Robert Fris has submitted a request for a major curricular change. His/her email address is: brandon.fris@wsu.edu.

Request (from selection dropdown): Add Graduate Certificate

Department: Biological Sciences

New Graduate Certificate: Bioinformatics Graduate Certificate

Requested Effective Date: Fall 2018

Campus: Everett, Pullman, Spokane, Tri-Cities, Vancouver,

Dean: Swindell, Samantha - CAS

Chair: Carter, Pat
I approve this proposal in its current form.

Pat

Patrick A. Carter  
Professor and Director  
School of Biological Sciences  
Washington State University  
Pullman, WA 99164-4236

email: pacarter@wsu.edu  
phone: 509/335-1447  
FAX: 509/335-3184  
webpage: http://www.wsu.edu/~pacarter/

Carter, Pat,  
Swindell, Samantha - CAS,  
Robert Fris has submitted a request for a major curricular change.  

Request (from selection dropdown): Add Graduate Certificate  

Department: Biological Sciences  
New Graduate Certificate: Bioinformatics Graduate Certificate  
Requested Effective Date: Fall 2018  
Campus: Everett, Pullman, Spokane, Tri-Cities, Vancouver,

Both Chair and Dean approval is required to complete the submission process. Please indicate that you have reviewed the proposal by highlighting one of the statements below and reply all to this email. (curriculum.submit@wsu.edu.) [Details of major change requested can be found in the attached supplemental documentation]
1. I approve this proposal in its current form.

2. I approve this proposal with revisions. Revisions are attached.

3. I do not approve this proposal. Please return to submitter.

If you do not respond within one week, you will be sent a reminder email. If no response is received within three weeks of the submission date, the proposal will be returned to the submitter.

Thank you for your assistance as we embark on this new process. If you have any questions or concerns, please let us know wsu.curriculum@wsu.edu.

Suzanne Lambeth, Assistant Registrar
Graduations, Curriculum, & Scheduling
Washington State University
Registrar's Office
PO Box 641035
Pullman WA 99164-1035
509-335-7905
slambeth@wsu.edu

Note: Please use the attachments to this email rather than the link below to view the supporting documentation.
2. I approve this proposal with revisions. Revisions are attached.

Carter, Pat,

Swindell, Samantha - CAS,

Robert Fris has submitted a request for a major curricular change.

Request (from selection dropdown): Add Graduate Certificate

Department: Biological Sciences

New Graduate Certificate: Bioinformatics Graduate Certificate

Requested Effective Date: Fall 2018

Campus: Everett, Pullman, Spokane, Tri-Cities, Vancouver,

Both Chair and Dean approval is required to complete the submission process. Please indicate that you have reviewed the proposal by highlighting one of the statements below and reply all to this email. (curriculum.submit@wsu.edu.) [Details of major change requested can be found in the attached supplemental documentation]

1. I approve this proposal in its current form.

2. I approve this proposal with revisions. Revisions are attached.

3. I do not approve this proposal. Please return to submitter.

If you do not respond within one week, you will be sent a reminder email. If no response is received within three weeks of the submission date, the proposal will be returned to the submitter.

Thank you for your assistance as we embark on this new process. If you have any questions or concerns, please let us know wsu.curriculum@wsu.edu.
Suzanne Lambeth, Assistant Registrar
Graduations, Curriculum, & Scheduling
Washington State University
Registrar's Office
PO Box 641035
Pullman WA 99164-1035
509-335-7905
slambeth@wsu.edu

Note: Please use the attachments to this email rather than the link below to view the supporting documentation.
Proposed Graduate Certificate Program

Certificate Title:
Bioinformatics Graduate Certificate

Contact information:
Joanna Kelley
Assistant Professor, Biological Sciences
joanna.l.kelley@wsu.edu, 5-0037

Omar Cornejo
Assistant Professor, Biological Sciences
omar.cornejo@wsu.edu, 5-0179

Justification and rationale for certificate program:
The certificate emphasizes the acquisition of biological and computational expertise by supplementing graduate students’ existing background with necessary training in molecular biology, genomics, and computer science. There is a clear need for the development of expertise to analyze the growing amount of biological data generated from genomic, phenotypic, environmental, and other sources. The goal of the certificate is to provide the coursework and a richer academic environment for graduate students to synthesize information across multiple disciplines. The certificate is aimed to prepare highly qualified graduate students who have rigorous multidisciplinary training in molecular biology, genomics, and computer science.

The certificate is aimed at graduate students in engineering, sciences, computer science, and agriculture, although students from other colleges may also find it valuable. The primary objective is to provide students with an interdisciplinary training in bioinformatics. Our goal is to develop among the students a critical scientific understanding of bioinformatics, including the biological and computational aspects of algorithm development and implementation. We anticipate the number of graduate students initially interested in the certificate will be approximately 5 to 10 because of the broad faculty participation and interest in the certificate.
Bioinformatics and data analytics are two of the most rapidly growing career areas. We anticipate that number will grow as more students who have interest begin their graduate programs at WSU. Additionally, as students take the core classes the instructors of those classes will mention the certificate program as an option for students to consider.

**Student Learning Objectives:**
The WSU Student Learning Objectives will be addressed in each course within the certificate program. *Critical and Creative Thinking, Quantitative Reasoning, Scientific Literacy,* and *Information Literacy* are core skills for graduate students and these skills will be developed across the certificate program. Each course builds on skills learned and expands the *Depth, Breadth and Integration of Learning* particularly with regard to bioinformatics. The certificate is interdisciplinary in nature and introduces the students to many application areas (for example agriculture, chemistry, medicine) through the courses and instructors. The main idea behind the proposal for a bioinformatics certificate is to direct students into a field that would allow them to synthesize information across multiple disciplines.

*Desired learning outcomes*
Students earning this certificate will be able to:

- Demonstrate a proficiency in basic UNIX skills and analysis of genomics data using common bioinformatics software, relational databases and web resources.
- Demonstrate a conceptual understanding of the interdisciplinary nature of bioinformatics
- Use biological and computational principles to describe algorithm implementation and development
- Learn how different fields intersect to contribute to computational biology
- Critically explore and evaluate relevant literature and ideas in biology and computer science and foster interdisciplinary thinking and development to address complex biological issues.
- Work on complex scientific questions within teams, write interdisciplinary research proposals, provide an oral overview of the proposal to faculty and other students, and constructively and critically review the proposals of other students.
- Attend seminars and interact with speakers brought to campus through departmental seminars to create a network and to broaden their thinking about their own disciplinary research.
- Create an individualized experience that allows students to integrate their own disciplinary research with the foundational training from the certificate.

**Assessment**

Students in the Certificate Program will be part of Departmental Assessment activities associated with each specific course, and instructors will know to provide each of these students with a variable so that they can be tracked as a group. Individuals completing the certificate will be provided with an exit survey in order to provide an overall assessment of the Certificate Program.

**Requirements:**

*General rules (Admission requirements):*

Admitted Masters or Ph.D. students under the advisement of WSU faculty, and post-graduate professionals who earned their degree in an appropriate field, are eligible to apply for the certificate program. Students who are eligible will notify their department’s graduate committee and their guidance committee of their interest in the certificate. Once the guidance committee has agreed that it is in the student’s best interest to pursue and complete the certificate, the student will apply to the Bioinformatics Certificate committee. The application will include a statement from the student’s advisor and graduate committee supporting the application. In this way, we hope to enhance the disciplinary degree.
For students to excel and get the most out of their participation in this certificate, we anticipate that students should have proficiency in the following: one year of calculus, coursework in probability and statistics (strongly advised as it is required for some courses). It is also advisable for students to have 1 year of computer programming (coursework or experience), but it is not required.

Course Requirements
Students must be simultaneously enrolled in a graduate-degree granting program at Washington State University as either full-time or part-time students, or in the case of post-graduate professionals, receive permission from the certificate administrators in SBS. A total of twelve credits are required for the graduate certificate. Three credits are mandatory and the final nine credits will be chosen from a list of electives depending on the background of the student and the cohesion with the research program. All courses must be approved by the Bioinformatics Certificate committee, prior to acceptance in the certificate program, and will also need the approval from the students’ Masters or PhD committee (on the plan of study).

Students must achieve a GPA of 3.0 (B) or better in each certificate course. Note, some courses require permission of the instructor and prerequisites; it is the responsibility of each student to meet the specific requirements for each course. Students must take 2 courses outside of their home department. The goal is to enrich beyond a student’s own departmental offerings.

Proposed Coursework:
All courses are available on the Pullman campus. In addition, all the BIOLOGY and MBIOS prefix classes are already available via AMS, and we anticipate that many of the remaining classes will soon be available via AMS, so this certificate can be earned on any WSU campus.
Mandatory Course (3 credits)

MBIOS 578 Bioinformatics Computer analysis of protein and nucleic acid sequences, functional genomics and proteomics data; modeling biological networks and pathways. Recommended preparation: Introductory genetics or biochemistry coursework.

Elective Courses (9 credits)

Biology:

BIOLOGY 519 Introduction to Population Genetics Survey of basic population and quantitative genetics

BIOLOGY 521 Quantitative Genetics Fundamentals of quantitative genetics; evolutionary quantitative genetics

BIOLOGY 534 Modern Methods in Population Genomics Problems and prospects of designing a study with genomic data: from raw data to demography and selection inferences.

BIOLOGY 576 Epigenetics and Systems Biology. Current literature based course on epigenetics and systems biology with topics in environmental epigenetics, disease etiology, and role epigenetics in evolutionary biology.

BIOLOGY 566 Mathematical Genetics See MATH 563.
Computer science:

**CPT S 570 Machine Learning** Introduction to building computer systems that learn from their experience; classification and regression problems; unsupervised and reinforcement learning.

**CPT S 571 Computational Genomics** Fundamental algorithms, techniques and applications.

**CPT S 572 Numerical Methods in Computational Biology** Prereq cell biology, probability and statistics, graduate standing in computer science, or permission of the instructor. Computational methods for solving scientific problems related to information processing in biological systems at the molecular and cellular levels.

Crop and Soil Sciences:

**CROP SCI 545 Statistical Genomics** Concepts and applications in modern breeding programs.

**CROP SCI 555 Epigenetics in Plants** Understanding principles of epigenetics in plants with a focus on its role in understanding and improving plant genomes and their adaptation to the changing environment. Recommended preparation: General genetics.

Horticulture:

**HORT 503 Advanced Topics in Horticulture** Only open when the topic is “Bioinformatics for Research”
Mathematics:

**MATH 563 Mathematical Genetics** Mathematical approaches to population genetics and genome analysis; theories and statistical analyses of genetic parameters. (Crosslisted course offered as MATH 563, BIOLOGY 566).

Molecular Biosciences:

**MBIOS 503 Advanced Molecular Biology** DNA replication and recombination in prokaryotes and eukaryotes; recombinant DNA methods and host/vector systems; genome analysis; transgenic organisms. Recommended preparation: Introductory genetics and biochemistry coursework.

Statistics:

**STAT 523 Statistical Methods for Engineers and Scientists** Hypothesis testing; linear, multilinear, and nonlinear regression; analysis of variance for designed experiments; quality control; statistical computing.

**STAT 530 Applied Linear Models** The design and analysis of experiments by linear models.

**MATH/STAT 536 Statistical Computing** Generation of random variables, Monte Carlo simulation, bootstrap and jackknife methods, EM algorithm, Markov chain Monte Carlo methods.

**STAT 565 Analyzing Microarray and Other Genomic Data** Statistical issues from pre-processing (transforming, normalizing) and analyzing genomic data (differential expression, pattern discovery and predictions).
Participating Faculty and Resources (faculty that contributed to the development of this proposal)

A group of researchers have coalesced across campus, representing a variety of departments and colleges, to propose this graduate certificate in Bioinformatics.

*College of Arts and Sciences (CAS):*
  - Omar Cornejo, Biological Sciences
  - Patrick Carter, Biological Sciences
  - Joanna Kelley, Biological Sciences
  - Eric Roalson, Biological Sciences

*Voiland College of Engineering and Architecture (VCEA):*
  - Shira Broschat, EECS
  - Ananth Kalyanaraman, EECS

*College of Agriculture Human and Natural Resources (CAHNRS):*
  - Dorrie Main, Horticulture
  - Zhiwu Zhang, Crop & Soil Sciences

*College of Veterinary Medicine (CVM):*
  - Kelly Brayton, Veterinary Microbiology and Pathology
  - Douglas Call, Global Animal Health
  - John Wyrick, Molecular Biosciences

**Oversight:**
Certificate oversight will be handled by the School of Biological Sciences.
CIP Code:
26.1103

Title: Biomathematics, Bioinformatics, and Computational Biology.

Campuses:
The certificate will be offered on all campuses because the minimum number of courses to complete the program are already offered via AMS.

Impacts:
No additional resources are needed for the implementation of the certificate, all of the courses are already developed and in the course catalog. Therefore, there is no impact.

Course catalog explanation:
Certificate in Bioinformatics
The certificate in bioinformatics requires 12 credit hours including MBIOS 578. In addition to the required course, students must take at least 9 credit hours of courses in biology, computer science, crop and soil sciences, horticulture, mathematics, molecular biosciences or statistics. A list of recommended courses is provided in the certificate description. Students must earn a GPA of 3.0 or better in each course to fulfill the requirements of the certificate.