[Medicinski fakultet u Rijeci]

Curriculum
2023/2024

[Za kolegij]

Proteins and Protein Modifications

Study program:	**Medical Studies in English (R)** (elective) [Sveučilišni integrirani prijediplomski i diplomski studij]
Department:	**[Centar za proteomiku]**
Course coordinator:	**prof. dr. sc. Lenac Roviš Tihana**
Year of study:	**2**
ECTS:	**1.5**
Incentive ECTS:	**0 (0.00%)**
Foreign language:	**Possibility of teaching in a foreign language**

Course information:

COURSE CONTENT:

L1 (2h): Proteins – Structure and Representation models
Explore the diverse world of proteins, the building blocks of life, in this foundational lecture. Gain insights into the basic structure of proteins, including domains, motifs, and mutations, and learn how different models are used to represent these complex molecules. By examining examples such as opsin protein mutations, you will discover how structural variations can influence biological processes and contribute to conditions like color blindness.

L2 (2h): Membrane Proteins and Sorting
Delve into the intricate architecture of membrane proteins and their essential roles in cellular function. This lecture covers how proteins are processed and transported within the cell, ensuring proper localization and function. By exploring the journey of proteins through cellular compartments, you will uncover the mechanisms that drive cellular communication and molecular trafficking, fundamental to maintaining cellular health.

L3 (1h): Detailed Case Study – Cohlin Mutation and Deafness
Engage with a real-life case study in this session, focusing on the Cohlin mutation and its role in hearing loss. Through this example, you will see how molecular tools can be used to correct protein mutations and address disorders. This lecture provides a practical application of the concepts learned in previous sessions, offering insight into the latest advancements in protein correction techniques and their potential to treat genetic diseases.

L4 (1h): Protein Modifications
Unlock the secrets of protein modifications and their profound effects on protein function and stability. In this lecture, you will explore how chemical changes, such as glycosylation and phosphorylation, shape protein interactions and dictate their role in biological processes. By understanding these modifications, you will gain insight into how proteins are tailored to meet the demands of the cellular environment, and how errors can lead to disease.

L5 (1h): Incorrect Protein Folding – Its Role in Disease
Discover the crucial link between protein misfolding and disease in this session. Learn how the failure of proteins to fold correctly can lead to the formation of harmful aggregates and amyloids, contributing to conditions like Alzheimer's and Parkinson's. This lecture sheds light on the cellular mechanisms responsible for maintaining protein integrity and the devastating consequences when these systems break down.

L6 (2h): Protein Engineering – Possibilities of Genetic Modification
Enter the cutting-edge field of protein engineering, where genetic modification opens up new possibilities for designing proteins with novel functions. In this lecture, you will explore the technologies used to engineer proteins, from recombinant protein production to the development of therapeutic proteins. Witness how these innovations are revolutionizing the treatment of diseases and paving the way for future breakthroughs in medicine.

L7 (1h): Insulin – A Pioneer in the Use of Biologic Recombinant Drugs
Take a journey into the history of biotechnology by examining insulin, the first recombinant protein used in medicine. This session explores the development of insulin as a life-saving treatment for diabetes and highlights the transformative impact of recombinant protein technology. Learn how this pioneering advancement set the stage for the creation of modern biologic drugs, reshaping the landscape of therapeutic medicine.

E1 (3h): Protein Isolation from Mouse Brain
Engage in a captivating experiment to isolate proteins from mouse brain tissue. In this session, you will experience firsthand the techniques used to extract proteins, gaining valuable insights into the steps required for protein preparation and purification. This foundational experiment sets the stage for subsequent analyses, allowing you to explore the complexity of protein composition in a biological sample.

E2 (4h): Protein Separation and Electrophoresis Analysis
Dive deeper into protein analysis through electrophoresis, a powerful technique for separating proteins based on size and charge. You will explore how to analyze protein samples to confirm whether the mouse has been knocked out for a specific gene, investigate the disulfide bonds in immunoglobulins, or visualize the recombinant SARS-CoV-2 protein N on a gel. This session provides critical experience in protein characterization and helps you unravel the molecular structure of proteins in various contexts.

E3 (2h): Bioinformatics Tools for Protein Analysis
Discover the essential bioinformatics tools used in protein analysis. In this session, you will learn to navigate online resources

to interpret primary amino acid sequences of proteins, unlocking the power of computational analysis in modern biology. This hands-on experiment equips you with the skills to extract meaningful data from protein sequences, enhancing your ability to analyze and understand complex biological information.

Seminars (6h): Engaging Discourse - Exploring the Frontiers of Protein Science

Participate in guided online seminars that encourage engaging discourse and exploration at the frontiers of protein science. Through a structured approach, students will prepare and deliver presentations, sparking insightful discussions and critical thinking. Topics can range from student-selected subjects to timely and relevant issues, such as the Spike protein of the SARS-CoV2 virus. Join this dynamic forum where knowledge meets innovation, fostering a deeper understanding of protein science.

COURSE OBJECTIVES:

The main objective of this course is to enhance students' understanding of proteins and broaden their knowledge of protein modifications.

This includes exploring natural protein modifications that facilitate specific functions, such as timely activation or precise cellular targeting, along with the fundamental methods employed for studying these modifications.

Additionally, the course aims to provide insights into undesired protein modifications that underlie various diseases, including the formation of insoluble aggregates implicated in severe neurodegenerative disorders. This will enable students to grasp the physiological and pathophysiological processes that rely on proteins.

Moreover, deliberate introduction of modifications or mutations will be addressed, focusing on the creation of recombinant proteins that exhibit enhanced stability or specificity for specific cell types. This has significant implications in the development of pharmacologically effective and targeted biological drugs.

Lastly, the course will encompass the study of pathogenic proteins, encompassing emerging pathogens, such as the proteome of the SARS-CoV2 virus, which is of current interest and relevance.

List of assigned reading:

Berg JM, Tymoczko JL, and Stryer L: Biochemistry Stryer – selected chapters

List of optional reading:

Selected scientific and professional papers and review papers from the course topic

Curriculum:

[Predavanja] list (with titles and explanation):

L1 (2h) Proteins and glycoproteins

The student will be able to:

Define the following terms related to proteins: cytoplasmic domain, transmembrane domain, ectodomain (extracellular, outer domain), receptor-ligand interaction.

Describe the basic structural features of membrane proteins.

Explain the fundamentals of cellular compartments involved in protein maturation and transport.

L2. Modifications of proteins and variations in their motifs

The student will be able to:

Define the following terms related to proteins and their modifications: distinction between modification and mutation, disulfide bond, glycoprotein (sugar modification of proteins), protein motif, protein domain.

Discuss the factors influencing the stability of protein-based drugs.

L3. Incorrect protein folding- role in disease development

P3 (2h) Pogrešno smatanje proteina – uloga u razvoju bolesti – načini uklanjanja proteina iz stanice te nakupine nepravilno smotanih proteina kao uzročnici bolesti, s naglaskom na neurodegenerativne bolesti (e.g. ‘kravlje ludilo’; Creutzfeldt Jakobova bolest; Alzheimerova bolest).

The student will be able to:

Describe the fundamentals of cellular compartments involved in protein degradation.

Explain the basics of the process of insoluble protein aggregate formation (aggregates, amyloids).

L4. Protein engineering - possibilities of genetic protein modification

The student will be able to:

Define the following terms related to proteins and their modifications: recombinant protein.

Discuss the potential applications of genetic modification of proteins.

L5. Insulin, a pioneer in the use of recombinant biologic drugs.

The student will be able to:

Describe the basic structural characteristics of insulin.

Explain the advantages of producing recombinant drugs.

L6. Introduction to protein analysis methods.

The student will be able to:

Define the following terms related to proteins and their analysis: transfected cell line, electrophoresis.

Describe at least 3 methods used for protein analysis from cells and tissues.

[Seminari] list (with titles and explanation):

S - Seminari

Seminars (6h): Guided online classes, step-by-step seminar preparation with instructions, corrections, use of online tools and resources, short student presentations with discussion, topics of choice or work on current topics (example: Spike protein of the SARS-CoV2 virus) are planned.

[Vježbe] list (with titles and explanation):

E1 Basic bioinformatics tools for the analysis of protein primary sequences.

The student will be able to:

1. Independently retrieve the amino acid sequence of any protein from online sources and perform basic analyses such as searching for related sequences or identifying functional domains.

E2 Basic bioinformatics tools for protein structure analysis.

The student will be able to:

1. Discuss the factors influencing protein structure determination (modeling).

E3 Isolation and analysis of proteins.

The student will be able to:

Independently perform protein separation and analysis on a gel under supervision.

Student obligations:

redovito pohađanje nastave (predavanja, seminari, vježbe)

izrada seminarskog rada/polaganje završnog ispita

Exam (exam taking, description of the written/oral/practical part of the exam, point distribution, grading criteria):

Other notes (related to the course) important for students:

Throughout the course, students will gain insight into protein analysis methods that are routinely conducted at the host institution and are commonly sourced from external providers. They will also explore the types of assistance they can expect to receive in their future experimental work and professional development. This exposure will not only provide them with a comprehensive understanding of the practical aspects of protein analysis but also equip them with valuable knowledge and support for their future endeavors in experimental research and professional growth.

COURSE HOURS 2023/2024

Proteins and Protein Modifications

[Predavanja] (Place and time or group)	**[Vježbe]** (Place and time or group)	**[Seminari]** (Place and time or group)

List of lectures, seminars and practicals:

[PREDAVANJA] (TOPIC)	Number of hours	Location
L1 (2h) Proteins and glycoproteins	2	
L2. Modifications of proteins and variations in their motifs	2	

L3. Incorrect protein folding- role in disease development	2	
L4. Protein engineering - possibilities of genetic protein modification	2	
L5. Insulin, a pioneer in the use of recombinant biologic drugs.	1	
L6. Introduction to protein analysis methods.	1	

[VJEŽBE] (TOPIC)	Number of hours	Location
E1 Basic bioinformatics tools for the analysis of protein primary sequences.	2	
E2 Basic bioinformatics tools for protein structure analysis.	2	
E3 Isolation and analysis of proteins.	5	

[SEMINARI] (TOPIC)	Number of hours	Location
S - Seminari	6	

EXAM DATES (final exam):