access to, participation in, or the benefits of, any program or activity operated by the University. Each qualified person shall receive the reasonable accommodations needed to ensure equal access to employment, educational opportunities, programs, and activities in the most integrated setting feasible.

For questions and assistance with addressing access, please contact:
the Office of Disability and Access Services (737-4098), or
the Office of Affirmative Action and Equal Opportunity (737-3556).

Title of Proposal: Biological Data Sciences (BDS)

Date: 12/11/18

School/Department/Program: Botany and Plant Pathology

College: CAS

- ❑ Accessibility (http://oregonstate.edu/accessibility/policies)
- ❑ Faculty Guidelines (http://ds.oregonstate.edu/facultyguidelines)
- ❑ Information Technology Guidelines (http://oregonstate.edu/accessibility/ITpolicy)

By signing this form, we affirm that at we have reviewed the listed documents and will apply a good faith effort to ensure accessibility in curricular design, delivery, and supporting information.

Sign (School/Department/Program Director/Chair/Head)

Jeff Chang (inaugural director of program)

Print (School/Department/Program Director/Chair/Head)

12/11/18

Date

Source: Office of Academic Programs, Assessment, and Accreditation (glb/ch; 4-26-16)

OSU Libraries
Collection Development

Library Evaluation for Category I Proposal

Biological Data Sciences (BDS)
Title of Proposal

Botany & Plant Pathology
Department

Agricultural Sciences
College

The subject librarian responsible for collection development in the pertinent curricular area has assessed whether the existing library collections and services can support the proposal. Based on this review, the subject librarian concludes that present collections and services are:

[ ] inadequate to support the proposal (see budget needs below)
[ ] marginally adequate to support the proposal
[x] adequate to support the proposal

Estimated funding needed to upgrade collections or services to support the proposal (details are attached)

Year 1:
$

Ongoing (annual):

Comments and Recommendations:

Date Received: August 31, 2018

Date Completed: September 6, 2018

Laurel Kristick
Collection Assessment Librarian

Laurel Kristick
Signature

Kerri Goergen-Doll
Head of Collections & Resource Sharing

Kerri Goergen-Doll
Signature

9/11/18
Date

Faye A. Chadwell
Donald and Delpha Campbell
University Librarian and
OSU Press Director

Faye A. Chadwell
Signature

9/11/18
Date

Oregon State University Libraries Evaluation of the Collection Supporting a Proposal to Initiate a Program in Biological Data Sciences

This Oregon State University Libraries and Press (OSULP) assessment reviews the print monographic, e-book, and electronic serials collections needed to support the proposed undergraduate major and minor in Biological Data Sciences (BDS). As stated in the Cat 1 proposal, this will provide 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 knowledgebase for all BDS students. From the OSULP perspective, students and researchers will tap various components of the library collections.

Summary of Recommendations

The monographic collection appears to be adequate to support the proposed program.

The journal collection is currently adequate to support the proposed program.

Print Monographs and E-Books

Library evaluations of proposed programs have traditionally included the analysis of OSULP's print monograph collection. Comparing the monograph collection with other universities' collections is routine. This analysis includes a comparison of the monograph collection with peer institutions with a program similar to the one proposed. Peer institutions were identified who had Bachelor of Data Science programs with a life sciences track. Due to OSULP's strengths in meeting the needs of the existing courses in the various disciplines, the collection will support the proposed program.

Table 1. Monograph Comparison with Peer Institutions.

Subject terms	OSU	Charleston College	Univ. of Rochester	Northwest Missouri State Univ.	OSU Rank Among Peers
Specific Biological Data Science Terms					
Bioinformatics	213	176	94	9	1
Computational biology	282	222	137	14	1
General Data Science Terms					
Big Data	55	87	36	25	2
Computer algorithms	639	233	584	35	1
Computer simulation	2,324	506	877	29	1
Data mining	384	280	270	50	1
Data models	694	189	355	13	1
Data processing	9,142	2,609	5,544	294	1
Data science	1,077	473	801	64	1
Data structures (computer science)	831	131	162	14	1
Database management	777	368	496	38	1

Subject terms	OSU	Charleston College	Univ. of Rochester	Northwest Missouri State Univ.	OSU Rank Among Peers
Databases	1,292	354	418	27	1
Eigenvalues and eigenvectors	122	20	80	0	1
Geographic information systems	799	263	157	92	1
Mathematical models	9,090	2,272	5,183	127	1
Simulation methods	759	204	422	14	1
Statistical methods	2,405	1,070	1,493	119	1
Data Science Titles with a focus on biological fields	1,254	571	526	47	1
Total	22,658	6,841	13,374	711	1

The growing availability of e-books makes it possible to expedite access to more information from various locations. Students are able to access the books from their computer or mobile device at any time. The library currently has over 13,000 e-books in data science topics.

OSU is well served by the OSULP investment in the Orbis/Cascades Alliance, whose combined collection is substantial. Students and faculty can order from the collections of all the libraries in the Orbis Cascade Alliance through the Summit catalog. University of Oregon, Portland State University, University of Washington and Washington State University are some of the larger research libraries represented in the Summit catalog. Books requested through Summit are delivered to OSUL within three to five working days.

Serials/Journals

The OSULP maintain an adequate collection of journals appropriate for this proposed program. There is concern that with regular price increases to our licenses and a flat budget that access may be eroded over time. The OSULP already have sacrificed timely access to some titles in favor of an embargo period to cut costs (these journals are only available after a 1-2 year delay). A list of key journals for this program was developed using the "Mathematical & Computational Biology" subject category in the Journal Citation Report (JCR). This produced a list of 59 journals (see Appendix A). The list includes those titles that we have current access to, those with embargoes and those not owned by the OSULP.

OSU Libraries has current subscriptions to 37 of these titles (63%), and delayed access to an additional two titles. Of the high-impact journals (impact factor in the top quartile), the library has access to 11 of the 16 journals. The five journals that OSULP does not subscribe to are not specifically data science titles, and Interlibrary Loan (ILL) requests for articles will be monitored to determine whether usage justifies the acquisition of additional journals.

Indexes and Databases

The core indexes to the relevant information for this program are listed in Table 2. In addition to these resources, other subject-based indexes may be relevant depending on the student's area of focus.

Table 2. Bibliographic Indexes, Databases and Datasets

Resource	Description
Web of Science	Interdisciplinary database that indexes journal articles in all science disciplines, includes cited reference searching
(TAIR) The Arabidopsis Information Research	Database of genetic and molecular data for *Arabidopsis thaliana*
CiteseerX (Computer & Information Science Papers)	Scientific literature digital library and search engine for literature in computer and information science
Synthesis Digital Library of Engineering & Computer Science	Short, authoritative electronic books that provide a grounding in a particular topic area.
Engineering Village (Compendex)	Indexes engineering and computer science journals, conference papers, book chapters, dissertations, and standards
ICPSR (Inter-University Consortium for Political & Social Research)	Primarily social science data sets; includes public health
SHARE	Facilitates finding publically available research datasets

Key library services & librarian expertise

The Library Liaison for the College of Engineering is Lindsay Marlow. The liaison for the College of Agricultural Sciences is Hannah Rempel. The Library Liaison for the College of Science in Diana Park. Liaisons are library faculty members that monitor the strategic directions and priorities of colleges and programs, and are a conduit to the expertise and services of the OSU Libraries.

Specifically for data sciences, OSULP also supports data management on campus through Clara Llebot Lorente, the Data Management Specialist. Professor Llebot Lorente is also available for class instruction or workshops (e.g., on data ethics and data management) and daylong software and data carpentry workshops that focus on teaching tools useful for data sciences (e.g., R, version control, or shell). A data management and planning subject guide is also available at http://ica.library.oregonstate.edu/subject-guide/1346-Data-Management-Planning.

The OSULP collections are built by the Collections Council. Providing access to items not owned by OSULP is the domain of the Interlibrary Loan and Summit staff both at OSULP and at lending libraries. Print articles located in the OSU Libraries collections may be requested via the Scan and Deliver service, which provides PDFs of the requested articles. Additional services for students include the physical attributes of the libraries including excellent computer facilities, study areas for individual and group work, and practice rooms for students.

Respectfully submitted,

Laurel Kristick
Collection Assessment and Science Librarian
September 6, 2018

Appendix A. Core Journals in Biological Data Science

Journal Title	ISSN	Journal Impact Factor	OSU Holdings
Wiley Interdisciplinary Reviews-Computational Molecular Science	1759-0876	8.836	-
BRIEFINGS IN BIOINFORMATICS	1467-5463	6.302	2000-1 year ago
BIOINFORMATICS	1367-4803	5.481	1998-present
Database-The Journal of Biological Databases and Curation	1758-0463	3.978	2009-present
PLoS Computational Biology	1553-734X	3.955	2005-present
IEEE Journal of Biomedical and Health Informatics	2168-2194	3.85	2013-present
Research Synthesis Methods	1759-2879	3.218	-
Frontiers in Neuroinformatics	1662-5196	3.074	2007-present
GENETIC EPIDEMIOLOGY	0741-0395	2.544	-
Journal of Mathematical Neuroscience	2190-8567	2.414	2011-present
International Journal for Numerical Methods in Biomedical Engineering	2040-7939	2.338	-
STATISTICAL METHODS IN MEDICAL RESEARCH	0962-2802	2.284	1992-present
SAR AND QSAR IN ENVIRONMENTAL RESEARCH	1062-936X	2.227	-
BMC BIOINFORMATICS	1471-2105	2.213	2000-present
COMPUTERS IN BIOLOGY AND MEDICINE	0010-4825	2.115	1970-present
Frontiers in Computational Neuroscience	1662-5188	2.073	2007-present
BMC Systems Biology	1752-0509	2.05	2006-present
Theoretical Biology and Medical Modelling	1742-4682	2	2004-present
MEDICAL & BIOLOGICAL ENGINEERING & COMPUTING	0140-0118	1.971	1977-present
Molecular Informatics	1868-1743	1.955	-
STATISTICS IN MEDICINE	0277-6715	1.932	-
JOURNAL OF MOLECULAR GRAPHICS & MODELLING	1093-3263	1.885	1997-present
Evolutionary Bioinformatics	1176-9343	1.877	2005-present
BioData Mining	1756-0381	1.857	2008-present
JOURNAL OF THEORETICAL BIOLOGY	0022-5193	1.833	1961-present
JOURNAL OF MATHEMATICAL BIOLOGY	0303-6812	1.786	1974-present
BIOMETRIKA	0006-3444	1.669	1901-present
Computational Intelligence and Neuroscience	1687-5265	1.649	2007-present
MATHEMATICAL MEDICINE AND BIOLOGY-A JOURNAL OF THE IMA	1477-8599	1.628	-
BIOSYSTEMS	0303-2647	1.619	1974-present
JOURNAL OF COMPUTATIONAL NEUROSCIENCE	0929-5313	1.606	1994-present
Journal of Biomedical Semantics	2041-1480	1.6	2010-present
Journal of Biological Dynamics	1751-3758	1.576	2007-present
THEORY IN BIOSCIENCES	1431-7613	1.552	-
Computational and Mathematical Methods in Medicine	1748-670X	1.545	2006-present

Journal Title	ISSN	Journal Impact Factor	OSU Holdings
Algorithms for Molecular Biology	1748-7188	1.536	2006-present
BIOMETRICS	0006-341X	1.524	1947-present
BIOSTATISTICS	1465-4644	1.504	2000-2 years ago
MATHEMATICAL BIOSCIENCES	0025-5564	1.5	1967-present
BULLETIN OF MATHEMATICAL BIOLOGY	0092-8240	1.484	1973-present
THEORETICAL POPULATION BIOLOGY	0040-5809	1.259	1970-present
Mathematical Biosciences and Engineering	1547-1063	1.23	-
JOURNAL OF COMPUTATIONAL BIOLOGY	1066-5277	1.191	1994-present
BIOMETRICAL JOURNAL	0323-3847	1.114	1977-present
Mathematical Modelling of Natural Phenomena	0973-5348	1.101	-
JOURNAL OF AGRICULTURAL BIOLOGICAL AND ENVIRONMENTAL STATISTICS	1085-7117	1.072	1996-present
Journal of Bioinformatics and Computational Biology	0219-7200	0.991	-
IET Systems Biology	1751-8849	0.873	2007-present
ACTA BIOTHEORETICA	0001-5342	0.857	1935-present
International Journal of Biomathematics	1793-5245	0.846	-
International Journal of Biostatistics	2194-573X	0.84	2005-present
Statistics in Biopharmaceutical Research	1946-6315	0.826	-
Statistical Applications in Genetics and Molecular Biology	2194-6302	0.812	2002-present
Interdisciplinary Sciences-Computational Life Sciences	1913-2751	0.796	-
International Journal of Data Mining and Bioinformatics	1748-5673	0.652	-
JOURNAL OF BIOLOGICAL SYSTEMS	0218-3390	0.649	-
Journal of Medical Imaging and Health Informatics	2156-7018	0.549	-
Current Bioinformatics	1574-8936	0.54	-
Statistics and Its Interface	1938-7989	0.398	-

This is a trans-disciplinary program that relies on foundational and extant courses offered by many units across the OSU campus. The magnitude of this program was communicated to administration, who agreed that listing all faculty involved is unnecessarily onerous but did recommend providing sufficient context to demonstrate sufficiency in faculty involvement.

As described in the proposal, we have had multiple conversations in the form of committees, townhall discussions, and one-on-one meetings with unit leaders and their faculty (Tables 1 and 2). The faculty that will be involved in teaching core and elective courses include those from Integrative Biology (Biology/Zoology program), Biochemistry & Biophysics (Biochemistry/Molecular Biology), Microbiology, Crop and Soil Science, Horticulture, Forestry, Fisheries and Wildlife, Pharmacy, VetMed, Chemistry, Mathematics, Statistics, Computer Science and units within CEOAS.

Table 1: Members of the 2014 "Bioinformatics and Computational Biology Curricula" taskforce.

Brett Tyler (CGRB; BPP) Chair	[2]Jan Medlock (BMS, CVM)
[1]*Jeff Chang (BPP, CAS)	[2]Natalia Shulzhenko (BMS, CVM)
[1]Michael Freitag (BB, COS)	[2]Stephen Ramsey (BMS/EECS, CVM/COE)
[1]Yanming Di (STAT, COS/CAS)	[2]David Hendrix (BB/EECS, COS/COE)
[1]Patrick De Leenheer (MATH/IB, COS)	[2]Andy Houseman (CPHHS)
[1]Kathleen O'Malley (HMSC/F&W, CAS)	[2]Emily Ho (CPHHS)
[1]Xiaoli Fern (EECS, COE)	[2]Andriy Morgun (COP)
[2]**Thomas Sharpton (MB/STAT, COS/CAS)	[2]Glenn Howe (COF)
[2]**Molly Megraw (BPP, CAS)	[2]Lorenzo Ciannelli (CEOAS)
[2]Massimo Bionaz (ARS, CAS)	[2]Yvette Spitz (CEOAS)

[1] Undergraduate sub-committee; * sub-committee chair
[2] Graduate sub-committee; ** sub-committee co-chairs

Table 2: Members of two planning committees for the undergraduate BDS programs

Name	Year	Affiliations (dept/college)
Committee #1		
Chang, Jeff (Chair)	2015	BPP/CAS
De Leenher, Patrick	2015	IB &Math/COS
Di, Yanming	2015	Stats/COS & CAS
Fern, Xiaoli	2015	EECS/COE
Field, Kate	2015	Micro/COS & CAS (Dir. BRR)
Freitag, Michael	2015	BB/COS
Levi, Taal	2015	FW/CAS
Committee #2		
Chang, Jeff (Chair)	2018	BPP/CAS
David, Maude	2018	Micro & Pharmacy/COS & CAS & Pharmacy
Hutchinson, Rebecca	2018	EECS & FW/COE & CAS
Megraw, Molly	2018	BPP/CAS
Tyler, Brett	2018	BPP/CAS (Dir. CGRB)

A list of faculty members in the Department of Botany and Plant Pathology who are involved in the delivery of 25 courses central to BDS as well as the administration of BDS (Table 3). Additionally included are faculty outside of the department who have direct involvement in delivering courses developed specific for the proposed BDS program.

Table 3: Faculty (BPP or directly) involved in the delivery and administration of BDS

Name	Degree	Unit	Rank	Involvement
Anderson, Jeff	PhD	BPP	Asst. Prof.	BI 213, BOT 460
Chang, Jeff	PhD	BPP	Assoc. Prof.	BI 212, BDS 407, director BDS
Curtis, Marc	PhD	BPP	Instructor	BOT 331, BB 314, BI 445
David, Maude	PhD	Micro/Pharmacy	Asst. Prof.	BDS 412, BDS 413
Fowler, John	PhD	BPP	Professor	BI 211
Hutchison, Rebecca	PhD	EECS/F&W	Asst. Prof.	BDS 211
Jaiswal, Pankaj	PhD	BPP	Assoc. Prof.	BOT 331
Jones, Andrew	PhD	BPP	Assoc. Prof.	BOT 341, BOT 442
Leboldus, Jared	PhD	BPP	Asst. Prof.	BOT413, BOT 458
Liston, Aaron	PhD	BPP	Professor	BOT 475
Megraw, Molly	PhD	BPP	Assoc. Prof.	BOT476, and BOT499 "Introduction to Genome Biology"
Smyth, Caitlyn	PhD	BPP	Instructor	BI 204, BI 205, BI 206
Spatafora, Joseph	PhD	BPP	Professor	Head of BPP
Thomas Duncan	PhD	BPP	Instructor	BOT 341
Tyler, Brett	PhD	BPP	Professor	Director of the CGRB (led campus-wide discussions on biological data sciences)
Uehling, Jessie*	PhD	BPP	Asst. Prof.	BDS 411
TBD**	PhD	BPP	Asst. Prof.	BDS 311

*starting 2020; search in 2019; starting in 2020

Faculty CVs are available upon request.

This assessment plan and report template has multiple tabs. Be sure to open your window wide enough to see the tabs.

What this assessment plan and report are asking for:

>>> This report is asking for a clear, succinct accounting of full-cycle assessment activities for each degree program. This means the program needs to engage in and report the following:

>> Each degree program must have **clear, measurable student learning outcomes** that represent the knowledge, skills, and values a graduating student will possess.

> The outcomes need to be meaningful to the faculty and other professionals in the field and represent what OSU students need to succeed and be valued in the field.

> The outcomes will likely have sub-components that help further define the outcome. If you develop sub-components, those can be submitted as an attachment to the report. For this report you can just list the primary outcome.

>> Each year one or more of the program outcomes must be in some stage of the assessment cycle (data collection, review/consideration of the data, implementation of changes as a result of the data) such that **ALL outcomes have been assessed and reported in a period of 5 years**.

> A plan must be in place to measure all outcomes within 5 years. A plan is built into this annual assessment report under questions 3.c. and 5. Separate, detailed plans are encouraged.

> A cycle of fewer than 5 years is fine. If the program has fewer than 5 outcomes, it will be on a shorter cycle (e.g. 4 outcomes = 4 or fewer years).

> If the program has >10 different outcomes and needs a longer cycle, please contact the APAA to develop an alternative plan. We are glad to work with you.

> If programs are in the developmental phases for program-level assessment and/or have new learning outcomes, start with assessing FEWER outcomes and ASSESS THEM WELL! Please communicate with the APAA if this is the case or if you want some help with designing an efficient assessment plan.

>> Each outcome must have **at least one direct measure** identified and aligned to it, but more than one measure is best practice and far more reliable.

> Indirect measures can be used to support or triangulate the data from the direct measures.

> In some cases indirect measures are the primary means of data collection. This is the exception rather than the rule. If indirect measures are the sole source of data, then please provide an explanation for its selection.

>> Use the student learning data to **inform programmatic decision-making** to maximize student learning and improve the strength, effectiveness, and efficiency of the program.

> You will be asked to describe the process your unit uses/d to reflect upon the data, how results of assessment efforts relate to strategic planning, and plans for any course, curricular, or unit level changes based upon the data.

Why are we asking for this?

>>> The number one reason we are asking for this information is to ensure the **use of evidence and data to inform curricula and pedagogy**.

>> Just as in our scholarly and creative work, evidence and data are essential supplements to the professional competence and commitment that we dedicate to our students.

>> Additional reasons, which should be compelling to educators and members of the academic community, are that we owe it to the the students and we must demonstrate genuine, full cycle assessment to our accrediting body, the NWCCU. Remember, accreditation is voluntary but necessary.

How the annual report submission and the associated tracking and submission process works:

>>> By switching to an Excel spreadsheet format your program can **report multiple years of data in one document**. Just use a new tab for a new year and label the tab.

>>> Submit reports to the APAA Sharepoint website: https://sharepoint.oregonstate.edu/sites/APAA/assessment/default.aspx

>> **Instructions can be found at: http://oregonstate.edu/admin/aa/apaa/assessment-resources**

Template was updated by Tam Belknap, 3/13/2018. Developed by Stefani Dawn, PhD, Assistant Director of Assessment, 2013-15

Feel free to send question, comments, or suggestion to tamara.belknap@oregonstateuniversity.edu, 541-737-2171

Column 1 (Level of Student Outcome Learning at Conclusion of Course): 1=Emerging; 2=Developing; 3=Proficient
Column 2 (Level of Student Outcome Learning upon Course Entry): I=Introduce; R=Reinforce; E=Emphasize
Column 3 (Intentional Correlation with Co-curricular Activities): C=Co-Curriculum

Learning Outcomes:
1. Apply the process of scientific investigation to real world biological datasets.
2. Use appropriate quantitative and visual methods in scientific investigation.
3. Demonstrate familiarity with general structures of large datasets and use appropriate methods to organize and manipulate large datasets.
4. Demonstrate effective communication and functioning in trans-disciplinary teams.
5. Perform work in a professional and ethical manner.
6. Apply the core concepts in the biological sciences, mathematics, statistics, and computer science to scientific investigation.

Outcome # ⇨		1. Scientific Investigation			2. Appropriate methods			3. Large Datasets			3. Communication			5. Ethical behavior			6. Core concepts		
Course prefix	Course ID	1.1	1.2	1.3	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	4.3	6.1	6.2	6.3
BI	21X	1	I		1	I		1	I		1	I					2	I	
BI	311	2	I		2	I		2	R								2	R	
BI	445	2	I		2	I											2	R	
CH	231	1	I		1	I											2	I	
CH	261	1	I		1	I											2	I	
MTH	251																2	R	
MTH	252																2	R	
MTH	231																2	R	
MTH	254																2	R	
MTH	341							2	R								2	R	
ST	351				2	I		2	R								2	I	
ST	411				2	R		3	E								3	E	
ST	412				3	E		3	E								3	E	
CS	161				2	I		2	I								2	I	
CS	162				2	R		2	R								2	R	
CS	261				2	R		2	R								2	R	
BDS	211	2	I		1	I		1	I		2	R		2	R		2	I	
BDS	311	2	R		2	R		2	R		2	R		2	R		2	R	
BDS	407										2	R		3	E		3	E	
BDS	411	3	E		3	E		3	E		3	E		3	E		3	E	
BDS	412	3	E		3	E		3	E		3	E		3	E		3	E	
BDS	413	3	E		3	E		3	E		3	E		3	E		3	E	
CH	232																2	R	
CH	233																2	R	
CH	262																2	R	
CH	263																2	R	
CH	321																2	R	
CH	332																2	R	
BB	450	2	R		2	R											2	R	
BB	451	2	R		2	R											2	R	
BB	314	2	R		2	R											2	R	
BOT	331	3	E		3	E											3	E	
BB	460	3	E		3	E											3	E	
BB	484	3	E		3	E											3	E	
BB	493	3	E		3	E											3	E	
MB	302	2	R		2	R											2	R	
MB	303	2	R		2	R											2	R	
Z	425	3	E		3	E											3	E	
Z	437	3	E		3	E											3	E	
Z	438	3	E		3	E											3	E	
BOT	476				3	E		3	E		2	R					3	E	
BOT	458	3	E		3	E		3	E		2	R					3	E	
BOT	460	3	E		3	E		3	E		2	R					3	E	
BOT	475	3	E		3	E		3	E		2	R					3	E	
BB	485				3	E		3	E								3	E	
MB	420	3	E		3	E		3	E								3	E	
ST	415	3	E		3	E		3	E								3	E	
MTH	256				2	R		1	I								2	R	
MTH	420				3	E		3	E								3	E	
MTH	427				3	E		3	E								3	E	
BI	370	2	R		3	E		3	E								3	E	
BI	351	2	R		3	E		3	E								3	E	
BI	358	2	R		3	E		3	E								3	E	
BI	481	2	R		3	E		3	E								3	E	
BI	495	2	R		3	E											3	E	
BOT	341	2	R		3	E		3	E								3	E	
BOT	413	2	R														3	E	
BOT	440	2	R		3	E		3	E								3	E	
FES	341	2	R					3	E								3	E	
FW	321	2	R		2	R											3	E	
FW	456	2	R		3	E		3	E								3	E	
FW	479	2	R		3	E		3	E								3	E	
BI	483	2	R		3	E		3	E								3	E	
BOT	442	2	R		3	E		3	E								3	E	
FW	320	2	R		3	E		3	E								3	E	
CSS	205																2	I	
ATS	201				1	I		1	I								2	I	
GEO	202	1	I														2	I	
OC	201																2	I	
OC	332																3	R	
OC	440							3	E								3	E	
GEO	221	1	I																
GEOG	201				2	I		2	I										
FE	209				2	I		2	I										
FE	257				2	I		2	I										
GEOG	360				3	E		3	E										
GEOG	480				3	E		3	E										
FW	303				3	E		3	E										
ROP/HOR	414				3	E		3	E										
CS	446				3	E		3	E								3	E	
ST	413				3	E		3	E								3	E	
ST	431				3	E		3	E								3	E	

ST	435	3	E	3	E	3	E
CS	325	3	E	3	E	3	E
CS	321	3	E	3	E	3	E
CS	331	3	E	3	E	3	E
CS	361	3	E	3	E	3	E
CS	362	3	E	3	E	3	E
CS	381	3	E	3	E	3	E
CS	420	3	E	3	E	3	E
CS	434	3	E	3	E	3	E
CS	458	3	E	3	E	3	E
CS	475	3	E	3	E	3	E

Program Information

Program:	Biological Data Sciences	**Associated Minors:**	Biological Data Sciences
College or Administrative Division:	College of Agricultural Sciences		
Subunit(s):	Dept of Botany and Plant Pathology		

How will you communicate program level student learning outcomes to the students and the public? (include web link)

Program Learning Outcomes, Benchmarks and Measures

Outcomes: List your program level student learning (SLO) outcome(s) . (Please indicate if outcome is for specific minor only)	1. Apply the process of scientific investigation to real world biological datasets.	2. Use appropriate quantitative and visual methods in scientific investigation.	3. Demonstrate profiency in using appropriate methods to organize and manipulate large datasets.	4. Demonstrate effective communication and functioning in trans-disciplinary teams.	5. Perform work in a professional and ethical manner.	6. Apply the core concepts in the biological sciences, mathematics, statistics, and computer science to scientific investigation.
Year was this outcome developed or most recently changed?	2018	2018	2018	2018	2018	2018
Next year will you be reporting on this outcome?						
Assessment Method: List the measures/methods /instruments used to assess the outcome. How do students demonstrate their attainment of this outcome and how is their learning evaluated?	Assessments will be made in two courses: BDS 407 (+ EL) and BDS 412/413. Evaluation will be based on oral and written reports as well as peer- and self-evaluation. Rubrics will be provided to students	Assessments will be made in upper-division math, statistics, and computer science courses. Assessments will also be made in BDS 311, 411, and 412/413 courses. Instruments include examinations and group projects.	Assessments will be made in "big data courses" as well as each of the BDS courses. Instruments include examinations and group projects.	Assessments will be made in the BDS cohort courses and the experiential learning. Evaluation will be based on oral and written reports as well as peer- and self-evaluation and mentor evaluation. Rubrics will be provided to students and the mentors	Assessments will be made in the BDS cohort courses and the experiential learning. Evaluation will be based on peer- and self-evaluation as well as evaluation by mentors. Rubrics will be provided to students and mentors	Students pass all courses core to BDS, including those in biology, math, statistics, and computer science. Assessments will be made BDS in 407 (+ EL) and BDS 412/413. Evaluation will be based on oral and written reports as well as peer- and self-evaluation. Rubrics will be provided to
Assessment Method: Are the measures/methods/instruments direct (D) or indirect (I)?	D and I	D	D and I	D and I	I	D and I
Assessment Method: What benchmarks or indicators of success are you using to determine if the outcome has been satisfactorily met by the students?	Students will be scored on provided rubrics as well as self- and peer-evaluation. 85% of students are expected to be proficient in all criteria.	75% of the students are expected to be proficient; 85% are expected to show developing ability.	Students will be scored on provided rubrics as well as self- and peer-evaluation. 85% of students are expected to be proficient in all criteria.	75% of the students are expected to be proficient; 85% are expected to show develpoing ability.	99% of the students are expected to meet this learning outcome	Students will be scored on provided rubrics as well as self- and peer-evaluation. 85% of students are expected to be proficient in all criteria.

Process

How will your unit reflect on the data you are reporting and who was involved? How are the results of your assessment efforts related to strategic planning and overall program review?	Data will be reported to the director of the BDS program, department Head and program advising committee. Data will be used to assess suitability of courses and defines areas of growth	Data will be reported to the director of the BDS program, department Head and program advising committee. Data will be used to assess suitability of courses and defines areas of growth	Data will be reported to the director of the BDS program, department Head and program advising committee. Data will be used to assess suitability of courses and defines areas of growth	Data will be reported to the director of the BDS program, department Head and program advising committee. Data will be used to assess suitability of courses and defines areas of growth	Data will be reported to the director of the BDS program, department Head and program advising committee. Data will be used to assess suitability of courses and defines areas of growth	Data will be reported to the director of the BDS program, department Head and program advising committee. Data will be used to assess suitability of courses and defines areas of growth
What data are you archiving? Where and how? How long do you expect to archive the data?	Examples of written work representing excellent, satisfactory, and inadequate performance will be kept by the Instructor of record for one full reporting cycle (5 years). The director will also use examples of excellent work to develop a program portfolio.	Examples of written work representing excellent, satisfactory, and inadequate performance will be kept by the Instructor of record for one full reporting cycle (5 years). The director will also use examples of excellent work to develop a program portfolio.	Examples of written work representing excellent, satisfactory, and inadequate performance will be kept by the Instructor of record for one full reporting cycle (5 years). The director will also use examples of excellent work to develop a program portfolio.	Examples of written work representing excellent, satisfactory, and inadequate performance will be kept by the Instructor of record for one full reporting cycle (5 years). The director will also use examples of excellent work to develop a program portfolio.	Examples of written work representing excellent, satisfactory, and inadequate performance will be kept by the Instructor of record for one full reporting cycle (5 years). The director will also use examples of excellent work to develop a program portfolio.	Examples of written work representing excellent, satisfactory, and inadequate performance will be kept by the Instructor of record for one full reporting cycle (5 years). The director will also use examples of excellent work to develop a program portfolio.

Program Information

Program:	This is the title of your primary degree program/certificate
College or Administrative Division:	This is the College or Administrative Division that contains the program
Subunit(s)	This is the Department and/or School
Report Submitted By:	Type the name and position/role with the unit
APAA Submission Cycle Due Date:	4/15/2018

*Please only include the outcomes that have new results or actions in this reporting year for clarity

Program Outcomes Matched with Measures and Results

Outcomes: List your program level student learning (SLO) outcome(s). *	1. Program level student learning outcome	2. Program level student learning outcome	3. Program level student learning outcome	4. Program level student learning outcome	5. Program level student learning outcome
Results: What do the data that result from you assessment methods or processes show about student learning relative to this outcome? Describe any patterns or trends that you identified as meaningful or that highlight areas of concern or success.					
Actions: Describe any course-level (content, pedagogical, structural, etc.) changes that will result /have resulted from the current year's assessment of this outcome. Include timelines.					
Actions: Describe any program/degree level (e.g. curricular, process, structural, etc.) changes related to this outcome that have resulted/will result from this year's assessment and/or from other sources (i.e. external accreditors)					
Full-Cycle impact: If this learning outcome has been assessed previously and is being reported on again this year, what impact have the changes incorporated (if any) had on student learning? If you have not yet assessed the results of the changes made based on previous results, please indicate the year you will revisit this outcome					

Process

How did your unit reflect on the data you are reporting and who was involved? Were there any challenges or concerns? How are the results of your assessment efforts related to strategic planning and overall program review?	
Are there specific data archiving notes for the outcome(s) you are reporting on in this report?	

Plans

Describe the unit's (or sub-units) assessment plans for the upcoming year.	

Copy and paste the template from the previous year. Doing "select all" does not always work with merged fields, so highlight the rows (arrow to the far left hold down mouse button), copy, click in this upper left cell and paste.

Outcomes and Quality Assessment notes – Biological Data Sciences

1. Observation: Overall, the six learning outcomes are well written and measurable. However, outcomes #3 and #5 could benefit from clarification or expansion.

Recommendation: In outcome #3, the phrase "demonstrate familiarity" only requires that students use large datasets. The outcome could be strengthened by requiring students to "demonstrate proficiency." Outcome #5 would become more measurable if professional and ethical were better defined.

Thank you. In the Cat I proposal, we changed LO #3 to have the recommended phrase and provided a better definition for LO#5.

2. *Observation:* There is no clear alignment between the learning outcomes and specific coursework. This will make it difficult to both assess specific learning outcomes and identify specific areas for improvement.

Recommendation: A curriculum map would help identify which courses address each outcome and where each outcome could be assessed. The curriculum map could also assist the program director when aligning course outcomes. It is also heavily advised that the program develop an assessment plan using the OSU reporting template. Once the program is approved, this plan must be submitted annually.

We apologize but must have neglected to include the curriculum map. BPP administers the Botany major and has a curriculum map. This was used a template for the proposed BDS major.

3. *Observation:* The use of a cumulative exam in BDS 412 is a great way to gain a summative assessment of proficiency at the completion of the program. The planned portfolio can be a great assessment tool for identifying areas of concern as students progress through the curriculum. However, additional information is needed about the assessment process, including how areas of concern will be identified.

Recommendation: A curriculum map can help identify specific courses that can be assessed by the portfolio. An assessment rubric will also need to be developed for the portfolio. The rubric will help the program measure student competence in the outcomes assessed through the portfolio assignments. This can help the program identify specific areas of the curriculum being assessed in BDS 412. For example, if the summative exam reveals that students are struggling with using the appropriate quantitative methods in scientific investigation, then the program will need to know the courses and assignments that already emphasize this skill. A curriculum map and a thorough portfolio rubric can help pinpoint existing target areas for improvement.

Please see response to the previous recommendation.

4. Observation: The program will create a committee to advise the director on the needs of the program. There is no description of how assessment information will be used in this process.

Recommendation: Please include details on how the program will analyze and reflect on the data collected from the portfolio and the summative exam.

This section of the Cat I proposal has been substantially revised in response to the recommendation.

Capital Planning and Development
Oregon State University
3015 SW Western Blvd
106 Oak Creek Building
Corvallis, Oregon 97331

P 541-737-5412
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cpd.oregonstate.edu

2/28/2019

Joey Spatafora
Dept Head and Faculty Athletics Representative
Dept Botany & Plant Pathology
2082 Cordley Hall
Oregon State University
Corvallis, OR 97331
spatafoj@science.oregonstate.edu

Dear Joey Spatafora,

We appreciate the opportunity to review the College of Botany and Plant Pathology proposal to offer a new degree of Biological Data Sciences. Per our review of the documentation provided and discussion, we understand that the program will require no immediate additional space to accommodate new faculty, instructional, research, student support and administrative functions.

From the Cat 1 proposal the additional space that is needed for this program will be found in the College of Botany and Plant Pathology space. Existing faculty will be used to teach the courses need to attain this degree of Biological Data Sciences.

Given that your proposal outlines a strategy for accommodating all of the current space needs within existing space assigned to the College of Botany and Plant Pathology, Capital Planning and Development supports this proposal.

Sincerely,

Libby Ramirez
University Architect/Manager, Capital Resources
Oregon State University

Eric Smith
Management Analyst / Space Management
Oregon State University

Dear Colleagues,

I am writing to share with you a presubmission draft of a Category 1 proposal that the Department of Botany and Plant Pathology will submit in Fall of 2018. 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 scientific inquiry to 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 BDS undergraduate program was developed by interdisciplinary teams of OSU Faculty including Michael Freitag (BB), Yanming Di (ST), Patrick De Leenheer (Math/IB), Xiaoli Fern (EECS), Kate Field (MB), Taal Levi (F&W) and Carol Rivin (BPP). The version outlined here was most recently worked on by a team that included Jeff Chang (BPP), Molly Megraw (BPP), Brett Tyler (CGRB), Rebecca Hutchinson (CS), and Maude David (MB). The program provides 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 knowledgebase for all BDS students. There will also be a series of BDS cohort classes courses that will foster: 1) active learning, application, and integration of the core knowledge base, 2) working in teams, and 3) communicating across disciplines.

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.

We are sharing this pre-submission draft to initiate the liaison process. This will allow us to address any issues and incorporate any feedback into the Category 1 proposal. We would be happy to meet with any of you in one-on-one or group meeting setting. Please provide feedback directly to Joey Spatafora (joseph.spatafora@oregonstate.edu) and Jeff Chang (changj@science.oregonstate.edu). Thank you in advance and we look forward to your feedback.

Sincerely,

Joey Spatafora, Department Head, Botany and Plant Pathology, joseph.spatafora@oregonstate.edu

Jeff Chang, Chair of the BDS Category 1 Committee, changj@science.oregonstate.edu

The request document and a draft of the Cat I proposal was sent to the following addresses:
To: Gary.Beach@oregonstate.edu, michael.lerner@oregonstate.edu, john.bailey@oregonstate.edu, allen.thompson@oregonstate.edu, ossiand@math.oregonstate.edu, robert.mason@oregonstate.edu, Jerri.Bartholomew@oregonstate.edu, Andy.Karplus@oregonstate.edu, theresa.filtz@oregonstate.edu, lesser@science.oregonstate.edu, Bose@eecs.oregonstate.edu, bill.bogley@oregonstate.edu, robert.mcgorrin@oregonstate.edu, selina.heppell@oregonstate.edu, norman.hord@oregonstate.edu, raw@coas.oregonstate.edu, jonesj@geo.oregonstate.edu, Roy.Haggerty@oregonstate.edu, Dan.J.Arp@oregonstate.edu, Joyce.Loper@oregonstate.edu, mark.leid@oregonstate.edu, scott.ashford@oregonstate.edu, javier.nieto@oregonstate.edu, marinelr@oregonstate.edu, "Tyler, Brett" <Brett.Tyler@oregonstate.edu>, tom.weller@oregonstate.edu

Received comments from:
COS
SLS
Math
EECS
BB
Micro
Chem

For COS, we met with Dean Haggerty and again with head/chairs in COS and received support for the proposed major.

Jeff Chang is also a member of the curriculum committee for the School of Life Sciences (IB, Micro, BB) and has introduced the BDS major to the committee on multiple occasions. Each time, the committee provided valuable feedback that helped us craft the submitted proposal.

Met with EECS committee (Carlos Jensen, Tom Weller, Ben Lee, and Mike Rosulek) and with EECS curriculum committee and received support for the proposed major:

1) They will open up seats in their courses for us.
2) For the 300- and 400-level courses, they recommended I bump them down one year in the “four-year plan”, remove CS321 and CS381 from the list (viewed as not essential for our majors), and the committee will see if there are others they would recommend.
3) They were enthusiastic with BDS211 and immediately stated it would be an important class for COE students. However, they indicated that their students may not take it unless it is a BaccCore course.
4) They suggested we expand the capstone course to two minimally two quarters so their students and our students could work together. Their senior capstone course is a whole year. They thought mingling our students would be transformative and bring in new types of data for them to work on. I really liked this idea. We originally had two quarters for the capstone.

On Aug 22, 2018, at 3:16 PM, Jerri Bartholomew <barthoje@oregonstate.edu> wrote:

Hi Joey,

No concerns, but I did pass by someone on our curriculum committee and they asked if it would be appropriate for MB 448: Microbial Ecology to be listed for the one option? The section that has classes on population, communities, and systems ecology?

Jerri

Jerri Bartholomew, Professor and Head, Department of Microbiology
Director John L. Fryer Aquatic Animal Health Laboratory
Oregon State University | Department of Microbiology |541-737-1834

Mailing address: Nash Hall 226, Corvallis, OR 97331-3804

Our response:

Jerri,

Thanks. We did not list classes on the CAT1 if there are prerequisites beyond those included in the major. MB448 requires CH332 whereas the major only requires 331 for those in the genomics option. Thus [sic] does not preclude a student wanting to take more Chemistry as part of their electives and taking MB448. So MB448 would accepted as an upper division elective, as would CH332 in this example.

HI Joey and Jeff,

I just got asked by our dean about your BDS Cat 1 proposal, and remembered you emailed me in August about it. I'm sorry that in the midst of the summer fall transition busy-ness I forgot about it and didn't getting back to you about it.

I did not read the whole thing but looked through the various course requirements. Here are a couple points of feedback:

1) Most importantly, for the "Genomics" option, I'd ask you please remove BB315 from the choices available to satisfy the one course needed for "**Advanced Molecular, Cell, Organismal or Physiology"**. BB493 can stay. The BB493 course is a conventional lab course in which we expect to have some capacity and that provides a good one-course survey of key molecular biology techniques. In contrast, the BB315 lab course is a new "course-based undergraduate research experience" we developed specifically for our BMB major and that we are worried about being oversubscribed. I think this change still leaves plenty of good ways to satisfy that requirement.

2) I found something confusing in the "minor in BDS" table. The last row of the table states "**Upper division electives** Choose 2-3 class; need at least 8 credits and at least one upper division class for a total of 12 upper division credits". I'm not sure what is meant, but the phrasing seems to imply that "at least one upper division class" can provide "a total of 12 upper division credits"?

Thanks for taking these comments into account.

Andy

Our response:
Removed BB315
Clarified the last row of the table.

Math department feedback on BDS Proposal

Below, we share some comments and concerns about the undergraduate mathematics coursework for the different options in the BDS major.

1) The ecological and environmental informatics (EEI) option:
   - We recommend replacing MTH 323 (Mathematical Modeling) with MTH 420 (Models and Methods of Applied Mathematics). While the content of MTH 323 is appropriate for the EEI option, MTH 323 serves as a WIC course for math majors and is in extremely high demand. We are concerned about accommodating BDS majors when space for math majors is already limited. MTH 420 is an adequate substitute for MTH 323, and the two courses have the same prerequisites. MTH 323 was removed and replaced with MTH420; this is an excellent recommendation. Thank you. (in red are modified responses to the Math department)
   - ST 415 is not a modeling course, so we do not understand why it is listed as an alternative to MTH 323 or MTH 427. ST415 is an alternative for students to fulfill the degree, which should not be conflated with it being an alternative as fulfilling the same domain knowledge. Please also bear in mind that as a starter, we are using pre-existing courses. We look forward to working with units to develop new courses as the program grows!

2) The Computational Biology (CB) option:
   - Students in the CB option would benefit from a course on computation. MTH 351 would serve this purpose (note MTH 253 is a prerequisite). An alternative to MTH 351 is MTH 420, with prerequisites of MTH 256 and 341. In MTH 420, students utilize computational tools such as MATLAB and PYTHON. Thank you. I agree. However, the strategy I used in the options was to list the courses with the "easiest path", i.e., they do not have additional pre-reqs that are not satisfied by the core courses or those core to an option. This does not preclude students from taking MTH351 to round out their option. We will need strong advising to help students navigate the complexities of so many disciplines.
   - Students in the CB option would also benefit from MTH 361 (Introduction to Probability) because of its applicability to several of the ST and CS courses listed in the option. Note that MTH 361 is a prerequisite for MTH 428, which could replace MTH 427 in the option as a course on mathematical modeling in biology. With this in mind, the CB option could offer two possible paths for math coursework: MTH 256, MTH 427 (deterministic modeling) or MTH 253, MTH 361, MTH 428 (probabilistic modeling). We felt it was best to avoid requiring so many 200-level MTH courses in an attempt for balance (3 intro bio, 1 intro chem, 4 intro math, 3 intro CS, and 3 Stats (not intro level, per se).

On Aug 24, 2018, at 1:53 PM, Lerner, Michael M <Michael.Lerner@oregonstate.edu> wrote:

Hi Joey and Jeff – I asked our relevant faculty and heard the following:

- This will increase the pressure on the BB labs and several of chemistry options require these labs (BB 493 and 494). BB might need to open more sections to handle the demand.
- Possibly the new major would increase demand for CH 231/261 in particular and CH 232/262 and 233/263. The students in the new major might have taken those for other majors, but if there is a real increase of 100 students, we would want to plan accordingly.

Our response:

Michael,

Thanks for the feedback.

We anticipate that the initial enrollment in the major will come from existing students at OSU who are looking for this type of major. Future growth of the major we anticipate will mirror that of the university. So we do not think that this major will result in rapid increase in capacity of the CH23X series.

Please let me know if you need any additional information.

OSU Internal Budget Outline Form

Estimated Costs and Sources of Funds for Proposed Program

Total new resources allocated to the Proposed Program, if any.
If no change in resources is required, the budgetary impact should be reported as zero.

PROGRAM TITLE: Biological Data Sciences

BUDGET PERIOD: From FY 2019-20 to FY 2022-23

Business Center AMBC Date 10/1/2018
Name and Title of Reviewer Jackie Thorsness, AMBC Manager

	One-Time: Course Development			
	Fiscal Year 1	Fiscal Year 2	Fiscal Year 3	Fiscal Year 4
Personnel				
Faculty, Tenured/Tenure-track	-	-		
Course Instruction				
Program Director				
Faculty, fixed-term	-	-		
Course Instruction				
Sub-total, Faculty	-	-	-	-
Support Staff				
Graduate Assistants	-	-		
Graduate Fee Remission				
OPE	-	-		
Personnel Subtotal	-	-	-	-
Other Expenses				
Services & Supplies	-	-		
Capital Equipment				
Other Expenses Subtotal	-	-	-	-
Physical Facilities	-			
Construction				
Major Renovation				
Other Expenses				
Physical Facilities Subtotal	-	-	-	-
Total Cost of Program	**-**	**-**	**-**	**-**
Resources				
Current Budget, unit				
Tuition (e campus, differential)				
Institutional Reallocation from other budgetary units				
Special State Appropriation				
Federal Funds and other Grants				
Fees/Sales				
Foundation Endowment				
Other, describe:				
Total Resources	**-**	**-**	**-**	**-**

Note: Please include budget narrative describing items listed above.

OSU Internal Budget Outline Form

Estimated Costs and Sources of Funds for Proposed Program

Total new resources allocated to the Proposed Program, if any.
If no change in resources is required, the budgetary impact should be reported as zero.

PROGRAM TITLE: Biological Data Sciences

BUDGET PERIOD: From FY 2019-20 to FY 2022-23

Business Center AMBC Date 10/1/2018
Name and Title of Reviewer Jackie Thorsness, AMBC Manager

	Recurring: Program Instruction and Coordination			
	Fiscal Year 1	Fiscal Year 2	Fiscal Year 3	Fiscal Year 4
Personnel				
Faculty, Tenured/Tenure-track				
Course Instruction	5,181	9,951	15,003	21,892
Program Director	12,160	12,525	12,901	13,288
Faculty, fixed-term				-
Course Instruction	-		-	-
Sub-total, Faculty	17,341	22,476	27,904	35,180
Support Staff	6,366	6,684	7,018	7,369
Graduate Assistants	-	8,299	17,095	17,608
Graduate Fee Remission	-	5,158	10,729	11,158
OPE	11,876	17,492	23,647	28,455
Personnel Subtotal	35,583	60,109	86,393	99,770
Other Expenses				
Services & Supplies				-
Capital Equipment				-
Other Expenses Subtotal	-	-	-	-
Physical Facilities				
Construction				-
Major Renovation				-
Other Expenses				-
Physical Facilities Subtotal	-	-	-	-
Total Cost of Program	**35,583**	**60,109**	**86,393**	**99,770**
Resources				
Current Budget, unit	35,583	60,109	86,393	99,770
Tuition (e campus, differential)				
Institutional Reallocation from other budgetary units				
Special State Appropriation				
Federal Funds and other Grants				
Fees/Sales				
Foundation Endowment				
Other, describe:				
Total Resources	**35,583**	**60,109**	**86,393**	**99,770**

Note: Please include budget narrative describing items listed above.

OSU Internal Budget Outline Form

Estimated Costs and Sources of Funds for Proposed Program

Total new resources allocated to the Proposed Program, if any.
If no change in resources is required, the budgetary impact should be reported as zero.

PROGRAM TITLE: Biological Data Sciences

BUDGET PERIOD: From FY 2019-20 to FY 2022-23

Business Center AMBC Date 10/1/2018
Name and Title of Reviewer Jackie Thorsness, AMBC Manager Signature of Reviewer

	Total			
	Fiscal Year 1	Fiscal Year 2	Fiscal Year 3	Fiscal Year 4
Personnel				
Faculty, Tenured/Tenure-track	-	-	-	-
Course Instruction	5,181	9,951	15,003	21,892
Program Director	12,160	12,525	12,901	13,288
Faculty, fixed-term	-	-	-	-
Course Instruction	-	-	-	-
Sub-total, Faculty	17,341	22,476	27,904	35,180
Support Staff	6,366	6,684	7,018	7,369
Graduate Assistants	-	8,299	17,095	17,608
Graduate Fee Remission	-	5,158	10,729	11,158
OPE	11,876	17,492	23,647	28,455
Personnel Subtotal	35,583	60,109	86,393	99,770
Other Expenses				
Services & Supplies	-	-	-	-
Capital Equipment	-	-	-	-
Other Expenses Subtotal	-	-	-	-
Physical Facilities	-	-	-	-
Construction	-	-	-	-
Major Renovation	-	-	-	-
Other Expenses	-	-	-	-
Physical Facilities Subtotal	-	-	-	-
Check math	-	-	-	-
Total Cost of Program	35,583	60,109	86,393	99,770
Resources				
Current Budget, unit	35,583	60,109	86,393	99,770
Tuition (e campus, differential)	-	-	-	-
Institutional Reallocation from other budgetary	-	-	-	-
Special State Appropriation	-	-	-	-
Federal Funds and other Grants	-	-	-	-
Fees/Sales	-	-	-	-
Foundation Endowment	-	-	-	-
Other, describe:	-	-	-	-
Total Resources	**35,583**	**60,109**	**86,393**	**99,770**
check math	-	-	-	-

Note: Please include budget narrative describing items listed above.

Biological Data Sciences (BDS) Degree
Budget Narrative

Please provide details on Personnel, FTE directly supported by the budget and reallocation of personnel if appropriate

Personnel:

During the implementation of this program the new courses (and related salary/ope costs) will come on-line gradually. See the summary below for the costs across the initial four years.

Employee	New Course & Start Yr	FTE Level	FY19 Base Year	Yr 1	Yr 2	Yr 3	Yr 4
T/TT Faculty #1	BDS211-yr1	0.15	5,030	5,181	5,336	5,497	5,661
T/TT Faculty #2	BDS311-yr2	0.15	4,350		4,615	4,753	4,896
T/TT Faculty #3	BDS411-yr3	0.15	4,350			4,753	4,896
T/TT Faculty #4	BDS412-yr4	0.15	3,950				4,446
T/TT Faculty #5	BDS407-yr4	0.05	1,771				1,993
Total Teaching			**19,451**	**5,181**	**9,951**	**15,003**	**21,892**
T/TT Faculty #5	N/A-full yr	1 mo smr	11,806	12,160	12,525	12,901	13,288
Total Director			**11,806**	**12,160**	**12,525**	**12,901**	**13,288**
Office Specialist 1 #1	N/A-full yr	0.10	3,031	3,183	3,342	3,509	3,684
Office Specialist 1 #2	N/A-full yr	0.10	3,031	3,183	3,342	3,509	3,684
Total Support Staff			**6,062**	**6,366**	**6,684**	**7,018**	**7,369**
GTA #1	BDS311-yr2	0.49	7,822		8,299	8,548	8,804
GTA #2	BDS411-yr3	0.49	7,822			8,548	8,804
Total GTAs			**15,644**	**-**	**8,299**	**17,095**	**17,608**
Grad Fee Remission			4,769		5,158	10,729	11,158
Total GFR			**4,769**	**-**	**5,158**	**10,729**	**11,158**
OPE using avg rates (does not include GFR)				**11,876**	**17,492**	**23,647**	**28,455**
TOTAL SALARY & OPE				**35,583**	**60,109**	**86,393**	**99,770**

Existing FTE:
Faculty, Tenured:

Four at 0.15 fte for teaching a 3 credit course
One at 0.05 fte for teaching a 1 credit course
One at one month summer salary for Program Director

3% average salary increase factor is assumed.

Graduate Assistants:

Two GTAs for two terms @ 0.49 fte

3% average salary increase factor is assumed.

Graduate Fee Remission:

Two for two terms each year

4% average tuition increase factor is assumed.

Support Staff:

Two Office Specialist 1s @ 0.10 fte

5% average salary increase factor is assumed.

OPE:

OPE rates used are average rates for each category of employee.

2% average OPE increase factor is assumed.

Other Expenses:

No other expenses are anticipated.

Resources: Please identify and explain sources of all funds and highlight whether they are recurring or one time.

Current Budget: E and G funds and e- campus revenue will be used to support the new program and cover expenses.