

# BIOANALIZNA KEMIJA

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Bioanalizna kemija
<b>Course title:</b>	BIOANALYTICAL CHEMISTRY
<b>Članica nosilka/UL Member:</b>	UL FKKT

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

<b>Univerzitetna koda predmeta/University course code:</b>	0100721
<b>Koda učne enote na članici/UL Member course code:</b>	BI2T04

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	30	15 LV			75	5

**Nosilec predmeta/Lecturer:** prof. dr. Helena Prosen

**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:

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

### Prerequisites:

The course has to be assigned to the student.

### Vsebina:

Inštrumentacija in analizni pristopi za analizo bioloških sistemov:  
- teoretske osnove in praktične izvedbe inštrumentacije za analizo bioloških sistemov (elektroforezne tehnike: conska elektroforeza, izoelektrično fokusiranje, kapilarna elektroforeza, eno- in dvodimenzionalna gelska elektroforeza; kromatografske tehnike: izključitvena/gelska, afinitetna, ionsko-izmenjalna kromatografija; spektroskopske tehnike: spektrometrične, fluorescenčne, luminiscenčne metode; masna spektrometrija: ionizacije - elektrorazprševanje, MALDI, DIOS; masni analizatorji - kvadrupol, ionska past, čas preleta, orbitrap; načini fragmentacije in snemanja produktnih ionov v tandemski MS; elektrokemijske tehnike:

### Content (Syllabus outline):

Instrumentation and analytical approaches for the analysis of biological systems:  
- theoretical basis and practical instrumental solutions for the analysis of biological systems (electrophoresis: zone electrophoresis, isoelectric focusing, capillary electrophoresis, one- and two-dimensional gel electrophoresis; chromatography: size-exclusion/gel, affinity, ion-exchange chromatography; spectroscopy: spectrometric, fluorescence, luminiscence methods; mass spectrometry: ionizations - electrospray, MALDI, DIOS; mass analyzers - quadrupole, ion trap, time of flight, orbitrap; types of fragmentation and product ion scan in tandem MS; electrochemistry: amperometry, potentiometry, conductometry; other: radioactivity measurement)

<p>amperometrija, potenciometrija, konduktometrija; drugo: merjenje radioaktivnega sevanja)</p> <ul style="list-style-type: none"> <li>- spoznavanje teorije in praktičnih izvedb postopkov za izolacijo in ločevanje spojin iz bioloških sistemov (ekstrakcija, preparativna elektroforetska in kromatografska separacija.</li> <li>- imunski testi / immunoassay (na principu protiteles, ligandov, radioizotopov, fluoroforjev, kemiluminiscence, encimov)</li> </ul> <p>Aplikacije, prednosti in omejitve analiznih metod za določanje različnih spojin v bioloških sistemih:</p> <ul style="list-style-type: none"> <li>- določanje zdravil in drugih eksogenih biološko aktivnih spojin</li> <li>- aplikacije imunskih testov</li> <li>- biosenzorji (amperometrični, potenciometrični, optično-fluorescenčni, piezoelektrični, encimski termistorji...)</li> <li>- uporaba masne spektrometrije za analizo bioloških makromolekul (kvalitativna in kvantitativna proteomika, določanje strukture proteinov in peptidov ter PTM, genomika in sekvenciranje oligonukleotidov, glikomika, lipidomika, kompleksomika, metabolomika in metabonomika, biomarkerji in diagnostika bolezni, določitev mikroorganizmov)</li> </ul> <p>Validacija bioanaliznih metod.</p>	<ul style="list-style-type: none"> <li>- theory and practical approaches to isolation and separation of compounds from biological systems (extraction, preparative electrophoretic and chromatographic separation)</li> <li>- immunoassays (on the basis of antibodies, ligands, radioisotopes, fluorophores, chemiluminiscence, enzymes)</li> </ul> <p>Applications, advantages and limitations of analytical methods for the determination of different compounds in biological systems:</p> <ul style="list-style-type: none"> <li>- determination of drugs and other exogenous biologically active compounds</li> <li>- applications of immunoassay</li> <li>- biosensors (amperometric, potentiometric, optical-fluorescent, piezoelectric, enzyme thermistors...)</li> <li>- application of mass spectrometry to analysis of biological macromolecules (qualitative and quantitative proteomics, determination of protein and peptide structure, PTM, genomics and oligonucleotide sequencing, glycomics, lipidomics, complexomics, metabolomics and metabonomics, biomarkers and disease diagnostics, determination of microorganisms)</li> </ul> <p>Validation of bioanalytical methods.</p>
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### Temeljna literatura in viri/Readings:

Bioanalytical Chemistry, S.R. Mikkelsen, E. Corton, Wiley (2004) 361 str. (50 %)  
 Mass Spectrometry for Biotechnology, G. Siuzdak, Academic Press (1996) 161 str. (30 %)  
 Mass Spectrometry, Principles and Applications (nekatera poglavja), E. de Hoffmann, V. Stroobant, Wiley, 2. izd. (2001) 407 str. (20 %)

### Dopolnilna literatura:

Mass Spectrometry, A Foundation Course, K. Downard, RSC (2004) 210 str.  
 Practical Organic Mass Spectrometry, J.R. Chapman, Wiley, 2. izd. (1993) 330 str.  
 Primarna literatura (znanstveni članki) / primary literature (scientific articles)

### Cilji in kompetence:

ki se uporabljajo v analitiki bioloških sistemov. Študentje naj bi spoznali prednosti in pomanjkljivosti posameznih pristopov, primerjali rezultate, pridobljene z njimi, in jih kritično vrednotili. Pridobili naj bi zmožnost samostojne izbire in uporabe primerne analize pristopa za reševanje specifičnih problemov.

Študentje si pri predmetu pridobijo naslednje specifične kompetence:

- zmožnost izbire najprimernejšega analiznega pristopa za reševanje specifičnih raziskovalnih problemov
- zmožnost poiskati v razpoložljivi primarni in sekundarni literaturi problemu primerno analizo metodo/postopek

### Objectives and competences:

Objective of the course is to gain knowledge of modern analytical techniques used in the analytics of biological systems. Students should get to know the advantages and disadvantages of different approaches, compare the obtained results and critically evaluate them. They should gain the ability to autonomously select and apply an appropriate analytical method to solve a specific problem.

Students acquire the following specific competences during the course:

- ability to select the most appropriate analytical approach to solve a specific research problem
- ability to find an appropriate analytical method/procedure for the respective problem in the available primary and secondary literature
- skill to implement the existing analytical methods to their specific research problem

<ul style="list-style-type: none"> <li>- usposobljenost za implementacijo obstoječih analiznih metod na svoje specifične raziskovalne probleme</li> <li>- kritično vrednotenje rezultatov, dobljenih z apliciranimi metodami/postopki</li> <li>- usposobljenost za pisanje poročil, kritično vrednotenje in interpretacijo eksperimentalnih rezultatov</li> <li>- usposobljenost za vodenje bioanaliznega laboratorija</li> </ul>	<ul style="list-style-type: none"> <li>- critical evaluation of the results obtained by the applied methods/procedures</li> <li>- skills for report writing, critical evaluation and interpretation of experimental results</li> <li>- skills and ability to run a bioanalytical laboratory</li> </ul>
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### Predvideni študijski rezultati:

<p><b>Znanje in razumevanje</b> Študent pozna osnove delovanja inštrumentov in teoretične osnove postopkov, ki se uporabljajo v bioanalizni kemiji. Razume prednosti in omejitve posameznih tehnik. Ve, kaj lahko vpliva na analizni postopek, pozna vire motenj in napak.</p> <p><b>Uporaba</b> Študent zna izbrati ustrezeni analizni pristop za reševanje specifičnega problema in prirediti obstoječe postopke nanj. Zna rokovati z enostavnejšimi analiznimi inštrumenti. Zna uporabljati imunske teste.</p> <p><b>Refleksija</b> Študent bo interpretiral, kritično vrednotil vsebino ter pred kolegi predstavil lastno razumevanje člankov iz znanstvenih publikacij. Pri tem bo uporabil pridobljena teoretična znanja ter jih vrednotil s predstavljenimi praktičnimi problemi oziroma izkušnjami.</p> <p><b>Prenosljive spretnosti</b> Uporaba domačih in tujih primarnih in sekundarnih literaturnih virov. Znanje, kako zbrati in interpretirati podatke. Ustno in pisno poročanje in interpretacija rezultatov. Identifikacija in reševanje problemov in virov napak. Kritična analiza in sinteza rezultatov, pisanje člankov.</p>
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### Intended learning outcomes:

<p><b>Knowledge and Comprehension</b> Student knows the fundamentals of instrumental operation and theoretical basis of the procedures used in analytical chemistry. Understands the advantages and limitations of different techniques. Knows the factors which can influence the analytical procedure, knows the sources of interference and error.</p> <p><b>Application</b> Student is able to select an appropriate analytical approach to solve a specific problem and apply the existing procedures to it. Is able to operate simple analytical instruments. Is able to use immunoassay.</p> <p><b>Analysis</b> Student will interpret, critically evaluate the contents and present their understanding of the scientific articles to their peers. They will use the acquired theoretical knowledge and evaluate it with the presented practical problems or experience.</p> <p><b>Skill-transference Ability</b> Use of domestic and foreign primary and secondary literature sources. Knowledge of data collection and interpretation. Oral and written reporting and interpretation of the results. Identification and solving of problems and error sources. Critical analysis and synthesis of results, manuscript preparation.</p>
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### Metode poučevanja in učenja:

Predavanja, seminarji, laboratorijske vaje.
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### Learning and teaching methods:

Lectures, seminar coursework, laboratory work.
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### Načini ocenjevanja:

Opravljen laboratorijske vaje in seminarska naloga so pogoj za pristop k pisnemu izpitu. Seminarska naloga Pisni izpit Ocene: 6-10 (pozitivno), 1-5 (negativno)
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### Delež/Weight

### Assessment:

Concluded laboratory work and seminar coursework are prerequisites for the written exam. Seminar coursework Written exam Grades: 6-10 (positive), 1-5 (negative)
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### Reference nosilca/Lecturer's references:

<ol style="list-style-type: none"> <li>1. T. Verovšek, A. Šuštarčič, M. Laimou-Geraniou, I. Krizman Matasić, <b>H. Prosen</b>, T. Eleršek, V. Kramarič Zidar, V. Mislej, B. Mišmaš, M. Stražar, M. Levstek, B. Cimrmančič, S. Lukšič, N. Uranjek, T. Kozlovič-Bobič, T. Kosjek, D. Kocman, D. J. Heath, E. Heath. Removal of residues of psychoactive substances during wastewater treatment, their occurrence in receiving river waters and environmental risk assessment. Science of the total environment 2023, 866, 161257.</li> <li>2. G. Koželj, <b>H. Prosen</b>. Thermal (in)stability of atropine and scopolamine in the GC-MS inlet. Toxics 2021, 9(7), 156.</li> </ol>
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3. K. Lampič, J. Trontelj, **H. Prosen**, D. Drobne, A. Šmid, T. Vovk. Determination of 6-thioguanine and 6-methylmercaptopurine in dried blood spots using liquid chromatography-tandem mass spectrometry: method development, validation and clinical application. *Clinica chimica acta* 2019, 499, 24-33.

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