UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	METODE DOLOČANJA 3D STRUKTURE MAKROMOLEKUL
Course Title:	METHODS FOR DETERMINING 3D MACROMOLECULAR STRUCTURE

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
MAG Biokemija, 2. stopnja	**/**	**1.**	**1.**
USP Biochemistry, 2nd Cycle	**/**	**1st**	**1st**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: BI212

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
60	**/**	**15 LV**	**/**	**/**	**75**	**5**

Nosilec predmeta / Lecturer: prof. dr. Kristina Djinović Carugo / Dr. Kristina Djinović Carugo, Full Professor
prof. dr. Janez Plavec / Prof. dr. Janez Plavec, Full Professor

Jeziki / Languages:

Predavanja / Lectures:	**slovenski / Slovenian**
Vaje / Tutorial:	**slovenski / Slovenian**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

Prerequisites:

The course has to be assigned to the student.

Vsebina:

Makromolekularna kristalografija
Viri roentgenskih žarkov, tehnike kristalizacije, simetrija (točkovne in prostorske skupine) Sipanje roentgenskih žarkov na materiji, atomski sipni faktor, strukturni faktor, elektronska gostota.
Metode reševanja faznega problema: molekularna izmenjava, uporaba derivatov težkih atomov (MIR, MAD).
Graditev in piljenje molekularnega modela. Strukturna analiza in validacija.

Nuklearna magnetna resonanca
Osnove NMR - teoretične osnove: opis razvoja

Content (Syllabus outline):

Macromolecular Crystallography
Sources of X-rays, crystallisation techniques, symmetry (point groups, space groups), unit cell, Bravais lattice, scattering of X-rays, atomic form factor, structure factor, electron density. Methods for solution of phase problem: molecular replacement, multiple isomorphous replacement, multiwavelenght anomalous dispersion, density modification techniques. Building of molecular model into electron density, refinement and structural analysis

Nuclear Magnetic Resonance
Basics of NMR – theoretical background:

magnetizacije, produkt operatorji, elementi pulznih zaporedij NMR spektrometer: osnovni sestavni deli in delovanje Procesiranje in intepretacija NMR spektrov Dvodimenzionalni NMR eksperimenti Homo- in heteronuklearni trodimenzionalni NMR eksperimenti Strategija asignacije spektrov proteinov in nukleinskih kislin Analiza sekundarne strukture Računanje 3D strukture iz NMR podatkov	description of magnetisation, product operators, elements of pulse sequences NMR spectrometer: basic building units and their operation Processing and interpretation of NMR spectra Two-dimensional NMR experiments Homo and heteronuclear three-dimensional NMR experiments Strategy of spectra assignment of proteins and nucleic acids Analysis of secondary structure Calculation of 3D structure from NMR data

Temeljna literatura in viri / Readings:

- David Blow, Outline of Crystallography for Biologists, Oxford University Press, 2002.
- Crystallography Made Crystal Clear, Gale Rhodes, Academic Press; 3 edition 2006.
- Bernhard Rupp, Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology,GS, 2009
- N.E.Jacobsen, NMR Spectroscopy Explained, Wiley-Interscience, 2007 (ca. 25% out of 650 pages)

Cilji in kompetence:	**Objectives and Competences:**
V okviru predmeta bo študent seznanjen z makromolekularno kristalografijo in nuklearno magnetno resonanco, dvema osnovnima metodama določevanja struktur makromolekul in njihovih kompleksov. Študent bo znal oceniti uporabnost in komplementarnost obeh metod ter analizirati strukture določene s tema metodama.	In the framework of this course a student will be introduced into macromolecular crystallography and nuclear magnetic resonance, two basic methods for structure determination of macromolecules and their complexes. Student will be able to evaluate efficacy and complementarity of both methods and analyse structures determined by these two methods.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent se seznami z osnovnima tehnikama za določanje 3D strukture bioloških makromolekul z atomsko ločljivostjo. **Makromolekularna kristalografija** Študent pri predmetu pridobi razumevanje o osnovah rentgenske difrakcije za biološke makromolekule. Spozna pojem sipanja elektromagnetnega valovanja na kristalu in se seznani s problemom faznega problema ter eksperimentalnimi metodami rešitve tega problema. **NMR**	<u>Knowledge and Comprehension</u> A student will be introduced to basic methods of structure determination of biological macromolecules with atomic resolution. **Macromolecular crystallography** A student will become acquainted with principles of macromolecular crystallography. A student will learn about principles of scattering of electromagnetic radiation on crystals, will be introduced to the phase problem and methods for its solution. **NMR**

Študent pridobi razumevanje osnov jedrske magnetne resonance in spozna uporabo večdimenzionalnih NMR metod pri študiju strukture in dinamike bioloških makromolekul. Študent se bo v praktičnem delu naučil izbrati ključne parametre v modernih NMR eksperimentih in analizirati zbrane podatke.	A student will comprehend basics of nuclear magnetic resonance and will be introduced into the use of multidimensional NMR methods in studies of structure and dynamics of biological macromolecules. During practical courses choice of critical parameters in modern NMR experiments and analysis of acquired data will be presented.
Uporaba Študij tega predmeta je podlaga za razumevanje molekularno in strukturno usmerjenih raziskovalnih pristopov in metod, ki jih bo uporabljal na različnih strokovnih področjih.	Application Material of this course represents the basis for understanding molecular and structurally oriented research approaches and methods which can be utilized in various fields.
Refleksija Študent pridobi znanja, ki omogočajo z molekularno strukturo podprt pogled, razumevanje in razlago bioloških vprašanj na molekularni osnovi.	Analysis A student obtains knowledge which enables insight and understanding of biologically relevant challenges through a view based on molecular structure.
Prenosljive spretnosti Timsko delo (pri vajah). Uporaba tuje literature. Podajanje poročil o opravljenem delu (pismeno) in prebrani literaturi ustno.	Skill-transference Ability Team work (during lab work). Use of foreign literature. Reporting about performed work (in written) and on literature (orally).

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja. Laboratorijske vaje. Ekskurzija: ogled sinhrotrona Elettra v Trstu.	Lectures. Laboratory exercises. Excursion: visit to synchrotron Elettra in Trieste.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Opravljene vaje so pogoj za pristop k izpitu. Pisni in ustni izpit.		Completed laboratory exercises are requested for taking an exam. Written and oral exam

Reference nosilca / Lecturer's references:

- M. Marušič, R. N. Veedu, J. Wengel**, J. Plavec**, G-rich VEGF aptamer with locked and unlocked nucleic acid modifications exhibits a unique G-quadruplex fold, Nucleic Acids Res. 2013, 41(29), 9524-9536.
- M. Trajkovski, M. Webba da Silva, **J. Plavec**, Unique Structural Features of Interconverting Monomeric and Dimeric G-Quadruplexes Adopted by a Sequence from the Intron of the N-myc Gene, J. Am. Chem. Soc. 2012, 134 (9), 4132–4141.
- M. Marušič, P. Šket, L. Bauer, V. Viglasky, **J. Plavec**, Solution-state structure of an intramolecular G-quadruplex with propeller, diagonal and edgewise loops, Nucleic Acids Res. 2012, 40 (14), 6946-6956.
- I. Biljan, G. Ilc, G. Giachin, **J. Plavec**, G. Legname, Structural Rearrangements at Physiological pH: NMR insights from the V210I Human Prion Protein Mutant, Biochemistry 2012, 51 (38), 7465-7474.

- Carugo, O., and **Djinovic Carugo, K**. (2013) Half a century of Ramachandran plots. Acta Crystallogr. D Biol. Crystallogr. 69, 1333-1341.
- de Almeida Ribeiro, E., Jr., Beich-Frandsen, M., Konarev, P. V., Shang, W., Vecerek, B., Kontaxis, G., Hammerle, H., Peterlik, H., Svergun, D. I., Blasi, U., and **Djinović-Carugo, K**. (2012) Structural flexibility of RNA as molecular basis for Hfq chaperone function. Nucleic Acids Res. 40, 8072-8084.
- Macedo, S., Pechlaner, M., Schmid, W., Weik, M., Sato, K., Dennison, C., and **Djinović-Carugo, K.** (2009) Can soaked-in scavengers protect metalloprotein active sites from reduction during data collection? J. Synchrotron. Radiat. 16, 191-204.