Computational Biology

Academic Year: (2023 / 2024) **Review date: 19-12-2023**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: VALENCIA BLANCO, LETICIA

Type: Compulsory ECTS Credits : 6.0

Year : 4 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is strongly advised to have knowledge in programming, fundamentals of molecular and cellular Biology and/or Biochemistry.

SKILLS AND LEARNING OUTCOMES

RA4: Be able to use appropriate methods to carry out studies and solve problems in the biomedical field, commensurate with their level of knowledge. Research involves conducting literature searches, designing and carrying out experimental practices, interpreting data, selecting the best approach and communicating knowledge, ideas and solutions within their field of study. May require consultation of databases, safety standards and procedures.
RA5: Acquire intermediate/advanced knowledge of engineering and biomedical sciences and demonstrate an understanding of the theoretical and practical aspects and methodology of work in their field of study.
CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3: Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4: Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CG2: Ability to design, draft and develop scientific-technical projects in the field of biomedical engineering.
CG4: Ability to solve problems with initiative, decision-making, creativity, and to communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the biomedical engineer's activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG7: Drafting, representing and interpreting scientific-technical documentation.
CG12: Ability to solve mathematically formulated problems applied to biology, physics and chemistry, using numerical algorithms and computational techniques.
CG16: Ability to handle and mine data obtained through "omics" technologies using bioinformatics techniques. Applications in biology and medicine.
ECRT18: Ability to apply different computational techniques to solve complex problems typical of biology and medicine. Ability to apply information obtained from databases to solve biomedical problems.
CT1: Ability to communicate knowledge orally and in writing to both specialised and non-specialised audiences.
CT2: Ability to establish good interpersonal communication and to work in multidisciplinary and international teams.
CT3: Ability to organise and plan their work, making the right decisions based on the information available, gathering and interpreting relevant data in order to make judgements within their area of study.

OBJECTIVES

The student will acquire the ability to apply different computational techniques to solve complex problems typical of biology and medicine. Such problems are characterized by involving the analysis of large quantities of information (data base searching, comparative analysis of sequences of DNA, RNA, microRNA and protein, domain searching, evaluation of the pathogenicity of variants, evolutionary conservation, phylogeny ..), so that in practice only they are approachable through intensive computing techniques, in which the student is formed.

DESCRIPTION OF CONTENTS: PROGRAMME

Topics to be addressed include approaches and computational techniques for the search of the genetic structure, sequence alignment through the use of dynamic programming, prediction of the folding and structure of proteins, interactions of proteins and drugs. Different examples will be studied in the different areas and students will make use of computational biology tools for their analysis. As part of the subject, the relationship between computational biology and biotechnology will be studied.

Topics covered include:

1. Computational approaches and techniques for searching sequence, structural and expression databases and its relationship with disease databases.
2. Alignment and comparison of sequences by using dynamic programming.
3. Gene structure prediction
4. Obtaining the protein sequence encoded
5. Folding and protein structure prediction
6. Prediction of functional and protein-binding domains
7. Molecular evolution and phylogenetic sequences analysis.
8. Linkage analysis, physical maps and identification of the disease-causing gene.
9. Genome structure analysis, repetitive sequence searching and microRNAs.
10. Evaluation of the pathogenicity of disease variants.
11. Search for restriction sites and generation of recombinant vectors in silico

Different examples will be reviewed in different areas and students make use of computational biology tools for analysis.

LEARNING ACTIVITIES AND METHODOLOGY

The teaching will be on site and it will include:
Lectures, which will present the skills that students should acquire and the bioinformatic tools to be used. To facilitate its development students will receive class notes and baseline texts that facilitates follow lessons and develop further work. Resolution of representative exercises will be included.
-Practices in computer lab for the resolution of exercises by means of bioinformatic tools.
-In-person classes for doubts resolution, tutorials and carrying out of the continuos evaluation exams and projects.

ASSESSMENT SYSTEM

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

The evaluation system includes continuous assessment of student work (class participation and 2 skills assessment tests and theoretical and practical knowledge), and final evaluation through a final (theoretical and practical exam) that comprehensively assess the knowledge and skills acquired throughout the course. There can be an additional research project proposed by the teachers to have an additional mark. The shares allocated are defined in the following terms.

% end-of-term-examination: 60 (minimum mark required is equal to 4)
% of continuous assessment (assigments, laboratory, practicals...): 40

BASIC BIBLIOGRAPHY

- - Lesk, A.M. Introduction to BioInformatics, Oxford University Press, Third Edition

- - Mount, DW Bioinformatics, Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition