

2026/2027

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Fizikalna farmacija
Course title:	Physical Pharmacy

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Farmacija, 2. stopnja		2.	4.
Pharmacy, 2. level		2.	4.

Vrsta predmeta / Course type: obvezni/obligatory

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
30		45			105	6

Nosilec predmeta / Lecturer: Ao. Univ.-Prof. Dr.phil.nat. Andreas Zimmer, MPharm

Jeziki / Languages: Predavanja / Lectures: slovenski/slovene
Vaje / Tutorial: slovenski/slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: Prerequisites:

/

Vsebina:	Content (Syllabus outline):
<p><u>Medmolekularne sile</u> Sile med molekulami, stanja snovi: plinsko stanje, tekoče stanje, trdno stanje, tekoči kristali</p> <p><u>Termodinamika v farmaciji</u> Termodinamsko ravnovesje in ničti zakon termodinamike. Prvi zakon termodinamike. Reverzibilnost termodinamskih procesov. Izohorni, izobarni, izotermni in adiabatni proces. Drugi zakon termodinamike in entropija. Tretji zakon termodinamike. Termodinamski potenciali.</p> <p><u>Fazni prehodi</u> Fazno ravnovesje, Claius-Clapeyronova enačba, fazno pravilo, fazni diagrami.</p> <p><u>Določanje fizikalnih lastnosti molekul</u> Atomski in molekularni spektri, UV VIS spektrofotometrija, fluorescenca in fosforescenca, električni dipol, polarne molekule, dielektričnost, IR spektrometrija, refraktometrija.</p>	<p><u>Molecular forces</u> Intermolecular forces, states of matter: the gaseous state, the liquid state, the solid state, liquid crystals.</p> <p>Thermodynamics in pharmacy Thermodynamic equilibrium and zeroth law of thermodynamics. First law of thermodynamics. Reversibility of thermodynamic processes. Isochoric, isobaric, isothermal and adiabatic processes. Second law of thermodynamics and entropy. Third law of thermodynamics. Thermodynamic potentials.</p> <p>Phase transitions Phase equilibria, Clausius Clapeyron equation, phase rule, phase diagrams.</p> <p>Determination of physical properties of molecules Atomic and molecular spectra, UV VIS spectrophotometry, fluorescence and phosphorescence, electric dipole, polar molecules, dielectric constant and induced polarization, IR spectrometry, refractive index and molar refraction.</p>

2026/2027

Neelektrolitske raztopine

Idealne raztopine, realne raztopine, Raoultov in Henryev zakon. Koligativne lastnosti neelektrolitskih raztopin.

Elektrolitske raztopine

Elektroliza, ionska transportna števila, električna prevodnost elektrolitskih raztopin, koligativne lastnosti elektrolitskih raztopin.

Difuzija

Fickovi zakoni difuzije in difuzijska enačba. Difuzija snovi preko membrane, difuzija snovi prek več zaporednih slojev. Opis eksperimentalnih metod za študij difuzije. Biološka difuzija, difuzijski transport zdravila v okolici membrane in sproščanje zdravila.

Kemijska kinetika

Hitrost reakcije, hitrostna konstanta reakcije, red reakcije. Primeri obravnave reakcij različnih redov. Encimske reakcije in Michaelis-Mentenova kinetika. Encimske reakcije z upoštevanjem prisotnosti encimskega inhibitorja. Vpliv temperature na hitrost reakcij, vpliv medija na hitrost reakcij. Kinetični opis interakcije med zdravilom proteinom. Stabilnost zdravil.

Osnove biofarmaceutike

Obravnava osnovnih procesov v tkivih in organih, ki kontrolirajo absorpcijo in dispozicijo zdravil. Absorpcija, distribucija, metabolizem, ekskrecija (ADME).

Osnove farmakokinetike

Obravnava osnovnih modelov raztapljanja in sproščanja zdravil: kinetika ničtega in prvega reda, Higuchiev model in različni primeri uporabe Higuchievega modela. Obravnava osnovnih farmakokinetičnih modelov in parametrov (eno in dvo shrambni model) in povezava z biofarmaceutiko.

Nonelectrolytes

Ideal solutions, real solutions, Raoult's and Henry's law. Colligative properties of nonelectrolytes.

Electrolyte solutions

Electrolysis, ion transport numbers, electric conductance of electrolyte solutions, colligative properties of electrolyte solutions.

Diffusion

Fick's laws of diffusion and diffusion equation, Diffusion through membranes, multilayer diffusion. Experimental methods for assessing drug diffusion. Biological diffusion, transport of a drug across a membrane and drug release.

Chemical kinetics

Velocity of a reaction, kinetic parameters, order of reactions. Mathematical models of chemical reactions of different orders. Enzyme reactions and Michaelis-Menten kinetics. Enzyme kinetics with inhibition. The effect of temperature on kinetic parameters and reaction velocity, the effect of medium on reaction velocity. Kinetic model of drug-protein interaction. Stability of drugs.

Basics of biopharmaceutics

Qualitative description of basic processes in tissues and organs that control drug absorption and disposition. Absorption, distribution, metabolism, excretion (ADME).

Basics of pharmacokinetics

Introduction to basic models that describe drug dissolution and release: kinetics of zero and first order, Higuchi model and different examples of its application. Introduction to basic one and two compartment pharmacokinetic models and their connection with biopharmaceutics.

Temeljni literatura in viri / Readings:

TEMELJNA LITERATURA:

1. Sinko P.J., Martin's Physical Pharmacy and Pharmaceutical Sciences, 8th edition, Lippincott Williams & Wilkins, 2023.
2. G. K. Jain, Theory and Practice of Physical Pharmacy 1st (ali kasnejša), Elsevier, 2021.

Cilji in kompetence:

Objectives and competences:

2026/2027

Seznani študente z uporabo znanj (bio)fizike, fizikalne kemije in kemije v farmaciji. Cilj je osvojiti znanja, ki so ključna za razumevanje nekaterih farmacevtsko-tehnoloških procesov pri načrtovanju novih izdelkov. Cilj je tudi osvojiti osnovna znanja, ki so potrebna za razumevanje procesov ob interakciji zdravilne učinkovine z biološkim okoljem.

To acquaint students with the knowledge of (bio) physics, physical chemistry and chemistry in various pharmaceutical systems and formulations. The purpose is to understand some of the key pharmaceutical and technological processes that underlie the design of new products. The goal is also to acquire the basic knowledge necessary to understand the processes involved in interaction of drugs with the biological environment.

Predvideni študijski rezultati:

Znanje in razumevanje:

Študent se usposobi uporabljati znanja z različnih področij (bio) fizike, fizikalne kemije in kemije pri študiju farmacevtskih sistemov in procesov. Študentje osvajajo kvantitativne fizikalno-matematične pristope in metode reševanja problemov. Študentje se usposobijo za samostojno reševanje zahtevnejših problemov s področja fizikalne farmacije. Poudarek je na celostnem pristopu reševanja problemov, pri čemer se študentje usposobijo probleme prepoznati, analizirati, ustrezno fizikalno formulirati ter predlagati in poiskati uporabno in praktično rešitev.

Prenosljive spretnosti – niso vezane le na en predmet:

Pridobljena znanja so uporabna tudi pri ostalih predmetih in v vsakdanjem življenju pri razlagi mnogih naravnih pojavov. Študent se usposobi za analizo in reševanje širšega spektra farmacevtskih problemov z uporabo fizikalnih zakonitosti in matematičnih orodij. Usposobijo se zbirati in smiselno urejati podatke ter interpretirati rezultate in o svojih zaključkih poročati.

Intended learning outcomes:

Knowledge and understanding:

Students are able to apply the knowledge from different fields of (bio)physics, physical chemistry and chemistry to analyse and study pharmaceutical systems and processes. Students are able to solve advanced problems of physical pharmacy. The emphasis is on an integral approach in which students become able to recognise problems, analyse and appropriately formulate problems as well as to propose and find practical solutions to problems by using quantitative mathematical-physical concepts and methods.

Transferable Skills - not limited to one subject:

The knowledge obtained is transferable to other fields of pharmacy as well as to everyday life in explaining many natural phenomena. Students are trained and qualified to analyse and solve a wide range of pharmaceutical problems by using physical laws and mathematical tools. They are also trained to collect and meaningfully organize data, interpret the calculation results and report on their conclusions.

Metode poučevanja in učenja:

Predavanja
Računske vaje

Learning and teaching methods:

Lectures
Tutorials

Načini ocenjevanja:

**Delež (v %) / Assessment:
Weight (in %)**

Način (pisni izpit, ustno izpraševanje, naloge, projekt)

Type (examination, oral, coursework, project):

2026/2027

<ul style="list-style-type: none"> • računski izpit • pisni izpit <p>ŠTUDIJSKE OBVEZNOSTI ŠTUDENTOV</p> <ul style="list-style-type: none"> • 80 % prisotnost na vajah. <p>POGOJ ZA PRISTOP K IZPITU</p> <ul style="list-style-type: none"> • Opravljene vaje so pogoj za pristop h računskemu izpitu. • Opravljen računski izpit je pogoj za pristop k pisnemu izpitu. 	<p>40 %</p> <p>60 %</p>	<ul style="list-style-type: none"> • calculation exam • written exam <p>STUDY OBLIGATIONS OF STUDENTS</p> <ul style="list-style-type: none"> • 80 % attendance at tutorials <p>CONDITIONS FOR TAKING THE EXAM</p> <ul style="list-style-type: none"> • Completed tutorials are mandatory for approaching the calculation exam. • Successful completion of the calculation exam is mandatory to approach the written exam.
---	-------------------------	--

Reference nosilca / Lecturer's references:

ANDREAS ZIMMER:

1. Fresacher-Scheiber, K., Ruseska, I., Siboni, H., Reiser, M., Falsone, F., Grill, L., & Zimmer, A. (2022). Modified Stability of microRNA-Loaded Nanoparticles. *Pharmaceutics*, 14(9). <https://doi.org/10.3390/pharmaceutics14091829>
2. Schertel, S., Salar-Behzadi, S., Karrer, J., Laggner, P., & Zimmer, A. (2021). Impact of polysorbate 65 on tripalmitin crystal growth and release stability of hot melt coated multiparticulate systems. *Int J Pharm*, 607, 120970. <https://doi.org/10.1016/j.ijpharm.2021.120970>
3. Tucak-Smajic, A., Ruseska, I., Letofsky-Papst, I., Vranic, E., & Zimmer, A. (2023). Development and Characterization of Cationic Nanostructured Lipid Carriers as Drug Delivery Systems for miRNA-27a. *Pharmaceutics (Basel)*, 16(7). <https://doi.org/10.3390/ph16071007>