UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Bio-slikanje**
Course title:	**Bioimaging**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Nanoznanosti in nanotehnologies, 3. stopnja	Bioznanosti	1	1
Nanoscience and Nanotechnologies, 3rd cycle	Biosciences	1	1

Vrsta predmeta / Course type	Izbirni / Elective
Univerzitetna koda predmeta / University course code:	NANO3-789

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Druge oblike Other	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. C. J. F. Van Noorden

Jeziki / Languages:	**Predavanja / Lectures:**	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 osnovna znanja biokemije, biologije in še posebej celične biologije in histologije.	Completed Bologna second cycle study program or an equivalent pre-Bologna university study program. Basic knowledge of biochemistry, biology and specifically cell biology and histology is needed.

Vsebina predmeta:

Predmet Bio-slikanje bo predstavlja nove revolucionarne dosežke na področju slikanja od nivoja ne-invazivnih metod v živalih, 4D posnetkov v živih celicah in tkivih (organoidih) do mikroskopije in nanoskopije. Kako pomembne so te tehnike, dokazujeta dve Nobelovi nagradi, podeljeni s tega področja v letih 2008 in 2014. Ti izsledki so postavili celično in tkivno biologijo v popolnoma nove dimenzije. Pri tem predmetu bodo obravnavani različni nivoji bio-slikanja:

- Ne-invazivne metode v živih živalih
- Slikanje celic, organoidov in tkiv in vitro
- Konfokalna mikroskopija

Content (Syllabus outline):

The course Bioimaging deals with the revolutionary new developments in bioimaging from the level of non-invasive imaging in live animals, 4D imaging of live cells and tissues (organoids) down to microscopy and nanoscopy. The Nobel prizes for the developments of fluorescent proteins in cell biology in 2008 and for nanoscopy in 2014 demonstrate the importance of the techniques. They have given cell and tissue biology completely new dimensions. In the course, the various approaches in bioimaging will be learned:

- Non-invasive imaging in live animals
- 3D histochemistry and imaging of tissues

- Fluorescenca proti absorbanci
- In situ hibridizacija, imunohistokemija in metabolno mapiranje z encimsko histokemijo
- Transmisijska in vrstična elektronska mikroskopija
- Kombinirana svetlobna in elektronska mikroskopija (CLEM1)
- 4D (čas in prostor) slikanje živih celic s kontrolirano ekspozicijsko mikroskopijo (CLEM2)
- Nanoskopija (super resolucija) s STED in PALM
- Slikovna citometrija in analiza slike
- Pretočna citometrija in celično sortiranje

- Imaging of cells, organoids and tissues in vitro
- Confocal microscopy
- Fluorescence versus absorbance microscopy
- In situ hybridization, immunohistochemistry
- and metabolic mapping
- Transmission and scanning electron microscopy
- Combined light and electron microscopy
- 4D (time and space) imaging of live cells with spatially-controlled illumination microscopy
- Light-sheet microscopy
- Nanoscopy (superresolution) with STED and PALM
- Image cytometry and image analysis
- Flow cytometry and cell sorting

Temeljna literatura in viri / Readings:

- Alberts B et al (2015) Chapter 9: Visualizing Cells in Molecular Biology of the Cell (6th edn) Garland Science, New York, pp 529-564.
- Molenaar RJ et al (2017) Metabolic mapping: Quantitative enzyme cytochemistry and histochemistry to determine activity of dehydrogenases in cells and tissues. J Vis Exp e56843
- Chieco P et al (2013) Image cytometry: protocols for 2D and 3D quantification in microscopic images. Progr Histochem Cytochem 47:211-233
- Krishnaswami V et al (2016) Spatially-controlled illumination microscopy. Quart Rev Biophys 49:e19
- Azaripour A et al (2016) A survey of clearing techniques for 3D imaging of tissues with special reference to connective tissue. Progr Histochem Cytochem 51:9-23
- Azaripour A et al (2018) Three-dimensional histochemistry and imaging of human gingiva. Sci Rep 8:1647

Cilji in kompetence:

Cilj predmeta je dati študentom praktičen in teoretičen vpogled in pregled tehnik in metodologij slikanja, ki so danes na voljo za slikanje celic, tkiv in organov v najbolj naravnih razmerah.

Vpogled in pregled ustvarjata podlago, da izberejo prave tehnike slikanja v svoji nadaljnji karieri pri uporabnih ali temeljnih raziskavah.

Objectives and competences:

The aim of the course is to give students practical and theoretical insight and overview of the imaging techniques and methodologies that are available these days to image cells, tissues and organs in the most true-to-nature conditions possible.

The insights and overview creates a basis for the students to select the right imaging techniques in their further career in applied or fundamental research.

Predvideni študijski rezultati:

Študentje, ki bodo uspešno zaključili ta predmet, bodo pridobili:

- Teoretično in praktično razumevanje tehnik in metodologij bio-slikanja.
- Sposobnost izbire ustrezne biomedicinske tehnike

Intended learning outcomes:

The students successfully completing this course will acquire:

- Theoretical and practical understanding of bioimaging techniques and methodologies.
- The ability to select the right bioimaging

ali metodologije za reševanje znanstvenega problema. • Sposobnost uporabe tehnik in metodologij za veljavno in pravilno pridobitev zanesljivih podatkov.	technique or methodology to tackle a scientific problem. • The ability to apply techniques and methodologies validly and correctly in order to obtain reliable data.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• Pridobljena teoretična in praktična znanja študent pridobi v izbranih predavanjih in konzultacijah • Možno je tudi vključevanje v eksperimentalno raziskovanje v laboratorijih	• The theoretical and practical knowledge is acquired in selective lectures, tutorials and consultations. • Students can also perform experimental scientific research.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ustni zagovor	70 %	Oral presentations
Sodelovanje pri pripravah člankov ali seminarske naloge	30 %	Writing essays

Reference nosilca / Lecturer's references:

- Molenaar RJ, Van Noorden CJF, Type 2 diabetes and cancer as redox diseases? Lancet 2014;384:853
- Molenaar RJ, Botman D, Smits MA, Hira VV, van Lith SA, Stap J, Henneman P, Khurshed M, Lenting K, Mul AN, Dimitrakopoulou D, van Drunen CM, Hoebe RA, Radivoyevitch T, Wilmink JW, Maciejewski JP, Vandertop WP, Leenders WP, Bleeker FE, Van Noorden CJ, Radioprotection of IDH1-Mutated Cancer Cells by the IDH1-Mutant Inhibitor AGI-5198. Cancer Res 2015;75:4790-4802
- Hira VVV, Van Noorden CJF, Carraway HE, Maciejewski JP, Molenaar RJ, Novel therapeutic strategies to target leukemic cells that hijack compartmentalized continuous hematopoietic stem cell niches. Biochim Biophys Acta 2017;1868:183-198
- Krishnaswami V, Van Noorden CJF, Manders EMM, Hoebe RA, Spatially-controlled illumination microscopy. Quart Rev Biophys 2016;49:e19
- Van der Wijk AE, Vogels IMC, Van Noorden CJF, Klaassen I, Schlingemann RO, TNFa-induced disruption of the blood-retinal barrier in vitro is regulated by intracellular 3',5'-cyclic adenosine monophosphate levels. Invest Ophthalmol Vis Sci 2017;58:3496-3505