UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Nanobiofizika
Course title:	Nanobiophysics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Nanoznanosti in nanotehnologije, 3.stopnja	/	1	1
Nanosciences and Nanotechnologies, 3rd cycle	/	1	1

Vrsta predmeta / Course type	Izbirni / Elective
Univerzitetna koda predmeta / University course code:	NANO3-815

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Druge oblike Others	Samost. delo Individ. work	ECTS
15	**15**			**15**	**105**	**5**

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transfered to individual work.*

Nosilec predmeta / Lecturer:	Prof. dr. Janez Štrancar
Jeziki / Languages: Predavanja / Lectures:	slovenščina, angleščina / Slovenian, English
Vaje / Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Zaključena druga stopnja bolonjskega študija ali diploma univerzitetnega študijskega programa. Potrebna so tudi osnovna znanja fizike, biologije, naravoslovja in tehnike.	Completed Bologna second level study program or an equivalent pre-Bologna university study program. Basic knowledge of physics, biology , natural sciences and technology is also requested.

Vsebina:	**Content (Syllabus outline):**
<u>Nano in supramolekularne strukture kot posledica tekmovanja interakcij:</u> - specifičnost ionskih kanalov: H-vez in velikost elektronskih oblakov, - samo-sestavljanje zaradi hidrofobne interakcije: prispevek H-vezi in orientacijske entropije, - pakiranje proteinskih ovojnic okoli DNA/RNA ali nanodelcev: prispevka elektrostatske in hidrofobne interakcije, - agregiranje nanodelcev: vlogi elektrostatske in Van der Waalsove interakcije <u>Časovne skale struktur:</u> - energije in življenjski čas vodnih plaščev okoli	<u>Nano and supramolecular structures due to interaction competition:</u> - specificity of ion channels: H-bond and size of electron clouds, - self-assembly due to hydrophobic interaction: contribution of H-bond and orientational entropy, - packing of the protein coating around DNA/RNA or nanoparticles: contribution of electrostatic and hydrophobic interaction, - nanoparticle aggregation: the role of electrostatic and Van der Waals interaction <u>Time scales of the structures:</u>

nabitih molekul, - kooperativnost in življenjski čas DNA, - konformacijska entropija in dinamika proteinskih stranskih verig ter življenjski čas proteinskih stikal <u>Kompleksi nanomaterialov z biološkimi strukturami:</u> - korona, ki spreminja identiteto nanodelcev, - lipidni plašč, ki spreminja interakcijo nanodelcev z membranami, - vpliv korone na prehod prek membrane, - dinamično pretvarjanje korone v lipidni plašč okoli nanodelcev <u>Koncepti eksperimentalnih metod za raziskovanje nanobiofizikalnih problemov</u> - superločljive mikroskopije, mikrospektroskopije in nanoskopije - primerjava prejšnjih z elektronskimi mikroskopijami in difrakcijskimi tehnikami	- energy and life-time of the water shells around charged molecules, - cooperativity and life-time of DNA, - conformational entropy and dynamics of the protein side chains and lifetime of the protein switches, <u>The complexes of the nanomaterials and biological structures:</u> - corona, which modulates the nanoparticle identity, - lipid wrap, which modulates the interaction of the nanoparticles with membranes, - the effect of corona on the transmembrane passage, - dynamical transformation of the corona into the lipid wrap <u>The experimental concepts to approach the nanobiophysical problems</u> - superresolution microscopies, microspectroscopies, nanoscopies - comparison of the previously mentioned technique with electron microscopies and diffraction techniques

Temeljna literatura in viri / Readings:

Izbrana poglavja iz naslednjih knjig oz. njihovih novejših izdaj: / Selected chapters from the following books or their latest editions:

T.A.Waigh: Applied Biophysics: A Molecular Approach for Physical Scientists. Wiley & Sons. 2007.
M.B.Jackson: Molecular and Cellular Biophysics. Cambridge press, 2006.
J. Israelaschvili: Intermolecular and Surface Forces. Academic Press, London, 2011.
I.N.Serdyuk, N.R.Zaccai, J.Zaccai: Methods in Molecular Biophysics. Cambridge press, 2007.

Kot tudi najnovejši članki na področju / As well as the latest scientific papers in the field.

Cilji in kompetence:	**Objectives and competences:**
Učni cilji: - Študentje so sposobni pojasniti strukturne spremembe v celicah v luči delovanja interakcij med molekulami in nanostrukturami ter celicami ter vpliva na delovanje telesa in zdravje - Študentje so sposobni proučiti vzroke in predvideti spremembe v molekularnih sistemih, od nivoja molekul, supramolekularnih struktur in celičnih organel do makroskopskih struktur, kot so tablete v luči vpliva na delovanje telesa in zdravje - Študentje so sposobni izbrati in ovrednotiti	Objectives: - Students can understand the structural changes in cells under perspective of the interactions between molecular and nanostructures and cells as well as of its influence on the function of the human body and its health - Students can analyze the origin of the molecular changes and predict them at the level of molecules, supramolecular structures, cell organelles, and macroscopic systems such as tablets under perspectives of the influence on the function of the human body and its health - Students can select and evaluate the selection of

izbiro primernih eksperimentalnih metod za karakterizacijo interakcij med molekulami in nanostrukturami ter celicami
- Študentje so sposobni uporabiti temeljne fizikalne koncepte in fizikalni način razmišljanja za razumevanje sprememb v telesu na molekularni skali
- Študentje so sposobni ovrednotiti obstoječe protokole in pogoje za analizo molekularnih strutkur in pojavov.

Kompetence:
- Sposobnost ovrednotenja postopkov in pogojev analiz vzorcev pri eksperimentalnem delu z nanomateriali in biološkimi sistemi hkrati
- Sposobnost oblikovanja izboljšanih postopkov in pogojev analiz vzorcev pri eksperimentalnem delu z nanomateriali in biološkimi sistemi hkrati
- Sposobnost spremljanja rezultatov preiskav in interpretacija vplivov snovi na spreminjanje struktur v telesu, organu oz. celici
- Sposobnost informiranja o vplivu snovi na spreminjanje struktur v telesu, organu oz. celici
- Sposobnost izvajanja varnega načina dela (preiskav)
- Sposobnost izvajanja z znanjem podprtega dela za izboljšanje kvalitete analiz vzorcev
- Sposobnost kontinuiranega profesionalnega razvoja in upravljanja lastne rasti

experimental methods to characterize the interactions between molecular and nanostructures and cells
- Students can apply the basic physical conepts and physical way of thinking to understand the changes in the human body on the molecular level
- Student can evaluate the existing protocols and conditions for analysis of the molecular structures and phenomena

Competences:
- Ability of evaluation of the procedures and conditions of sample analysis during experimental work with nanomaterials and biological systems at the same time
- Ability of improvement of the procedures and conditions of sample analysis during experimental work with nanomaterials and biological systems at the same time
- Ability of monitoring of the results of analysis and of interpretation of the influences of matter on structural changes within body, tissue or cell
- Ability of informing about the influences of matter on structural changes within body, tissue or cell
- Ability of performing safe work and analysis
- Ability of implement knowledge-driven analysis for the improved sample analysis
- Ability of continuous profesional development and personal growth

Predvideni študijski rezultati:

Znanje in razumevanje:

študenti bodo z uspešno opravljenimi obveznostmi tega predmeta pridobili:
- razumevanje kompleksnih struktur iz nanomaterialov in bioloških struktur
- razumevanje dinamike in samosestavljanja teh struktur
- pregled aktualnih znanstvenih problemov in dosežkov na področju
- pregled metod raziskovanja na področju
- sposobnost uporabe znanja in napovedovanja interakcij med novimi nanomateriali in znanimi biološkimi strukturami
- sposobnost ugotavljanja primernosti metod eksperimentalnega dela za raziskovanje

Intended learning outcomes:

Knowledge and understanding:

students successfully completing this course will acquire:
- understanding the complex structures of nanomaterials and biological structures
- understanding the dynamics and self-assembly of these structures
- overview of current scientific problems and achievements in this field
- overview of the research methods in this field
- the ability to apply the skills and knowledge to predict the interactions between new nanomaterials and the known biological structures
- the ability to identify whether the methods are

kompleksnih struktur med nanomateriali in biološkimi strukturami	appropriate to explore the complex structures of nanomaterials and biological structures

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, konzultacije, individualno eksperimentalno delo	Lectures, consultancy, individual experimental work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarska naloga	50 %	Seminar work
Ustni zagovor seminarske naloge	50 %	Oral defense of seminar work

Reference nosilca / Lecturer's references:

- ANDJELIĆ, Sofija, DRAŠLAR, Kazimir, HVALA, Anastazija, LOKAR, Nina, ŠTRANCAR, Janez, HAWLINA, Marko. Anterior lens epithelial cells attachment to the basal lamina. Acta ophthalmologica, ISSN 1755-375X, May 2016, vol. 94, iss. 3, str. e183-e188.
- SEDMAK, Ivan, URBANČIČ, Iztok, PODLIPEC, Rok, ŠTRANCAR, Janez, MORTIER, Michel, GOLOBIČ, Iztok. Submicron thermal imaging of a nucleate boiling process using fluorescence microscopy. Energy, ISSN 0360-5442. [Print ed.], Aug. 2016, vol. 109, str. 436-445.
- PODLIPEC, Rok, ŠTRANCAR, Janez. Cell-scaffold adhesion dynamics measured in first seconds predicts cell growth on days scale - optical tweezers study. ACS applied materials & interfaces, ISSN 1944-8244. [Print ed.], 2015, vol. 7, no. 12, str. 6782-6791
- LJUBETIČ, Ajasja, URBANČIČ, Iztok, ŠTRANCAR, Janez. Recovering position-dependent diffusion from biased molecular dynamics simulations. The Journal of chemical physics, ISSN 0021-9606, 2014, vol. 140, no. 8, str. 084109-1-084109 -11
- PODLIPEC, Rok, GORGIEVA, Selestina, JURAŠIN, Darija, URBANČIČ, Iztok, KOKOL, Vanja, ŠTRANCAR, Janez. Molecular mobility of scaffolds' biopolymers influences cell growth. ACS applied materials & interfaces, ISSN 1944-8244. [Print ed.], 2014, vol. 6, iss. 18, str. 15980-15990