University of Nicosia, Cyprus

Course Code	**Course Title**	**ECTS Credits**
BIOL-412	Modern Genomics and Bioinformatics	8
Department	**Semester**	**Prerequisites**
Life and Health Sciences	Spring	BIOL-232 Human Molecular Genetics; BIOL-231
Type of Course	**Field**	**Language of Instruction**
Life Sciences Elective	Molecular Biology, Genomics	English
Level of Course	**Year of Study**	**Lecturer**
1st Cycle	3rd or 4th	Dr. Kyriakos Felekkis
Mode of Delivery	**Work Placement**	**Co-requisites**
Face-to-face	N/A	None

Objectives of the Course:

This course aims to guide students in the use of bioinformatics applications available for the use of the information derived from the study of genomics to generate knowledge and make discoveries based on informed interpretation. The main objectives of the course are to:

- Make students aware of the elements and aspects studied in the area of genomics (organization and information content of the genome).
- Introduce the broad scope of applying bioinformatics to collect, store, organize, manage, distribute and retrieve genomic data (DNA/RNA and protein sequences) and model biological molecules.
- Discuss the theory and practice of computational methods used in the field of genomics and demonstrate the various databases and basic programming tools available through the internet.
- Provide students with the opportunity to practice in inputting and retrieving information and interpreting genomic data using computational analysis and programming tools.
- Make students aware of how scientific hypotheses on structure-function of biological molecules and systems can be tested/interpreted using computational analysis and modeling and help to generate new knowledge.

Learning Outcomes:

After completion of the course students are expected to be able to:

1. Discuss the potential and limitations of bioinformatics applications on throughput

data derived from modern biotechnology instrumentation used for the molecular sequencing of genes and proteins.

2. Distinguish the uses of major databases and programming tools to conceptualize the raw data obtained from genomics and proteomics research and to derive information.
3. Use computer databases and programming tools available in the internet to input and retrieve information from molecular sequence analysis (genomic mapping, protein classification and structure prediction; comparative genome analysis and gene expression analysis).
4. Evaluate genotype to phenotype relationships and emergent properties on structure-function and evolution from the computational analysis of molecular sequences.
5. Discuss the basic principles of systems biology modeling and explain the theoretical basis of the algorithms used in cell biology research.
6. Discuss how cell modeling systems and computational analysis of genomics data can help to research and understand diseases and to develop drug.
7. Demonstrate skills on critical analysis of genomics scientific literature and problem-solving skills using bioinformatics.

Course Contents:

1. Revision of molecular genetics (DNA to RNA to Protein; The genetic code); The International Nucleotide Sequence Database Collaboration; Accession numbers and annotations.
   (**Tutorial exercises:** Accessing Molecular Genetic Information through the Internet: Nucleotide Sequence Databases (GenBank, EMBL, DDBJ); Protein sequence Databases (UniProt): NCBI's Entrez; OMIM
2. Identifying homologies in gene sequences; The theory and practice of pairwise sequence comparisons (dotplot graphical analysis, scoring matrices and statistical output).
   (**Tutorial exercises:** Introduction to using BLAST for pairwise sequence analysis.)
3. Comparative mapping: Genetic and physical mapping.
   (**Tutorial exercises**: practice using BLAST on pairwise and multiple sequence alignments)
4. Global and local alignment algorithms (basics) used in pairwise and multiple sequence alignment.
   (**Tutorial exercises:** Practice using FASTA for sequence similarity searching against complete genomes databases).
5. Throughput biotechnology applications for the sequencing of genes and proteins.
   (**Tutorial exercises:** Practice using additional database tools to design molecular tools and experiments for biotechnology applications).
6. Protein analysis, protein modeling and proteomics; Gene Ontology Annotation (UniProtKB-GOA) Database; The Hidden Markov Models and multiple sequence alighnments.
   (**Tutorial exercises:** Use PDB for Protein sequence alignment and computational approaches for studying protein structure and obtaining physical parameters).
7. Molecular phylogeny and evolution; Introduction to the basic phylogenetic models. Trees and profiles used to identify evolutionary relationships from gene sequences. The Human genome project and SNP's
   (**Tutorial Exercises:** Comparative Genome Analysis using strategies for physical mapping; polymorphisms).
8. Quantitative models of biochemical and cellular systems
   (**Tutorial Exercises:** Simulation models and reaction diagrams using BioModels Database (EBI http://www.ebi.ac.uk/biomodels/)
9. Computational interactive tools for linking structural and proteomics data (Tutorial Exercises: Data Integration).
10. Cellular modeling
11. Bioinformatic approaches to RNA and microarray analysis. (**Tutorial Exercises**: Accessing and analysis of microarray data using online databases)

Learning Activitiaes andTeaching Methods:

Lectures, Tutorials and Computer Exercises, Discussions, Literature paper reviews

Assessment Methods:

Assignments, Tests and Mid-term Exam; Final Exam

Required Textbooks/Readings:

Authors	Title	Publisher	Year	ISBN
Jonathan Pevsner	Bioinformatics and Functional Genomics [Paperback] and web site http://www.bioinfbook.org/	Wiley-Blackwell;	2nd ed. 2009	**ISBN-10:** 0470085851 **ISBN-13:** 978-0470085851
A.D. Baxevanis, B. F. Francis Ouellette	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.	Wiley-Interscience	2004, 3rd ed.	ISBN:0471478784

Recommended Textbooks/Readings:

Authors	Title	Publisher	Year	ISBN
1. EO Voit	Computational Analysis of Biochemical Systems: A Practical Guide for Biochemists and Molecular Biologists	Cambridge University Press	2000	**ISBN-10:** 052178087X **ISBN-13:** 978-0521780872
D. Mount	Bioinformatics: Sequence and Genome Analysis And web site: http://www.bioinformaticsonline.org/	Cold Spring Harbour Laboratory	2nd ed. 2004	**ISBN-10:** 0879697121 **ISBN-13:** 978-0879697129
Neil C. Jones, Pavel A. Pevzner	An Introduction to Bioinformatics Algorithms (Computational Molecular Biology) [Hardcover]	The MIT Press	1st ed., 2004	**ISBN-10:** 0262101068 **ISBN-13:** 978-0262101066
A.Malcolm Campbell, Laurie J. Heyer	Discovering Genomics, Proteomics, and Bioinformatics	Benjamin Cummings	2003 w/CD-ROM	ISBN-13: 978-080534722-7