**BIORISE D6.1**

# SYLLABUS OF THE CSMM BIOINFORMATICS COURSE

The attached syllabus has been prepared by the CING Bioinformatics ERA Chair, Dr George Spyrou. The proposed syllabus has been submitted to the CSMM and following an internal approval, it is expected to be submitted for approval to the Ministry of Education by Fall 2016.

CYPRUS SCHOOL of molecular medicine

# BMI101: BIOINFORMATICS (10 ECTS)
# Course Information


| | |
|---|---|
| Course Coordinator: | **Dr. George Spyrou** |
| Email: | georges@cing.ac.cy |
| Office Tel.: | **22392852** |
| Office Hours: | **Available Monday to Friday by appointment** |


## COURSE DESCRIPTION

Bioinformatics is a new multidisciplinary field that includes the development and implementation of computational methods and tools suitable to handle, decipher and interpret the plethora of biomolecular data derived nowadays, acting as a bridge between bio-information and biological knowledge extraction. It is recognized that bioinformatics are fueling the rise of translational research and the success of molecular medicine. The aim of the course is to enable students to get familiar with a significant number of bioinformatics tools and databases, understand the computational methods behind them, be able to exploit in-depth the capabilities of the tools, implement and competently interpret and present the results of a wide range of bioinformatics analyses, critically discuss the current limitations and design the next generation of tools. The course will consist of lectures, tutorials, workshops and literature studies. Each lecture will be focused on one major bioinformatics method or a group of methods with relevant application examples. Methodology and applications to be covered include: Databases and Web Servers, Elements of Computational Intelligence and Programming, Sequence/Structural/Functional Analysis, Omics Data Analysis, Biological Network Reconstruction and Analysis, Modeling and Simulation in Biology, Computational Biomarker Discovery, In Silico Drug Discovery, Integromics and Personalized Medicine, BioBank Informatics, Ethics in Bioinformatics and Informatics inspired by Biology.

## LEARNING OUTCOMES (LO)

Upon completion of the course students will be able to:

- LO1. Understand and choose appropriate bioinformatics tools and databases for their investigation.
- LO2. Understand the computational part behind the bioinformatics tools.
- LO3. Perform sequence/structural/functional analysis of biomolecules.
- LO4. Analyse and interpret omics data.
- LO5. Perform Biological Network Reconstruction and Analysis.
- LO6. Get familiar with modelling and simulations in Biology.
- LO7. Get familiar with computational biomarker and drug discovery.
- LO8. Describe and discuss various aspects of personalized medicine, biobanks and ethics related to bioinformatics.
- LO9. Present scientific work.

**EMPLOYMENT OBJECTIVES (EO)**

EO1. Ability to choose appropriate tools and databases for specific bioinformatics analysis.
EO2. Ability to computationally analyze and interpret biomolecular properties.
EO3. Ability to perform high throughput omics analysis.
EO4. Ability to design new bioinformatics pipelines for specific needs.
EO5. Ability to report results.

**BOOKS/READINGS**

1. **Bioinformatics and Functional Genomics**, Jonathan Pevsner, 3rd Edition, 2015, ISBN: 978-1118581780
2. **Introduction to Bioinformatics**, Arthur Lesk, 4th Edition, 2014, ISBN: 978-0199651566
3. **Original journal publications** to be announced during the course.
4. **Recommended journals list for regular reading:**
   Nature Communications
   Scientific Reports
   PLoS Computational Biology
   Bioinformatics
   Briefings in Bioinformatics
   Briefings in Functional Genomics and Proteomics
   Journal of Computational Biology
   npj Systems Biology and Applications
   IEEE/ACM Transactions on Computational Biology and Bioinformatics
   Nucleic Acids Research (Web Server and DataBase Issues)
   Genome Research
   Molecular Systems Biology
   BMC Bioinformatics
   BMC Systems Biology

**EVALUATION AND ASSESSMENT METHOD**

The final grade in percentage will be based on the student's performance on the following:

1. **Midterm examination: 30%**
   Covers course material of lectures 1 to 12.

2. **Assignment: 10%**
   Power-point presentation of a peer-reviewed paper by the student.
   To be assigned one month prior to scheduled presentation day.

3. **Final examination: 60%**
   Covers all course material.

*The midterm exam is scheduled to be held on ……*
*The final exam is scheduled to be held on ……*

**Please refer to the students' handbook regarding the grading scale, the passing criteria and the academic honesty policy.**

**STUDENTS ATTENDANCE POLICY**

According to a policy set by the Cyprus Ministry of Education and Culture, a mandatory student attendance of min 80% on all lectures of the Private Schools of Higher Education was set. All Students must sign an attendance sheet provided by the Education Office during each lecture. Lecturers are responsible to hand out the attendance forms for signature and return them to the Education Office during the Semester. In case of a student's absence, appropriate justification (e.g. medical) will be considered upon submission to the Education Office. If any student fails to meet the attendance requirements, he/she will not be allowed to sit the examination, and considered failed.

**COURSE TOPICS AND CALENDAR**

| LECTURE | LECTURER | TOPIC | TYPE | RELATED LO | RELATED EO |
|---|---|---|---|---|---|
| 1 | G. Spyrou | Introduction – an informatics perspective of biomolecules | Lecture | LO1 | EO1- EO2 |
| 2 | G. Spyrou | Bioinformatics Databases and Web Servers: Design, implementation, usage | Lecture | LO1 | EO1- EO2 |
| 3 | G. Spyrou | Elements of Computational Intelligence: Clustering | Lecture | LO2 | EO1- EO2 |
| 4 | G. Spyrou | Elements of Computational Intelligence: Classification | Lecture | LO2 | EO1- EO2 |
| 5 | G. Spyrou | Understanding Network Analysis and Network Metrics | Lecture | LO2 | EO1- EO2 |
| 6 | G. Spyrou | Statistics for Bioinformatics | Lecture | LO4 | EO1- EO2 |
| 7 | G. Spyrou | Sequence Analysis | Lecture | LO3 | EO1- EO2 |
| 8 | G. Spyrou | Sequence Analysis Workshop | Workshop | LO3 | EO1- EO2 |
| 9 | G. Spyrou | Structural Analysis | Lecture | LO3 | EO1- EO2 |
| 10 | G. Spyrou | Structural Analysis Workshop | Workshop | LO3 | EO1- EO2 |
| 11 | G. Spyrou | Functional Analysis | Lecture | LO3 | EO1- EO2 |
| 12 | G. Spyrou | Functional Analysis Workshop | Workshop | LO3 | EO1- EO2 |
| 13 | G. Spyrou | MID-TERM EXAMINATION | Exam | | |
| 14 | G. Spyrou | Omics Data Analysis: Genomics | Lecture | LO4 | EO3- EO4 |
| 15 | G. Spyrou | Omics Data Analysis: Proteomics | Lecture | LO4 | EO3- EO4 |
| 16 | G. Spyrou | Biological Network Reconstruction and Analysis | Lecture | LO5 | EO3- EO4 |
| 17 | G. Spyrou | Modeling and Simulation in Biology | Lecture | LO6 | EO3- EO4 |

| | | | | | |
|---|---|---|---|---|---|
| 18 | G. Spyrou | Computational Methods for Biomarker Discovery | Lecture | LO7- LO8 | EO3- EO4 |
| 19 | G. Spyrou | In Silico Drug Discovery | Lecture | LO7- LO8 | EO3- EO4 |
| 20 | G. Spyrou | Integromics and Personalized Medicine | Lecture | LO7- LO8 | EO3- EO4 |
| 21 | G. Spyrou | BioBank Informatics | Lecture | LO7- LO8 | EO3- EO4 |
| 22 | G. Spyrou | Ethics in Bioinformatics | Lecture | LO7- LO8 | EO3- EO4 |
| 23 | G. Spyrou | Informatics inspired by Biology | Lecture | LO1-LO9 | EO3- EO4 |
| 24 | G. Spyrou | Assessment – 10% | Journal Club | LO9 | EO5 |
| 25 | G. Spyrou | Assessment – 10% | Journal Club | LO9 | EO5 |
| 26 | G. Spyrou | Revision | Lecture | LO1-LO9 | EO1- EO5 |
| | G. Spyrou | FINAL EXAMINATION | Exam | | |

| TUTORIAL | LECTURER | TOPIC | TYPE | RELATED LO | RELATED EO |
|---|---|---|---|---|---|
| 1 | G. Spyrou | Programming Elements- SQL queries | Tutorial | LO1- LO4 | EO2- EO4 |
| 2 | G. Spyrou | Programming Elements- PHP/HTML | Tutorial | LO1- LO4 | EO2- EO4 |
| 3 | G. Spyrou | Clustering and Classification Pipelines | Tutorial | LO1- LO4 | EO2- EO4 |
| 4 | G. Spyrou | Programming Elements- PERL | Tutorial | LO1- LO4 | EO2- EO3 |
| 5 | G. Spyrou | Analysis/Programming Elements- R Tutorial I | Tutorial | LO1- LO4 | EO2- EO3 |
| 6 | G. Spyrou | Analysis/Programming Elements- R Tutorial II | Tutorial | LO1- LO4 | EO2- EO3 |
| 7 | G. Spyrou | Functional Analysis Pipelines I | Tutorial | LO3 | EO1- EO3 |
| 8 | G. Spyrou | Functional Analysis Pipelines II | Tutorial | LO3 | EO1- EO3 |
| 9 | G. Spyrou | Omics Analysis Pipelines I | Tutorial | LO4 | EO2- EO3 |
| 10 | G. Spyrou | Omics Analysis Pipelines II | Tutorial | LO4 | EO2- EO3 |
| 11 | G. Spyrou | Network Visualization and Analysis with Cytoscape I | Tutorial | LO5 | EO2- EO3 |
| 12 | G. Spyrou | Network Visualization and Analysis with Cytoscape II | Tutorial | LO5 | EO2- EO3 |
| 13 | G. Spyrou | Modeling and Simulation Tools | Tutorial | LO6 | EO1- EO4 |