2024/2025. ACADEMIC YEAR

PROGRAM OF STUDY (FOR STUDENTS OF 3RD YEAR)

Full (Hun) name of the subject: Gyógyszerkémia és analízis II.

Program: Undivided program (pharmaceutical)

Schedule: full-time

Short name of the subject:

English name of the subject: Pharmaceutical Chemistry and Analysis II.

German name of the subject: Pharmazeutische Chemie und Analytik II

Type of registration: obligatory/obligatory elective/elective/criteria requirement

Neptun code of the subject: GYKGYK279E2A

Responsible Department:

Responsible tutor **Dr. György Tibor Balogh** **Contact information: Semmelweis University, Department of Pharmaceutical Chemistry** 1092 Budapest, Hőgyes Endre u. 9**.** - **phone:** 06-1-217-0891 - **email:** balogh.gyorgy.tibor@semmelweis.hu	**Title, academic degree:** Head of department, DSc, PhD, dr. habil
Name of the persons responsible for the teaching of the subject: Dr. György Tibor Balogh Dr. Péter Horváth Dr. Károly Mazák Dr. Márta Kraszni Dr. Gergő Tóth Dr. Arash Mirzahosseini Dr. Ádám Golcs Dr. Tamás Pálla Dr. Réka Angi Dr. Vivien Bárdos Dr. Balázs Simon Dr. Rita Szolláth Anna Vincze	**Title, academic degree:** Head, full professor, PhD Associate professor, PhD Associate professor, PhD Associate professor, PhD Associate professor, PhD Adjunct, PhD Adjunct, PhD Adjunct, PhD Adjunct, PhD Assistant professor Assistant professor Assistant professor Assistant professor
Class per week: 4 lectures 4 practices	**Credit point(s):** 7

Professional content, intent of acquirement and it's function in order to implement the goals of the program:

Integration of the curriculum of various chemical and biological courses and extension with specific chemical knowledge regarding properties, mechanism of action and analytics of drug substances.

Short description of the subject:

Theory: Synthesis, analytics, physicochemical and chemical properties, structure-activity relationships, receptor binding and biochemical background of biological effects of drug substances and related instrumental methods are taught.

Practice: Teaching the analytical, physico-chemical and chemical properties of drugs and their testing methods.

Course data							
Recommended term	**Contact hours (lecture)**	**Contact hours (practice)**	**Contact hours (seminar)**	**Individual lectures**	**Total number of contact hours/semester**	**Normal course offer**	**Consultations**
6	56	56			112	Autumn semester* Spring semester Both semesters *(* Please underline)*	

Program of semester**

Topics of theoretical classes (pro week):

1. Cardiovascular drugs: Cardiac glycosides. Chemistry, analytics of cardiac glycosides, sugars
   Cardiovascular drugs: antiarrhythmic agents
2. Cardiovascular drugs: antianginal agents
   Cardiovascular drugs: antihypertensive agents
3. Cardiovascular drugs: antihyperlipidemic agents
   Cardiovascular drugs: anticoagulants
4. Diuretics
   Antidiabetics
5. Vitamins I.
   Vitamins II.
6. Antihistamines
   Corticosteroids
7. Sexual hormones
   Disinfectants
8. Chemotherapeutics: sulfonamides
9. Chemotherapeutics: antimalarial drugs, fluoroquinolones
   Chemotherapeutics: antituberculotics, antifungal agents
10. Antibiotics: tetracyclines, aminoglycosides
    Antibiotics: β-lactams, macrolides
11. Antiviral drugs
    Anticancer drugs
12. New approaches in drug therapy (biologics) I
    New approaches in drug therapy (small molecules) II
13. Drugs acting on the thyroid gland
    Analysis of medicinal products I.
14. Analysis of medicinal products II. (Instrumental)
    Consultation

Topics of practical classes (pro week):

1 EQUIPPING, IDENTIFICATION
2 DIGITALIS GLYCOSIDES, SUGARS
3 β-RECEPTOR BLOCKERS, ANTIANGINAL DRUGS
4 ANTIHYPERTENSIVE AGENTS, ANTICOAGULANTS
5 DIURETICS
6 VITAMINS; PROJECT REPORT 1
7 ANTIHISTAMINS
8 STEROID HORMONES
9 DISINFECTANTS and CHEMOTHERAPEUTICS I.
10 CHEMOTHERAPEUTICS II. and ANTIBIOTICS; PROJECT REPORT 2
11 IDENTIFICATION AND QUANTITATIVE DETERMINATION OF DRUG MIXTURES
12 AAS spectroscopy of metal content of drugs, excipients; PROJECT REPORT 3
(theoretical part of the practical final exam)
13 PRACTICAL FINAL EXAM; RETAKE 3 (theoretical part of the practical final exam) before starting the practical part
14 SUBSTITUTIONAL PRACTICE, DESEQUIPPING

Other subjects (both compulsory and optional) relating to the transversal issues of the subject. Possible overlaps between subjects:

Schedule of consultations:

Course requirements

Prerequisites: Pharmaceutical Chemistry and Analysis I.

Conditions of attending the classes, amount of acceptable absents, way of presentation of leave, opportunity for makeup:
Based on the Study and Examination Regulation

The grading method; the conditions for getting the signature; the number, topic(s) and date(s) of the mid-term assessments, (reports, term tests), and the process in which they contribute to the final grade; and the possibility of their retake or their upgrading retake (as provided in §§ 25-28 of the STUDY AND EXAMINATION REGULATIONS):

Project reports on weeks 6; 10 and 12; (Possibility of substitutions/retakes according to the thematic plan issued at the beginning of the semester.)
The average of the project report papers written during the semester counts for 1/3 of the exam mark, while the result of the final exam counts for 2/3.

The final exam consists of two parts, a written and an oral part. An oral examination may be taken if the written examination is passed with at least 50%.

The average of the marks obtained in the project reports during the semester counts for 1/3 of the examination mark and the marks obtained in the two oral examination topics count for 1/3-1/3 of the examination mark, but both topics must be at least satisfactory.

Requirements of signature (as provided for in STUDY AND EXAMINATION REGULATIONS § 29):
Attendance of lectures. (Extent of the absence is based on the Study and Exam Regulation)
Attendance of practices. (Extent of the absence is based on the Study and Exam Regulation)
The average of the scheduled project reports is at least 2 without rounding.
The required minimum amount of points during practices is accumulated.
If the result of the 12th week practical examination is unsatisfactory, the signature of the semester will be refused. (Retake is possible on week 13)
In week 13, the practical assignment grade must be at least 50%.

Number and type of projects students have to perform independently during the semester and their deadlines:

Type of the semester-end examination: signature*/practical grade*/ comprehensive examination*/final/end-term examination*

* Please underline

Examination requirements: (list of topics, test examination topics, mandatory parameters, diagrams, concepts, list of calculations, practical skills, and project tasks recognised as examinations, criteria for completion and assessment):

First topic: pharmacological groups

1/1 Sedato-hypnotics and anxiolytics. Classification. Representatives of barbituric acid derivatives and benzodiazepines. Structure, chemical and physical characteristics, structure-activity relationships.
Structures: chloral hydrate, chlorobutanol, phenobarbital, thiopental, nitrazepam, diazepam, chlordiazepoxide, midazolam, alprazolam
1/2 Main groups of major analgetics. Morphine and its semi-synthetic and synthetic derivatives. Main representatives of agonist and antagonist derivatives. Structure, chemical, physical and pharmacological characteristics.
Structures: morphine, codeine, ethylmorphine, dihydrocodeine, oxycodone, naloxone, naltrexone, dextrometorphan, fentanyl, methadone, tramadol
1/3 Minor analgetics and non-steroid anti-inflammatory agents. Classification and structural characterization. Chemical and physical characteristics.
Structures: salicylic acid, sodium salicylate, acetylsalicylic acid, paracetamol, phenazone, metamizole sodium, niflumic acid, diclofenac, indometacin, ibuprofen, naproxen, phenylbutazone, piroxicam, celecoxib, nimesulide
1/4 Antipsychotics. Classification. Phenothiazines and related compounds. Major representatives of atypical antipsychotic agents. Structure, chemical and physical characteristics, structure-activity relationships.
Structures: chlorpromazine, levomepromazine, fluphenazine, fluphenazine decanoate, chlorprothixene, flupentixol, sulpiride, clozapine,
1/5 Antidepressive agents. Classification. In more detail about the tricyclic compounds and SSRI drugs. Structure, chemical and physical characteristics, structure-activity relationships.
Structures: imipramine, amitriptyline, maprotiline, fluoxetine, sertraline
1/6 Representatives of parasympathomimetic and parasympatholytic drugs. Structure, chemical and physical characteristics and their interactions with the receptor.
Structures: acetylcholine, carbachol, pilocarpine, physostigmine, atropine, hyoscine (=scopolamine), homatropine, homatropine methylbromide, ipratropium, tiotropium
1/7 Sympathomimetic drugs and their major representatives. Selective $ß_2$-agonists, as brochodilators. Structure, chemical and physical characteristics and their relationship with the activity.
Structures: noradrenaline, adrenaline, isoprenaline, terbutaline, phenylephrine, ephedrine, naphazoline
1/8 Local anaesthetics, classification, major representatives. Structure, chemical and physical characteristics, structure-activity relationships.
Structures: cocaine, benzocaine, procaine, tetracaine, lidocaine, mepivacaine, ropivacaine, bupivacaine, articaine
1/9 Cardiac glycosides, structure and properties of main representatives. Mechanism of action.
Structures: digitoxin, digoxin, deslanoside, lanatoside C, gitoxin
1/10 Antihypertensive agents. Classification. In more detail about the ACE-inhibitors. Structure, chemical and physical characteristics. Criteria of the receptor-binding.
Structures: captopril, enalapril, lisinopril, ramipril, quinapril, losartan
1/11 Classification of antiarrhythmic agents, their main representatives. Chemical properties, structure-activity relationship.
Structures: quinidine, procainamide, lidocaine, mexiletine, propafenone, propranolol, metoprolol, bisoprolol
1/12 Antianginal drugs. Main representatives of nitrites and nitrates. General structure of 1,4-dihydropyridines, some representatives. Structure, chemical and physical properties.
Structures: amyl nitrite, glyceryl trinitrate, isosorbide mononitrate, nifedipine, nitrendipine, amlodipine

1/13 Antihyperlipidemic agents, classification. Phenoxy-isobutyric acid derivatives, structures, properties. General structure of natural statins, pharmacophore group, properties. Synthetic statins with example.
Structures: clofibrate, ciprofibrate, lovastatin, fluvastatin
1/14 Cardiovascular agents. Anticoagulants. Vitamin K antagonists, structures, properties, analysis. Heparin, structure, properties.
Structures: warfarin, acenocoumarol, glucosamine, glucuronic acid, iduronic acid, acetylsalicylic acid, ticlopidine, clopidogrel
1/15 Diuretics. Classification. Saluretics and loop diuretics in detail. Structures, properties, mechanism of action, analysis.
Structures: hydrochlorothiazide, chlorthalidone, indapamide, etacrynic acid, furosemide
1/16 Antidiabetics. Insulin and analogs: structure and properties. Orally administered antidiabetics, chemical groups with examples.
Structures: gliclazide, nateglinide, metformin, vildagliptin
1/17 Vitamins. Structure of A- and D-vitamins, chemical and physical characteristics. Structure of vitamin B_1, B_2, B_6 and C. Chemical and physical characteristics.
Structures: retinol, retinol acetate, cholecalciferol, calcitriol, thiamine, riboflavin, pyridoxine, ascorbic acid
1/18 Classification of steroid hormones. Main representatives of corticosteroids. Chemical and physical characteristics.
Structures: cortisone, hydrocortisone, prednisone, prednisolone, triamcinolone, dexamethasone, betamethasone, hydrocortisone acetate, triamcinolone acetonide, fluocinolone acetonide, budesonide
1/19 Classification of sex hormones. Estrogens and antiestrogens in detail. Structures, properties, structure-activity relationships, analysis.
Structures: estrone, estradiol, estriol, ethinylestradiol, diethylstilbestrol, tamoxifen
1/20 Antihistamines, classification and their major representatives. Structure, chemical and physical characteristics. New generation non-sedative drugs.
Structures: histamine, diphenhydramine, dimetindene, hydroxyzine, promethazine, cetirizine, loratadine, desloratadine, cimetidine
1/21 Classification of chemotherapeutic drugs. China-alkaloids and synthetic fluoroquinolones. Structure, chemical and physical characteristics.
Structures: quinine, ciprofloxacin, norfloxacin, ofloxacin, levofloxacin
1/22 Classification of sulfonamides. Structural elements of antibacterial sulfonamides. Chemical, physical and pharmacological properties.
Structures: sulfacetamide, sulfadimidine, sulfaguanidine (+some samples from other pharmacological groups)
1/23 General structure of b-lactam antibiotics, classification and major representatives. Reactivity, physical and chemical characteristics.
Structures: benzylpenicillin, ampicillin, amoxicillin, sultamicillin, clavulanic acid, sulbactam, cefalexin, cefaclor
1/24 Tetracycline-type antibiotics. Structure of main representatives, chemical and physical properties. General structure of aminoglycoside antibiotics with the example of streptomycin.
Structures: tetracycline, oxytetracycline, doxycycline, streptomycin
1/25 Antifungal drugs, classification and major representatives. 14α-demethylase-inhibitors in detail. Main structural elements of membrane-damaging polyene antibiotics (e.g. nystatin), their mechanism of action.
Structures: bifonazole, clotrimazole, miconazole, fluconazole
1/26 Strategies used in cancer therapy, grouping of agents used. Details of chemotherapy and targeted therapy options.
(Cross-linking /covalent- noncovalent/, alkylation, typical structures of topoisomerase inhibiting antibiotics, characterisation of antimetabolites, main grouping of kinase inhibitors, their mechanism of action)
Structures. cyclophosphamide, cisplatin, fluorouracil,

Second topic: general part

2/1 Distinction of inorganic and organic compounds. Preliminary investigations: burning test; dissolution test. Identification reactions of cations (aluminium; zinc; calcium; magnesium; potassium).

2/2 Distinction of inorganic and organic compounds. Preliminary investigations: burning test; dissolution test. Identification reactions of anions (chloride; bromide; iodide; phosphate).
2/3 Distinction of inorganic and organic compounds. Preliminary investigations: burning test; dissolution test. Identification reactions of functional groups in Ph. Eur. (aromatic primary amines; phenols; quaternary amines).
2/4 The role of lipophilicity in the transport of drugs. Definition and determination methods of the log*P* value.
2/5 Solubility parameters and their characterization. Relationship between solubility and pH. Possibilities of increasing solubility. Methods for determining solubility. (Kinetic and thermodynamic solubility, excipients)
2/6 Basicity of drugs and bio-molecules in terms of macro- and microconstants. Calculation of the pH-dependent concentration of the various macro- and microforms. Determination of the protonation constants of bases and dissociation constants of acids. Calculation of the pH-dependent number of bound hydrogen ions and the charge of the molecule.
2/7 Thermodynamic and structural preconditions of drug-receptor interactions. Complementarity and bioisosteric substitutions. Bonding types and energies of drug-receptor interactions.
2/8 Theory and practice of the impurity tests in the Ph. Eur. (heavy metals, iron, chlorides).
2/9 Theory and practice of the impurity tests in the Ph. Eur. (arsenic, potassium, ammonium, sulphates).
2/10Theory and practice of the impurity tests in the Ph. Eur. (calcium, magnesium, phosphates).
2/11 Appearance of solution (clarity and degree of opalescence, colour of liquids). The practice of the pH measurement in the Ph. Eur. Examples for the application of the potentiometric titrations in the Ph. Eur.
2/12 Special aspects in the qualitative and quantitative analysis of drug preparations.
2/13 Determination of organic bases and salts of organic bases. Examples. (see 1/3; 1/15)
2/14 Determination of organic acids. Examples.
2/15 UV and VIS spectrophotometry in the pharmaceutical analysis. Principles (chromophore; auxochrome groups; shifts in spectrum; pH-dependence; Lambert-Beer law; quantitative measurement of a single component, ratio method).
2/16 Classification of chromatographic methods. Theory and practice of thin-layer chromatography. Application in drug analysis. System suitability test.
2/17 Classification of chromatographic methods. Theory and practice of high performance liquid chromatography. Main chromatographic parameters. Application in drug analysis.
2/18 Stages and system of drug research. Trends in drug research.Finding new chemical entities by fragment based research, biologics.
2/19 Analysis of major analgetics (morphine, codeine, ethylmorphine, papaverine).
2/20 Analysis of minor analgetics (salicylic acid, acetylsalicylic acid, paracetamol, phenazone, aminophenazone, metamizole sodium).
2/21 Analysis of xanthine derivatives (caffeine, theophylline, theobromine).
2/22 Identification and distinction of sugars (glucose, fructose, lactose, sucrose).
2/23 Analysis of local anaesthetics (benzocaine, procaine, tetracaine, lidocaine).

Form of the semester-end examination: written*/oral*/**combinated examination**/practical examination/the assessment of completing project work (according to STUDY AND EXAMINATION REGULATIONS 30.§)* *(* Please underline)*

The possibility and conditions for offering grades:

A list of the basic notes, textbooks, resources and literature that can be used to acquire the knowledge necessary to master the curriculum and to complete the assessments, ****with exact description about which of them is required to acquire which part of the syllabus (e.g. description based on topics)), as well as the main technical and other aids and study aids that can be used:
Theoretical and practical material uploaded to Moodle system.
Lecture notes
Foye's Principles of medicinal chemistry

In the case of a subject lasting more than one semester, the position of the teaching/research department on the possibility of parallel enrolment and the conditions for admission**:** yes*/**<u>no*</u>**/on and individual assesment basis* *(* Please underline)*
The course description was prepared by: Dr. Péter Horváth

***** A tantárgy tematikáját oly módon kell meghatározni, hogy az lehetővé tegye más intézményben a kreditelismerési döntéshozatalt, tartalmazza a megszerzendő ismeretek, elsajátítandó alkalmazási (rész)készségek, (rész)kompetenciák és attitűdök leírását, reflektálva a szak képzési és kimeneti követelményeire.***