BIL 309 – Fall Semester

Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Fundamentals of biotechnology and drug research

ECTS: 5

Course leader:
Ivana Ratkaj

This course is designed so that 3rd year students of the undergraduate study program know the historical development of biotechnology; it explains the beginnings and methods of biotechnological production that led to the development of modern biotechnology as interdisciplinary areas that use knowledge from various natural and engineering fields in order to produce medicines such as recombinant proteins (insulin, interferons) and antibodies. Also during lectures, students will gain an insight into the key role that biotechnology plays in the creation and application of genetically modified organisms (GMO). Students will also be familiar with one of the fundamental branches of modern biotechnology - green biotechnology, which uses and applies biotechnological knowledge in processing waste water and pollution by bioremediation methods. Special emphasis in the course will be placed on carrying out exercises during which students will gain knowledge and practical experience in breeding procedures of biotechnological microorganisms such as yeast and bacteria, cloning, protein expression, purification of plasmid DNA and proteins. The aim of the course is to acquire knowledge related to the basic concepts of biotechnology, its significance and development that ultimately led to biotechnological development in the field of research and production of new drugs. Special emphasis will be placed on acquiring practical experience during the course laboratory exercises, which will enable students to get acquainted with relevant biotechnology methods in the research and production of medicines.

After completing the course, students will:

- understand the key concepts of the origin and development of biotechnology
- adopt the basic principles of biotechnological production based on classical and modern approach
- gain knowledge from different areas where molecular biotechnology methods are used for production of medicines
- adopt the basic principles of use and design of GMO organisms
- understand the principles of waste water treatment by the bioremediation process
- independently describe the hybridoma production process

BIL 305 – Fall Semester

Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Bioassays in drug research

ECTS: 5

Course leader:
Christian Reynolds

The course includes knowledge and principles of conducting bioassays and knowledge of the most important techniques used in designing bioassays in the fields of biotechnology and drug development. The course provides students with the opportunity to acquire experimental and practical knowledge for conducting experiments and bioassays. During the implementation of the course, students will learn basic concepts from the field of bioassays, methods and instrumentation used in biochemical and cellular assays, basics of assays with cell cultures, strategies and development of bioassays based on methods of protein binding and enzyme activity monitoring, and bioassays based on high-flow analysis methods. During the course, students will acquire the knowledge they need in the field of bioassay application, the ability to analyse and interpret bioassay designs, knowledge and skills for performing bioassays, and the knowledge to understand traditional methods and instrumentation used in bioassay implementation and new viscoflow methods and accompanying instrumentation.

After completing the course, students will be able to:

- define and explain the types and basic principles of bioassay work
- describe the use of bioassays and their role in drug development
- interpret biochemical processes in the process of designing a suitable bioassay
- describe the principles on which measurements are made during the implementation of bioassays
- confidently distinguish and interpret traditional methods in bioassays in relation to high-flow analysis methodologies
- analyse and interpret scientific data from scientific papers based on bioassays
- independently create a written text and presentation of an individual bioassay based on data from the scientific literature
- perform laboratory exercises safely and effectively, which includes working with samples for analysis, preparation of working solutions, implementation of bioassays according to a pre-explained and demonstrated protocol, presentation of results and implementation of simple analyses/calculations, and drawing conclusions from the obtained results.

IRL 202 – Fall Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Introduction to research work

ECTS: 5

Course leader:
Rozi Andretić Waldowski

This course will give students the basic knowledge required for their future research work in research laboratories, which includes: preparing a hypothesis driven research plan based on scientific evidence in accordance with bioethical standards and skills in presenting results of their work, writing a CV and project proposal. In the bioethics part of the course students will learn: to distinguish scientific from non-scientific approaches, explain the characteristics of the scientific method and how it evolved from philosophy of science, understand the importance of ethical approaches in performing scientific research and objectively discuss ethical principles in modern bioscience. In the science writing part of the course, students will learn to: independently search different literature databases, become proficient in the use of a reference management software, formulate a pertinent scientific question based on researched literature, formulate a hypothesis, acquire skills in scientific writing, be able to write a Master thesis, research paper and be able to present their work in oral or poster form to either expert or lay audience.

Students will:

- Gain general knowledge about the scientific method and hypothesis-driven research
- Gain general knowledge about types of scientific investigation and example of scientific method applied during drug research development
- Gain general knowledge about the characteristics and types of scientific literature
- Gain practical skills related to using different search databases for literature searches and references management
- Gain general knowledge about the elements and practical skills involved in formatting a Master Thesis
- Gain general experience about scientific writing
- Gain specific experience in poster and oral communication
- Gain general knowledge of bioethics as it applies to research work and publication
- Gain specific experience about writing a project proposal
- Gain general knowledge about communicating science to experts and lay audiences

BIL 307 – Fall Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Chemoinformatics: structure and function of biomolecules

ECTS: 3

Course leader:
Daniela Kalafatovic

The aim of the course is to enable participants to acquire knowledge and skills with which they can independently perform basic computer analyses of the structure and function of biomolecules (peptides). The theoretical settings of studies of the structure and function of molecules will be presented in parallel with accompanying computer approaches. The aim of the course is to enable students to visually present the material they have learned in previous courses.

At the end of the course students should be able to:

- Independently search Uniprot and RCSB PDB databases
- Independently analyse and understand SMILES and PDB records
- Download, filter and purify data for analysis
- Create a molecule for simulation in Avogadro and PyMol
- Prepare the simulation system via CHARMM-GUI
- Start and analyse the molecular dynamics simulation using the GROMACS program
- Analyse data using Excel
- Use Python to make API requests

IRL 201 – Fall Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Statistics and analysis of scientific results

ECTS: 4

Course leader:
Marta Žuvić

The goal of the Statistics and Analysis of Scientific Results course is to enable participants to acquire the following knowledge and skills: Knowledge of types of research and their features with regard to sampling and features with regard to the type of new information provided by scientific research. Distinguishing types of data and understanding their relationships, knowledge of creating a database, creating a graphical way of displaying data and distributing data. Knowledge of basic concepts of probability theory: random variable, probability distribution of random variable, central limit theorem and consequences. Knowledge of the terms: population and sample, types and characteristics of samples. Knowledge of the concept of statistical hypothesis, null hypothesis and alternative hypothesis and the types of errors in statistical inference (type I and II errors) and the connection with the strength of the research. Knowledge of the correct formulation and testing of a statistical hypothesis, selection of a statistical test and statement, analysis and interpretation of results for: determination of the difference in proportions, analysis of contingency tables, determination of measures of data connection, comparison of a sample with a given measure in the population, comparison of measures of central tendency of two or more samples , connection of numerical data (single linear, non-linear and multiple regression), connection of numerical and categorical data (logistic regression and ROC analysis) and survival analysis.

At the end of the course students should be able to:

- State the types and forms of research and their features with regard to sampling and with regard to the type of new information provided by scientific research.
- Differentiate types of data and their relationships, correctly classify given data sets, create a database in a suitable computer application, select and create an appropriate way of graphically displaying data and data distribution.
- Correctly interpret the basic concepts of probability theory, give an example of a random variable and its quantification method, distinguish and determine the type of random variable using an example, distinguish and explain probability distributions, correctly interpret the central limit theorem, create and analyse probability distributions for selected random variables.
- Correctly interpret the concepts of population and sample and give an example, distinguish types of samples and state their characteristics.
- Correctly state a statistical hypothesis (null hypothesis and alternative hypothesis), define and distinguish types of errors when accepting or rejecting a statistical hypothesis and correctly interpret the connection with the strength of the research.
- Independently create examples of setting up and testing a statistical hypothesis, differentiate and correctly choose a suitable statistical test with regard to the types of data, the number and type of groups, and successfully express, analyse and interpret the results for: determination of the difference in proportions, analysis of contingency tables, determination of measures of association of categorical data, comparison of a sample with a given measure in the population, comparison of measures of central tendency of two or more samples, association of numerical data (single linear, non-linear and multiple regression), connection of numerical and categorical data (logistic regression and ROC analysis) and survival analysis.

BIL 106 – Fall Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Introduction to bioinorganic chemistry

ECTS: 4

Course leader:
Toni Todorovski

The course will provide students with a general overview of the functions performed by metals (mainly so-called transition metals) and their complexes in biological systems. It is expected that students who successfully master this course will understand the concepts of coordination chemistry in a biological environment and rationally analyse the influence of such an environment on the reactivity of the metal centre. The foundations of bioinorganic chemistry adopted in this course should also serve as motivation for students in further deepening their knowledge in the field of bioinorganic chemistry, such as understanding the structure and function of metalloenzymes, physical methods of analysis of metal complexes, synthesis of new materials and drugs that contain metal in their structure. The focus of the course is on understanding the importance of inorganic elements in biological systems.

At the end of the course students will be able to:

- understand and use the concepts of coordination chemistry in biological systems to analyse the influence of such an environment on the reactivity of the metal centre and vice versa.
- explain the structural and functional role of metals in biological systems by knowing their properties based on their position within the periodic table of elements.
- on the basis of electronic configurations of metal centres, determine the geometry, colour and magnetic properties of coordination (complex) compounds.
- explain the influence of key factors on the stability of metal complexes.
- explain the structure of amino acids, peptides and proteins and their complexes with transition metals.
- explain the strength of intermolecular forces based on the shape and size of the molecule, functional groups and their orientation in space.
- explain the effect of intermolecular forces on the stability of proteins and metal complexes in biological systems.
- explain and evaluate the role of metals for diagnostic and/or pharmacological applications.

MK 102 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Physical organic and computational chemistry

ECTS: 6

Course leader:
Dean Marković

The course aims to acquaint students with the basic principles of physical organic and computational chemistry and their application in planning the synthesis of potential drugs and understanding the relationship between physical, chemical and biological properties of the active components of medicines. Participants will be trained in the application of physical-organic and computational chemistry in the design of potential drugs and their synthesis.

At the end of the course students will understand:

- the basics of physical-organic chemistry
- mechanisms of organic reactions and methods of researching reaction mechanisms
- the influence of structural and electronic factors on molecular properties and chemical reactivity
- acids and bases and their application in the catalysis of organic reactions
- computational chemistry (molecular mechanics, quantum mechanics, molecular dynamics)
- computational methods and application of computational methods in researching the properties of molecules and reaction mechanisms

IRL 108 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Natural compounds and their use in pharmacology

ECTS: 5

Course leader:
Željka Maglica

This course aims to familiarise students with natural compounds: primary and secondary metabolites, division and biogenetic origin of natural compounds, isolation of natural compounds, their main biological activities, the importance of natural compounds for the organism that produces them, and the possibility of their use in pharmacology, biomedicine, and industry. Toxins and their role and action. Main examples of pharmacologically active natural compounds and toxins. Phases of discovery and testing of pharmacologically interesting natural compounds and strategies for obtaining larger quantities of these compounds (chemical synthesis, cell and organism cultures, recombinant DNA technology).
Special attention will be paid to selected secondary metabolites from marine organisms. In doing so, their structure and biosynthesis, biological activity in vitro and in vivo, and their meaning for the organism that produces them, as well as the possibility of their use in pharmacology, biotechnology and biomedicine, will be presented.

After completing the course, the student will:

- Be familiar with the extraction of natural compounds from natural materials, their biosynthesis, biological activities, ecological role and the possibilities of their use in pharmacology, biotechnology and biomedicine.
- Understand and integrally perceive natural compounds and toxins from microorganisms, plants and animals, as well as their action and use.
- Be able to describe natural compounds and toxins with regard to their primary structure and mode of action.

BIL 102 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Scientific communication in the English language

ECTS: 3

Course leader:
Nicholas J. Bradshaw

English is the principle language of international science, with over 80% of scientific journals published in this language. In order to build a career in science, whether academically or in industry, it is therefore important both to be able to understand the English scientific literature, and to be confident at speaking and writing scientific information in this language. This course will be taught entirely through seminars, in two groups. Approximately half of the seminars will consist of short taught sections on elements of written English communication, followed by group and individual exercises for practice. The remainder will give the students the opportunity to practise public speaking in scientific English, through presentation of a scientific paper and through debates. Additionally, one seminar will be given over to advice on public speaking in English and time to prepare for later tasks.

After completion of this course, students should:

- Be aware of the importance of communication in English in international science
- Be familiar with the scientific style of writing for English
- Be aware of the basic structure of the scientific literature and how to effectively extract information from them
- Be aware of common mistakes when writing scientific material in English, and how they can be avoided
- Have experience of paraphrasing English scientific literature, and be aware of the conventions and potential difficulties surrounding quoting, citing and plagiarising
- Have gained experience and confidence at public speaking in English

BIL 306 – Spring Semester

Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Pharmacognosy and natural products

ECTS: 5

Course leader:
Stribor Marković

This course aims to enable the student to acquire knowledge about herbal drugs and compounds from natural sources that are used as active substances that are incorporated into the finished medicine. Lectures are a form of teaching that provides insight and an overview of a thematic unit that is not covered in seminars. These topics allow students to master concepts related to herbal medicines, food supplements, active substances, indications and testing methods, and enable them to critically evaluate the issues of the mentioned topics.

The student prepares a thematic unit (seminar topic) in advance in the form of a power-point presentation and presents it for at least 15 minutes. The student receives relevant scientific literature for his/her seminar and is free to search the literature by himself/herself using databases such as Pubmed and the website of the European Agency of Medicine. At the seminars, the student presents to his/her colleagues examples of medicines made from natural substances or their problems, such as the quality of clinical research and contamination, and actively considers and critically discusses the topic together with the teacher. Students are encouraged to have an active discussion and exchange the prepared materials, which also serve as literature for the exam, and after the discussed presentation. The teacher evaluates the presented work, which is stored in the course archive.

After completion of the course the student will:

- Know what pharmacognosy is and how it studies substances from plants that are used in therapy and health preservation
- Recognize how herbal drugs or herbal preparations are tested
- Assign correct pharmacopeial names for herbal drugs and herbal preparations
- Differentiate between herbal drugs and herbal preparations used in phytotherapy
- Know how to recognize which organs and organic systems certain plant substances have an effect on
- Differentiate between health products that contain herbal drugs and herbal preparations
- Recognize the unwanted effects of certain herbal substances
- Interpret legislation that regulates herbal medicines, food supplements, cosmetic products with herbal substances
- Know the natural plant substances that have influenced the development of medicinal chemistry and new medicines
- Critically reflect on the issue of herbal medicines and active substances within the framework of translational medicine and potential in medicinal chemistry

EBIL 124 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Molecular neurobiology

Course leader:
Miranda Mladinić Pejatović

ECTS: 3

This course aims to acquaint students with the fundamental principles of modern molecular neurobiology, and the research that, with its achievements, has made it possible to understand the molecular mechanisms underlying the functioning of the human nervous system, during its normal functioning, as well as in neurodegenerative and other brain diseases, most of which are still incurable. After a brief introduction to the structure and organisation of the nervous system, students will learn about the basic molecular mechanisms that underlie the functioning of the nervous system. They will learn how genes regulate and control the development, work, communication, and death of nerve cells, and how the molecular processes of nerve cells are transformed into the physical and psychological activity of humans and other beings. Furthermore, they will learn about the molecular changes that cause neurodegenerative and other diseases of the nervous system. Students will get an insight into the research results that contributed the most to the progress of modern molecular neurobiology, and to be able to understand the contribution of the development of molecular biology techniques in understanding the work of the brain, as well as in the diagnosis and treatment of disorders of the nervous system. Through discussion and seminar papers, they will have the opportunity to critically look at some of the assumptions and historical misconceptions of neuroscience.

After passing the exam, students will be able to:

- Describe and understand the basic structure, development, organization and metabolism of the brain,
- Understand and describe the molecular mechanisms on which the work and communication of nerve cells are based,
- Understand the regulation of gene expression and protein synthesis in nerve cells,
- Understand and describe the genetic basis of the complexity of the structure and functioning of the human brain,
- Understand and describe the molecular changes that cause neurodegenerative and other diseases of the nervous system,
- Understand and describe the most important achievements of contemporary experimental molecular neurobiology,
- Critically assess and evaluate the importance and value of the scientific results of contemporary neuroscience.

EBIL 135 – Spring Semester

Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Bacterial organisms in biotechnological production

ECTS: 3

Course leader:
Ivana Ratkaj

Biotechnology is an interdisciplinary field of science, and therefore this course brings the basics of knowledge from chemistry, biochemistry and molecular biology integrated with engineering methods in order to obtain a socially useful product. In accordance with the conclusions of the European Federation for Biotechnology, which emphasize that biotechnology "connects natural and engineering sciences in order to achieve the application of organisms, cells, their parts and molecular analogues in obtaining products for the benefit of humanity", this course includes a detailed presentation of the material and classifications of bacterial organisms and describes the biotechnological processes in which they are used.

The course shows not only today's standard methods of biotechnological production, but also brings knowledge based on recombinant DNA technology. It also mentions a very important branch of biotechnology that is used in the preservation and protection of the environment.

During the course, students will master the basic biotechnological terms related to obtaining a wide range of biotechnological products as a basis for further knowledge acquisition in later years of study.

During the course the course the students will:

- Learn the structure of biotechnological microorganisms
- Understand the basics of traditional biotechnological processes that use bacterial organisms or their parts
- Get acquainted with the modern approach of recombinant DNA biotechnology
- Get to know the wide spectrum of biotechnological products and applications of microorganisms

EBIL 157 – Spring Semester

Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Microscopy

ECTS: 3

Course leader:
Željka Maglica

The development of microscopy revolutionised the world of cellular and molecular biology. The microscopy course aims to introduce students to the basic types of microscopy used in biological sciences through their theoretical concepts and practical application. Students will be introduced to optical microscopy, with special emphasis on modern fluorescence microscopy techniques. Students will also learn about super-resolution techniques that allow the visualization of individual molecules inside the cell. The second part of the course will cover the principles and application of transmission electron microscopy, scanning electron microscopy and atomic force microscopy. The seminars will introduce students to additional specific elements and techniques of microscopy. Practical exercises will enable students to master the basics of working with a light and confocal microscope and the basics of image analysis.

During the course, students will gain knowledge about the advantages and limitations of certain types of microscopy. This knowledge will help them decide which type of microscopy to apply for a specific scientific problem, how to use a specific type of microscope to obtain a representative image of a sample, and how to process the obtained image so that it is ready for publication. Using examples from scientific literature, students will be encouraged to critically approach the interpretation of results obtained by microscopy.

At the end of the course students will be able to:

- Define and explain the basic principles of different types of optical and electron microscopy
- Describe the application of a particular type of microscopy
- Critically interpret microscopic images and quantitative microscopy results
- Independently visualize a biological sample on a fluorescent microscope
- Independently process and analyse images obtained by microscopy

EBIL 163 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Advanced Microscopy in Neuroscience

ECTS: 3

Course leader:
Jelena Ban

In the last 20 years or so, modern microscopy has experienced extremely important advances, especially in resolution, approaching nanometre dimensions. The aim of the course is to describe the principles of modern microscopy with application in neuroscience. The course is a continuation of the elective course "Microscopy" (EBIL 157). Students will be familiar with the working principle of modern fluorescence microscopy techniques: starting from standard light, fluorescence and confocal microscopy, up to super-resolution and atomic force microscopy. The mentioned techniques will be accompanied by concrete examples of their application in the field of neuroscience, such as the differentiation of embryonic stem cells into nerve cells whose efficiency can be "manipulated" using nanostructured substrates of different softness and composition. The activity of nerve networks can be effectively observed using fluorescent calcium indicators (so-called calcium imaging) and at the same time the interaction of neurons and glial cells can be studied. Induced pluripotent stem cells (iPSC) have potential clinical applications in the treatment of neurodegenerative diseases, but many more are in vitro research is needed to confirm their effectiveness and eliminate possible risks. The goal of this course is to supplement basic knowledge in the field of optical microscopy and to acquaint students with the basics of the most modern achievements, along with their application in neurobiology, in order to facilitate the choice of an adequate technique for a specific biological problem in future scientific work. The seminars will introduce students to scientific research in the field of neuroscience, in which the techniques described during the lectures are used. During the practical exercises, students will prepare a biological sample for microscopy, master the basics of working with light and confocal microscopes, and analyse the obtained images. Demonstration exercises on the atomic force microscope will give students basic knowledge about its use and possibilities.

After completing the course, students will be able to:

- Define and explain the basic principles of different types of fluorescence microscopy
- Understand and describe the application of a particular type of microscopy
- Prepare and present a seminar paper on the most modern elements of microscopy
- Independently prepare a biological sample for microscopy and analyse it on a fluorescent microscope
- Independently process and analyse images obtained by microscopy

EBIL 168 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

The Biology of Mental Illness

ECTS: 3

Course leader:
Nicholas J. Bradshaw

Major mental illnesses are devastating conditions that represent one of the most significant causes of disability both globally and within Europe. Despite the enormous personal and economic effects of these illnesses, progress in revealing their underlying biology has been slow, and is only now truly beginning to be understood. In this course, students will be taught about biological aspects of major mental illnesses, with a particular focus on schizophrenia, bipolar disorder and major depressive disorder. Lectures will provide an overview of the aetiology and symptoms of these conditions, before focussing in turn on therapeutic options available for treatment, how we define the conditions, the biological causes of the conditions at a personal and cellular level and how these conditions can be studied in clinical and laboratory situations. Students will explore the sociological and ethical complications surrounding research and treatment of these conditions through a series of organised debates. Assessment will occur through individual written tasks and group seminar-based activities, including the debates. For the group tasks, students will be required to work together with students from other YUFE Universities. Through this course, it is intended that students will develop an understanding of the devastating and widespread conditions, but also gain a broader understanding of the experimental methods by which researchers can investigate and eventually understand complicated biological conditions.

After completion of the course, students should be able to:

- Describe the symptoms and methods of diagnosis for a range of mental illnesses
- List a range of treatment options for these conditions and discuss (where known) their means of action
- Understand and describe environmental factors contributing to their onset
- Understand the role of heritability in major mental illness, and genetic methods by which candidate genes for the conditions can be identified
- Describe several prominent examples of genes studied in relation to schizophrenia
- Understand the potential uses and limitations of different animal models in mental illness research
- Discuss the means by which genetic-environmental interactions can be studied, both in the clinic and using animal models
- As an example, describe the use of Drosophila in addiction research
- Discuss modern approaches to major mental illness, including protein-based methods
- Debate and discuss ethical and sociological issues regarding mental illness

EBIL 178 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Immunological methods in experimental work and diagnostics

ECTS: 3

Course leader:
Marin Dominović

The goal of the ˝Immunological methods in experimental work and diagnostics˝ course is to present contemporary immunological methods to students, and how to implement them in experimental work and diagnostics. Students will upgrade their prior knowledge of immunology and physiology by integrating novel material and immunological methods. In addition to the working principles of individual methods, students will develop the ability to use them in a practical and creative way, both in scientific work and in diagnostics.

On completion of the course students will be able to:

- Understand the importance and ways of using animal models for experimental purposes
- Define ways of designing experiments
- Define methods of isolation of immune cells from tissue and blood
- Describe the use of magnetic separation in the isolation of immune cells
- Define the method of immunohistochemistry and its use for scientific and diagnostic purposes
- Understand the use of the cytotoxicity test and ways to define the viability and form of cell death
- Define the use of neutralization tests
- Define the use of tetramers in diagnostics
- Describe the use of the ELISA method and similar methods in practice
- Recall previously acquired knowledge in immunology and use it to understand the use of individual immunological methods in original scientific works
- Get acquainted with the current state of diagnosis of infectious and autoimmune diseases using immunological methods
- Be familiar with conducting a lymphocyte proliferation test

EBIL 187 – Spring Semester

Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Micronutrients

ECTS: 3

Course leader:
Stribor Marković

Micronutrients, which can be essential or non-essential, are a necessary part of the diet and participate in a large number of physiological processes in the body. Unfortunately, the use of micronutrients in supplementation is an area of intense marketing activity that is not always well founded. On the other hand, the study of micronutrients is an excellent interdisciplinary field that combines physiology, biochemistry, molecular biology, immunology, pharmacology and other biomedical disciplines, which helps to network the knowledge acquired during studies at the Faculty of Biotechnology and Drug Development. In the course, each micronutrient will be studied from the aspect of discovery and history, molecular mechanism of action and physiological function, causes of possible deficiency and diagnostics and their medical application based on evidence through important meta-analyses. Students will independently present some of the issues of individual micronutrients in seminars in order to gain experience in the analysis of scientific publications and the art of presenting data.

At the end of the course students will be able to:

- Understand the physiological functions of micronutrients
- Recognise the sources of micronutrients in food, medicines and supplements
- Recognise the mutual interactions of drugs and micronutrients
- Apply the principles of evidence-based medicine when administering micronutrients

BUM 106 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Cell therapy

ECTS: 5

Course leader:
Bojan Polić

Cell therapy is a term that describes the process of using cells in the regeneration of damaged tissue or the treatment of malignant diseases. The content of this course includes modern knowledge about the origin and biology of individual stem cells, the mechanisms of their self-renewal and differentiation, as well as modern knowledge about the use of stem cells for the purpose of experimental or clinical therapy in biomedicine.

At the end of the course students will be able to:

- Define what stem cells are and what types of stem cells they are
- Describe stem cells that can potentially be used in cell therapy
- Describe the latest trends in stem cell research
- Describe the different possibilities of using cellular therapy
- Describe the use of cellular therapy in clinical practice
- Analyse problems and risks in cell therapy
- Describe the techniques of isolation, characterization and cultivation of cells for the needs of cell therapy
- Describe the potential use of stem cells in order to find and test new drugs

BUM 101 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Systemic biomedicine

ECTS: 6

Course leader:
Katarina Kapuralin

The goal of this course is to provide students with an in-depth understanding of the basic principles of systems biomedicine, a discipline that focuses on the analysis of dynamic interactions within biological systems in order to understand their comprehensive functioning, rather than just individual components and processes. Through the course, students will become familiar with the basics and principles of modern experimental approaches in the study of diseases, especially through the simultaneous analysis of large data sets. With a particular emphasis on genomics and metabolomics, this course will explain how these "omics" technologies are used to investigate the molecular pathogenesis of disease. In addition, we will discuss the role of "omics" methods in early diagnosis, prognosis and development of diseases, identification of new therapeutic targets, as well as in drug safety research and understanding of their mechanisms of action. Furthermore, students will be introduced to the basics of modelling and bioinformatics, key tools that enable the interpretation and analysis of complex biological data.

At the end of the course students should be able to:

- Define and explain what systemic biomedicine is
- Understand how the monitoring and analysis of dynamic interactions among the factors of a biological system enable the understanding of the entire biological system
- Understand the principles and methods used for measurements and analyses in systemic biomedicine
- Understand the basic principles of modern analysis methodologies
- Understand the basic principles of modelling, statistical analysis, and bioinformatics approaches in systemic biomedicine
- Independently analyse data sets using algorithms and software presented in seminars and exercises

BUM 102 – Spring Semester

Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Nanomedicine

ECTS: 5

Course leader:
Jelena Ban

The course includes an introduction to the principles of nanomedicine and knowledge of the most important methods and achievements in the field of nanotechnology aimed at medicine, based primarily on basic research. The course provides students with the opportunity to acquire experimental and practical knowledge in nanotechnology. During the implementation of the course, the basic concepts, methods and instruments used in nanotechnology will be explained. The course is held for domestic and foreign students (if necessary, also in English, in agreement with the students). During the course, students will acquire the knowledge they need to understand the field of application of nanomedicine, understanding how to design nanodevices and nanomedicines, and the difference between traditional methods and nanotechnology.

After completing the course, students will be able to:

- understand the basic principles of nanotechnology and its applications in biomedicine
- understand the application of nanomedicine in drug development, diagnosis, prevention and treatment of diseases
- recognise the contribution of nanotechnology in medicine
- get acquainted through exercises with some of the methods and techniques used in nanomedicine, such as atomic force microscopy (AFM) and high-resolution microscopy

IRL 103 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Protein research methods

ECTS: 5

Course leader:
Nicholas J. Bradshaw

This course will help students to understand both how we study and how we make use of proteins in biotechnology. In lectures, students will learn about experimental approaches to studying proteins, via cell biology, proteomics, biophysics and structural biology approaches. This will be supplemented by computer-based seminars in which students get experience of handling data and investigating proteins through bioinformatics. Students will also study individual proteins in group work. Finally, students will gain laboratory experience at producing, purifying and testing recombinant proteins from bacteria, using a combination of previously covered and novel experimental techniques.

By the end of this course students should:

- Understand the general structure of proteins (revision from previous years)
- Understand typical functions of proteins, including protein-protein interactions, and how they are investigated experimentally
- Understand proteomics approaches for identifying proteins and how data is handled for these experiments
- Understand how the structure of proteins is studied experimentally, and have experience at bioinformatics approaches to investigating protein structure.
- Understand how proteins can be produced and purified from biological systems, and have experience of these processes in bacteria

IRL 104 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Antiviral and antitumour drugs

ECTS: 6

Course leader:
Mladen Merćep

The main goal of this course is to provide insight into the molecular mechanisms of tumour biology, an approach to the development of antitumour drugs based on the biological targets of their action. For this purpose, the principles of medicinal chemistry and the application of these principles in the development of new anticancer drugs will be presented.

After attending the course and successfully passing the exam, the student will be able to:

- List the main characteristics of cancer
- Understand the key molecular mechanisms involved in the regulation of DNA replication and gene expression, cell cycle, growth, forms of death, changes in metabolism, angiogenesis, and metastases and interactions with the tumour environment and the host's immune system
- List the main target molecules in the development of antitumour drugs
- List the main classes of antitumour drugs
- Critically analyse the shortcomings of medicines in use
- List strategies in the development of new drugs
- Understand the molecular mechanisms of drug action
- Prepare and present a seminar paper for the purpose of improving one's own practice of public speaking, understanding of the topic and group work

IRL 105 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Toxicology of drugs

ECTS: 5

Course leader:
Ivan Gudelj

The course Toxicology of drugs provides an overview of basic terms, biochemical and physiological processes, and methods and models related to preclinical research on the properties of drugs, such as their absorption, distribution, metabolism, elimination, toxicity and mechanism of action. In particular, the course will provide an introduction to the latest technologies and in vitro systems used today in the pharmaceutical industry to evaluate the toxicity of new drugs in the early stages of drug discovery and development. The goals of the course are to teach students to distinguish and describe different molecular mechanisms of toxic effects of drugs on individual tissues and organs, and to adopt methods for determining toxicity that are used in the early screening of drugs.

After completing the course, students will be able to:

- Explain the mechanisms of toxic effects of drugs on individual organs
- Explain the relationship between dose and response to medication
- Explain the term therapeutic index
- List types and examples of drug interactions
- State the stages of drug metabolism and key enzymes
- Explain the role of drug transporters in the study of drug interactions and drug toxicity
- Explain the importance of analysis of drug-metabolizing enzyme polymorphisms for determining individual dosage using specific examples of drugs
- Explain the importance of assessing mitochondrial toxicity in the early stages of drug discovery and development
- Explain the role of molecular components of cell junctions in the toxic effects of drugs
- Explain the principle of methods and distinguish between in vitro models and systems for testing the toxic effects of new drugs in preclinical trials
- Give examples of therapeutic proteins and peptides, and explain strategies to reduce their immunogenicity
- Differentiate molecular imaging methods and give examples of their application in drug research
- Explain the concept of in silico toxicology
- Discuss scientific papers that study the toxic effects of drugs
- Find relevant information in the field of drug toxicology on the Internet

BLS 104 – Fall/Spring

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Intellectual property

ECTS: 3

Course leader:
Petra Karanikić

The objective of the course is to acquire and apply basic knowledge about the protection and management of intellectual property in both a scientific and a business environment, with a special emphasis on the field of biotechnology. The course deals with the basics of intellectual property protection and management, various forms of intellectual property rights protection (formal and informal) are studied. Ways of applying the protection and management of intellectual property in scientific research and organisations are discussed. Different ways of commercialising intellectual property are presented. The role and significance of intellectual property protection in the field of biotechnology is especially addressed.

At the end of the course students will:

- Understand the importance of protecting and managing intellectual property.
- Differentiate individual forms and procedures of intellectual property protection.
- Understand the importance of intellectual property in the scientific and business environment.
- Understand and define the appropriate way of commercialising different forms of intellectual
- ownership.
- Understand the importance of managing and protecting intellectual property in the field of biotechnology.

EBIL 154 – Spring Semester

Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Pathophysiology of current public health problems and diseases

ECTS: 6

Course leader:
Marina Cetkovic-Cvrlje

The international summer school course is held as a result of the collaboration of the Faculty of Biotechnology and Drug Development with the Department of Biological Sciences of the University of St. Cloud State University (SCSU). The course has been held regularly since 2013, and is designed as an interactive form of teaching that provides a platform for the translation of generally accepted "best practice" methods of teaching in the form of a capstone course, enabling teaching through the synthesis of previous knowledge of the series courses, team learning and scientific writing and argumentation exercises. During classes, the emphasis is on critical thinking and teamwork in "mixed" small Croatian-American groups of a maximum of 4 students. Each group (of 5) works on a project investigating the etiopathogenesis of selected diseases in Croatia versus the USA, comparing and contrasting a number of aspects including public health, etiopathogenetic, pharmacological and epidemiological. On each topic, the groups prepare oral presentations and scientific essays (written in the prescribed American Psychological Association format), and carry out a detailed peer-review of all works. For each topic covered, students listen to lectures by professors from the University of Rijeka, Institute of Public Health PGŽ and SCSU, which is the basis for discussion of student works. The entire class will be conducted live using the classrooms of the Faculty of Biotechnology and Drug Development of the University of Rijeka. The SCSU-supported D2L Brightspace platform will be used to publish professor lectures, student presentations and papers, and all additional teaching materials.

During the course the student will:

- Synthesize knowledge from a wider range of courses, including physiology, pathophysiology, genetics, pharmacology and bioethics, with the aim of interdisciplinary analysis of complex public health pathologies
- Define and compare the most important public health challenges in Croatia and the USA
- Acquire the skill of scientific writing in the field of public health pathologies
- Acquire the skill of scientific argumentation and verbal communication in English in the field of public health pathologies
- Think critically and create one's own attitude about specific health problems, based on scientific facts
- Practice the skill of teamwork in small groups.

EBIL 164 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Neuroimmunology

ECTS: 3

Course leader:
Ivana Munitić

The aim of the course "Neuroimmunology" is to enable students to understand the importance of the interaction between the immune and nervous systems in both health and disease. Cellular and molecular mechanisms of neurodegenerative and neuroinflammatory diseases will be discussed as well as potential immunotherapeutic approaches for targeting them.

By the end of the course, students will be able to:

- Understand the importance of the immune surveillance of the CNS.
- Explain how the immune system cells enter the CNS.
- Define neuroinflammation.
- Understand the importance of neuroinflammatory processes in health and disease.
- Describe the relationship between the immune system and stress.
- Understand the molecular basis of sickness behaviour.
- Understand the molecular and cellular basis of neurodegenerative diseases.
- Critically discuss the current therapeutic approaches in neurodegenerative diseases.
- Integrate previously acquired knowledge in immunology, molecular biology and neuroscience for the purpose of proposing new immunotherapeutic approaches in neurodegenerative diseases.

EBIL 131 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Basics of biomolecule chromatography

ECTS: 3

Course leader:
Uroš Anđelković

This optional course provides an overview of the application of liquid chromatography of biological macromolecules in the field of biomedical sciences. The focus of the course is equally on both areas of chromatography - analytical and preparative. The course consists of lectures and seminars. During the lectures, the students will be given an introduction to the issues that will be covered in the seminars. Each student will find and inform the rest of the group about the chromatography of biological macromolecules, primarily proteins, nucleic acids and polysaccharides, and also the nanoparticles that are composed of these components, and the application of this analytical and preparative method of separation according to previously specified topics determined by the course leader.

After completing the course, students will:

- Be able to differentiate between various chromatography system configurations and why they are important
- Understand and plan experiments with liquid chromatography applied to analysis and preparative isolation of biological macromolecules and nanoparticles
- Be more familiar with the systemic analyses of biological macromolecules and nanoparticles
- Understand the role and significance of high-throughput analyses
- Connect existing knowledge with new knowledge

EBIL 136 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

OMICS methods in biotechnology

ECTS: 3

Course leader:
Uroš Anđelković

In the post-genomic era, progress in biosciences is based on new technologies. The great complexity of biological systems requires a comprehensive approach. Biological information contained in individual biological molecules (nucleic acids, proteins, peptides, lipids, glycans and other metabolites) is necessary for understanding biological systems. Due to the different biochemical properties of biological molecules, their analysis technologies are different. The large heterogeneity requires high-throughput methods to be considered in a sustainable time frame. Data collection and validation are the basis of successful application of OMICS technologies in research, medicine, biotechnology. The integration of biological data obtained by different techniques and different experiments is necessary to get a more detailed insight into the functioning of the cell and to better understand the molecular basis of the disease. The aim of the course is to familiarise the students with the application of various high-throughput techniques in the analysis of biological molecules necessary in the search for answers to given biological questions and their application in medicine and biotechnology.

After completing the course program, students will be able to:

- Explain the principles of relevant high-throughput methods for the characterisation of biological systems and understand the information contained in the results of individual high-throughput methods
- Evaluate the advantages and disadvantages of specific high-flow methods
- Understand the importance of evaluation and data quality in OMICS research
- Choose methods and understand the steps necessary for the design of OMICS experiments
- Understand the importance and potential application of an integrative OMICS approach
- Monitor and critically evaluate the scientific literature in the OMICS field

EBIL 175 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Basics of bioinformatics

ECTS: 3

Course leader:
Gordana Apić

The main goal of the course is to acquaint students with the basics of searching publicly available databases, the possibilities that such databases provide, basic file formats, and the basics of bioinformatics analysis and programming (Python, Linux). Modern science is often based on experiments that generate extremely large amounts of data that need to be analysed with bioinformatics tools (e.g. transcriptome, R, etc.), and students will gain insight into some of these tools.

After completing the course, students will be able to:

- Search publicly available databases (e.g. NCBI)
- Search for similarity of sequences of interest with sequences in the database
- Compare (align) sequences using online tools
- Program basic commands in Python
- Work in the Linux interface
- Analyse Next-Generation-Sequencing data
- Analyse NGS miRNA dataset
- Read, critically analyse and integrate knowledge obtained from research articles

EBIL 183 – Spring Semester

BIOtech
Fakultet biotehnologije i razvoja lijekova
Faculty of Biotechnology and Drug Development

Advanced topics in neuroscience

ECTS: 3

Course leader:
Željka Minić

The aim of the course is to understand the interplay between cognition and visceral physiological processes both in health and disease states. The course will focus on understanding cognition from the neuroscience perspective by exploring literature published in scientific journals. The students will explore the distinction between the brain and the mind to understand how cognitive processing drives human behaviour and motivation. The materials will be explored both intellectually and experientially to gain comprehensive insight into neurocircuits influencing cognitive function.

By the end of the course, the students will be able to:

- Understand higher brain functions and specifically, the role of the frontal cortex
- Understand neurobiological responses to stress
- Describe the difference between the brain and the mind
- Understand how the brain controls cognitive processes
- Critically discuss the role of mindfulness practice in cognition
- Explore their own cognition
- Integrate pre-existing knowledge of physiology and neuroscience with the knowledge gained during the course to develop new therapeutic approaches for mental disease