Univerza v Mariboru
Medicinska fakulteta

UČNI NAČRT PREDMETA / COURSE SYLLABUS			
Ime predmeta:	**Nanodelci v biomedicini**		
Course title:	**Nanoparticles in Biomedicine**		
Študijski program in stopnja Study programme and cycle	**Študijska smer Study option**	**Letnik Year of study**	**Semester Semester**
Biomedicinska tehnologija/3. stopnja		**2**	**3 ali 4**
Biomedical Technology/3rd Degree			

Vrsta predmeta (obvezni ali izbirni) / Course type (compulsory or elective)	Izbirni Elective
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	**Seminar Seminar**	**Vaje Tutorial**			**Klinične vaje Clinical training**	**Druge oblike študija Other forms of study**	**Samost. delo Individual work**	**ECTS**
		10						
15	**20**	**AV**	**LV**	**RV**			**135**	**6**

Nosilec predmeta / Course coordinator:	Prof. dr. Darko Makovec

Jeziki /Languages:	**Predavanja / Lectures:**	Slovenščina/Slovene
	Vaje / Tutorial:	Slovenščina/Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites for enrolling in the course or for performing study obligations:**

Vsebina (kratek pregled učnega načrta):	**Content (syllabus outline):**
Nanostrukturirani materiali, ki vsebujejo nanodelce. Pomen nanodimenzije v bio okolju in prednosti nanomaterialov pred klasičnimi materiali v biomedicini. Splošna predstavitev posebnosti uporabe nanodelcev v medicini. Predstavitev osnovnih lastnosti (kemijskih, optičnih, magnetnih, toksikoloških, itd) nanodelcev za uporabo v različnih postopkih diagnostike in zdravljenja. Predstavitev problematike uporabe nanodelcev v medicini na primeru magnetnih nanodelcev. Uporaba magnetnih nanodelcev za ciljano dostavo zdravilnih učinkovin, zdravljenje raka z magnetno hipertermijo ali magneto-mehansko terapijo, magnetni nanodelci kot kontrastno sredstvo pri slikanju z magnetno resonanco (MRI), detekcija in separacija biomolekul, itd. Magnetni nanodelci lahko zaradi svoje majhnosti potujejo po tkivu, hkrati pa so	Nanostructured materials based on nanoparticles. Relevance of nano-dimension in bio environment and advantages of nanomaterials when compared to “classical” materials. General introduction to nanoparticles application in medicine. Introduction of basic properties, e.g., chemical, magnetic, optical, toxicological, of nanoparticles for diagnostics and therapy. Introduction to problematics of biomedical applications of nanoparticles using magnetic nanoparticles as the typical example. Applications of the magnetic nanoparticles in targeted drug delivery, cancer treatment with magnetic hyperthermia or magneto-mechanical therapy, magnetic nanoparticles as contrast media in magnetic resonance imaging (MRI), detection and separation of biomolecules, etc. Due to their nano-dimension the nanoparticles can move across tissue. The

zaradi interakcije z magnetnim poljem sledljivi in vodljivi z uporabo magnetnega polja. Z magnetnim poljem jih lahko skoncentriramo v določenem delu telesa in na ta način dosežemo relativno visoke koncentracije učinkovin na določenih patoloških mestih. Zaradi interakcije z izmeničnim magnetnim poljem lahko magnetni nanodelci lokalno segrevajo okolico (hipertermija) ali pa pretvorijo elektromagnetno energijo v mehansko (magneto-mehanska terapija). Magnetni nanodelci vplivajo na okolico vodikovih protonov in izboljšajo kontrast pri NMR preiskavah. Nanodelci so pomembni tudi pri diagnostiki zunaj telesa (in vitro). Z modifikacijo površine magnetnih delcev se doseže selektivnost adsorpcije različnih bioaktivnih molekul, ki omogoča njihovo separacijo ter detekcijo. Za detekcijo antiteles, hormonov in podobnih substanc se lahko izrablja spremembe v magnetni relaksaciji delcev ob selektivni absorpciji analiziranih substanc (magnetorelksometrija).	magnetic particles interact with an external magnetic field and can be followed and guided by the field. They can be magnetically concentrated in a targeted tissue. Thus, relatively high concentrations of drugs can be delivered to the pathological sites. Due to interaction with alternating magnetic field the magnetic nanoparticles can locally heat the environment (hyperthermia) or transform electromagnetic energy to mechanical energy (magneto-mechanical therapy). Moreover, the magnetic nanoparticles influence an environment of hydrogen atoms and thus improve the contrast during MRI. The nanoparticles are important also for in-vitro diagnostics. With modification of the nanoparticles' surfaces, selective absorption of various bioactive molecules is enabled for their magnetic separation and detection. For the detection of antibodies, hormones and similar substances magnetic relaxation of the nanoparticles (magnetorelaxometry) can be followed.
Temeljni literatura in viri / Reading materials:	
– N. T. K Thanh (Ed.) »Clinical Applications of Magnetic Nanoparticles: From Fabrication to Clinical Applications« CRC Press, 2018. – GORŠAK, Tanja, JARC JOVIČIĆ, Eva, TRATNJEK, Larisa, KRIŽAJ, Igor, SEPULVEDA, Borja, NOGUES, Josep, ERDANI-KREFT, Mateja, PETAN, Toni, KRALJ, Slavko, MAKOVEC, Darko (avtor, korespondenčni avtor). The efficient magneto-mechanical actuation of cancer cells using a very low concentration of non-interacting ferrimagnetic hexaferrite nanoplatelets. Journal of colloid and interface science. 2024, vol. 657, str. 778-787, ilustr. ISSN 1095-7103. https://www.sciencedirect.com/science/article/pii/S0021979723023391?via%3Dihub, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.1016/j.jcis.2023.12.019. [COBISS.SI-ID 176772867]	
Cilji in kompetence:	**Objectives and competences:**
Uporaba nanostrukturanih materialov v biomedicini. Poudarek je na materialih, katerih lastnosti temeljijo na specifičnih lastnostih nanodelcev, ki jih vsebujejo. Materiali, ki vsebujejo nanodelce so pomemben del nanotehnologije, ki je trenutno v svetu najpomembnejša raziskovalna tematika in zajema študij, kontrolo in ravnanje z materiali z dimenzijo delcev pod 100 nm. Veliko zanimanje za področje nanotehnologije in nanoznanosti je povezano z možnostjo njene uporabe na različnih področjih, med drugim tudi v biomedicini. Zlasti magnetni nanodelci imajo izjemne možnosti za uporabo v biomedicini. Nanotehnologija omogoča raziskovalcem, da prilagodijo lastnosti materiala za delovanje na celičnem in molekulskem nivoju in prispevajo k napredku na področju biomedicinskih znanosti. Specifične lastnostih nanodelcev za uporabo v biomedicini.	Objectives: Application of nanomaterials in biomedicine. The emphasis will be on materials with properties that depend on their nanostructure. Materials that are composed of nanoparticles are of importance in nanotechnology, which is currently one of the most significant research areas, and includes the study, control and application of materials consisting of nanoparticles with dimensions below 100 nm. The great interest in nanotechnology is associated with its potential for use in various techniques, and in particular in biomedicine, where magnetic nanoparticles are of key importance. Nanotechnology makes it possible to use materials on the cellular level, which can contribute to progress in the field of life sciences. Specific properties of nanoparticles used in biomedicine
Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje: Znanje o uporabnosti nanodelcev v medicini.	**Knowledge and understanding:** Knowledge of the applicability of nanoparticles in medicine.
Prenosljive/ključne spretnosti in drugi atributi: Nanotehnologija omogoča prispevek k napredku na področju biomedicinskih znanosti.	**Transferable/key competences and other abilities:** Nanotechnology enables to contribution to progress on field biomedical sciences.
Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja/konzultacije Seminarsko ali projektno vodenje učenja Vaje Samostojno delo	Lectures/consultations Seminar or project assisted teaching Tutorial Individual work

Načini ocenjevanja:	**Delež (v %) / Share (in %)**	**Assessment methods:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Method (written or oral exam, coursework, project):
Seminarska naloga	**50 %**	Seminar paper
Ustni izpit	**50 %**	Oral exam

Reference nosilca / Course coordinator's references:

GORŠAK, Tanja, JARC JOVIČIĆ, Eva, TRATNJEK, Larisa, KRIŽAJ, Igor, SEPULVEDA, Borja, NOGUES, Josep, ERDANI-KREFT, Mateja, PETAN, Toni, KRALJ, Slavko, MAKOVEC, Darko (avtor, korespondenčni avtor). The efficient magneto-mechanical actuation of cancer cells using a very low concentration of non-interacting ferrimagnetic hexaferrite nanoplatelets. Journal of colloid and interface science. 2024, vol. 657, str. 778-787, ilustr. ISSN 1095-7103. https://www.sciencedirect.com/science/article/pii/S0021979723023391?via%3Dihub, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.1016/j.jcis.2023.12.019. [COBISS.SI-ID 176772867],

GORŠAK, Tanja, DRAB, Mitja, KRIŽAJ, Dejan, JERAN, Marko, LYUBOMIROVA GENOVA, Julia, KRALJ, Slavko, LISJAK, Darja, KRALJ-IGLIČ, Veronika, IGLIČ, Aleš, MAKOVEC, Darko. Magneto-mechanical actuation of barium-hexaferrite nanoplatelets for the disruption of phospholipid membranes. Journal of colloid and interface science. 1 Nov. 2020, vol. 579, str. 508-519, ilustr. ISSN 0021-9797. https://www.sciencedirect.com/science/article/pii/S0021979720308249, DOI: 10.1016/j.jcis.2020.06.079. [COBISS.SI-ID 20924163],

GYERGYEK, Sašo, GRILC, Miha, LIKOZAR, Blaž, MAKOVEC, Darko. Electro-hydrogenation of biomass-derived levulinic acid to γ valerolactone via the magnetic heating of a Ru nanocatalyst. Green chemistry. [Online ed.]. Apr. 2022, vol. 24, no. 7, str. 2788-2794, ilustr. ISSN 1463-9270. https://pubs.rsc.org/en/content/articlelanding/2022/gc/d2gc00102k, DOI: 10.1039/D2GC00102K. [COBISS.SI-ID 101040387], [