M.Sc. Programme in Genomics and Bioinformatics (Full-time and Part-time)

School of Biomedical Sciences, Faculty of Medicine, CUHK

<For reference only>

GNBF5010 Introduction to Programming

Course description

This course introduces programming for students with no previous computer programming experiences. Students learn how to apply computational tools to design, implement, test, debug and document programs. They also learn the techniques of developing programs for problem solving through object-oriented programming methodology.

Learning outcomes

After finishing this course, students should be able to

a. Master key programming concepts such data-types, variables, conditions, loops and functions
b. Understand fundamental concepts in object-oriented programing and pattern matching
c. Solve small to medium size programming tasks that arise in bioinformatics
d. Write well-structured and maintainable programs in Python

Topics

The topics include Introduction to Computers and Programming; Branching and Iteration; Decomposition and Functions; Lists, Tuples and Strings; Recursion; Dictionaries; Midterm Examination; Object-Oriented Programming; Python Classes and Inheritance (I); Python Classes and Inheritance (II); Biopython; Understanding Program Efficiency; Basic Searching Algorithms; Regular Expressions; Testing, Debugging and Exceptions; More Programming Languages; Course Review; Final Examination.

Assessment scheme

The assessment scheme includes attendance (5%), assignments (30%), mid-term examination (25%) and final examination (40%).

GNBF5020 Introduction to Molecular Biology and Genetics

Course description

This course introduces students to the molecular mechanisms responsible for the transmission, expression and regulation of genetic information in prokaryotic and eukaryotic organisms. Students will also learn the basic concepts of genetics including population genetics, developmental genetics and evolutionary genetics.

Learning outcomes

After finishing this course, students should be able to

a. understand basic concepts in biomolecules and cell biology
b. know how molecular biology can explain the transmission of genetic information
c. correlate molecular biology concepts with genetic and phenotypic traits

Topics

The topics include Introduction to Biomolecules; Basic Cell Biology; DNA and Chromatin Structure; DNA Replication, Repair and Recombination; Control of Gene Expression; Mid-term

Examination; Methods in Molecular Biology; Genomic Applications in Biomedical Research; Molecular Genetics of Mendelian Diseases; Molecular Genetics of Complex Diseases; Population Genetics; Evolutionary Genetics; Final Examination.

Assessment scheme

The assessment scheme includes attendance (5%), mid-term examination (47.5%) and final examination (47.5%).

GNBF5030 Bio-computing

Course description

This course introduces popular Biocomputing environments and software to answer problems using nucleotide sequences and other common data encountered in biological analyses.

Learning outcomes

After finishing this course, students should be able to

a. accustom themselves to Linux computing environment
b. acquire the usage of common bioinformatics tools
c. employ common statistical methods for bioinformatics problems using R

Topics

The topics include Introduction to Linux computational environment; Basic Linux commands (I); Basic Linux commands (II); Installing and running software in Linux: hmmer; Using BLAST and more sequence alignment tools in Linux; Quality Control of NGS data; Variant calling workflow; Introduction to programming with R; Introduction to R Plotting; Basic statistical methods for bioinformatics (I); Basic statistical methods for bioinformatics (II); High performance computing; course review; Final examination.

Assessment scheme

The assessment scheme includes attendance (5%), assignments and project (50%) and final examination (45%).

GNBF5040 Genomics: Basic Concepts and Applications

Course description

This course introduces the basic concepts of genomics. It covers the structure and organization of human genome, and the strategies that are used to map sequence and analyze the genomes. Students learn how to make connections between genomic data and the relevant biological questions. They also learn how genomic sequence information is utilized in biomedicine including pharmacogenomics, drug discovery, diagnostics and personalized medicine.

Learning outcomes

After finishing this course, students should be able to

a. acquire the basic concept of genomics
b. learn the principle, strategies and limitations of genomic technology
c. apply genomics to solve biological and biomedical questions

Topics

The topics include Introduction to genomics; An overview of large scale genomic projects; Genomic sequencing and data analysis; Genome assembly: a key step towards comprehensive

genomic maps; Functional annotation of genomes: gene, mutation, and SNP; Workshop I; Mid-term examination; Functional annotation of genomes: transcriptional regulation; Functional annotation of genomes: transcriptome analysis; Functional annotation of genomes: noncoding RNA and single cell sequencing; Medical genomics; Workshop II; Final examination.

Assessment scheme

The assessment scheme includes mid-term examination (50%) and final examination (50%).

GNBF5050 Theories and Algorithms in Bioinformatics

Course description

The course introduces basic concepts, methods and tools in bioinformatics. It covers topics including sequence alignment, phylogeny, motifs and domains, functional annotations, and processing and analysis of high-throughput data. Students learn these topics by attending lectures and getting hands-on experience through assignments and project.

Learning outcomes

After finishing this course, students should be able to

a. apply bioinformatics methods to solve basic biological and biomedical problems
b. locate useful tools for specific bioinformatics tasks
c. conduct scientific and technical communications with bioinformaticians and computational biologists
d. study other advanced topics in bioinformatics

Topics

The topics include Sequence Alignment and searching I; Sequence Alignment and searching II; Molecular phylogenetics I; Molecular phylogenetics II; Molecular structures I; Molecular structures II; Motifs and domains I; Motifs and domains II; Functional annotations; Processing and analysis of high-throughput data I; Processing and analysis of high-throughput data II; Processing and analysis of high-throughput data III; Final examination.

Assessment scheme

The assessment scheme includes attendance (5%), assignments (45%) and final examination (50%).

GNBF5060 Systems Biology

Course description

This course introduces how systems biology combines molecular biology and genomics with physical chemistry and mathematical modeling to make bio-systems work. Students will learn basic concepts of nonlinear dynamics and genetic networks. They will also learn mathematical modeling techniques needed to study biological questions, as well as experimental methods in systems biology.

Learning outcomes

After finishing this course, students should be able to

a. know the basic principle of systems biology

b. learn how to apply nonlinear dynamics and genetic networks on genomics and bioinformatics
c. use systems biology to solve biological questions

Topics

The topics include Introduction to systems biology; Mathematical modeling in systems biology; Modeling reaction networks with ODEs; Workshop: Building and Simulating Models using COPASI; Basic concepts and properties of biological networks; Modeling gene regulatory networks with Boolean networks, Petri nets and Bayesian networks; Network motifs in transcription networks; Analysis of expression data; Workshop: Introduction to Cytoscape; Metabolic Flux Analysis; Network Medicine; Course Review; Presentation; Final Examination.

Assessment scheme

The assessment scheme includes attendance (5%), assignments (25%), discussion section performance (20%), and final examination (50%).

GNBF5070 Genome Informatics

Course description

This course introduces the knowledge of genomics and bioinformatics. Students will learn the concepts and methods for different categories of genomic studies, including reference genome studies, population genomic studies, and genomic applications. In each of these categories of studies, basic knowledge as well as most recent progress will be presented. In addition to theoretical lectures, students will also have hand-on practice of the mentioned tools, thus they will have better idea about genomics and bioinformatics.

Learning outcomes

After finishing this course, students should be able to:

a. know the basic principle of and pipeline for sequencing and genomic studies;
b. know the current progress of genomic studies;
c. learn how to analyze the second-generation sequencing data;
d. learn how to use/apply different bioinformatics tools;
e. learn how to conduct a genomic study.

Topics

The topics include Overview of genome informatics; Sequencing to provide genome information; Genome assembly to obtain the reference genome; Reference genome based studies; Hands-on study on reference genome analysis; Resequencing to identify genomic variations; Genomic variation based studies (I); Genomic variation based studies (II); Hands-on study on resequencing analysis; Using genome sequencing as a tool for other researches; Using genome sequencing as a tool for applications; Summary of genome informatics; Final examination.

Assessment scheme

The assessment scheme includes attendance (5%), assignments (45%) and final examination (50%).

GNBF6010 Research Project

Course description

Students are required to conduct a research project on a current topic in genomics and bioinformatics under the supervisors in the Chinese University of Hong Kong.

Topics

Students are required to conduct a research project on a current topic in genomics and bioinformatics under the supervisors in the Chinese University of Hong Kong. Although there will be no lectures, students are expected to meet with supervisors and complete their research projects according to supervisors' suggestions and give out 15-minute oral presentation in the end of April and submit a research proposal and a final report in the beginning and the end of the Term 2 respectively.

Assessment scheme

The assessment scheme includes research performance (30%), progress report (5%), proposal (15%), oral presentation (15%) and final report (35%).