**12 credit Computational Biology Certificate (CBC) for Rutgers Ph.D. Students (032)**

**PURPOSE OF CERTIFICATE**
Computational biology uses computer simulations, mathematical modeling and data analysis to understand biological systems and interactions. While computational biology is the used by many researchers in academia and industry, Ph.D. students are never systematically taught these skills and how to apply them to their research. The goal of this 12-credit Certificate is to train biomedical Ph.D. students in Computational Biology. Upon its successful completion of this degree, the Certificate will be added onto the transcript in addition to the Ph.D. degree.

**ELIGIBILITY**

PhD candidates in biomedical sciences affiliated with the following programs who are entering their second year or higher of graduate school are eligible to apply for the CBC: Biochemistry, Biomedical Engineering, Cell and Developmental Biology, Chemical and Biochemical Engineering, Chemistry and Chemical Biology, Electrical Engineering, Endocrinology and Animal Biosciences, Exposure Science, Medicinal Chemistry, Microbial Biology, Microbiology and Molecular genetics, Neuroscience, Nursing, Nutritional Sciences, Pharmacology, Pharmaceutical Sciences, Physiology and Integrative Biology, Psychology, Public Health, Quantitative Biomedicine and Toxicology.

For Ph.D. students to apply to the CBC, everyone must complete the application form below. Approval must also be obtained by the PI and the Program Director. Once you have been accepted, you will meet with Assistant Dean Janet Alder to discuss the timing and sequence of courses that work best with your schedule.

The 12 credits from the certificate courses cannot be used towards the minimum research credit requirements or the course credit requirements for a student’s PhD program but can be part of the 72 credits they need to reach their total number of credits required for a PhD degree.

**LEARNING GOALS**

* Demonstrate competence in Python coding to perform data analysis
* Analyze and interpret bioinformatic and omic data
* Apply artificial intelligence concepts to data analysis
* Apply machine learning concepts to data analysis

**REQUIREMENTS:**

Pre-requisites: Students should have completed statistics as well as linear algebra (e.g. 01:640:250) prior to applying for the certificate. Students must obtain a B or better in each of the courses below in order to receive the certificate.

If the student does not have prior Python coding experience then they will take Python Methodologies as their first class.

Python Methodologies 16:137:552 (3 credits) Fall, Spring, and Summer or equivalent course. This course acts as an introduction to computer programming with the Python programming language.  The basics of imperative programming will be covered as well as selected areas of computer science, object-oriented programming, and data structures. Computer programming is about problem-solving so we will begin to think about how to solve problems in discrete steps as computers do.  After the beginning of the course, when we have our sea legs, we will begin to introduce ideas from Data Science and use what we have learned about computer programming and problem-solving in this area.

If the student has prior Python coding experience then they will take Computational Genomics class instead.

Computational Genomics 16:761:505 (3 credits) Spring Semester (note this will not be offered until Spring 2025) or equivalent course. The main focus of this course is to learn R programming and apply it to the analysis of genomic datasets. In this course, we will focus on the basics of programming, data wrangling, creating user-defined functions, and exploratory graphical data analysis. The primary data sets considered will contain genome sequences, genome annotations, RNA-seq, and/or other expression data from multiple model organisms.

All students in CBC will take the following classes for the remainder of their credits:

Bioinformatics 16:765:585 (3 credits) Fall Semester or equivalent course. This course is designed to introduce experimental biologists to bioinformatics concepts, principles, and techniques within the framework of basic shell scripting and web-based databases/tools. Prior to starting class, students are expected to know how to work in a command-line environment and have a basic understanding of programming/scripting. The course includes a brief introduction to working with UNIX/LINUX systems, writing Python scripts, and automating/using existing applications for the analysis of large datasets. All work will be done in a live development environment.

Introduction to Artificial Intelligence 16:198:520 (3 credits) Fall and Spring Semester or equivalent course. Overview of artificial intelligence. Basic problems and methods; deductive inference, declarative programming, heuristic search; reasoning and representation in perception, planning, and learning. Python coding, statistics and linear algebra are pre-requisites.

OR

Computational Systems Biology 14:125:437 (3 credits) offered once every 2 years in Spring (not spring 2024): Introductory overview of key issues in computational systems biology. Defines systems and biological components independently to provide an appreciation of the special features of both elements. Introduction of medical informatics concepts. Students model biological systems in appropriate computational languages, such as MATLAB, Python and R.

Machine Learning I - Pattern Recognition: Theory and Applications 16:198:535 (3 credits) Fall Semester or equivalent course. The principal purpose of this course is to introduce the student to the problems of pattern recognition through a comparative presentation of methodology and practical examples. The course is recommended for students who plan to work in the area of biomedical applications of computers. 16:198:520 is a pre-requisite.

OR

Machine Learning for Engineers 14:332:443 (3 credits) Spring semester or equivalent course: This course, which is open to all engineering and non-engineering majors, introduces students to the fundamentals of machine learning through a blend of mathematical and statistical descriptions, hands-on programming exercises, and real-world engineering problems. Additional emphasis is placed on discussing various practical aspects of machine learning systems that include ethics and bias.

**ACADEMIC INTEGRITY**

This certificate requires all students to follow the university’s academic integrity policy (http://academicintegrity.rutgers.edu ) including the following basic principles of academic integrity. These principles forbid plagiarism and require that every Rutgers University student:

• properly acknowledge and cite all use of the ideas, results, or words of others

• properly acknowledge all contributors to a given piece of work

• make sure that all work submitted as his or her own in a course or other academic activity is produced without the aid of unsanctioned materials or unsanctioned collaboration

• treat all other students in an ethical manner, respecting their integrity and right to pursue their educational goals without interference.

This requires that a student neither facilitate academic dishonesty by others nor obstruct their academic progress.

The syllabi for the courses in the certificate will note that violations of academic integrity will be treated in accordance with university policy, and sanctions for violations may range from no credit for the assignment, to a failing course grade to (for the most severe violations) dismissal from the university.

**APPLICATION FOR COMPUTATIONAL BIOLOGY CERTIFICATE ASSOCIATED WITH PhD**

Name

Graduate Program

Thesis Advisor/Principal Investigator

Year Started Graduate School

Date Completed or Anticipated for Qualifying Exam Part A

RUID/A #       Net ID

E-mail       Phone Number

Please attach transcript from Rutgers (unofficial is acceptable)

Please indicate if you have completed the following pre-requisites with a grade of a B or better, the year it was taken and attach the syllabus to the course.

Graduate-level Statistics [ ]  Yes [ ]  No. If yes, year taken

College-level linear algebra [ ]  Yes [ ]  No. If yes, year taken

In 250 words or less, please describe your motivation for applying for the Computational Biology Certificate and how the skills you will align with your future career goals:

Signature of Student      \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date      \_\_\_\_\_\_\_\_\_\_\_\_\_

Signature of Thesis Advisor/PI      \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date      \_\_\_\_\_\_\_\_\_\_\_\_

Signature of Graduate Program Director      \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date      \_\_\_\_\_\_\_\_\_\_\_\_

Signature of Course Director/Dean SGS      \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date      \_\_\_\_\_\_\_\_\_\_\_\_

Please submit form to Tina Marottoli in the SGS office tina.marottoli@rutgers.edu

675 Hoes Lane West, Research Tower Room 102, Piscataway NJ 08854