Research Seminar Syllabus

1. Overview

<mark>Title</mark>			**Introduction to Bioinformatics**
<mark>Prerequisites</mark>	**High School Students**	Required course/Knowledge	The course "Introduction to Bioinformatics" provides students with an understanding of Bioinformatics as an interdisciplinary field that mainly includes molecular biology and genetics, computer science, mathematics and statistics. Large-scale biological problems requiring large amounts of data are solved from a computational point of view. By other word, Bioinformatics is defined as the application of tools of computation and analysis to the capture and interpretation of biological data. Currently, the bioinformatics covers many specialized and advanced areas of biology and medicine.
		Recommended Materials for preparing for the course	Introduction to Bioinformatics by Arthur Lesk, 5th Edition, 2019; Oxford University Press; 5th edition; ISBN: 0198794142 Introduction to Bioinformatics
	College Students	Required course/Knowledge	Basis of Biology, Basic computer skills
		Recommended Materials for preparing for the course	By Anna Tramontano, 2007 Chapman & Hall ISBN 9781584885696 Bioinformatics: A Practical Approach; Shui Qing Ye, Chapman & Hall, 2008 ISBN: 9780367388751 You can use any other bioinformatics textbooks, preferably published after ~2005

2. Program Introduction and Objectives

Course Description	This course introduces how bioinformatics can be used as a powerful set of tools for extracting and analyzing biological data, and how bioinformatics can be applied to a wide range of disciplines such as molecular biology, medicine and biotechnology.

		The most important thing to understand is that bioinformatics is a set of mathematical methods that we apply in molecular biology. And molecular biology is the science of how genes are arranged, how genes and biomolecules regulate our lives.
	Software/Tools (if any)	No special software required but any online resources can be used.

3. Program Schedule

Class		Instructor Session	Teaching Fellow Session
1	**Topic**	**What is Bioinformatics?**	
	Detail	Bioinformatics is the application of computational and analysis tools to collect and interpret biological data.	Need to show a simple example of the application of bioinformatics in medicine
2	**Topic**	**Molecular Biology in Bioinformatics**	
	Detail	An introduction to molecular biology involves addressing questions: What is life made of?	It is necessary to explain the processes of transcription and translation on which life is based
3	**Topic**	**How genetic information is stored in living cells**	
	Detail	The genetic code as the molecular basis of life on earth. The concept of a nitrogenous base - a structural element of DNA and RNA.	It is necessary to explain how transcription and translation of genes work and how we can describe this process mathematically (genetic code)
4	**Topic**	**Computational Goals of Bioinformatics**	
	Detail	The main goals of the Bioinformatics are to enable the discovery of new biological insights as well as to create a global perspective from which unifying principles in biology can be discerned. Example of Biochips: DNA microarray biochips: These biochips allow scientists to analyze gene expression levels in cells. They consist of a small glass slide with thousands of tiny spots containing fragments of DNA, RNA, or proteins. By measuring the binding of labeled nucleic acid or protein targets to the spots, researchers can determine the expression levels of various genes. Protein biochips: These biochips contain tiny spots of different proteins and can be used to detect protein-protein interactions, protein-drug interactions, and post-translational modifications of proteins.	Examples of applications bioinformatics: • Prediction: functions or structures of newly sequenced genes or proteins. • Development of a systematic and genomic approach to cellular signaling. • Modeling: gene expression and protein structure Students are not required to bring laptops. But if one of them wants to use a laptop in class, it's not forbidden
5	**Topic**	**Bioinformatics: A Practical Approach**	

	Detail	With the deciphering of the complete genomic sequences of many organisms, new horizons of research have opened in computational biology. The scientific community now has free access to genome sequencing data from public databases. In many cases it is difficult to make sense of this huge dataset of DNA and protein sequences.	It is necessary to explain students how genome sequencing takes place, and how a database is compiled on its basis
6	**Topic**	**Final Project Preparation -1**	
	Detail	● **Final Project Milestone:** ➢ Make a mini-presentation and within 5 minutes, using no more than 10 slides, tell the chosen topic ● **Things to do during the class and arrangement**: During the presentation, the lecturer encourages students to ask questions to the speaker and moderates the discussion.	
7	**Topic**	**Case Study**	
	Detail		
8	**Topic**	**Final Project Preparation -2**	**Final Project Preparation -2**
	Detail	● **Final Project Milestone:** ➢ Familiarize yourself with the description of available databases of human genes associated with hereditary diseases ➢ Select a genetic human disease and make a brief report about the disease and find information in the gene' database ● **Things to do during the class and arrangement**:	Examples of topics can be used: 1. What applications of biochips do you find most interesting, and why? 2. How do you think biochips could change the future of medicine and healthcare? 3. What ethical considerations should be taken into account when using biochips for research or clinical purposes? 4. How do you think the development of biochips could impact other fields, such as biotechnology, engineering, or computer science? 5. How do you envision the future of biochips, and what potential advancements or breakthroughs could be made in this field?
9	**Topic**	**Case Study**	
	Detail	Is it possible to use bioinformatics methods for the development of personalized medicine? If so, how?	
10	**Topic**	**Final Oral Presentation and Written Reporting**	
	Detail	Students must make a short oral presentation, perhaps a presentation from a group of students of 1-3 people	

4. Problem Sets/Written Assignments/Quizzes

Requirements of Assignments	
Content: The essay should demonstrate a clear understanding of the topic and its relevance to medicine and biology. It should also provide some examples or case studies to illustrate the potential applications and benefits of bio-information technologies. Structure: The essay should have a clear introduction, body, and conclusion. The introduction should provide some background information and context for the topic, while the body should present the main arguments and evidence. The conclusion should summarize the key points and provide some implications or recommendations for future research or development. Style: The essay should be written in a clear and concise style, with proper grammar, spelling, and punctuation. It should also use appropriate academic language and referencing style Originality: The essay should be original and not plagiarized from any other source. Any external sources used should be properly cited and referenced.	**Assignment 1：** The student must write a mini-essay, choosing any application of bio-information technologies in medicine and biology. Size - no more than 1 page, you can use any sources. **Assignment 2：** The student must write a mini-essay on the topic "genome sequencing and bioinformatics". It is allowed to include in the essay a self-made (not from other sources!) Illustration, size - no more than 1 page. **Assignment 3：** The student must write a mini-essay on the topic "Bionfomatics and Peptides". Illustration, size - no more than 1 page. **...**
Submission Deadline	_____ Hours/Days after distribution/ announcement
Does teaching fellow need to grade assignment(s)?	Yes (X)	No ( )
Will a standard answer be provided?	Yes ( )	No (X)
Other Requirements (if any)	Students can use any sources of information but don't use copy-paste.	

5. Reading Materials

Lecture	Reading Materials (If Any)
1	**Introduction to Bioinformatics by Arthur Lesk, 5th Edition, 2019;** **Oxford University Press; 5th edition;** **ISBN: 0198794142**
2	"Molecular Biology of the Cell" by Bruce Alberts - Chapter 4 "DNA and Chromosomes".
3	Alberts, B., Johnson, A., Lewis, J., et al. (2002). Molecular Biology of the Cell. 4th edition. Garland Science, New York. Chapter 4: DNA, Chromosomes, and Genomes.

4	Essential Bioinformatics by Jin Xiong: Chapter 1 "Introduction", Chapter 2 "Computational Molecular Biology", Chapter 3 "Database Searching and Sequence Alignment".
5	Chapter "Introduction to Bioinformatics" , book "Bioinformatics: A Practical Handbook of Next Generation Sequencing and Its Applications" by S. Mallick, B. K. Mandal, A. Ghosh and D. Samanta.
6 (Final Project Preparation - 1)	
7 (Case Study)	
8 (Final Project Preparation - 2)	
9 (Case Study)	

6. Final Oral and Written Project

Detailed requirements of the final project:

➢ Grouping: individual/group work (please advise the group size)
➢ Topic(s)
➢ ...

In the final project, students are divided into groups of 3 people. Each group prepares a mini project and an oral report. The topic is chosen independently - the use of bioinformatics in a specific issue, in medicine, biotechnology or biology. The project and presentation should include a description of the problem, a statement of the problem, and a method for solving it, in which bioinformatics technology is used.

5.1 Final Oral Presentation
➢ Oral Project Requirements (e.g: if slides needed; Format; Criteria; Deadline):

Oral report was given by 1 student from the group. The report is given 5 minutes, another 5 minutes - answers to questions. Questions are answered mainly by other students from the group (not the main speaker)

5.2 Will you require a written final report as well?
➢ Written Project Requirements (e.g: word count; style; criteria; Deadline):
essay(writing component)

Requirements for the final project:
• Selecting a research question or problem related to bioinformatics
• Conducting a literature review and summarizing relevant findings
• Applying relevant bioinformatics tools and techniques to analyze data
• Interpreting results and drawing conclusions
• Communicating findings clearly and concisely in a written report
• Including proper citations and references in the report.

7. Evaluation

Percentage basis of evaluation (<mark>must total 100%</mark>):
Participation: ___10%____;
Assignments: __40%___;
Final Project: __50%____ (Oral: __25%___; Written: __25%__).

The overall score is based on the results of the evaluation of all mini-essays and the final project

8. Suggested Future Research Fields/Direction/Topics

I strongly advise students to pay attention to neurotechnologies and neuroscience research in general. I would be very happy to conduct additional classes on this topic