BIOFIZIKALNA KEMIJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Biofizikalna kemija
Course title:	Biophysical chemistry
Članica nosilka/UL Member:	UL FKKT

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Kemija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik, 2. letnik		izbirni

Univerzitetna koda predmeta/University course code:	0072214
Koda učne enote na članici/UL Member course code:	K2I21

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	15	15 LV			75	5

Nosilec predmeta/Lecturer:	doc. dr. San Hadži, prof. dr. Jurij Lah
Vrsta predmeta/Course type:	izbirni strokovni/Elective Professional
Jeziki/Languages:	Predavanja/Lectures: Angleščina, Slovenščina Vaje/Tutorial: Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.	The course has to be assigned to the student.

Vsebina:	Content (Syllabus outline):
Biološko pomembne molekule Proteini, nukleinske kisline, polisaharidi, lipidi, maščobe, surfaktanti. Struktura, funkcija in njihovo okolje v celici . **Proteini, nukleinske kisline in lipidi v vodni raztopini** Voda : Vodikove vezi , struktura ledu in tekoče vode. Hidratacija: Bornov model hidratacije ionov, solvatacija polarnih in nepolarnih topljencev, hidrofobni efekt. Interakcije, ki stabilizirajo strukturo proteinov in nukleinskih kislin. Proteini in nukleinske kisline kot polielektroliti. Topnost in kristalizacija proteinov. Tvorba in funkcija bioloških membran. **Termodinamika biomolekularnih sistemov**	**Biologically important molecules** Proteins, nucleic acids, polysaccharides, fats, lipids, surfactants. Structure, function and their environment in the cell. **Proteins, nucleic acids and lipids in aqueous solution** Water: Hydrogen bonds, structure of crystalline and liquid water. Solvation: The Born model of ion salvation, solvation of polar and non-polar solutes. The hydrophobic effect. Interactions stabilizing protein and nucleic acids structure. Proteins and nucleic acids as polyelectrolytes. Protein solubility and crystallization. Form and function of biological membranes.

Energija, informacije in življenje. Termodinamska analiza fotosinteze, glikolize, cikla citronske kisline, oksidativne fosforilacije in hidrolize ATP, osmoze, dialize, membranskega transporta, stabilnosti proteinov in nukleinskih kislin. Termodinamika medsebojnega prepoznavanja bioloških makromolekul : osnove, uporaba pri načrtovanju zdravil. **Kinetika** Hitrost reakcije in njena odvisnost od temperature. Mehanizmi zvitja in vezanja proteinov in nukleinskih kislin. Napačno zvitje proteinov in s tem povezane bolezni. Tehnike za spremljanje zelo hitrih procesov, relaksacijske metode, izmenjava vodika, površinska plazmonska resonanca.	**Thermodynamics of biomolecular systems** Energy, information, and life. Thermodynamic analysis of photosynthesis, glycolysis, and the citric acid cycle, oxidative phosphorylation and ATP hydrolysis, osmosis, dialysis, membrane transport, protein stability and nucleic acids stability. Thermodynamics of recognition of biological macromolecules: introduction, application in drug design. **Kinetics** Rate of reaction and its temperature dependence. Mechanisms of protein and nucleic acids folding and binding. Protein folding and pathological misfolding. Rapid reaction techniques, relaxation methods, hydrogen exchange, surface plasmon resonance.

Temeljna literatura in viri/Readings:

- *Principles of Physical Biochemistry*, K.E. van Holde Prentice Hall (1998), 657 str., (30 %)
Biophysical Chemistry, A. Cooper, RSC, Cambridge (2004), 184 str., (50%)

Dopolnilna literatura:

- *Thermodynamics and Kinetics for the Biological Sciences*, G.G. Hammes, J. Wiley & Sons (2000), 158 str.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta: Spoznavanje, razumevanje in obravnava fizikalno-kemijskih lastnosti bioloških makromolekul ter zakonitosti, ki te lastnosti določajo in povezujejo. *Predmetno specifične kompetence*: Sposobnost osnovne fizikalno-kemijske karakterizacije raztopin bioloških makromolekul, njihovega vezanja in strukturnih sprememb.	Knowledge and understanding of the basic physico-chemical properties of biological macromolecules in solution and understanding of physical laws that determine these properties and link them together. Ability to accomplish basic physico-chemical interpretation of properties of biological macromolecules in the solution, their binding and structural alterations.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Predmet daje študentu teoretično (predavanja, seminar) in praktično (laboratorijske vaje) znanje osnov biofizikalne kemije. Pridobljeno znanje je potrebno za razumevanje bioloških procesov na molekularni ravni. *Uporaba:* Pridobljeno teoretično in praktično znanje je potrebno za uspešno poučevanje kemije. *Refleksija:* Študent bo pridobil občutek, kako lahko s pomočjo fizikalnih zakonov opišemo relativno zapletene biokemijske procese. S pridobljenim znanjem bo lahko kritično ovrednotil rezultate laboratorijskih vaj in ga uporabil v praksi. *Prenosljive spretnosti:* Študent se nauči teoretičnih in eksperimentalnih pristopov, ki so osnova pri načrtovanju, spremljanju in vodenju eksperimentov v kemiji in biokemiji.	*Knowledge and Comprehension:* The subject gives students the theoretical (lectures, seminars) and practical (lab exercises) knowledge of basic biophysical chemistry. The acquired knowledge is necessary to understand basics thermodynamics of biological processes at the molecular level. *Application:* Acquired theoretical and practical knowledge is necessary for successful teaching of chemistry. *Analysis:* Students will find out how to use laws of physics s in description of relatively complex biochemical processes. With the knowledge gained they will be able to critically evaluate the results of laboratory work and use it in practice. *Skill-transference Ability:* Students will learn some of the theoretical and experimental approaches, which set the basis for planning and monitoring experiments in chemistry and biochemistry

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarji, laboratorijske vaje.	Lectures, seminars, laboratory exercises.

Načini ocenjevanja:	Delež/Weight	Assessment:
Pisni izpit po uspešno opravljenih laboratorijskih vajah. Ocene: pozitivno (6-10); negativno (5).		Written exam. Tutorials are a prerequisite for taking the exam. Grades: pass (6-10); fail (5).

Reference nosilca/Lecturer's references:

- **Hadži S**., Loris R., **Lah J**. The sequence–ensemble relationship in fuzzy protein complexes. *PNAS* (2021) 118, 1-9.
- **Hadži, S.,** Kocman, V., Oblak, D., Plavec J., **Lah J**. Energetic basis of AGCGA-rich DNA folding into a tetrahelical structure. *Angewandte Chemie I.E.* (2019) 58, 2387-2391.
- Bunc M., **Hadži S.,** Graf C., Bončina M., **Lah, J.** Aggregation time machine : a platform for the prediction and optimization of long-term antibody stability using short-term kinetic analysis. *Journal of medicinal chemistry*. (2022) 65, 2623-2632.
- **Hadži S.**, **Lah J.** Origin of heat capacity increment in DNA folding : the hydration effect. *Biochimica et Biophysica Acta. General subjects* (2021) 1865, 1-9.
- Šarac B., **Hadži S.** Analysis of protonation equilibria of amino acids in aqueous solutions using Microsoft Excel. *Journal of chemical education* (2021), 98, 1001-1007.