Interdisciplinary Doctoral Programme

in

Biomedicine

Ljubljana, 2013

INTRODUCTION

The field of biomedicine encompasses knowledge from the areas of biochemistry and molecular biology, pharmacy, clinical biochemistry and laboratory biomedicine, medicine, microbiology, toxicology, genetics and veterinary medicine. The need for a high-quality and up-to-date doctoral programme to acquire suitable knowledge in these areas is dictated by rapid and extensive development in these various scientific fields, as well as their impact on the quality of life. Due to previous good experiences and the advantages of an interdisciplinary approach to existing postgraduate studies, the doctoral study of biomedicine is organised at university level. The field of biomedicine is very broad and is being developed at the first two educational levels by various faculty members at the University of Ljubljana. It seems reasonable to link the third educational level (doctoral studies) in terms of organisation and content. This approach also enables the collaboration of teachers and researchers from separate scientific fields, thus forming a broader interdisciplinary field. The connections of university research with research institutes is also achieved.

The Interdisciplinary Doctoral Programme in Biomedicine replaces the previous four-year university scientific postgraduate study established at the University of Ljubljana in 1999 as the first postgraduate programme organised at university level. The restructuring of the programme was dictated by many reasons, two major ones being implementation of the Bologna Declaration in the Republic of Slovenia and new state legislation which separates doctoral programmes from masters programmes.

The primary emphasis of doctoral study is on research, interdisciplinarity and collaboration between internationally renowned local and foreign experts. Based on recommendations of the European University Association (EUA), international student exchange is also foreseen. As the end result of the research work, the publishing of at least one scientific article is expected. Special emphasis is placed on a productive relation between the doctoral candidates and their mentors. Students can choose mentors from amongst internationally recognised and established experts in compliance with the rules of the University of Ljubljana and collaborating faculties.

1. The programme

The duration of the Interdisciplinary Doctoral Programme in Biomedicine is three years (180 ECTS credits), and according to the Bologna guidelines this represents the third cycle of the educational scheme. The programme has been conceived in agreement with all the requirements and legislation of the Republic of Slovenia and meets all criteria for doctoral study established by the EUA. In this way, the direct inclusion of programme components in an international exchange with universities from other countries using the ECTS system is rendered possible.

Biomedicine combines knowledge from the fields of biochemistry and molecular biology, pharmacy, genetics, clinical biochemistry and laboratory biomedicine, clinical, primary and social medicine, microbiology, toxicology and veterinarian medicine.

The programme consists of organised classes (60 credits) and individual research work for the doctoral thesis (120 credits).

The programme leads to the degree of Doctor of Science in the following fields:

- Biochemistry and Molecular Biology
- Pharmacy
- Genetics
- Clinical Biochemistry and Laboratory Biomedicine
- Basic Medicine
- Clinical Medicine
- Microbiology
- Social Medicine
- Toxicology
- Veterinary Medicine

The programme is organised by the University of Ljubljana through its faculties and three Slovene research institutes.

- Biotechnical Faculty
- Faculty of Pharmacy
- Faculty of Chemistry and Chemical Technology
- Faculty of Medicine
- Veterinary Faculty
- The Jožef Stefan Institute
- The Chemical Institute
- The National Institute of Biology

All previous postgraduate programmes offered by Faculty of Pharmacy, Faculty of Medicine and Veterinary Faculty are joined together in the Doctoral Programme in Biomedicine. The Biotechnical Faculty and the Faculty of Chemistry and Chemical Technology contributed parts of their previous programmes connected with biomedicine. The research institutes contribute teachers who take part in organised courses, mentors and the research infrastructure for executing the experimental part of doctoral work.

2. Basic programme goals and general competence

The basic goal of the Interdisciplinary Doctoral Programme in Biomedicine is to further educate highly qualified experts in the scientific fields that constitute the area of biomedicine. The programme is interdisciplinary and encompasses biochemistry and molecular biology, pharmacy, genetics, clinical biochemistry and laboratory biomedicine, clinical, basic and social medicine, microbiology, toxicology and veterinary medicine.

The programme goal is to qualify future doctors for scientific thinking and problem-solving with an interdisciplinary approach.

After the completion of their studies the new doctoral graduates will be qualified for creative and independent scientific research work and dealing with the scientific problems of future employers. They will acquire the ability of understanding, critically judging and solving complex scientific-research issues. They will be qualified for creative and independent research, for the critical assessment of research results, the development of new research methods and the transfer of new research methods and knowledge into practice.

3. Expected number of doctoral candidates

The total number of enrolled candidates will be 140.

4. Admission requirements and criteria for selection

4.1. Admission requirements

For admission to the Interdisciplinary Doctoral Programme in Biomedicine graduates of the following programmes are invited:

- Second cycle study programmes in biomedicine, biotechnology, natural science and mathematics;
- Study programmes providing education for occupations regulated by Directives of the European Union (93/16/EEC for doctors, 78/1027/EEC for veterinarians, 78/687/EEC for dentists and 85/432/EEC for pharmacists) evaluated with at least 300 credits;
- Study programmes leading to specialisation, provided that candidates have previously completed a higher education professional study programme in biomedicine, biotechnology, natural sciences or mathematics. The Biomedicine Programme Council will specify additional entry requirements for candidates in individual areas amounting from 30 to 60 credits;
- Study programmes leading to a master of science or to specialisation after completing a university study programme in biomedicine, biotechnology, natural science and mathematics. 60 credits of study obligations will be recognised to such candidates;
- Academic study programmes in disciplines related to biomedicine, biotechnology, natural sciences and mathematics.

Candidates with foreign qualifications are required to apply for recognition of their entry qualifications. Applications should be submitted at the same time as applications to the programme, but separately submitted to the Univerza v Ljubljani, Kongresni trg 12, Ljubljana, Slovenija.

4.2. Criteria for selection of candidates

The selection of candidates is particularly at issue when the number of candidates significantly exceeds the number of places offered. Selection will be primarily based on the candidate's level of achievement in previous studies.

The main criteria for selection are based upon:
- achived grades
- graduation work (diploma)
- research article(s)
- student scientific awards
- professional specialisation or degrees from other high level programmes

4.3. Mentoring

Prior to the enrolment to the programme candidates are requested to choose the mentor who will agree to supervise their research work.
List of potencial mentors and their respective fields of research are available at: http://www.uni-lj.si/studij_na_univerzi/podiplomski_studij/univerzitetni_interdisciplinarni_studijski_programi/biomedicina.aspx .

5. Recognition of knowledge and skills acquired before admission to the programme

Knowledge and skills acquired through formal and informal learning, and experience before entry will be recognised and evaluated by the Programme Council in accordance with criteria for the accreditation of study programmes.

In recognising respective knowledge and skills, the following are considered:
- professional specialisation
- a second degree from an undergraduate programme
- previous scientific research work
- published scientific work
- previous professional experience

6. Requirements for progression through the programme

The requirement for progression from the first to the second year of doctoral study is the fulfillment of all study obligations in the selected courses. Successful completion of at least 45 credits, of which at least 20 credits must derive from obligatory basic courses, is required. Candidates who have fulfilled all organised study obligations in the first and second year are permitted to enter the third year of doctoral study.

7. Conditions for completing the programme and the doctoral degree

7.1. Doctoral thesis

The registration of topic, the nomination of an academic advisors – mentors, as well as the nomination of an expert committee for evaluation of a doctoral thesis and graduation

committee, are in the domain of coordinating faculty senates. The Senate of the University of Ljubljana approves of the topic of the doctoral thesis and the proposed academic advisor(s).

7.2. Conditions for completing the programme

The condition for completing the programme of study and acquiring a doctoral degree is the successful completion of all study obligations defined by the programme and the successful defence of the doctoral thesis. The doctoral candidate must publish at least one scientific article based on the research presented in the doctoral thesis in a scientific journal indexed by the SCI or SSCI. The article with the candidate's name listed as first author must be published or accepted for publication prior to the defence of the doctoral thesis.

7.3. Doctoral diploma

After fulfillment of all study requirements the doctoral diploma, jointly signed by the Rector of the University of Ljubljana and the dean of the responsible faculty, is awarded to the candidates. Doctoral diploma is awarded by the Rector of the University of Ljubljana. Graduates of the Interdisciplinary Doctoral Programme in Biomedicine receive the title »Doctor of Science«.

8. Transfer between study programmes

Transfer between programmes is possible if candidates fulfil the access requirements of the programme. Applications for transfer of such candidates to Interdisciplinary Doctoral Programme in Biomedicine will be treated individually by the Programme Council in accordance with the University Statute.

9. Grading system

According to the programme, exams will be written and oral. In accoirdance with the Statue of Universitiy of Ljubljana examnination results are graded from 1 to 10, wherevy positive pass grades range form 6 to 10 Preparation and oral presentations of seminars are also graded. The examinations in doctoral programs may also be graded as not passed, passed and passed with honors.

10. Career Prospects

The possibilities for employment of doctoral graduates from the Interdisciplinary Doctoral Programme in Biomedicine are very diverse. Future doctors of science can become employed in pedagogical and research fields as important new personnel at Slovene universities and other educational or research institutions. They can also work in health institutions as well as in other companies that perform research. They will also be employable in the pharmaceutical industry and in government administration. The employment in other institutions that employ experts with the highest educational level is also possible.

11. Programme Council

The Programme Council consists of members of each faculty and research institute. Representatives are proposed by the faculty senates and confirmed by University Senate for a period of four years. The Council is chaired by the chairman, who has a deputy. The president's mandate is four years and can be repeated. The seat of the Programme Council is at the University of Ljubljana.

12. Field coordinators

Biochemistry and Molecular Biology:
Prof Dr Ana PLEMENITAŠ, phone: 543-76 50, fax: 543-7641
e-mail: ana.plemenitas@mf.uni-lj.si
Deputy: Prof Dr Vita DOLŽAN, phone: 543-76 70,fax: 543-7641
e-mail: vita.dolzan@mf.uni-lj.si

Pharmacy:
Prof Dr Danijel KIKELJ, phone: 476-9561, fax: 425-8031
e-mail: kikeljd@ffa.uni-lj.si
Deputy: Prof Dr Mirjana Gašperlin, phone: 476-9634, fax: 425-8031
e-mail: mirjana.gasperlin@ffa.uni-lj.si

Genetics:
Prof Dr Simon HORVAT, phone: 320-3917, fax: 724-1005
e-mail: simon.horvat@bf.uni-lj.si
Deputy: Prof Dr Branka JAVORNIK, phone: 320-3260, fax: 423-1088
e-mail: branka.javornik@bf.uni-lj.si

Clinical Biochemistry and Laboratory Biomedicine:
Prof Dr Janja MARC, phone: 476-9600, fax: 425-8031
e-mail: marcj@ffa.uni-lj.si
Deputy: Prof Dr Darko ČERNE, phone: 476-9644, fax: 425-8031
e-mail: darko.cerne@ffa.uni-lj.si

Clinical Medicine:
Prof Dr Lovro STANOVNIK, phone: 543-7337
e-mail: lovro.stanovnik@mf.uni-lj.si
Deputy: Prof Dr Žarko FINDERLE, phone: 543-7512
e-mail: finderle@mf.uni-lj.si

Basic Medicine:
Prof Dr Kristijan JEZERNIK, phone: 543-7682
e-mail: kristijan.jezernik@mf.uni-lj.si
Deputy: Prof Dr Marko ŽIVIN, phone: 543-7058
e-mail: marko.zivin@mf.uni-lj.si

Microbiology:
Prof Dr Srečko KOREN, phone: 543-74-02
e-mail: srecko.koren@mf.uni-lj.si
Deputy: Prof Dr Gorazd AVGUŠTIN, phone: 721-78-27, fax: 722-41-00
e-mail: gorazd.avgustin@bf.uni-lj.si

Social Medicine:
Prof Dr Igor ŠVAB, phone: 438-6915
e-mail: igor.svab@mf.uni-lj.si
Deputy: Prof Dr Marjan BILBAN, phone: 585-5106, fax: 585-5101
e-mail: marjan.bilban@zvd.si

Toxicology:
Prof Dr Marija SOLLNER DOLENC, phone: 476-9572
e-mail: marija.sollner@ffa.uni-lj.si

Deputy: Prof Dr Damjana DROBNE, phone: 320-3375, fax: 257-3390
e-mail: damjana.drobne@bf.uni-lj.si

Veterinary Medicine:
Prof Dr Robert FRANGEŽ, phone: 477-9131, fax: 283-2243
e-mail: robert.frangez@vf.uni-lj.si
Deputy: Prof Dr Azra POGAČNIK, phone: 477-9118, fax: 283-2243
e-mail: azra.pogacnik@vf.uni-lj.si

13. Programme

The programme consists of organised forms of teaching and research. Organised teaching comprises of 60 credits; the remaining 120 credits are intended for research work for the doctoral thesis.

Content and structure of the programme (by year)

The structure of the programme is designed to emphasise organised study in the first year and beginning of second year, while later the emphasis is on research and the preparation of the doctoral thesis.

First year:
- obligatory core courses (the student's obligation consists of active participation in classes, preparing seminars and other obligations (30 credits))
- individual research work (30 credits)
Total = 60 credits

Second year:
- elective courses (15 credits)
- presentation of the theme of the doctoral thesis; this requirement can be satisfied by presenting suitable scientific publications (5 credits)
- individual research work (40 credits)
Total = 60 credits

In the second year, the doctoral candidate chooses elective courses (15 credits). The candidate's selection of courses must be approved by the mentor and the coordinator of the specific scientific field. Part of these credits may be earned at foreign universities. With the mentor's approval, 10 percent of the programme credits may be obtained in other doctoral programmes offered by the University of Ljubljana or other universities.

Third year:
- individual research work (50 credits)
- presentation of the doctoral thesis prior to public presentation; this requirement can be satisfied by presenting suitable scientific publications (5 credits)
- preparation of the doctoral thesis and public defence (5 credits)
Total = 60 credits

The focus of the third year is research work, and preparation and defence of the doctoral thesis.

14. Links to other study programmes

The Interdisciplinary Doctoral Programme in Biomedicine is both horizontally and vertically linked to other study programmes at the University of Ljubljana. Horizontal exchange enables students to fulfill their elective course requirements from other graduate study programmes at the University of Ljubljana in agreement with their mentors and course lecturers. The vertical link is inherent in the very design of the study programme through its syllabus and the possibilities of choosing different courses. Furthermore, it is possible to exchange study courses with other comparable programmes taught at other universities. The quality and comparability of courses must be evaluated by the Programme Council. International exchange takes place on the basis of international contracts and bilateral agreements.

International exchange is also possible through collaboration in mobility programmes for students and professors (ERASMUS, SOCRATES, CEEPUS and others). The programme is also open to foreign students.

15. Course presentation

The programme is composed of three types of courses:

- obligatory core courses
- elective theoretical courses
- elective individual research courses

The doctoral candidates, together with their mentors and the field coordinators, design individual study programmes by selecting courses from obligatory and both types of elective course pools. The obligatory core courses are modular. For each scientific field a choice of at least 20 credits is needed from the obligatory core modules proposed by the respective scientific fields, while the remaining 10 credits can be chosen from modules of other obligatory core courses. Remaining credits can be obtained from the selection of various elective courses. Elective credits can also be selected from the university pool of generic skills courses, listed at the web page of the University of Ljubljana.

15. 1. Obligatory core courses

Obligatory core courses are designed for each specific scientific field. The content of courses is chosen on the basis of the research work of the professors.

Each scientific field proposed at least one obligatory core course, which is as a rule constructed from modules. The selection of modules is made in agreement with the mentor and the field coordinator.

Obligatory core courses

Code	Scientific field	Course title
B-1-100	Biochemistry and Molecular Biology	Selected advanced topics in biochemistry and molecular biology
F-1-200	Pharmacy	Molecular basis of medicinal chemistry
F-1-220	Pharmacy	Molecular biopharmaceutics and pharmacokinetics
F-1-210	Pharmacy	Pharmaceutical technological

		operations and dosage forms
G-1-600	Genetics	Genetics
L-1-300	Clinical Biochemistry and Laboratory Biomedicine	Clinical biochemical diagnostics – algorithms and interpretation
J-1-400	Basic Medicine	Medical cell biology
K-1-500	Clinical Medicine	Research in clinical medicine
M-1-410	Microbiology	Microbiology
S-1-420	Social Medicine	Scientific aspects of public health
T-1-230	Toxicology	Toxicology
V-1-700	Veterinary Medicine	Regulation of processes in healthy and sick animals
V -1-710	Veterinary Medicine	Health suitability of foods

15. 2. Short presentation of core courses

Code: B-1-100
Course title: Selected advanced topics in biochemistry and molecular biology (30 ECTS)

Contents:
The course consists of three modules, each equivalent to 10 ECTS credits. Students can take the course as a whole or individual modules.
Module 1: *Selected metabolic processes with regulatory mechanisms;experimental approaches*
Topics: metabolism of xenobiotics; mitochondrial biogenesis; energy metabolism in mammals; structure and functional assimetry of biological membranes (membrane microdomains – lipid rafts); protein interactions with membranes; signal transduction.
Module 2: *Structure and function of biological molecules*
Topics in molecular immunology and proteolysis: molecular recognition in the system of innate immunity; recognition of molecular patterns connected with pathogenic microorganisms; structure determination of complexes between proteases and their endogenous or synthetic inhibitors; techniques of protein engineering and molecular modeling of proteins for prediction of their function.
Module 3: *Functional genomics and proteomics*
Topics dealing with genome structure, organization and regulation, complex polygenic features and comparative genomics will be considered. The following principles of global genomic analysis will be discussed: global genomic maps, physical mapping, global cytogenomics, EST maping and identification, positional cloning and the concept of QTL. Theoretical principles and experimental approaches in the studies of transgenesis, transcriptomics, proteomics, metabolomics, interactomics and bioinformatics will be presented in details.

Code: F-1-200
Course title: Molecular basis of medicinal chemistry

Contents:
The course introduces students to the fundamental laws of molecular interactions and molecular dynamics in biological systems, physical-chemical properties and drug-like properties, the computational and other systematic approaches in medicinal chemistry

(virtual screening, fragment-based drug design, scaffold hopping, analogue-based drug design), mimetic approaches in medicinal chemistry, prediction of ADMET properties, and to complete overview of drug targets and methods of drug design unique to each target. The course is divided into three modules each with 10 ECTS. Students can attend the subject as a whole (30 ECTS) or separately by modules (each 10 ECTS).

Module 1: *Drug structure and their properties*

Complex systems and interactions: drug-organism, drug-target, target specificity, selectivity. Intermolecular interaction forces.Molecular properties, molecular descriptors, molecular fields, functional groups, computing techniques, techniques of molecular property design. Molecular conformational space, molecular mechanics, molecular dynamics. Radical reactions in biological systems, free radicals, antioxidants. Drug chirality. Physical and chemical properties of drugs relevant to the biological environment of the organism (acidity, basicity, polarity, hydrophilicity, lipophilicity).

Drug-like properties. Chemical space as a source of new drugs.

Module 2: *Drug structure and biological activity*

Lead compound, multiple ligands, prodrugs. Drug structure and molecular recognition, self-assembly, aggregation, artificial receptors. Pharmacophore, SAR, binding specificity and selectivity, non-specific interactions. Drug structure and transport properties, metabolic transformations, toxicological properties, ADMET prediction. Peptidomimetics and mimetic concepts in drug design. Virtual screening, fragment-based drug design, bioisosteric replacements, scaffold hopping, analogue-based drug design.

Module 3: *Drugs and their targets*

Drug-target interactions. Receptors, signal transduction, recent examples of receptor agonists/antagonists design. Enzymes as drug targets, enzyme kinetics, recent examples of enzyme inhibitors. Ion channels as drug targets. Agents affecting the structured components of the cell (DNA, tubular system) and the ordered membrane structure. Industrial view of drug design. An example of antibacterial agents. Molecular modelling of drug-target interaction, prediction of biological effect.

NMR spectroscopy in drug design, X-ray crystallography, homologue models.

Code: F-1-210

Course title: Pharmaceutical technological operations and dosage forms

Contents:

The aim of the course is to give the students a deeper knowledge about new materials, technologic procedures and dosage forms and to stress the importance of developing new environmental friendly technologies. During the course students are informed about quality assurance of medicinal products taking into account the latest scientific achievements and regulatory demands. The course is divided in three modules, each equivalent to 10 ECTS credits.

Module 1: *Pharmaceutical-technological operations*

Theoretical background of pharmaceutical dosage forms as multiphase and multicomponent systems; physical-chemical approach (adhesion, cohesion, surface energy etc); technological procedures (mixing, compression of solid materials, procedures with supercritical fluids, filtration, emulsification, suspending process, sterilization, lyophilization, neuronal networks); safe work and development of environmental friendly technologies.

Module 2: *Pharmaceutical dosage forms*

Advanced up to date knowledge on formulation, design and evaluation of modified release solid dosage forms, dermatics, sterile dosage forms, dosage forms for inhalation, phytopharmaceutics, radiopharmaceutics; new excipients regarding selection, physical-chemical and technological characteristics and usage (i.e. polymers, superporous desintegrantors, bioenhancers etc).

Module 3: *New drug delivery systems*

New delivery systems e.g. liposomes, nanoparticles, polymeric micelles, microemulsions etc.

for peptide and protein drugs, antigens and gene fragments; specific procedure for their preparation, physical characterization, chemical stability assays and biological assays.

Code: F-1-220
Course title: Molecular biopharmaceutics and pharmacokinetics

Contents:
The course is divided in three 10 credit modules. Students can take the complete course (30 KT) or individual modules.
Module 1: *Role and importance of pharmacokinetic studies in drug discovery and development*
Preclinical pharmacokinetic studies; clinical pharmacokinetic studies; allometric scaling; bioavailability and bioequivalence studies; principles for small and large molecules; regulatory issues; role and importance of analytical methods in pharmacokinetic studies.
Module 2: *LADME processes*
Dissolution, absorption, distribution, presystemic and systemic metabolism, elimination of drugs; mechanisms and kinetics of processes; physico-chemical and biological parameters which influence these processes; experimental and theoretical models for studying LADME processes; biopharmaceutical classification system: solubility and permeability of drugs; in-vitro/in-vivo correlation: statistical and mathematical models.
Module 3: *Pharmacokinetic analysis*
Linear and non-linear models; compartmental and physiologically based models; pharmacokinetic – pharmacodynamic models; design of drug delivery systems; influence of demographic, clinical-biochemical and genetic factors on drug pharmacokinetics; individualization of drug dosing regimens; population pharmacokinetics; artificial intelligence methods in pharmacokinetics.

Code: G-1-600
Course title : Genetics

Contents:
The course encompasses genetic concepts and genetic strategies for understanding functions of genes that affect biological processes; it deals with model organisms and bioinformatics tools for studying genetic principles. It is divided into three modules, each equivalent to 10 ESCT credits. Student take the course as a whole (30 ESCT) or individual modules.
Module 1: *Genetic concepts*
Introduction to genetic research and concepts. Forward genetics - identification of genomic regions and physical gene cloning. Reverse genetics - random and target mutagenesis and by phenocopying. Silico genomic analysis.
Module 2: *Model organisms*
The followingf model organisms will be covered: *E. coli, S. cerevisiae, N. crassa, A. thaliana, C. elegans, D. melanogaster in M. musculus.* Their main features and use in genetic analysis will be presented.
Module 3: *Bioinformatics*
High throughput methodologies in biology. Genomic projects and comparative genomics. Bioinformatics tools in proteomics, interactomics, transcriptomics, environmental genomics and farmacogenomics. Systems biology.

Code: L-1-300
Course title: Clinical biochemical diagnostics – algorithms and interpretation

Contents:
The course is organised in four modules, each equivalent to 10 ECTS credits. Two to four modules (20 to 40 credits) may bet aken as a core course, and a single module (10 credits) as an elective course.
Module 1: *Genetic basis of common diseases*
Classification of frequent genetic diseases, screening and diagnostic tests based on increased/decreased levels of toxic/normal metabolites, functional assessment of mutated proteins (enzymes) and molecular analyses of disease causing DNA sequence variations. Examples of diagnostic algorithms with interpretation of laboratory findings. Ethics in molecular diagnostics.
Module 2: *Immune-mediated diseases*
Definition of immune-mediated disease (primary, secondary, autoimmune). Basic laboratory algorithms in diagnostic evaluation of immune-mediated diseases and hypersensitivity. Directed investigation of immune system disorders. Algorithms used in differential diagnostics of some organ-specific and systemic autoimmune diseases.
Module 3*: Malignant diseases*
Role of biological molecules in mechanisms of development and progression of malignant diseases. Epidemiology of disease and application of biological molecules in diagnostics. Development, application, control and quality assurance of diagnostic assays.
Module 4: *Pharmacogenomic diagnostics*
Human genome and the role of variable DNA sequences in diagnostics. Application of pharmacogenetic tests in individualized therapy. Methodologies and relevant technologies. Direct and reverse pharmacogenomic approaches in drug design, clinical trials and basic research. Postgenomic technologies. Social, ethical, and legal aspects of pharmacogenomic applications in diagnostics.

Code: K-1-500
Course title: Research in clinical medicine

Contents:
The course consists of three 10 ECTS credit modules, organized vertically in three levels. Each module is further subdivided into thematic blocks. The student choose either one block from each module or a set of topics from the first module corresponding to 10 credits.
The field of Clinical medicine with its four thematic blocks enables doctoral studies in the subfields of Cardiovascular Medicine, Clinical neurosciences, Surgical sciences and Clinical immunology, and the field of Basic medicine science enables studies in the subfield of Cancer.

Module 1: *Methods in medical research*
The module provides basic knowledge about modern methods used commonly in biomedical research that are available at the Faculty of Medicine in Ljubljana, including general principles of biomedical research, clinical research, modern biostatistical methods in clinical research, presentation of scientific results and writing of scientific papers, selected medical measuring techniques and selected methods in medical resarch.
Module 2: *Basic science in clinical research*
This module deals with theoretical bases for research in selected medical fields. It includes six thematic blocks: physiology of cardivascular system, respiratory physiology, physiology and biomechanics of locomotor system, pharmacology, neurophysiology, and immunology. Each block is equivalent to 10 credits. The student may select either one block from this module or 10 credit module from the courses Basic medical science, Biochemistry or

Microbiology.
Module 3: *Achievements in clinical research*
This module is considered with new diagnostic, therapeutic and preventive methods in selected medical fields. Emphasis is placed on comparison of the new methods with reference one, especially with respect to predictive value. The module is intended only for physicians and dentists. It is composed of four thematic blocks, each corresopnding to 10 credits; cardiovascular clinical sciences, neurological clinical sciences, surgical sciences, and clinical imunology and allergology. The student selects one block.

Code: J-1-400
Course title: Medical cell biology

Contents:
This is an advanced course dealing with the structure and function of the cell and application of this knowledge in important medical fields, such as human reproductive biology, cancer cell biology and genetics. Is composed of a core module (Module 1) and three elective modules, each equivalent to 10 ECTS credits. All students are obliged to take the core module and one elective module either from this course or from the Biochemistry and molecular biology course.
Module 1*: Fundamentals of medical cell biology*
Cell cycle in normal and in abnormal cells (in: cancer, autoimmune dissease, aids, neurodegeneration, stroke and in aging)
Cell death – apoptosis, necrosis and autophagy
The role of cell junctions in development and in differentiated cells. Reasons and consequences for false composition and function.
The role of endoplasmic reticulum, Golgi apparatus and lysosomes in synthetic and secretory pathway in normal cell and in storage diseases.
Peroxisomes in normal cells and consequences of false functioning.
Intracellular vesicular traffic. The molecular mechanisms of exocytosis and endocytosis and their role for the normal cell functioning. Intracellular pathogens and the mechanisms for entering and leaving host cells.
Molecular mechanisms of mitochondrial functioning in healthy and in complex human disorders. The influence of the environment on mitochondrial functioning.
The cytoskeleton. Structure and the role of actin filaments, microtubules, and intermediate filaments during cell differentiation and their role in certain diseases.
Module 2: *Reproductive biology in vivo and in vitro*
Oogenesis in humans, spermatogenesis in humans, biology of oocytes, biology of spermatozoa, fertilization, development of human embryo before implantation, implantation, *in vitro* fertilization
Module 3: *Cell biology and genetics*
Characteristics of malignant cell transformation, apoptosis and cancer, stem cells and cancer, gene therapy of cancer with emphasis on delivery systems. Uniparental monosomy, cytogenetics, cytology and genetics of acute leukaemia, In situ hybridization (research of developmental processes), stem cell technology (development of novel treatment strategies).

Code: M-1-410
Course title: Microbiology

Contents:
The course deals with the structure and function of microorganisms in physiological and pathological circumstances, elucidating the complex relations among microorganisms, between microorganisms and their hosts, and between microorganisms and their natural environment. The course is divided into four modules, each evaluated with 10 credits. Students may select a single module or a combination of three modules.
Module 1: *Basic medical microbiology*
Virulent factors and pathogenetic mechanisms in microbes; fundamentals of antimicrobial chemotheraphy and vaccination; fundamentals of laboratory diagnostics of microbes; molecular epidemiology; emerging microorganisms; prions.
Module 2:*. Clinical microbiology*
Diagnostic algorithms in clinical microbiology; critical interpretation of the results of the microbiological tests; ways of solving complex diagnostic problems; errors made when ordering microbiological tests - medical and economic consequences; problems with communication between laboratory and clinical staff.
Module 3: *Microbial diversification, identification, evolution and biotechnology*
Traditional and molecular taxonomy - principles and differences in approach; principles of microbial diversification; principles and philosophical views on evolution and molecular evolution; applications of microbial biotechnology in medicine, pharmacy, food technology, agriculture, environmental protection and production of alternative sources of energy and raw materials.
Module 4: *Biochemistry, physiology and ecology of microorganisms*
Enzymatic reactions; membrane processes; toxins; processes of the regulation; enzymes; metabolism of microorganisms, response of microbial population to environmental changes; mechanisms of microbial signalling; examples of microbial differentiation; influence of microbes on the circulation of substances and energy in selected ecosystems; interaction among microorganisms, interaction between microbes and higher organisms; concept of microbial food cycle; approaches to study of activities and structure of microbial groups.

Code: S-1-420
Course title: Scientific aspects of public health

Contents:
The course consists of two modules, each equivalent to 10 ECTS credits.
Module 1: *Determinants of health and disease*
Biological basis of public health problems**;** determinants of health (life style, occupation); selected major health problems: cardiovascular diseases, cancer, mental health (with emphasis on depression and psychosocial rehabilitation of psychoses and dependencies); high risk groups.
Module 2: *Methodology of public health measures*
Health care systems and health policy; health services planning and management; quality in health care; health promotion; systems of disease prevention (vaccinations, screening, epidemiological monitoring); primary health care; rehabilitation methods.

Code: T-1-230
Course title: Toxicology

Contents:
Molecular basis of how chemicals disrupt biological targets. Influence of xenobiotics on suborganism, organism, population and ecosystem levels.
Module 1: *Relationship between structure and toxicity*
Covalent and noncovalent interaction xenobiotics with cell macromoleculs in different organisms, formation of reactive oxygen species; biotransformation reactions of xsenobiotics, influence of products on different tissues.
Module 2: *Influence of toxic compounds on processes within cell*
Transmembrane transport of xenobiotics; mechanism of necrotic and apoptotic cell death; cytokine-, receptor- and enzyme-mediated toxicity; immunotoxicity and genotoxicity of xenobiotics.
Modulu 3: *Influence of toxic compounds on environment and ecosystems*
Influence of xenobiotics at suborganism, organism, population and ecosystem levels; bioaccumulation of xenobiotics in the environment and in different species; i*n vivo* and in vitro tests for identification of xenobiotics in soil and water.

Code: V-1-700
Course title: Regulation of processes in healthy and sick animals

Contents:
The course is composed of two modules. The complete course or individual modules may be taken.
Module 1: *Regulation of basic processes in animals*
Composition of living structures; cell as organism; morphological and functional composition of animal cells; cell as carrier of heredity; transfer of hereditary information to offspring; response of cells to environmental influences; intercellular communication and regulation of genetic expression; defensive, metabolic, cititoxic and oncogenetic mechanisms of cells; in vitro investigation of cells; homeostasis and homeoresis; neural and endocrine regulation of digestion and metabolism; regulation of blood parameters; regulation of blood circulation and respiration; adaptation to physical stress; regulation of excretion; regulation of body temperature; links among endocrine, nervous and immune systems; nerve and sensual perception in domestic animals; progenesis, fecundation and early embryonic development in domestic animals.
Module 2: *Regulation of processes in animals on the basis of diagnostic parameters*
Basic causes of disturbances and elementary pathophysiological processes in organisms essential for understanding evolution of different diseases, establishing clinical diagnosis and providing therapy; morphological changes of organs, tissues and cells underlying functional abnormalities; reactions of organism to disease; biochemical parameters used in functional evalution of liver, kidneys, muscles and digestive tract, assessment of mineral, electrolyte metabolism, and estimation of acid-base balance; changes of processes in animals related to dietary intake of harmful substances, pathogenic microorganisms, micotoxins, natural toxic substances, dietary supplements and radionuclides, and regulation of such changes.

Code: V-1-710
Course title: The elements of health suitability of food

Contents:
Food borne toxicoinfections

Salmonella, Listeria monocytogenes, Q fever, *Bacillus cereus*, *Clostridium perfringens*, botulism, *Staphylococcus aureus*, *Escherichia coli* O 157: H_7, *Vibrio spp.,* mycotoxins, shellfish toxins (DSP, PSP, amnesic toxin), toxic fish, histamine, toxins of some land mammals. Environmental pollutants: pesticides, PCB, trace elements, radionuclides, purgatives. Veterinary drugs: antibiotics, sulfonamides, antiparasitics, hormones.

15. 3. Elective courses

The various scientific fields offer a great variety of elective courses. The candidate can choose between elective theorethical courses and elective individual research courses evaluated at 5 or 10 credits. The courses are offered by professors who are at the same time leading scientists in their respective scientific fields. Elective individual research courses are offered by researchers who can accept doctoral candidates in their laboratories, where they can aquire up-to-date scientific technologies and approaches to experimental work. A total of 10 elective credits can be selected from the university pool of generic skills courses, listed at the web page of University of Ljubljana (www.uni-lj.si).

15. 3. 1. Elective theoretical courses

Code	Course title	ECTS
F-2-231	Analysis of drugs and metabolites in biosystems	5
V-2-736	Animal hygiene with ecology	10
V-2-740	Animals in experiments	5
B-2-851	Asymmetric synthesis	5
L-2-333	Autoimmunity	5
K-2-542	Basic principles of clinical pharmacology	5
B-2-950	Biochemistry of biological membranes	5
F-2-234	Biogenic medicines	10
B-2-842	Biomolecular thermodinamics	5
J-2-430	Biophysics	5
F-2-932	Biophysics of biological processes, cells and tissues	5
F-2-933	Biophysics of macromolecules and membranes	5
S-2-444	Biostatistical planning of clinical and epidemiological research	5
F-2-235	Biotechnological processes in pharmacy	5
B-2-133	Cell physiology	5
M-2-661	Cell to cell microbial communications	5
L-2-332	Clinical biochemistry – selected topics	10
F-2-253	Clinical pharmacokinetics	5
T-2-656	Clinical toxicology in laboratory medicine	5
F-2-254	Combinatorial chemistry	5
G-2-635	Comparative genomics	5
V-2-730	Comparative odontology and periodontal medicine	10
B-2-951	Computer modeling of biological macromolecules	5
G-2-640	Control of gene expression	5
F-2-259	Design and synthesis of enzyme inhibitors	5
F-2-263	Drug design	10
L-2-330	Design of biodiagnostics and biosensors	10
G-2-642	Development genetics	5
F-2-270	Drug stability	10
F-2-248	Drug synthesis - selected topics	10
J-2-433	Experimental neurochemistry	5
F-2-238	Electron paramagnetic resonance spectroscopy in biological	5

	systems	
J-2-434	Electroporation based technologies and treatments	5
V-2-731	Endocrinology of domestic animales	10
B-2-136	Enzyme catalysis	5
V-2-735	Ethology in animal health care	10
B-2-937	Evolutionary genomics	5
G-2-636	Experimental genetics	5
F-2-937	Experimental methods in biophysics	5
F-3-273	Free radicals in biological systems	5
V-3-776	Gastrointestinal problems in horses	5
B-2-132	Gene technology	5
G-2-631	Genetic analysis of organisms	5
G-2-633	Genetic mapping and QTL analysis	5
G-2-630	Genome analysis by flow cytometry and in situ hybridisation	5
K-2-548	Genomic biomarkers for human diseases	5
L-2-337	Haematology - selected topics	5
J-2-431	High resolution optical microscopy - confocal microscopy	5
G-2-638	Horizontal DNA transfer	5
G-2-632	Human citogenetics	5
G-2-641	Human genetics	10
S-2-440	Impact of mercury on antioxidative capacity and serotonin/melatonin balance	5
F-2-272	Industrial medicinal chemistry	5
F-2-246	Industrial development of drug delivery systems	10
K-2-553	Inovations and new treatment strategies in heart failure	5
F-2-247	Interactions of drug formulations in biosystems	5
F-2-255	Macromolecular crystallography	5
B-2-649	Macromolecular interactions	5
B-2-131	MAP kinase systems and signal transduction	5
K-2-544	Mechanisms and consequences of neurological disorders	5
M-2-438	Medical virology	5
V-2-733	Methodology of scientific research	10
L-2-334	Methods and models of cell and tissue engineering	5
T-2-351	Methods for determination of reactive metabolites of xenobiotics	5
F-2-258	Methods for determination of antithrombotic properties of drugs	5
F-2-256	Methods for surface and interface study	5
F-2-257	Methods for studying the structure and properties of drugs	5
M-2-660	Microbial symbioses	10
M-2-664	Microbiology of gastrointestinal tract	5
B-2-934	Molecular bioinformatics	5
L-2-335	Molecular aspects of immunological methods	5
V-2-734	Molecular biology in veterinary medicine	10
G-2-639	Molecular biology of the mamary gland	5
B-2-640	Molecular genetics	5
B-2-144	Molecular genetics in medicine	5
B-2-139	Molecular genetics of cancer	5
B-2-547	Molecular mechanisms of cancer	5
B-2-130	Molecular mechanisms of adaptation of microorganisms to extreme environments	5
B-2-138	Molecular pharmacology	5
B-2-148	Monoclonal antibodies – an overview and application in basic research, diagnostics and therapy	5
T-2-901	Mutagenesis and genetic toxicology	5

K-2-546	Network communications in medical research	5
K-2-551	Neuromuscular junction and its synaptogenesis	5
F-2-261	New drug delivery systems	10
B-2-941	Nuclear magnetic resonance in research of biological macromolecules	5
F-2-264	Packaging materials development	5
L-2-331	Pathobiochemical mechanisms and models	5
F-2-239	Pharmaceutical biotechnology	10
F-2-240	Pharmaceutical communicology	5
K-2-545	Pharmaco-toxicological testing of drugs	5
F-2-242	Pharmacoeconomics	10
B-2-135	Pharmacogenetics in medicine	5
F-2-243	Pharmacogenomics in pharmacy	5
F-2-244	Pharmacometrics	5
F-2-230	Pharmacotherapeutics	10
K-2-540	Physical principles in physiology	5
M-2-662	Physiology and ecology of fungi	5
T-2-640	Poisonous plants and poisons from plants	10
K-2-543	Principles of medical immunology and alergology	5
M-2-663	Probiotics	10
S-2-443	Psychosomatic medicine	5
S-2-442	Qualitative methods in health behaviour research	5
L-2-336	Quality design and quality assurance in medical laboratories	5
F-2-245	Quality design and validations in pharmaceutical industry	5
T-2-352	Reactive metabolites of xenobiotics	5
S-2-441	Research in quality of care assessment	5
F-2-252	Quality of medicinals	5
G-2-643	Quantitative and statistical genetics	5
G-2-634	Quantitative real-time PCR	5
K-2-550	Rare neurometabolic and neurodegenerative diseases during development	5
F-2-262	Rational design of peptidomimetics	5
B-2-145	Regulation of gene expresion by DNA-protein interaction	5
F-2-265	Regulatory aspects of nonclinical and clinical studies of drugs	5
K-2-552	Research methods in the field of orthopaedics	5
F-2-266	Rheology and biorheology	5
J-2-432	Screening tests for Down syndrome	5
V-2-737	Selected chapters from animal immunology	10
F-2-250	Selected topics in cosmetology	10
F-2-249	Selected topics in physical pharmacy	5
V-2-732	Selected topics in veterinary toxicology and toxinology	5
K-2-541	Selected topics on biomechanics in surgery and rehabilitation	5
B-2-146	Separation methods	5
K-2-549	Sleep related breathing disorders in early life	5
F-2-289	Social pharmacy and pharmacoepidemiology	5
T-2-655	Stress biology	10
F-2-267	Synthesis and analysis of chiral drugs	5
F-2-251	Synthesis of chiral drugs	5
F-2-868	Syntetic medicinal chemistry	5
F-2-260	Thermal analysis in pharmacy	5
F-2-236	Tissue and cell engineering	5
T-2-657	Toxicokinetics	5
T-2-645	Toxicological evaluation of new chemical entities	10

T-2-902	Toxicology on molecular scale	10
K-2-547	Transfusion medicine, transplantation and advanced cellular therapies	5
F-2-271	Transport and metabolism of drugs in biosystems	10
F-2-241	Veterinary drug delivery systems	5
V-2-738	Veterinary laboratory medicine	10
V-2-739	Veterinary pharmaceuticals in environment	5
G-2-637	Yeast genetics	5

15. 3. 2 Elective individual research courses

Code	**Course title**	***ECTS***
S-3-492	Acute respiratory tract infections as a public health problem	5
V-3-780	Advanced methods in emergency care of small animals	5
K-3-38A	Allergology	5
K-3-38B	Allergology	10
S-3-494	Analysis of cancer burden	10
S-3-496	Analysis of lifestyle, sexual health and behaviour	10
V-3-761	Animal hygiene	5
M-3-681	Applied microbial enzymatics	5
M-3-68B	Applied microbial enzymatics	10
S-3-498	Basic principles of health care for women, children and adolescents	10
S-3-495	Bahavioural monitoring and promotion of healthy lifestyle	10
V-3-763	Biology and health care of honey bee colonies	10
V-3-769	Breeding and health care of wild animals	10
K-3-595	Cachexia and body wasting	5
K-3-59E	Cachexia and body wasting	10
K-3-570	Cardiovascular dynamics	5
M-3-667	Characterization and identification of microfungi	10
K-3-571	Chemical pharmacological methods	5
V-3-790	Cito- and histochemistry (analytical, enzymatic, immune, in situ)	5
K-3-583	Clinical aspects of human reproduction	5
K-3-584	Clinical cardiac electrophysiology	5
K-3-561	Clinical electroencephalography	5
K-3-575	Clinical neurophysiological methods for evaluation of muscles and the nervous system	5
K-3-592	Clinical neurosonological methods for assessment of cerebral circulation	5
J-3-472	Cytometry in oncology and cell biology	5
G-3-672	Data management in genetics	5
K-3-587	Dermatology and venereology; epidemiology, genetics, immunology and allergology	5
V-3-765	Dermatology of dogs and cats	5
V-3-76F	Dermatology of dogs and cats	10
B-3-169	Design, preparation and site directed mutagenesis of recombinant proteins	10
J-3-474	Detection and localization of molecules in cells with	5

	imaging techniques	
J-3-466	Determination of specific protein expression in sceletal muscle cells by western blot analysis	5
J-3-46M	Determination of specific protein expression in sceletal muscle cells by western blot analysis	10
B-3-168	Determination of variations and mutations in genomes	10
M-3-480	Diagnostic microbiology	5
M-3-48G	Diagnostic microbiology	10
V-3-764	Diseases and health care of fish	10
B-3-171	DNA microarray technology	5
B-3-17B	DNA microarray technology	10
K-3-562	Echocardiography	10
S-3-493	Economic assessment of work related injuries	10
L-3-360	Eksperimental methods in laboratory biomedicine	5
K-3-560	Electronic analogue circuitry for physiological and pathophysiological studies	5
K-3-56G	Electronic analogue circuitry for physiological and pathophysiological studies	10
K-3-594	Electrophysiological study of the visual system	5
K-3-59J	Electrophysiological study of the visual system	10
V-3-762	Ethological methods	5
L-3-361	Evidence-based laboratory biomedicine	5
K-3-564	Experimental immunology	5
K-3-56J	Experimental immunology	10
B-3-961	Experimental methods in innate immunity	5
B-3-96B	Experimental methods in innate immunity	10
B-3-164	Experimental methods in pharmacogenetics	10
B-3-962	Experimental methods in studies of nucleic acid structure	10
V-3-797	Experimental neuroendocrinology	5
M-3-481	Experimental virology	5
M-3-48B	Experimental virology	10
V-3-793	Food control	10
V-3-768	Functional anatomy of animal locomotor apparatus	5
K-3-577	Functional magnetic resonance and diffusion tensor imaging	5
K-3-57V	Functional magnetic resonance and diffusion tensor imaging	10
B-3-163	Functional protein analysis in signal transduction	5
J-3-467	Genetic counseling and testing in oncology	5
J-3-46V	Genetic counseling and testing in oncology	10
J-3-468	Genetics of coronary artery disease	5
J-3-46S	Genetics of coronary artery disease	10
G-3-670	Genetics of mice	5
K-3-589	Guidelines for point of care testing	5
V-3-788	Health care of pigs	10
V-3-787	Health care of poultry	10
V-3-789	Health care of ruminants	10
V-3-786	Health care of small companion animals	10
K-3-567	Haemostasis	5
K-3-56V	Haemostasis	10
K-3-563	High precision electrocardiography	5

J-3-464	High resolution optical microscopy – confocal microscopy	5
J-3-46J	High resolution optical microscopy – confocal microscopy	10
V-3-775	Hygiene and pathology of animal nutrition	5
V-3-77K	Hygiene and pathology of animal nutrition	10
K-3-568	Hyperbaric medicine	5
J-3-462	Immunohistochemistry	5
J-3-469	Injection methods and their application	5
J-3-46T	Injection methods and their application	10
K-3-590	Intensive care medicine	10
K-3-591	Intraoperative and intensive care neurophysiology	5
K-3-581	Investigation of pulmonary function in cardiology and pulmology	5
K-3-58B	Investigation of pulmonary function in cardiology and pulmology	10
K-3-572	Mechanisms and consequences of neurological dieases	5
B-3-973	Methods in experimental oncology	5
B-3-97L	Methods in experimental oncology	10
J-3-475	Methods in single cell physiology	5
J-3-47K	Methods in single cell physiology	10
V-3-773	Microbiological techniques	10
V-3-796	Microbiology	10
K-3-573	Microcirculation	5
M-3-682	Microorganisms in bioassay systems	5
M-3-68F	Microorganisms in bioassay systems	10
J-3-461	Molecular genetics in pathology	5
B-3-565	Molecular genetics of hormonal and metabolic diseases	10
K-3-574	Molecular methods in pharmacology	5
M-3-680	Molecular microbial taxonomy	5
M-3-68A	Molecular microbial taxonomy	10
J-3-463	Morphology, morphometry and histochemistry of sceletal muscle	5
J-3-46L	Morphology, morphometry and histochemistry of sceletal muscle	10
V-3-792	Morphometric analysis of cells and tissues	5
J-3-480	Nano and microelectrophysiological methods	10
K-3-586	Neurology of early development and neuro-intensive diagnostics and treatment	5
K-3-576	Neurosurgery of intracranial tumours	10
K-3-591	Objective verification of the brain damage after brain injury	5
K-3-579	Oral and maxillofacial pathology	5
K-3-593	Osteosynthesis	5
S-3-480	Perinatology	5
S-3-48G	Perinatology	10
V-3-767	Pharmacology and toxicology	5
J-3-476	Phospholipid and biological membranes	5
J-3-47M	Phospholipid and biological membranes	10
J-3-465	Preparation of sceletal muscle cell culture	5
J-3-46K	Preparation of sceletal muscle cell culture	10

B-3-866	Principles and techniques in biochemistry and molecular biology	10
V-3-774	Principles of molecular virology	10
J-3-477	Quantitative methods in animal models of brain disease	5
J-3-47V	Quantitative methods in animal models of brain disease	10
K-3-582	Radiology	5
V-3-779	Reproduction and obstetrics	10
V-3-798	Reproductive toxicology	5
S-3-490	Research in physical and rehabilitation medicine	5
S-3-49G	Research in physical and rehabilitation medicine	10
K-3-569	Selected immunological methods	5
K-3-565	Selected methods in pharmacokinetics	5
J-3-478	Silencing of specific genes with siRNA method	5
J-3-47S	Silencing of specific genes with siRNA method	10
K-3-588	Sleep medicine and polysomnographic recordings for evaluation of sleep disorders	5
V-3-782	Small animal ultrasonography	10
V-3-778	Special veterinary pathology	10
B-3-660	Stem cells as a tool for basic research and therapeutic cloning	10
J-3-460	Stereology and quantitative image analysis	5
J-3-46G	Stereology and quantitative image analysis	10
S-3-497	Stigmatisation	10
B-3-172	Studies of enzyme reactions	5
J-3-471	Studies on isolated organs	5
V-3-771	Surgery and ophtalmology	5
K-3-566	Surgical gastroenterology	5
K-3-56M	Surgical gastroenterology	10
K-3-578	Surgical oncology	5
K-3-57S	Surgical oncology	10
J-3-479	Techniques for studying membrane proteins and assessing membrane integrity by the model of mitochondrial biogenesis	5
V-3-781	Technology of nucleic acid hybridization	5
V-3-78B	Technology of nucleic acid hybridization	10
J-3-473	Toxinology and ecotoxinology	5
J-3-47L	Toxinology and ecotoxinology	10
G-3-671	Transgenesis in animals	10
V-3-772	Treatment methods in veterinary oncology	5
V-3-77F	Treatment methods in veterinary oncology	10
J-3-470	Tumour biology	5
J-3-47G	Tumour biology	10
K-3-585	Urogynaecology	10
V-3-777	Veterinary anaesthesiology	5
V-3-770	Veterinary cardiology	10
V-3-794	Veterinary clinical laboratory diagnostics	10
V-3-795	Veterinary diagnostic cytopathology	5
V-3-784	Veterinary morphology	5
V-3-783	Veterinary orthopaedics and neurosurgery	10
V-3-785	Veterinary radiology	10
S-3-491	Workplace health promotion	10

16. KEY TO COURSE CODES

The courses are coded with a capital letter and two numbers. The capital letter indicates the scientific field or a combination of fields. The first number indicates the type of the course and the second one consists of three digits, the first indicating the location and the last two the consecutive number of the course.

Scientific fields:
G- Genetics
B - Biochemistry and Molecular Biology
F - Pharmacy
L - Clinical Biochemistry and Laboratory Biomedicine
J - Basic Medical Science
K - Clinical Medicine
M - Microbiology
V - Veterinary Medicine
S - Social Medicine
T - Toxicology

Types of courses:
1 – core courses
2 – elective theoretical courses
3 – elective individual research courses

Course locations:
1 – Faculty of Medicine - Biochemistry and Molecular Biology
2 – Faculty of Pharmacy – Pharmacy, Toxicology
3 – Faculty of Pharmacy - Clinical Biochemistry and Laboratory Biomedicine, Toxicology
4 – Faculty of Medicine – Basic Medical Science, Social Medicine, Microbiology
5 – Faculty of Medicine, University Medical Centre Ljubljana, Institut of Oncology Ljubljana, University Psyhiatric Hospital Ljubljana – Clinical Medicine
6 – Biotechnical Faculty - Microbiology, Genetics, Toxicology
7 – Veterinary Faculty – Veterinary Medicine
8 – Faculty of Chemistry and Chemical Technology
9 – research institutes: Josef Stefan Institute, Chemical Institute, National Institute of Biology

Hence, the course bearing the code B-2-940 belongs in the area of biochemistry and molecular biology (B), is an elective theoretical course (2) and is carried out at a research institute (9).

I. CORE COURSES

G-1-600 Genetics

G-1-601 Module1: *Genetics concepts*
G-1-602 Module2: *Model organisms*
G-1-603 Module3: *Bioinformatics*

B-1-100 Selected advanced topics from biochemistry and molecular biology

B-1-101 Module1: *Selected metabolic processes with regulatory mechanisms; experimental approaches*
B-1-102 Module2: *Structure and function of biological molecules*
B-1-103 Module3: *Functional genomics and proteomics*

F-1-200 Molecular basis of medicinal chemistry

F-1-201 Module1: *Drug structure and properties*
F-1-202 Module2: *Drug structure and biological activity*
F-1-203 Module3: *Drug targets*

F-1-210 Pharmaceutical technological operations and dosage forms

F-1-211 Module1: *Pharmaceutical-technological operations*
F-1-212 Module2: *Dosage forms with controlled release*
F-1-213 Module3: *New delivery systems*

F-1-220 Molecular biopharmaceutics and pharmacokinetics

F-1-221 Module1: *Role and importance of pharmacokinetic studies in drug discovery and development*
F-1-222 Module2: *LADME processes*
F-1-223 Module3: *Pharmacokinetic analysis*

L-1-300 Clinical biochemical diagnostics – algorithms and interpretation

L-1-301 Module1: *Genetic basis of common diseases*
L-1-302 Module2: *Immune-mediated diseases*
L-1-303 Module3: *Malignant diseases*
L-1-304 Module4: *Pharmacogenomic diagnostics*

J-1-400 Medical cell biology

J-1-401 Module1: *Fundamentals of medical cell biology*
J-1-402 Module2: *Reproductive biology* in vivo *and* in vitro
J-1-403 Module3: *Cell biology and genetics*

K-1-500 Research in clinical medicine

K-1-501 Module1: *Methods in medical research*
K-1-520 Module2: *Basic science in clinical research*
- K-1-521 Topic 1 – Physiology of the cardiovascular system
- K-1-522 Topic 2 - Physiology of the respiratory system
- K-1-523 Topic 3 - Physiology and biomechanics of the locomotor system
- K-1-524 Topic 4 - Pharmacology
- K-1-525 Topic 5 - Neurophysiology
- K-1-526 Topic 6 - Immunology

K-1-530 Module3: *Achievements in clinical research*
- K-1-531 Topic 1 – Sceintific principles in cardiovascular medicine
- K-1-532 Topic 2 – Scientific principles of surgical methods
- K-1-533 Topic 3 – Clinical neurosceince
- K-1-534 Topic 4 - Scientific principles in medical immunology and allergology

M-1-410 Microbiology

M-1-411 Module1: *Basic medical microbiology*
M-1-412 Module2: *Clinical microbiology*
M-1-613 Module3: *Microbial diversification, identification, evolution and biotechnology*
M-1-614 Module4: *Biochemistry, physiology and ecology of microorganisms*

V-1-700 Regulation of processes in healthy and sick animals

V-1-701 Module1: *Regulation of basic processes in animals*

V-1-702 Module2: *Regulation of processes in animals on the basis of diagnostic parameters*

V-1-710 The element of health suitability of food

S-1-420 Scientific aspects of public health

S-1-421 Module1: D*eterminants of health and disease*

S-1-422 Module2: *Methodology of public health measures*

T-1-230 Toxicology

T-1-231 Module1: *Relationship between structure and toxicity*

T-1-232 Module2: *Influence of toxic compounds on processes within cells*

T-1-233 Module3: *Influence of toxic compounds on environment and ecosystems*