Department of Computer and Information Sciences

Program Type:\*

Bioinformatics & Systems Biology (PhD)

Provide a brief summary of the proposed program changes and describe the rationale for the change(s):

Bioinformatics Data Science is a rapidly growing field. The additional course option to include Data Analytics is proposed to meet the expanding academic and research needs of our students in preparation for the professional marketplace. This interdisciplinary Data Science option draws from multiple fields of study, ranging from heath informatics, translational medicine, artificial intelligence, and machine learning.

Our proposal of reducing the number of required seminar credits, while retaining the number of semesters students attend seminar, is reflective of similar changes made to the Master's degree.

List new courses required for the revised curriculum. How do they support the overall program objectives of the major/ minor/ concentrations)?

This proposal is spreading the 6 credit requirements found within Systems Biology to 3 credits of Systems Biology and 3 credits of Data Analytics. Students are able to choose from the courses listed below to meet the PhD curriculum core requirements. The total course requirements (9 credits) remain unchanged.

Please note - Program policy was not updated since 2012. List below reflects courses permanently added/discontinued/redesigned. The list reflects minimal change to proposed PhD program requirements.

Listed below are additional core and elective course options:

Bioinformatics Core Option (3 credits)

BINF644: Bioinformatics

Systems Biology Core Option (3 credits)

BINF694: Systems Biology I (redesigned)

BINF695: Computational Systems Biology (redesigned)

Data Analytics Core Option (3 credits):

NURS/HLTH844 Population Healthcare Informatics

CISC681 Artificial Intelligence\*

CISC683 Introduction to Data Mining\*

CISC684 Introduction to Machine Learning\*

Prerequisites:

BISC609 Molecular Biology of the Cell

PLSC667 Applications of Genome Science: From Microbes to Mammals

BINF690 Programming for Bioinformatics

​Database:

BINF640 Database for Bioinformatics

Biostatistics:

STAT611 Regression Analysis

Recommended Electives:

BISC609 Molecular Biology of the Cell\*

BINF690 Programming for Bioinformatics\*

BINF695: Computational Systems Biology\*

BISC654: Biochemical Genetics\*

CISC 667 Introduction to Human-Computer Interaction\*

CISC 681 Artificial Intelligence\*\*

CISC 683 Introduction to Data Mining\*\*

CISC 684 Introduction to Machine Learning\*\*

CISC 884 Computational Biomedicine

NURS/HLTH 844 Population Healthcare Informatics

PLSC667 Applications of Genome Science: From Microbes to Mammals\*\*

Electives:

BHAN 856 Multivariable Biostatistics

BINF650 Protein Modifications: Protein Structure and Function (redesigned)

BISC605 Advanced Mammalian Physiology

BISC625 Cancer Biology

BISC690 Fundamentals of Pharmacology

BISC833 Special Topics in Biology: Grant Writing

CHEG621 Metabolic Engineering

CHEM 641 Biochemistry

CISC640 Computer Graphics

CISC642 Introduction to Computer Vision

CISC650 Computer Networks

CISC675 Object Oriented Software Engineering

CISC849 Advanced Topics in Computer Applications

CISC889 Advanced Topics in Artificial Intelligence

ELEG671 Mathematical Physiology

KAAP602 Data Analysis and Interpretation in Health Sciences

MAST607 Writing Papers in the Marine Sciences

MAST626 Microbial Molecular Genetics

MATH637 Mathematical Techniques in Data Science

MEEG621 Linear Systems

PLSC671 Paradigms in Cell Signaling

STAT612 Advanced Regression Techniques

STAT617 Multivariate Methods

STAT621 Survival Analysis

STAT674 Applied Data Base Management

\*listed as core option

\*\*on previous elective list

Courses that have been redesigned/removed from list:

ANFS644: Bioinformatics

BINF697: Systems Biology I: Experimental Techniques and Bioinformatics Analysis of Omics Data

BINF698/MATH660: Systems Biology II: Computational Modeling of Processes in Cells and Biological Systems

MAST697: Bioinformatics Programming for Biologists

UAPP648 Environmental Ethics

PLSC636: Plant Genes and Genomes

STAT613: Multivariate Statistical Methods with Biology Applications

CISC841: Algorithms in Bioinformatics

EGGG867: Writing Academic Research in Engineering and Science

ANFS670: Principles of Molecular Genetics

ANFS/PLSC671: Paradigms in Cell Signaling

BISC600: Biotechnology and Molecular Medicine

BISC631: Practice of Science

BISC641: Microbial Ecology

BISC645: Bacterial Evolution

BISC693: Human Genetics

EGGG 667 Technical and Scientific Writing

MATH607: Survey of Scientific Computing

MATH667: Math for Life Scientists

Identify other units affected by the proposed changes and provide letters of support from those units. :

Most of the core and elective course listed above are included in the MS degree and will result in very little change to class enrollment. One unit minimally affected by the additional course listing will be Behavioral Health & Nutrition by adding NURS/844 Population Healthcare Informatics to our core Data Science curriculum option, since it was not on our previous elective list.

 Resolutions:

RESOLUTION to Change the Name of the PhD in Bioinformatics & Systems Biology to Bioinformatics Data Science

WHEREAS, the Center of Bioinformatics and Computational Biology has expressed the intent to change of the PhD degree to Bioinformatics Data Science, and

WHEREAS, the current name of the PhD in Bioinformatics & Systems Biology suggests a narrow area of focus in systems biology, which is not inclusive of the expanding research in data analytics, and

WHEREAS, the name of the PhD in Bioinformatics Data Science reflects that our educational programs have expanded to encompass areas from developing computational methods, bioinformatics tools, and databases to application in life science and data analytics at the graduate level including:

Graduate Certificate in Bioinformatics

Online Graduate Certificate in Applied Bioinformatics

Masters in Bioinformatics & Computational Biology

Professional Science Masters in Bioinformatics

WHEREAS, the name PhD in Bioinformatics Data Science is reflective of the new and ongoing scientific research by our Affiliated Faculty from five colleges across campus, which includes:

Development of mathematical methods and computational tools for gene networks, molecular modeling and metabolic engineering

Biological text mining and biomedical ontology development

Bioinformatics cyberinfrastructure, cloud computing and high-performance computing

Biological databases, semantic data integration and big data analytics

Health data analytics and computational epidemiology

Next generation sequencing and genomic, epigenomic, and molecular network analysis to gain insight into biological systems

Statistical and computational modeling of bioimaging data, and

WHEREAS, the name of the PhD in Bioinformatics Data Science more accurately reflects the interdisciplinary nature of the research our graduate students and their mentors are engaged in, with projects ranging from heath informatics, systems biology, energy and environmental studies, translational medicine, and data mining, and

WHEREAS, the new name will be globally more representative of the diversity of our teaching mission, the research conducted by the faculty, our service to the community and the mission of our center “To promote, coordinate, and support interdisciplinary activities,” and

WHEREAS, the name of the PhD in Bioinformatics Data Science reflects collaboration with the newly launched Data Science Institute (DSI) research initiative fostering additional multidisciplinary research providing further synergy among data science research and academic programs, be it therefore

RESOLVED, that the Faculty Senate recommends the name of PhD in Bioinformatics & Systems Biology be changed to PhD in Bioinformatics Data Science.

Overview of Degree Requirements

Description

Students must complete a minimum of 15 hours of coursework, plus 3 credit hours of seminar, 6 credit hours of research and 9 credit hours of doctoral dissertation. Students who are admitted directly after a B.S degree will be required to fulfill the Bioinformatics and Computational Biology M.S. core curriculum by completing an additional 9 credit hours as prerequisites (for a total of 24 coursework credits) in the following areas: Database Systems, Statistics, and Introduction to Discipline. In addition, if students entering the program with an M.S. degree are lacking equivalent prerequisites, they also will be required to complete courses in these three areas; however, these courses may fulfill the elective requirement in the Ph.D. program, if approved in the program of study. Students must maintain a 3.0 cumulative GPA and courses with a grade of C or below will not be counted towards the degree.

Credit Requirements:

Description

Bioinformatics Data Science Core: 9 Credits

Prerequisites\*: 3-9 Credits

Electives: 6 Credits

Seminar: 3 Credits

Research: 6 Credits

Doctoral Dissertation: 9 Credits

\*Direct admit students

Total number of required credits: 33-42

Title

Total number of required credits: 33-42

Description

A. Bioinformatics Data Science Core (9 credits)

Title

A. Bioinformatics Data Science Core (9 credits)

Description

Bioinformatics (3 credits)

Title

Bioinformatics (3 credits)

Description

Courses

BINF 644 Bioinformatics (3cr.)

Data Science (6 credits - select two)

Title

Data Science (6 credits - select two)

Description

System Biology (select one)

Title

System Biology (select one)

Description

Courses

BINF 694 Systems Biology I (3cr.)

[before]

BINF 695 Computational System Biology (3cr.)

[after]

or

[after]

Systems Biology recommended elective upon approval by dissertation committee and Graduate Program Director.

Data Analytics (select one)

Title

Data Analytics (select one)

Description

Courses

NURS/HLTH 844 Population Healthcare Informatics (3cr.)

CISC 681 Artificial Intelligence (3cr.)

CISC 683 Introduction to Data Mining (3)

CISC 684 Introduction to Machine Learning (3cr.)

or

Data Analytics recommended elective upon approval by Dissertation Committee and Graduate Program Director.

B. Prerequisites - if required (3-9 credits)\*

Title

B. Prerequisites - if required (3-9 credits)\*

Description

Introduction to Discipline (select one)

Title

Introduction to Discipline (select one)

Description

Courses

BISC 609 Molecular Biology of the Cell (3cr)

BISC 654 Biochemical Genetics (3cr.)

PLSC 667 Applications of Genome Science: From Microbes to Mammals

BINF 690 Programming for Bioinformatics (3cr)

Database

Title

Database

Description

Courses

BINF 640 Database for Bioinformatics (3cr.)

CISC 637 Database Systems (3cr.)

Biostatistics

Title

Biostatistics

Description

Courses

STAT 656 Biostatistics (3cr.)

STAT 611 Regression Analysis (3cr.)

Note:

Title

Note:

Description

\*Necessary for students lacking equivalent courses

C. Electives (6 credits)

Title

C. Electives (6 credits)

Description

Please see list of [Elective Courses](http://bioinformatics.udel.edu/education/degrees_n_courses/#elective).

D. Seminar (3 credits)

Title

D. Seminar (3 credits)

Description

must enroll in every semester for the first three years and present one seminar in the second and third years

Courses

BINF 865 Seminar (0 to 1cr.)

E. Research (6 credits)

Title

E. Research (6 credits)

Description

Courses

BINF 868 Research (1 to 6cr.)

[right]

- Until successful completion of preliminary exam(1-6)

BINF 964 Pre-Candidacy Study (3 to 12cr.)

[right]

- Until successful completion of candidacy exam (1-6)

F. Doctoral Dissertation (9 credits)

Title

F. Doctoral Dissertation (9 credits)

Description

Courses

BINF 969 Doctoral Dissertation (1 to 9cr.)

BINF - 640 - Database for Bioinformatics (3cr.)

BINF - 644 - Bioinformatics (3cr.)

BINF - 690 - Programming for Bioinformatics (3cr)

BINF - 694 - Systems Biology I (3cr.)

BINF - 695 - Computational System Biology (3cr.)

BINF - 865 - Seminar (0 to 1cr.)

BINF - 868 - Research (1 to 6cr.)

BINF - 964 - Pre-Candidacy Study (3 to 12cr.)

BINF - 969 - Doctoral Dissertation (1 to 9cr.)

BISC - 609 - Molecular Biology of the Cell (3cr)

BISC - 654 - Biochemical Genetics (3cr.)

CISC - 637 - Database Systems (3cr.)

CISC - 681 - Artificial Intelligence (3cr.)

CISC - 683 - Introduction to Data Mining (3)

CISC - 684 - Introduction to Machine Learning (3cr.)

MAST - 697 - Bioinformatics Programming for Biologists (3cr.)

NURS/HLTH - 844 - Population Healthcare Informatics (3cr.)

PLSC - 636 - Plant Genes and Genomes (3cr.)

PLSC - 667 - Applications of Genome Science: From Microbes to Mammals

STAT - 611 - Regression Analysis (3cr.)

STAT - 656 - Biostatistics (3cr.)