
DTU

Course Introduction 2021

22145 Immunological Bioinformatics

Instructors team

Course Responsibles

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Immunoinformatics and Machine Learning

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AI for immunological molecules

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PhD student

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Post doc

Alessandro Montemurro
PhD student

Platforms during the course

- **Zoom** (for live online lessons and group work)

Registration is required (Meeting ID: 624 4168 9408)

https://dtudk.zoom.us/meeting/register/u5Ypc-iupjIuGtzs8eF0RlM5xijlcFdwQaQq

- **Wiki** (all about the course edition 2021 including recorded classes)

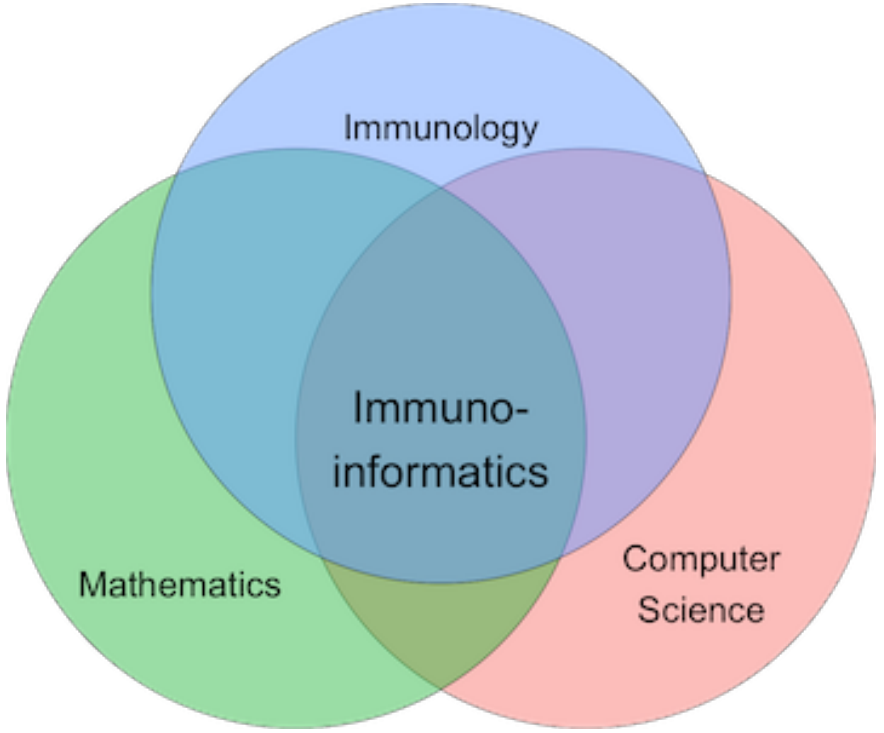
https://teaching.healthtech.dtu.dk/22145/index.php/22145_-_Immunological_Bioinformatics

- **Piazza** (for Q&A)

Post your questions on the corresponding day/topic

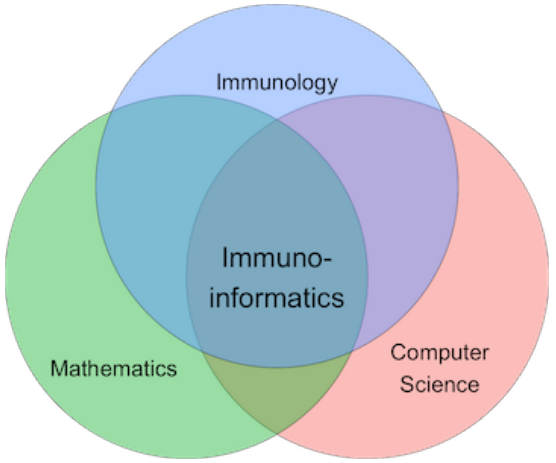
https://piazza.com/dtu.dk/fall2020/22145

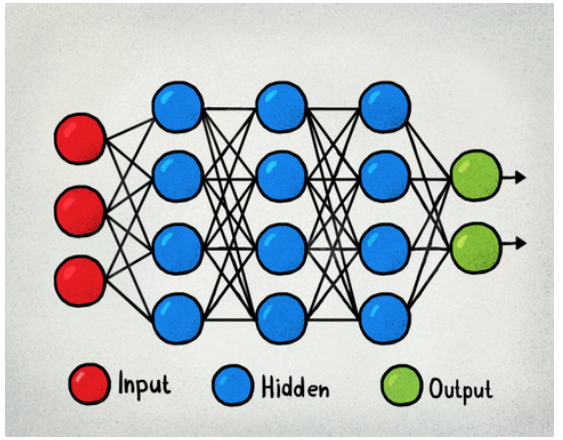
What is Immunological Bioinformatics?



What is Immunological Bioinformatics?

- By modelling the immune system, we can learn how the immune system deals with infections
- The models can be used for targeted design of vaccines against cancer and infectious diseases
- The MHC system has been successfully modelled by the group, but there is still much we do not understand
- The models we use are based on machine learning methods and require us to work with collaborators around the globe to get data





Global aim of the course

- The overall aim of this course is to:
  - Introduce you to immunological bioinformatics in the context of vaccine design and cancer
  - Introduce you to a variety of existing tools
  - Understand how they work and can be extended
  - Hopefully you will be able to directly apply what you have learned in your research / further studies

Course overview

- The course aims to introduce the students to *state-of-the-art* methods within computational immunology

- We will focus on introducing **the methods** in context with immunology as domain specific knowledge area. Furthermore, introduction to the theory of the methods will be followed by practical exercises, enabling the student to independently perform analyses. The course covers immunological bioinformatics and computational vaccinology with an outlook to infectious diseases and cancer immunotherapy

- The course is taught in two parts. **Part 1** covers lectures and group based exercises and **part 2** will cover group based project work aiming at creating a full project workflow

- On day 8 of the course, there will be a mini-symposium featuring prominent researchers within immunoinformatics

General course objectives

- Theory and application of computational methods in context with the prediction of immune responses, moreover:
  - The involvement of TCR and BCR and MHC class I/II in inducing immune response
  - The structural and genetic characteristics of the TCR and BCR and MHC class I/II and corresponding epitopes
  - Computational methods for modelling TCR and BCR and MHC class I/II and respective epitope interactions
  - Application and challenges of the above in disease context, i.e. vaccinology of infectious diseases and cancer

- General engineering competencies are included in the form of theory in context with concrete application and group based project work, where the students are responsible for planning, designing, implementing and communicating a project.

Learning objectives

A student who has met the objectives of the course will be able to:

- List the structural characteristics of the MHC class I and II molecules, respective antigen processing pathways and ligands
- Identify relevant immunological databases on the internet and extract desired data
- Identify the used germ-line genes in a final rearrangement of antibody encoding genes
- Explain the structural and functional differences between the MHC class I and class II molecules and an antibody/BCR and a TCR
- Explain the background for predicting peptide-MHCI/II binding and linear and conformational B cell epitopes
- Explain what a Position Specific Scoring Matrix is and how a PSSM is used to create a sequence logo from a set of peptides

https://kurser.dtu.dk/course/22145

Learning objectives

- Conceptually explain how an artificial neural network is constructed, trained and predictions are made
- Use appropriate tool for predicting:
    - i. Peptide-MHCI/II binding (T-cell epitopes),
    - ii. Linear/conformational B cell epitopes,
    - iii. Interaction between a TCR and the pMHC complex and
    - IV. T-Cell receptor and antibody structure
- Use the allele frequencies database to identify vaccine population coverage
- Use web-based tools for the analysis of repertoires of TCRs and BCRs
- When presented with a proposed peptide vaccine, determine if it meets target disease criteria and population coverage and evaluate its potential effectiveness
- Using the knowledge obtained in the course by applying in silico methods, plan and conduct i. A peptide vaccine design project and ii. A protein drug de-immunization project

https://kurser.dtu.dk/course/22145

Course Structure

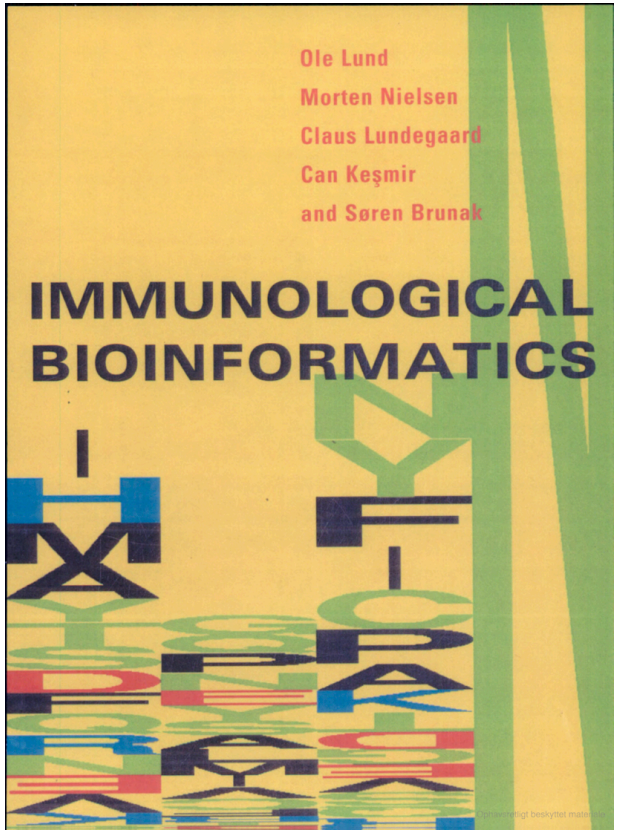
- Time: 9 – 17 (teaching starts at 9am everyday)

- 3-weeks course, distributed on:
  - Part 1
    - Lectures and exercises, January 4-12th
    - Mini-symposium, January 13th
  - Part 2
    - Project group work, January 13-20th
    - Oral presentations January 21th
    - Online exam, January 22th

- See for overview: http://teaching.healthtech.dtu.dk/22145

Teaching Materials

- Slides, papers and ”Immunological Bioinformatics” book (pdf on inside)
- All teaching material will be available online via the course website or DTU inside



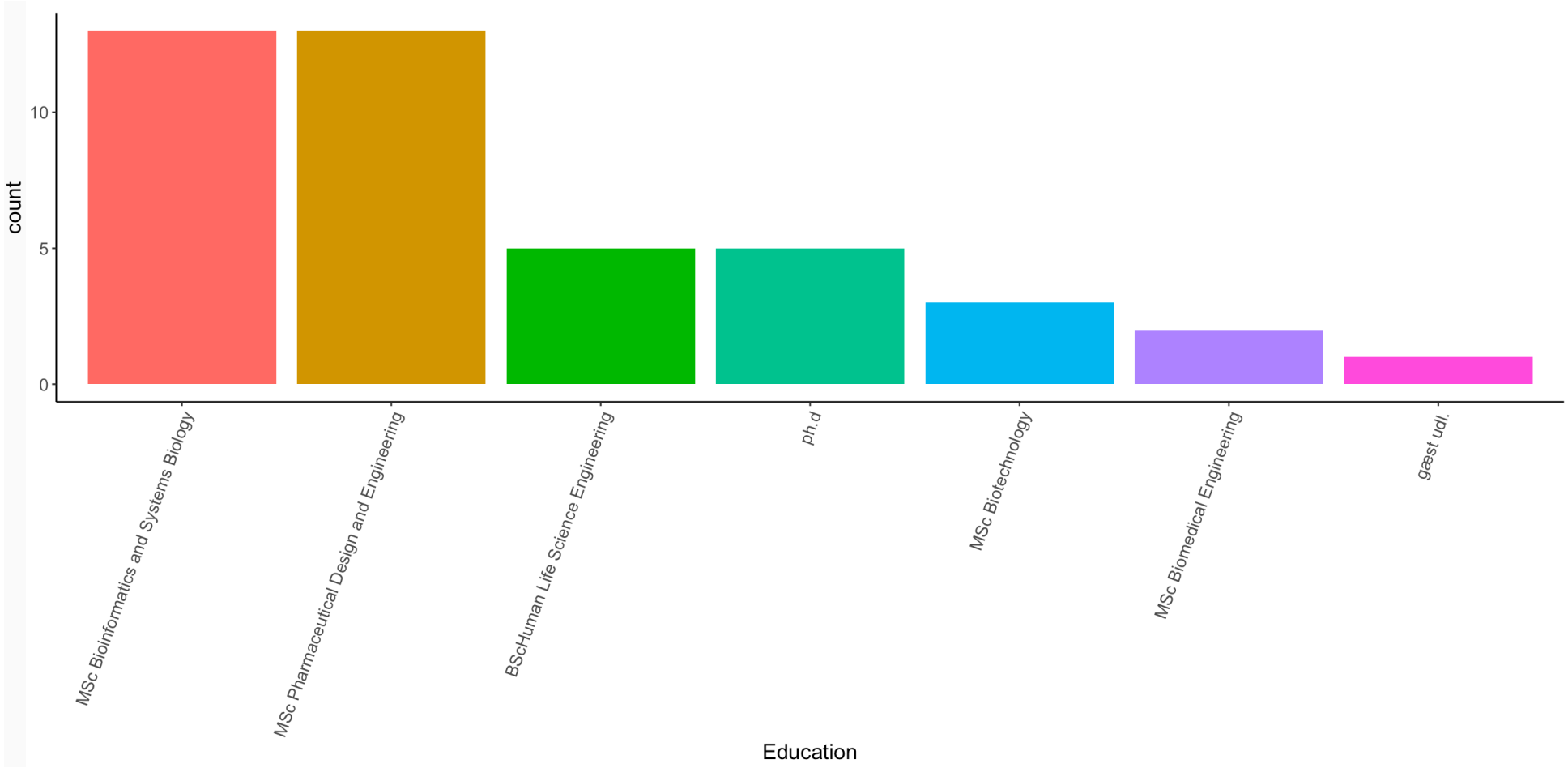
Exam

- General exam format will consist on 2 parts
  - *Oral presentation of the group project 10-12 min presentation + 2-3min questions total 15 minutes per group*
  - Individual written exam ~20 short questions, 2hs total

- The deadline for uploading the final project presentation to DTU Inside will be Wednesday January 20 at 23.59. It is a prerequisite for the exam to complete this assignment

- Exam dates:
  - Oral presentation: **January 21st** (Group Times to be announced)
  - Individual written exam: **January 22nd**

This Year's Educational Diversity (n = 42)



Preset groups based on educational diversity

- 10 groups of 4-5 students

- As in previous editions of the course, we have pre-formed the groups aiming at mixing educational diversity (list with emails is available on DTU Inside)

- Why?
  – From the DTU Course Base:

*"General engineering competencies are included in the form of theory in context with concrete application and **group based project work**, where the students are responsible for planning, designing, implementing and communicating a project"*

– Basically, once you have completed your education, it will no longer be possible for you to decide with whom you wish to work and you will be placed in teams

Questions?

Today’s programme

- AIM: Learn basic and essential concepts of immunology
- Active-learning-work with a learning method called "Inquiry based learning", which is quite close to the way a researcher works
- Briefly, "Inquiry based learning" is based on a main question defining the topic and subsequently a series of investigative questions are generated. By working with and answering these questions, a deeper knowledge on the topic is obtained compared to simply sitting passively in on a classic lecture

Today's programme

- This course requires a working understanding of the bio-molecular mechanisms underlying human immunity to infection, so without further ado, the main question of today is:

A one-immunity-gene-one-pathogen system is obviously not possible, so how is it that we as humans are able to respond to infections by pathogens that we have never been exposed to before?

- Go to http://teaching.healthtech.dtu.dk/22145 and click on todays session to find the detailed agenda

- Once again, Welcome and happy learning!