Medicinski fakultet u Rijeci

**IZVEDBENI NASTAVNI PLAN**
**2025/2026**

Za kolegij

# Proteins and Protein Modifications

| | |
|---|---|
| Studij: | **Medical Studies in English (R)** (izborni) |
| | Sveučilišni integrirani prijediplomski i diplomski studij |
| Katedra: | **Centar za proteomiku** |
| Nositelj kolegija: | **prof. dr. sc. Lenac Roviš Tihana** |
| | |
| Godina studija: | **2** |
| ECTS: | **1.5** |
| Stimulativni ECTS: | **0 (0.00%)** |
| Strani jezik: | **Mogućnost izvođenja na stranom jeziku** |

**Podaci o kolegiju:**


**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.

## Popis obvezne ispitne literature:

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

## Popis dopunske literature:

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

# Nastavni plan:

## Predavanja popis (s naslovima i pojašnjenjem):

### L1 (2h): Proteins – Structure and Representation models

The student will be able to:

- Define key protein-related terms, including cytoplasmic domain, transmembrane domain, ectodomain, receptor-ligand interaction, domain, motif, conformation, wild-type, and mutant.
- Understand different professional models for protein representation and evaluate their advantages and limitations.
- Discuss the impact of protein mutations, using opsin protein mutations as an example to illustrate different types of color blindness

### L2 (2h): Membrane proteins and Sorting

The student will be able to:
• Describe structural features of membrane proteins.
• Explain the fundamentals of cellular compartments involved in protein maturation and transport.

### L3 (2h): Protein modifications with Examples

The student will be able to:

- Define the process and significance of disulfide bonds, glycosylation, phosphorylation, lipidation, and protein anchoring.
- Discuss the factors that influence the stability of protein-based drugs and receptor-ligand interactions.

### L4 (2h): Incorrect protein folding – its role in disease

The student will be able to:
Describe the fundamentals of protein degradation.
Explain the basics of the process of insoluble protein aggregate formation (aggregates, amyloids).

### L5 (1h): Protein engineering – possibilities of genetic 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.

### L6 (1h): Insulin – a pioneer in the use of biologic recombinant drugs

The student will be able to:
Describe the basic structural characteristics of insulin.
Explain the advantages of producing recombinant drugs.

## Vježbe popis (s naslovima i pojašnjenjem):

### E1 (2h): Basic informatic tools for protein analysis

The student will be able to:

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 (3h) isolation of proteins from biological mixtures

the student will be able to:

Explain the method of protein isolation from biological samples using tissues such as the brain as an example.
2. List the basic methods for determining protein concentration.
3. Under supervision, perform protein isolation experiments from tissues and determine their concentration using standard biochemical methods.
4. Apply mathematical methods for data analysis and processing (determining the concentration of isolated proteins based on a standard curve).
5. Write a report on the performed experiments.

**E2a (2h) Introduction to protein analysis**

Ishodi učenja

The student will be able to:

Independently perform protein detection under supervision.

**E2b (2h) Protein analysis and interpretation**

Ishodi učenja

The student will be able to:

Independently perform protein detection under supervision.

**Seminari popis (s naslovima i pojašnjenjem):**

**Seminars Proteins online**

**Seminars Proteins**

# Obveze studenata:

redovito pohađanje nastave (predavanja, seminari, vježbe)

izrada seminarskog rada/polaganje završnog ispita

# Ispit (način polaganja ispita, opis pisanog/usmenog/praktičnog dijela ispita, način bodovanja, kriterij ocjenjivanja):

# Ostale napomene (vezane uz kolegij) važne za studente:

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.

# SATNICA IZVOĐENJA NASTAVE 2025/2026

Proteins and Protein Modifications

| Predavanja<br>(mjesto i vrijeme / grupa) | Vježbe<br>(mjesto i vrijeme / grupa) | Seminari<br>(mjesto i vrijeme / grupa) |
|---|---|---|
| **29.10.2025** | | |
| L1 (2h): Proteins – Structure and Representation models:<br>• Centar za proteomiku (16:00 - 18:00) [180]<br>  ○ PAPM | | |
| prof. dr. sc. Lenac Roviš Tihana [180] | | |
| **30.10.2025** | | |
| L6 (1h): Insulin – a pioneer in the use of biologic recombinant drugs:<br>• Centar za proteomiku (18:00 - 18:45) [202]<br>  ○ PAPM<br><br>L5 (1h): Protein engineering – possibilities of genetic modification:<br>• Centar za proteomiku (19:00 - 19:45) [180]<br>  ○ PAPM | | |
| izv. prof. dr. sc. Brizić Ilija, mag. ing. biotechn. [202] · prof. dr. sc. Lenac Roviš Tihana [180] | | |
| **31.10.2025** | | |
| L2 (2h): Membrane proteins and Sorting:<br>• Centar za proteomiku (18:00 - 19:45) [180]<br>  ○ PAPM | | |
| prof. dr. sc. Lenac Roviš Tihana [180] | | |
| **03.11.2025** | | |
| L3 (2h): Protein modifications with Examples:<br>• Centar za proteomiku (18:00 - 19:40) [180]<br>  ○ PAPM | | |
| prof. dr. sc. Lenac Roviš Tihana [180] | | |
| **04.11.2025** | | |
| L4 (2h): Incorrect protein folding – its role in disease:<br>• Centar za proteomiku (18:00 - 19:45) [180]<br>  ○ PAPM | | |
| prof. dr. sc. Lenac Roviš Tihana [180] | | |
| **05.11.2025** | | |
| | E1 (2h): Basic informatic tools for protein analysis:<br>• ONLINE (16:40 - 18:40) [204]<br>  ○ PAPM | |
| Kučan Brlić Paola, PHD [204] | | |
| **24.11.2025** | | |

| | E2a (2h) Introduction to protein analysis:<br>• Centar za proteomiku (16:00 - 17:30) [180]<br>  ○ PAPM | |
|---|---|---|
| prof. dr. sc. Lenac Roviš Tihana [180] | | |
| **01.12.2025** | | |
| | E2 (3h) isolation of proteins from biological mixtures:<br>• Centar za proteomiku (17:00 - 19:30) [3286]<br>  ○ PAPM | |
| asistentica Bellulovich Ema [3286] | | |
| **11.12.2025** | | |
| | E2b (2h) Protein analysis and interpretation:<br>• Centar za proteomiku (10:00 - 11:30) [180] [1412] [1625]<br>  ○ PAPM | |
| prof. dr. sc. Lenac Roviš Tihana [180] · Malić Suzana [1625] · Miklić Karmela [1412] | | |
| **16.12.2025** | | |
| | | Seminars Proteins:<br>• P08 (14:30 - 17:30) [180]<br>  ○ PAPM |
| prof. dr. sc. Lenac Roviš Tihana [180] | | |
| **18.12.2025** | | |
| | | Seminars Proteins online:<br>• ONLINE (17:00 - 19:30) [180]<br>  ○ PAPM |
| prof. dr. sc. Lenac Roviš Tihana [180] | | |

## Popis predavanja, seminara i vježbi:

| PREDAVANJA (TEMA) | Broj sati | Mjesto održavanja |
|---|---|---|
| L1 (2h): Proteins – Structure and Representation models | 2 | Centar za proteomiku |
| L2 (2h): Membrane proteins and Sorting | 2 | Centar za proteomiku |
| L3 (2h): Protein modifications with Examples | 2 | Centar za proteomiku |
| L4 (2h): Incorrect protein folding – its role in disease | 2 | Centar za proteomiku |
| L5 (1h): Protein engineering – possibilities of genetic modification | 1 | Centar za proteomiku |
| L6 (1h): Insulin – a pioneer in the use of biologic recombinant drugs | 1 | Centar za proteomiku |

| VJEŽBE (TEMA) | Broj sati | Mjesto održavanja |
|---|---|---|
| E1 (2h): Basic informatic tools for protein analysis | 2 | ONLINE |
| E2 (3h) isolation of proteins from biological mixtures | 3 | Centar za proteomiku |
| E2a (2h) Introduction to protein analysis | 2 | Centar za proteomiku |

| E2b (2h) Protein analysis and interpretation | 2 | Centar za proteomiku |
|---|---|---|

| SEMINARI (TEMA) | Broj sati | Mjesto održavanja |
|---|---|---|
| Seminars Proteins online | 3 | ONLINE |
| Seminars Proteins | 3 | P08 |

## ISPITNI TERMINI (završni ispit):