

COURSE DESCRIPTION

Academic year: 2026/2027	
University: Comenius University Bratislava	
Faculty: Faculty of Pharmacy	
Course ID: FaF.KFANF/16-Mgr-A/26	Course title: Analytical monitoring of drug levels in practice
Educational activities: Type of activities: lecture / laboratory practicals Number of hours: per week: 2 / 1 per level/semester: 28 / 14 Form of the course: on-site learning	
Number of credits: 3	
Recommended semester: 5.	
Educational level: I.II.	
Prerequisites:	
Course requirements: Obligatory subject. The condition for recognition of laboratory practice is the completion of all practical tasks with a sufficient number of points - at least 60%. The elaborated protocol from the exercise is evaluated. To successfully complete the exercises from the subject, it is necessary to obtain at least 60% of the sum of points from individual exercises, while an unrecognized exercise is evaluated 0%. The exam will take place in writing - by test. To pass the exam, you must obtain at least 60% of the possible points. The final grade is the arithmetic average of the score from the exercises and exams, the minimum value is 60%. An A rating corresponds to obtaining at least 92% of the maximum number of points, B – 84%, C – 76%, D – 68%, E – 60%, Fx less than 60%. Scale of assessment (preliminary/final): 50/50	
Learning outcomes: Reliable identification and quantification of drugs in biological systems are essential steps to understand the mechanisms of their action in a living organism. Drug concentration levels are an important indicator of the therapeutic process at the molecular level, usable in optimizing the treatment management of individual patients. Therapeutic drug monitoring (TDM) is recommended and performed for (i) drugs with a narrow therapeutic range, (ii) drugs with a well-defined relationship between drug concentration and effect (therapeutic or toxic), (iii) drugs with large inter- or intra-individual differences in drug distribution or clearance. Integral components of TDM are (I) collection and processing of biological material, (II) development, validation and application of analytical methods, and (III) processing and interpretation of analysis results. Interpretation of TDM results requires adequate knowledge of the pharmacokinetics and pharmacodynamics of the monitored drugs and their association with the patient's clinical data. Thus, for the successful implementation of TDM in clinical practice, it is necessary to combine theoretical knowledge and practical aspects of methods of clinical analysis and clinical pharmacology. In a broader context, monitoring of biologically active substance concentrations is also carried out in the areas of disease diagnosis, toxicology, doping control, forensic analysis and other practical areas. When screening endogenous and exogenous substances in biological systems, emphasis is placed on basic methodological and practical aspects of metabolomics, lipidomics, genomics/transcriptomics, and proteomics. The graduate of the course will gain knowledge related to the development and application of analytical methods and	

procedures usable in solving the tasks of the above areas of pharmaceutical practice.

Class syllabus:

Introduction to TDM

- Definition of the term “therapeutic drug monitoring”
- Importance of TDM in clinical practice (current state of the field)
- Analytical aspects in TDM
- Pharmacological aspects in TDM

Groups of Drugs Subject to Therapeutic Monitoring

- Drugs with a narrow therapeutic index
- Drugs with a well-defined relationship between drug concentration and effect (therapeutic or toxic)
- Drugs with large inter- or intra-individual differences in distribution or clearance
- Classification of drug groups (by pharmacological effect)
 - Antibiotics with nephrotoxic and ototoxic effects (aminoglycosides: amikacin, gentamicin, netilmicin, tobramycin; polypeptide antibiotic vancomycin)
 - Cardiovascular drugs (cardiac glycosides: digoxin; antiarrhythmics: quinidine)
 - Antiepileptics (carbamazepine, ethosuximide, phenobarbital, phenytoin, primidone, valproic acid)
 - Tricyclic antidepressants (amitriptyline, imipramine, clomipramine)
 - Antiasthmatics (theophylline)
 - Immunosuppressants (cyclosporin A, tacrolimus, azathioprine, 6-mercaptopurine, 6-thioguanine)
 - Cytostatics (methotrexate)

Monitoring Biologically Active Compounds in the Preclinical Phase

- New molecules as potential drugs
- In vitro and in vivo tests
- ADME-Tox screening
- Animal models
- Statistical data analysis

Medical Laboratories in the TDM Process

- Laboratory accreditation and its significance
- Legislation in the area of accreditation
- Quality management, validation
- Good Laboratory Practice

Interpretation of TDM Results

- Interpretation of serum drug concentrations in the context of all clinical data (related areas: pharmacokinetics and pharmacodynamics)
- Factors affecting drug concentrations
- Practical aspects of interpretation
- Use of therapeutic drug monitoring data
 - Therapy optimization (dose adjustment, streamlining therapy, reducing toxicity risk) — pharmacokinetic software and calculators
 - Patient adherence
 - Reducing treatment costs

Analytical aspects of genomics and transcriptomics

- DNA/RNA analysis — sequence, variants, expression, isoforms, epigenetic marks
- Targeted and untargeted analysis — panels/WES/WGS

- Sampling and sample preparation — blood/plasma (cfDNA/cfRNA), tissues (fresh/FFPE); stabilization, extraction, QC (RIN/DIN, A260/280)
- Analytical techniques — qPCR/dPCR, NGS (short/long reads), DNA microarrays, RNA-seq, CE, blotting
- Method validation
- Practical aspects — liquid biopsy/MRD, pharmacogenomics, pathogen detection, prenatal screening
- # Analytical aspects of proteomics
 - Protein/peptide analysis — sequence, PTMs, conformation, complexes
 - Targeted and untargeted analysis
 - Sampling and sample preparation — plasma, serum, CSF, urine, saliva, tissues; denaturation, cleanup, fractionation (SCX, HILIC...)
 - Analytical techniques — LC (SEC, IEC), LC-MS, MALDI-TOF, electrophoresis (SDS-PAGE, IEF), CE-MS, immunoassays, NMR, CD, X-ray crystallography; top-down, bottom-up, middle-up approaches
 - Method validation
 - Practical aspects — TDM (biologics), protein biomarkers
- # Analytical aspects of metabolomics
 - Analysis of small molecules — endogenous compounds, drugs, metabolites
 - Targeted and untargeted analysis — quantification of known compounds vs. discovery of unknowns
 - Sampling and sample preparation — plasma/serum, urine, CSF, saliva, DBS, tissues, stool; quenching, protein precipitation, LLE/SPE, derivatization (GC)
 - Analytical techniques — LC-MS (RP/HILIC), GC-MS, CE-MS, NMR, ion mobility
 - Method validation
 - Practical aspects — TDM (small molecules), PK/PD studies, disease biomarkers, toxicology
- # Analytical aspects of lipidomics
 - Analysis of lipids — glycerophospholipids, sphingolipids, glycerolipids, sterols, fatty acids; lipid mediators (eicosanoids)
 - Targeted and untargeted analysis — mediator panels vs. global lipid profiling
 - Sampling and sample preparation — plasma/serum, DBS, tissues; antioxidants, extraction; class-specific internal standards
 - Analytical techniques — LC-MS, direct MS (“shotgun”), GC-MS, ion mobility — isomer resolution
 - Method validation
 - Practical aspects — risk of cardiovascular events (ceramide score), inflammatory mediators, liver disease, neurodegeneration
- # Anti-doping, Toxicology, and Forensic Analysis
 - Monitoring concentrations of biologically active compounds for toxicological, anti-doping, and forensic analysis
 - Toxic and banned substances (doping, narcotic and psychotropic substances, poisonings) and drugs administered without a physician’s approval (self-medication)
 - Commercial pharmaceuticals (e.g., β 2-agonists)
 - Experimental drugs (e.g., SARMs)
- # Application Areas — Worked Examples and Case Studies
 - TDM of monoclonal antibodies and thiopurines to optimize therapy in patients with inflammatory bowel diseases
 - TDM of antiepileptics to optimize therapy in patients with epilepsy
 - TDM of antibiotics to optimize the efficacy and safety of antibiotic therapy

- Monitoring concentrations of banned substances (clenbuterol, SARMS) in connection with anti-doping control

Recommended literature:

- Mikuš, P., Maráková, K.: HYPHENATED ELECTROPHORETIC TECHNIQUES IN ADVANCED ANALYSIS, Bratislava, KARTPRINT, 2012. 217 p.
- Mikuš, P., Hanko, M., Piešťanský, J., Maráková, K., Dokupilová, S., Mikulová, M.: Analytical chemistry: Instrumental analysis. Bratislava : VEDA, in preparation.
- Dasgupta A. Therapeutic Drug Monitoring Newer Drugs and Biomarkers, 1st Edition. Academic Press 2012.
- Stove, C. New Sampling Strategies in Toxicology and Therapeutic Drug Monitoring, Future Science Ltd, 2015.
- Samanidou, V, Karageorgou, E. Drug Monitoring by Hplc : Recent Developments Nova Science Publishers, Incorporated 2010.
- Scientific publications registered in the Web of Science database: keywords: Mikus (author), Comenius (Address), amino acids, biogenic amines, thiopurines (Topic)

Languages necessary to complete the course:

english language

Notes:

Past grade distribution

Total number of evaluated students: 0

A	ABS	B	C	D	E	FX
0,0	0,0	0,0	0,0	0,0	0,0	0,0

Lecturers:

Mgr. Michal Hanko, PhD., RNDr. Jana Havlíková, PhD., MSc., PharmDr. Zuzana Kiliánová, PhD., PharmDr. Michal Kolorz, PhD., PharmDr. Andrej Kováč, PhD., Ing. Jana Pašková, PharmDr. Kristián Slíž, PhD.

Last change: 04.09.2026

Approved by: prof. RNDr. Peter Mikuš, PhD.