COURSE DESCRIPTION CARD - SYLLABUS

Course name
Computational Immunology [S2Bioinf1>IMOB]

Course

Field of study
Bioinformatics

Year/Semester
2/3

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

mgr Mateusz Twardawa
mateusz.twardawa@put.poznan.pl

Lecturers

Prerequisites

Students taking this course shall know basics of molecular biology, genetics, cel biology and microbiology. In addition students shall be familiar with statistics and machine learning, including ability to perform simple statistical analysis and use of basic machine learning techniques. Students shall also possess elementary knowledge about genomics, proteomics and high throughput techniques.

Course objective

The main course objective is to equip students with knowledge and skills needed to preform data analysis from immunological experiments and medical results. Students will gain crucial knowledge about immunological processes and mechanism, that is necessary to understand context of immunological data. Students will also learn how to use statistical and machine learning tools in order to solve problems in immunological data analysis.

Course-related learning outcomes

Knowledge:
1. Student knows crucial immunological processes and mechanisms and bases their interpretation on empirical data using mathematical, statistical and machine learning methods.

2. Student knows structure and function of cells essential for immunological processes. Student is familiar with immunological signaling and reactions. Student knows structure and functions of immunoglobulins.
3. Student has basis in theoretical modeling of immunological processes.
4. Student is familiar with current trends in computational immunology.

Skills:
1. Student is able to extract useful information from literature, immunological data bases and other properly selected sources including those in English.
2. Students is able to identify system and non-technical aspects of tasks related to data analysis in computational immunology.
3. Student is capable of applying basic technics and tools in computer science to solve biological and medical problems in scope of computational immunology. Student is able to evaluate those methods.
4. Student is capable of applying basic statistical methods, algorithms and computational techniques to describe immunological process and analyze data.

Social competences:
1. Student is ready to lifelong learning and improving his (or her) skills and competence trough understanding of dynamically developing field of computational immunology and its problems.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Students will have to complete the final test from material covered on lectures.
During laboratories students will be evaluated by their activity and reports (each class will have specific exercises to perform and problems to solve).

Programme content

Lectures on Computational Immunology classes will be divided into 6 parts.
First part of lectures will focus on modern basis of immunology. This part will cover characterization of different immune cells, antigens, antibodies, innate and adaptive immune mechanism as well as cell and humoural immune responses, stages of immune response. Some physiological and histological aspects of lymphatic system will be also presented.
Second part of lectures will be concentrated on antibodies, B cell and T cell receptors. In scope of this part detailed aspects of immunoglobulins will be covered such as their structure, function, types, avidity, specificity, valency, diversity, mechanism of synthesis (VDJ recombination, class switching, somatic hypermutation), monoclonal antibodies and chosen aspects of medical treatment based on immunoglobulins.
Third part of lectures will cover mechanism and processes involved in immune response. Students will be familiarized with major histocompatibility complex, antigen presentation mechanisms, maturation, circulation and activation of lymphocytes, immune cell profiling and cytotoxicity. Most important cytokines and signalization mechanism in immune system will be presented along with other concepts such as complement system, innate immune mechanisms, protecting barriers and immunological memory.
During forth part of lectures crucial aspects and mechanism of anti-infective response and vaccines will be covered. Students will be presented antiviral, antibacterial, antifungal and antiparasitic immune responses. Moreover, this part will cover different types of vaccines with description of their mechanisms of function, safety and effectiveness. This part will be summarized with an overview of modern technologies in vaccine development.
Fifth part will focus on immune system pathologies. In scope of this part mechanism of well-known immunological diseases will be covered including: hypersensitivity and allergies, autoimmunization processes, immune deficiency, all of which will be presented with examples of relevant medical conditions. This part will also cover some aspects of cancer immunology.
Last part of lectures will concentrate on presenting modern diagnostic and research techniques in immunology.
Practical part of the course will focus on statistical and machine learning method in immune data analysis. Students will analyze immune repertoires (including T cell and B cell receptors as well as immunoglobulins), model immune processes and interaction networks. Students will also gain practical

skills in usage of tools and methods for antibody design and identification of biomarkers.

Teaching methods

1. Lecture – multimedia presentation with examples presented on blackboard.
2. Labolatories - activity on classes and reports

Bibliography

Basic
Jakub Gołąb, Marek Jakóbisiak, Witold Lase, Immunologia, PWN, Warszawa, 2017
Additional
Shyamasree Ghosh, Computational Immunology: Basics, CRC Press, 2019
Shyamasree Ghosh, Computational Immunology: Applications, CRC Press, 2020
Josep Bassaganya-Riera, Computational Immunology, Academic Press, Models and Tools, 2015

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00