JOSIP JURAJ STROSSMAYER UNIVERSITY OF OSIJEK

FACULTY OF FOOD TECHNOLOGY OSIJEK
FACULTY OF MEDICINE OSIJEK

PROPOSAL OF THE INTERDISCIPLINARY GRADUATE STUDY PROGRAMME IN ENGLISH: BIOTECHNOLOGY

Osijek, March 2020

The proposal of the Interdisciplinary Graduate Study Programme in English: Biotechnology has been drafted as a part of the project titled Development and Implementation of the Interdisciplinary Graduate Study Programme "Biotechnology" in English (as part of the Call "Internationalisation of Higher Education" from the European Social Fund (ESF), operational programme "Efficient Human Resources 2014 – 2020").

The following people participated in the process of drafting the proposal:

1. Stela Jokić, PhD, full professor at the Faculty of Food Technology Osijek (project coordinator, writing the analysis for the study programme, development of the curriculum for the 1st year of the study programme, as well as the curriculum for the module Industrial Biotechnology)
2. Ljubica Glavaš-Obrovac, PhD, full professor with tenure at the Faculty of Medicine Osijek (project coordinator representing the Faculty of Medicine Osijek. Proposal and development of the study programme curriculum, writing the analysis of the study programme, development of the curriculum for the 1st year of the study programme, as well as the curriculum for the module Medical Biotechnology)
3. Ivica Strelec, PhD, full professor at the Faculty of Food Technology Osijek (development of the curriculum for the 1st year of the study programme and the curriculum for the module Industrial Biotechnology)
4. Natalija Velić, PhD, associate professor at the Faculty of Food Technology Osijek (development of the curriculum for the 1st year of the study programme, and the curriculum for the module Industrial Biotechnology)
5. Daniela Čačić Kenjerić, PhD, full professor at the Faculty of Food Technology Osijek (learning outcomes at the study programme level)
6. Authors of the courses curricula - course teachers and their associates.

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1.1. Title of the study programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
1.2. Holder of the study programme	Faculty of Food Technology Osijek of the Josip Juraj Strossmayer University of Osijek (PTFOS)
1.3. Partner institutions	Faculty of Medicine Osijek of the Josip Juraj Strossmayer University of Osijek (MEFOS)
1.4. Type of the study programme	University study programme
1.5. Level of the study programme	Graduate
1.6. Implementation method of the study programme	Standard
1.7. Academic / professional title after the completion of the study programme	Master of Biotechnology
1.8. Scientific / field of the proposed study programme	8. Interdisciplinary Areas of Science, field 807 Biotechnology in Biomedicine (natural area, biomedicine and healthcare, biotechnical area)

2. INTRODUCTION	
2.1. Reasons for establishing the study programme	The goal of the proposed study programme is contributing to the resolution of numerous recognised social issues and challenges. Primarily, Croatian institutions of higher education offer a very low number of study programmes in foreign languages, which results in a very low incoming and outgoing mobility of students. The international mobility of students and academic staff is crucial for achieving the University's competitiveness, international competitiveness and internationalization. The main obstacles to mobility are considered to be an insufficient number of exchange programmes, language barriers, and the lack of funding. Apart from that, the existing study programmes are not sufficiently attractive to foreign students and are often not adapted to the needs and requirements of the labour market. Study programmes in the area of biotechnology are implemented in Croatia as part of two undergraduate and three graduate study programmes, but currently there are no Biotechnology study programmes in Croatia that are fully implemented in English. Research and innovation in the area of biotechnology are a driver for the development of new technologies in sustainable agricultural production and food production, medicine, the development of "green" industrial processes, and ecologically safer and more energy efficient sources of energy. The region of Slavonia and Baranja is the forerunner in agricultural production and food production in the Republic of Croatia. Apart from that, there is a valuable but insufficiently utilised renewable resource in the region, which is lignocellulosic waste generated in agriculture, food industry, and the wood processing industry, and it represents a basis for a sustainable production of biofuels. All of the above, as well as the fact that the burning problems of the 21st century include reduction of resources, environmental pollution, and the fight against diseases, which are all areas where biotechnology can offer a solution, justify the need for the education of new qualified people in the area, i.e. the implementation of a study programme in biotechnology in this region as well. The distinguishing features of this study programme, when compared to the other study programmes currently being implemented in the Republic of Croatia, are its interdisciplinary nature and the English language which would be used throughout the study programme, and would greatly contribute to the internationalisation of the University and the increase in incoming mobility of (foreign) students. Enrolment quotas in EU countries and beyond are low considering the demand, and these often include study programmes which are not interdisciplinary or flexible regarding enrolment (they require previous knowledge in the area of biotechnology or demand that students pass many bridging courses before enrolling). Specifically, due to its interdisciplinary nature, this study programme will enable interested students who acquired appropriate previous knowledge as part of undergraduate study programmes in various areas to enrol to the interdisciplinary study programme in biotechnology after completing their undergraduate studies.
2.2. Evaluation of purposefulness	The interdisciplinary graduate study programme Biotechnology is the first university study programme in the Republic of Croatia of its kind, fully

considering the requirements of the labour market in the public and private sectors	implemented in English, which makes it unique on the labour market, both in the public and the private sectors. The development and implementation of a graduate study programme Biotechnology in English, with two modules, *Industrial Biotechnology* and *Medical Biotechnology*, conforms to the previously mentioned needs and requirements of the labour market, i.e. the economy sector. *Industrial Biotechnology* is the basic factor for the development of bio-economics and sustainable technologies, i.e. "green technologies", which are characterised by the sustainable use of renewable raw material for industrial purposes, with the preservation of biological diversity and environmental protection. *Medical biotechnology* is based on applying the achievements of life sciences to the development of innovative technologies aimed at improving human health. The programme of this module includes topics like recombinant DNA technology, genetic and protein engineering, tissue engineering, medication and vaccine development, rapid diagnostics, personalised medicine, and gene therapy. *Medical Biotechnology* is a particularly propulsive area which is continuously growing, and which is expressed through significant financial investments into research and development within existing companies, as well as establishing new biotechnological companies in this area. Economic operators from the public and the private sectors were the ones who indicated the need to start a study programme which will educate experts who will possess knowledge, skills, and competencies in these two areas of biotechnology. Apart from that, students who finish the study programme will acquire communication and presentation skills which will enable them to present scientific and professional achievements in English. This is often not the case for the existing study programmes which are only implemented in Croatian, and problems with communication in English may present an issue when working in an international environment. Furthermore, the new study programme will enable the students from the Republic of Croatia, as well as from all across Europe and beyond, to acquire knowledge, skills, and competencies for employment, i.e. to be able to participate in the work of existing biotechnological and similar companies (and the public sector), as well as for establishing new companies, particularly in priority areas like sustainable food production, nutraceutical and pharmaceutical production, biomedical research, and environmental protection. As a consequence, it will provide them with a higher level of competitiveness at the international and European labour markets, as well as academic exchange. Namely, there is an actual need within the EU for personnel with knowledge, skills, and competencies in biotechnology, which will be acquired as part of the proposed interdisciplinary study programme. The same information has been presented as part of the current operational programme Horizon 2020, as well as the upcoming programme Horizon Europe, in which the research and cooperation with industrial partners are aimed toward the development of innovative products and the development of high added value, according to the principles of circular economy, environmental preservation, reducing climate change, i.e. sustainable development. Upon completion of the interdisciplinary graduate study programme Biotechnology in English, students will have the above competencies, which will enable them to be more employable (by introducing key knowledge and innovations into the economy) and increase their competitiveness in the domestic and international labor market.

2.3. Conformance with the mission of the University and the applicant's strategy, as well as with the strategic document of the Network of Higher Education Institutions	The proposed study programme conforms to numerous strategic documents at the local, national, and the European level. Primarily, it adheres to the Strategy of the Josip Juraj Strossmayer University of Osijek for the period 2011-2020, its goal and vision, which are defined as "striving toward making a step forward to achieve competitive advantage and a desirable place to study and work". With that in mind, "It is necessary to join the European area of higher education, develop the Bologna process and mobility while ensuring quality". New study programmes are of strategic significance for the Osijek University, which will be attractive to domestic and foreign students, adapted to their individual needs, and relevant with regard to the demands set by the labour market. At the national level, it conforms with the Partnership Strategy between the Republic of Croatia and the European Commission for the use of ESIF 2014-2020, which emphasizes the problem of low participation of students in the entire STEM area, outdated curricula and educational programmes, and their lack of coordination with the demands of the labour market, insufficient incoming and outgoing mobility, and indirectly, insufficient internationalisation, focus on the quality of education, and in general a low number of programmes available in foreign languages. The Josip Juraj Strossmayer University of Osijek fully supports the mission and the development strategy of its constituent parts, the Faculty of Food Technology Osijek and the Faculty of Medicine Osijek. Another goal of the University is increasing the number of students in the STEM (*Science, Technology, Engineering, Mathematics*) area. ***Conformance of study programmes with the mission and the strategic goals of the Faculty of Food Technology Osijek*** The Faculty of Food Technology Osijek (PTFOS) of the Josip Juraj Strossmayer University of Osijek is a modern institution of higher education with an active scientific and professional community and eight different university study programmes at three levels of higher education, and those study programmes are equivalent to similar study programmes in Europe. The concept of lifelong education is implemented through various programmes, which, along with the formal education programmes, comprise an education that conforms to the Bologna process. In the times of an increasingly dynamic development of technology and science, and the integration of the national system of education into the European Higher Education Area (*European Higher Education Area* – EHEA), the primary task of the PTFOS is constantly improving the conditions and the quality of the study process, developing scientific-research and professional activities, and increasing the standard of living for the students, teachers, and other employees of the PTFOS. In January of 2018, the *Development Strategy of the Faculty of Food Technology Osijek for the Period 2017/2018-2021/2022* has been adopted. The PTFOS Development Strategy is based on the self-analysis of the existing condition and the criteria and the conditions under which the PTFOS operates, on the principles and recommendations from the strategic European Union documents which are the foundation of the European Research Area (European Research Area, ERA) and the European Higher Education Area (European Higher Education Area, EHEA), national and university strategic documents, standing legislation, as well as University

and Faculty bylaws. In the process of drafting the Strategy, the issues that were considered included the specificity of the Faculty, the conditions under which it operates, and the wider social context. The *Strategic Areas of Development of the Faculty of Food Technology Osijek are:* education and students; research and innovation: cooperation; and the organisation, resources, and the quality assurance system.

Strategic goals of the Faculty:

1. Upgrading existing and establishing new study programmes and lifelong education programmes, as well as the continuous advancement of the education process
2. Upgrading the research capacities, the scientific and innovation work, and advancing cooperation and the transfer of knowledge and research results to the economy
3. Advancing the international, interinstitutional, and business cooperation
4. Continuous advancement of human, facility, and scientific-research capacities of the Faculty

The PTFOS Development Strategy defines the mission and the vision of the PTFOS:

The mission of the Faculty of Food Technology Osijek is the systematic development and dissemination of nationally and internationally recognised excellence in education and research in the area of biotechnical, technical, and natural sciences, and the transfer and application of knowledge for the benefit and prosperity of all the members of society. The Faculty ensures the mobility of students and teachers, the rational use of human and material resources, supervision and the constant improvement of quality, competitiveness, and international competitiveness of the educational and scientific work. In the course of realising this mission, the Faculty is systematically implementing a development strategy based on excellence in the scientific-education and professional activities.

The mission of the PTFOS is fully determined by:

1. The Faculty's area of activity,
2. Positive European trends in the development of higher education, and
3. The existing and future legislation at the level of the Republic of Croatia, University of Osijek, and the Faculty.

According to the modern considerations regarding the position of higher education, the Faculty is developing its area of activities through the following activities:

a) Educational activities – educating competent professionals at the level of undergraduate (three-year), graduate (two-year), postgraduate specialist, and doctoral study programmes, as well as various lifelong education programmes,
b) Scientific activities – working on scientific projects aimed at raising the general level of fundamental and particularly applied knowledge withing the Faculty's area of activity,
c) Professional activities – working on professional projects provides quick and efficient application of the latest scientific achievements in the economy, or the areas of general and public interest,
d) Social activities – working on raising the general social awareness on the place and the role of our profession or on the current problems and

achievements in the area of our own scientific, educational, and professional activities.

The vision of the Faculty of Food Technology Osijek is to be an elite scientific and educational institution in Croatia, focused at the implementation of internationally recognisable scientific, developmental, and professional research in the area of biotechnical, technical, and natural sciences, that matches the European Higher Education Area (*European Higher Education Area* – EHEA) and the European Research Area (*European Research Area* – ERA). The PTFOS will continue with its education of internationally recognised, high quality, and competent professionals, produce internationally recognised scientific and professional research and provide strong support to the development of the economy. Through its implementation of the policy of quality, the PTFOS will continue to work on its recognisability and establishment as a desirable institution of higher education, as well as a reliable partner to the economy, domestic and foreign scientific and educational institutions, and students. With the goal of implementing this, the PTFOS will cooperate with academic and economic partners domestically and abroad, and ensure constant supervision and increase in quality, competitiveness, and international competitiveness of the educational, scientific, and professional work. With everything mentioned above in mind, *the Strategic Programme of Scientific Research of the Faculty of Food Technology Osijek, Josip Juraj Strossmayer University of Osijek* has been made.

Finally, we can conclude that the study programmes of the Faculty of Food Technology Osijek conform to the scientific mission and vision of the PTFOS, i.e. with the strategic goals from the Development Strategy and the Strategic Programme of Scientific Research of the PTFOS. The goals and the structure of the proposed interdisciplinary study programme Biotechnology in English conform to the Development Strategy of the Faculty of Food Technology Osijek and the Development Strategy of the Josip Juraj Strossmayer University of Osijek

Conformance of the study programme with the mission and the strategic goals of the Faculty of Medicine Osijek

Article 1 of the Statute of the Faculty of Medicine Osijek states that: "The mission of the Faculty of Medicine Osijek of the Josip Juraj Strossmayer University of Osijek is the education of future physicians and other medical staff, teachers, and scientists, encouraging scientific research, as well as conducting research. The Faculty of Medicine Osijek strives toward excellence in education and research in the area of biomedicine and healthcare, based on modern teaching principles, the humane approach, and strict ethical principles. It systematically encourages future and present medical personnel to engage in lifelong education and to create and apply medicine grounded in proof. Acquiring new knowledge through biomedical research and the education of educational and scientific staff is the foundation for preserving health and advancing prevention, diagnosis, and treatment of illnesses in the community where we are active".

According to our mission, and also considering one of the most important recommendations of the WHO, realising Goal 18 – Development of Human Resources in Health: "By 2010, all EU Member States must ensure that all healthcare personnel within the healthcare system, but also within other related areas, have the appropriate knowledge, attitudes, and capabilities,

	with the purpose of preserving and advancing health". According to the strategy of the World Health Organisation (WHO) "Health for All in the 21st Century", Directive 2005/36/EC[1], Directive 2013/55/EU[2], Operational Programme: Efficient Human Resources 2014-2020[3], Strategic Plan for the Development of Human Resources in Health 2015–2020[4], as well as the Strategy for Education, Science, and Technology (2014; Official Gazette 124/14-2364)[5], we believe that it is our obligation to enable the improvement in the area of education of healthcare personnel. Considering that the emphasis is on the systematic education of all profiles of healthcare personnel, it is important to note that the medical-laboratory, or biomedical-laboratory science has an important role in the promotion of the national programme for the development of human health and social stability. Medical-laboratory diagnostics, which is actually the fusion of natural sciences and medical disciplines, must be improved and it must provide the best possible option for the modern diagnostic and treatment trends. We believe that it is an essential component of a good healthcare system of every country because it has a vital role in diagnosing and treating illnesses, as well as the leading role in illness prevention programmes, as well as a lot of scientific research. In the spirit of the tendencies for European integration and the Bologna process through establishing study programmes at the undergraduate, graduate, and postgraduate levels, the Faculty of Medicine Osijek enables vertical mobility through all 3 cycles of higher education, including lifelong education of healthcare personnel, which also matches our development strategy and mission. Vertical mobility through the education system is provided all the way to the eighth level of the Croatian Qualifications Framework (HKO). The study programme conforms to the Guidelines and Criteria for Establishing New Study Programmes at Institutions of Higher Education, the strategic document of the Network of Higher Education Institutions in the Republic of Croatia, issued by the National Higher Education Council in 2011.
2.4. Comparability of the study programme with the study programmes of accredited institutions of higher education in Croatia and in the European Union	There is a long-standing tradition of implementing study programmes in biotechnology (since 1956) in the Republic of Croatia, which started when the University of Zagreb established one of the oldest study programmes of biotechnology in Europe, which is being implemented at the Faculty of Food Technology and Biotechnology (PBF) of the University of Zagreb. It features a comprehensive programme consisting of industrial and molecular biotechnology. Other aspects of biotechnology application are also represented at the University of Zagreb and other Croatian universities, e.g. the Faculty of Chemical Engineering and Technology, the School of Medicine, the Faculty of Pharmacy and Biochemistry, and the Faculty of Science of the University of Zagreb, as well as the Faculty of Medicine Osijek of the Josip Juraj Strossmayer University of Osijek, the Department of Biotechnology of the University of Rijeka, the School of Medicine of the University of Split, and the University of Dubrovnik and the University of Zadar. So, the proposed study programme is comparable to the following programmes offered by accredited institutions of higher education in Croatia and the European Union: Graduate study programmes "Molecular Biotechnology" and "Bioprocess

	Engineering" at the Faculty of Food Technology and Biotechnology of the University of Zagreb http://www.pbf.unizg.hr/studiji/diplomski_studij/molekularna_biotehnologija http://www.pbf.unizg.hr/studiji/diplomski_studij/bioprocesno_inzenjerstvo Graduate university study programme "Biotechnology in Medicine" at the Department of Biotechnology of the University of Rijeka https://www.biotech.uniri.hr/hr/studiji/diplomski-sveucilisni-studij-biotehnologija-u-medicini.html Graduate study programme "Biotechnology" at the Universität für Bodenkultur (BOKU), Vienna, Austria (specialisation/module *Medical Biotechnology* is implemented in cooperation with the Medical University of Vienna) https://boku.ac.at/fileadmin/data/H01000/mitteilungsblatt/MB_2018_19/MB17/066_418_Mastercurriculum_BT_2019U.pdf Graduate study programme "Biotechnology" at the TU Graz, Graz University of Technology, Graz, Austria https://www.tugraz.at/en/studying-and-teaching/degree-and-certificate-programmes/masters-degree-programmes/biotechnology/ Graduate study programme "Industrial Biotechnology" at the Technical University of Munich, Munich School of Engineering, München, Germany https://www.mse.tum.de/en/prospective-students/industrial-biotechnology/ Graduate study programme "Medical Biotechnology" at the KTH Royal Institute of Technology, Stockholm, Sweden https://www.kth.se/en/studies/master/medicalbio/course-overview-1.268135 The proposed study programme is interdisciplinary in nature and the second year of study (i.e. the 3rd and the 4th semester) will be implemented as part of two thematically different modules, Industrial Biotechnology and Medical Biotechnology. That is why the study programmes offered for comparison had both the general titles "Biotechnology", as well as specific study programmes with the titles "Industrial Biotechnology" and "Medical Biotechnology". The comparison of the proposed study programme with the previously mentioned study programmes leads to the conclusion that there is a high level of conformance and comparability of the proposed study programme with the considered study programmes of Croatian and European universities, which matches the guidelines of the European Commission and is in the spirit of the Bologna process, which promotes the mobility of students and teachers within the European university area as one of its main goals. There are currently no graduate study programmes of biotechnology which are fully implemented in English in Croatia, and it is a valuable initiative which will also serve as a tool for attracting students from outside of the Republic of Croatia.
2.5. Options regarding student mobility	According to the principles of the Bologna declaration, the proposed study programme has been structured and evaluated in ECTS credits. The

as part of the study programme	Proposed study programme Biotechnology is designed in a way that enables the acceptance of students from other related education institutions (from all over the world). The ECTS credit system, the defined competencies acquired by a master of biotechnology after they complete the study programme, and the list of knowledge and skills for every course and the entire programme are the basis for the openness of the study programme toward student and teacher mobility in the common European higher education area. International mobility of the students and teachers is based on the bilateral partnership agreements between universities, and it is supported through European Union programmes for encouraging mobility at universities. After completing this study programme, the masters of biotechnology may enrol into a postgraduate university study programme (duration 3 years, 180 ECTS credits) and/or a postgraduate specialist study programme (duration one to two years) at institutions of higher education domestically or abroad.
2.6 Connectivity with the local community (economy, entrepreneurship, civil society...)	Initiating this study programme is very significant for the entire region of Eastern Croatia, which is why it is supported by the City of Osijek and the Osijek-Baranja County. The goal of the proposed study programme is to attract as many students as possible to the University of Osijek, from Croatia, Europe, and beyond. Considering the modern emigration trends among the younger population of this country to Western European countries in the pursuit of jobs, but also to study, this study programme is an attempt to change the direction of their mobility, i.e. keep young people in Osijek as students. The proposed study programme will increase the attractiveness of the University of Osijek as an education centre in the area of biotechnology. Considering the increasing number of jobs appearing at the labour market (e.g. production of biofuel, small fermentation industries, biological waste and wastewater processing, biotechnological food production, biopharmaceuticals production, production of biosensors based on biochips, cellular therapy, molecular diagnostics, etc.) which require knowledge, skills and competencies provided by the proposed study programme, it can be expected that the initiation of this study programme will have a positive impact on the local community as a whole.
2.7. Harmonisation with the requirements of professional associations	The main professional association of biotechnologists in Croatia is the Croatian Society of Biotechnology (CSB), which is a member of the European Biotechnology Thematic Network Association (EBTNA) and has an active cooperation with the European Federation of Biotechnology (EFB), as well as being a member of the Croatian Engineering Association which is a member of FEANI (Fédération Européenne d'Associations. Nationales d'Ingénieurs). The CSB includes gatherings of biotechnologists and professionals from related areas, for the purpose of advancing all areas of biotechnology, offering professional and scientific assistance, and advancing biotechnology courses at institutes of higher education. Furthermore, one of the departments of the Croatian Academy of Engineering (CAE) is the Department of Bioprocess Engineering, and some of the teachers employed by the proposed study programme are members of that Department. The Croatian Academy of Engineering (CAE) is a member

	of the European association of academies Euro-CASE. The participation of teachers from this study programme in the activities of national professional associations and the work of the Department of Bioprocess Engineering of the CAE, which includes close cooperation with international professional associations, guarantees that the recommendations offered by the practice will be promptly incorporated in the implementation of the proposed study programme of Biotechnology. The proposed interdisciplinary study programme conforms to the requirements of the professional associations, primarily the Croatian Society of Biotechnology.
2.8. List of potential partners from outside the system of higher education	Considering the previously mentioned fact that the need for the initiation of this study programme, which will provide professionals with knowledge, skills, and competencies for these two areas of biotechnology, was expressed by the economic operators from the public and private sectors, who are also the partners from outside of the system of higher education. These are partners with whom both institutions have been cooperating for many years in the course of implementing scientific-professional projects and professional practice for students: the Institute Ruđer Bošković, Agricultural Institute Osijek, Veterinary Institute, Vodovod Osijek d.o.o., Hrvatske vode, Inspecto d.o.o., Podravka, Pivovara Osijek d.o.o., Slavonija slad d.o.o., Meggle Hrvatska d.o.o., Žito grupa Osijek, Kandit d.o.o., Saponia d.d, Bioplin – OSATINA d.o.o. - Osatina Grupa, Unikom d.o.o., Croatian Institute for Public Health of the Osijek-Baranja County, Institute for Medical Research, University Hospital Centre Osijek, Apipharm, Yasenka, and others.

<table>
<tr><th colspan="2">3. GENERAL PART</th></tr>
<tr><td>3.1. Duration of the study programme</td><td>Two (2) academic years (4 semesters)</td></tr>
<tr><td>3.2. Minimum number of ECTS credits required to complete the study programme</td><td>120</td></tr>
<tr><td>3.3. Conditions for study programme enrolment</td><td>Enrolment to the study programme is done according to a public contest announced by the University Senate in accordance with the Statute. The enrolment contest is announced by the University at least six months before the classes start. The content of the contest is regulated by the Statute, and the conditions and criteria contained in the contest are determined by the Faculty.
Admission to this master programme in Biotechnology is subject to the possession of a three-year university degree (6 semesters, 180 ECTS) or other suitable qualification obtained abroad.
Graduates with an excellent Bachelor's degree are admitted directly if they:
• hold a Bachelor's degree in a related life sciences, biotechnical or biomedical field with a mark of A, B or ≥ 5 or an equivalent mark (≥ good)
• or demonstrate an equivalent background (BSc) and practical experience
• and have excellent English skills.
Prospective students who meet most but not all of the entry requirements are invited to interview.
Students should possess university level knowledge of:
o Mathematics and Physycs;
o Chemistry and Biochemistry;
o Biology;
o Microbiology
Moreover, candidates must meet the curricular requirements and pass a test to assess their personal competences and skills.
English Language Assessment
English Language knowledge, level B2 (or higher) according to the Common European Framework of Reference for Languages (CEFR).
This should be certified in one of the following ways:
• Through one of the certificates TOEFL Certificate (at least 90 points) or IELTS Certificate (6 and above with at least 5.5. in every section).
• Hold a Degree obtained in English. The document must state that the Degree Programme was held in English;
• English native speakers (i.e. English is their mother-tongue).</td></tr>
<tr><td>3.4. Language of the study programme</td><td>English</td></tr>
<tr><td>3.5. Learning outcomes of the study programme according to the legal</td><td><u>Module: Industrial Biotechnology</u>
<table><tr><th>Category</th><th>Learning outcomes</th></tr><tr><td>Knowledge</td><td>▪ BIOTECH-1: Comprehensively commenting</td></tr></table></td></tr>
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regulations, requirements of authorised professional associations, requirements of the labour marker	**and understanding**	the general phenomena and problems in the biotechnology, pharmaceutical and related industries ▪ INDBIOT-1: Discussing various aspects of biotechnology (biological, engineering, ethical, etc.) ▪ INDBIOT-2: Integrating and mobilising the acquired basic knowledge in the area of molecular biology, microbiology, biochemistry, and engineering in order to better understand the basic biotechnological principles and processes ▪ BIOTECH-2: Displaying a high level of professional knowledge and behaviour in laboratories and biotechnological industry facilities in accordance with the professional and ethics code in the field of biotechnical sciences
	Application of knowledge (analysis, synthesis, and evaluation)	▪ INDBIOT-3: Applying the acquired knowledge and skills for recognising and analysing the problems and proposing solutions in industrial microbiology, protein engineering, fermentation technologies, and the biotechnological production of nutraceuticals and pharmaceuticals ▪ INDBIOT-4: Applying the acquired knowledge and skills in planning, monitoring, and maintaining production and other processes according to the principles of sustainable development ▪ INDBIOT-5: Applying the acquired knowledge from the area of designing, modelling, simulating, and optimising for the purpose of improving the existing processes, as well as the development of new technologies ▪ BIOTECH-3: Applying the acquired knowledge for the purposes of improving and developing new products ▪ INDBIOT-6: Preparing, processing, and analysing statistical results
	Presentation skills	▪ BIOTECH-4: Successfully communicating with colleagues from the profession and transferring own ideas ▪ BIOTECH-5: Successfully communicating with colleagues at the facility ▪ BIOTECH-6: Successfully presenting professional content to the broader public
	Learning skills	▪ BIOTECH-7: Keeping up with scientific and

	professional literature and improving the acquired knowledge and skills according to job requirements ▪ BIOTECH-8: Accepting responsibility for own decisions ▪ BIOTECH-9: Accepting the requirements of other professions and being prepared to participate in interdisciplinary activities ▪ BIOTECH-10: To achieve the level of knowledge and skills necessary for further education in the area of biotechnology and related sciences

Module: Medical Biotechnology

Category	Learning outcomes
Knowledge and understanding	▪ BIOTECH-1: Comprehensively commenting the general phenomena and problems in the biotechnology, pharmaceutical and related industries ▪ MEDBIOT-1: Connecting the knowledge on the composition and structure of the genome of single-cell and multi-cell organisms with the options provided by genetic engineering regarding the development of biotechnological products in the form of food, medications, and other pharmaceutical products ▪ BIOTECH-2: Displaying a high level of professional knowledge and behaviour un biochemical, microbiological, and molecular-genetic research and industrial laboratories in accordance with the professional and ethics code in the field of biomedicine
Application of knowledge (analysis, synthesis, and evaluation)	▪ MEDBIOT-2: Applying the acquired knowledge and skills for recognising and analysing problems and proposing design proposals ▪ MEDBIOT-3: Applying the acquired knowledge in bioinformatics for data processing ▪ MEDBIOT-4: Applying the acquired knowledge in the area of modelling and simulation for the purpose of improving the existing processes, as well as the development of new technologies ▪ BIOTECH-3: Applying the acquired knowledge for the purposes of improving and developing new products

		▪ MEDBIOT-5: Applying modern molecular biotechnology methods for the development of medications, diagnostics, and treatments
	Presentation skills	▪ BIOTECH-4: Successfully communicating with colleagues in the profession and transferring own ideas ▪ BIOTECH-5: Successfully communicating with colleagues at the facility ▪ BIOTECH-6: Successfully presenting professional content to the broader public
	Learning skills	▪ BIOTECH-7: Keeping up with scientific and professional literature and improving the acquired knowledge and skills according to job requirements ▪ BIOTECH-8: Accepting responsibility for own decisions ▪ BIOTECH-9: Accepting the requirements of other professions and being prepared to participate in interdisciplinary activities ▪ BIOTECH-10: To achieve the level of knowledge and skills necessary for further education in the area of biotechnology and related sciences
3.6. Evaluation of the employability of students after the completion of study programme	Upon completion of the study programme, masters of biotechnology will be able to gain employment in scientific, higher education, and research institutions in the Republic of Croatia, as well as the European Union Member States and beyond. Furthermore, employment is also possible in state agencies and public services and companies. Specifically, graduated masters of biotechnology may work in the fermentation industry, pharmaceutical industry, production-technological and analytical laboratories, production of biofuel, on positions dealing with environmental protection within various production processes.	
3.7. Possibility for the continuation of education	Upon completion of this study programme, the masters of biotechnology may enrol in the postgraduate doctoral university study programmes (3-year programmes, 180 ECTS) and/or postgraduate specialist study programmes (one to two-year programmes) at institutions of higher education domestically and abroad.	
3.8. Lower-level study programme/s of the applicant or other institutions in the Republic of Croatia from which students may enrol to the proposed study programme	Undergraduate study programmes in the Republic of Croatia: “Food Technology” (PTFOS); Biotechnology (Faculty of Food Technology and Biotechnology); Medical-Laboratory Diagnostics (MEFOS); “Chemical Engineering” (Faculty of Chemical Engineering and Technology), “Ecological Engineering” (Faculty of Chemical Engineering and Technology, “Chemical Technology” (Faculty of Chemistry and Technology), “Chemistry” (Josip Juraj Strossmayer University of Osijek), Biotechnology and Drug Research (Department of Biotechnology, University of Rijeka).	

	Some of the undergraduate study programmes in the EU and the surrounding countries include: “University Study Programme Chemical Engineering”, University of Ljubljana, Slovenia; “Chemical Technology”, University of Maribor, Slovenia; “Environmental Sciences”, University of Nova Gorica, Slovenia; “Chemical and Process Engineering”, TU Graz, Austria. Apart from the mentioned study programmes, all relevant undergraduate study programmes from Europe and all over the world are welcome.

4. STUDY PROGRAMME DESCRIPTION

4.1. List of obligatory and elective courses/module

1st YEAR

I semestar		Number of teaching hours					
Label	**Course**	**L**	**S, SE**	**E**	**F**	**Total**	**ECTS**
BIOTECH-01	Introduction to biotechnology	10	5	0	0	15	**1**
BIOTECH-02	Molecular biology with genetic engineering	20	15	15	0	50	**5**
BIOTECH-03	Genetics and genomics	45	15	15	0	75	**7**
BIOTECH-04	Structural biochemistry	25	10	15	0	50	**5**
BIOTECH-05	Protein engineering	30	20	10	0	60	**6**
BIOTECH-06	Bioinformatics and biostatistics	20	20	20	0	60	**6**
	Total	150	85	75	0	310	**30**

L - Lectures, S - seminars, SE - seminary exercises, E - exercises (laboratory or computational), F-field exercises

II semestar		Number of teaching hours					
Label	**Course**	**L**	**S, SE**	**E**	**F**	**Total**	**ECTS**
BIOTECH-07	Molecular enzymology	30	15	15	0	60	**6**
BIOTECH-08	Biochemistry and physiology of industrial microorganisms	30	15	30	0	75	**6.5**
BIOTECH-09	Applied microbiology	30	15	30	0	75	**6.5**
BIOTECH-10	Molecular modelling	30	15	0	0	45	**3**
BIOTECH-INT	Internship	0	0	0	80	80	**2**
	Elective course I					30	**3**
	Elective course II					30	**3**
	Total	120	60	75	80	395	**30**

L - Lectures, S - seminars, SE - seminary exercises, E - exercises (laboratory or computational), F-field exercises

Elective courses

		Number of teaching hours					
Label	**Course**	**L**	**S, SE**	**E**	**F**	**Total**	**ECTS**
BIOTECH-E01	Methodology of scientific-research work	20	10	0	0	30	**3**
BIOTECH-E02	Bioethics, biosafety and intellectual property rights in biotechnology	20	10	0	0	30	**3**

BIOTECH-E03	Protein purification	15	5	10	0	30	**3**
BIOTECH-E04	Experimental molecular biology	10	10	10	0	30	**3**
BOTECH-E05	Biotechnology entrepreneurship	20	10	0	0	30	**3**
BIOTECH-E06	Enzyme immobilization techniques	15	5	10	0	30	**3**

* Out of the offered elective courses, a student must elect at least 2 at the first year of study**.**

L - Lectures, S - seminars, SE - seminary exercises, E - exercises (laboratory or computational), F-field exercises

2nd YEAR

MODULE: INDUSTRIAL BIOTECHNOLOGY

III semestar		**Number of teaching hours**					
Label	**Course**	**L**	**S, SE**	**E**	**F**	**Total**	**ECTS**
INDBIOT-01	Bioprocess engineering	30	15	30	0	75	**6**
INDBIOT-02	Fermentation technologies	30	15	30	0	75	**6**
INDBIOT-03	Biocatalysts and biotransformation	30	10	15	0	55	**4.5**
INDBIOT-04	General plant biotechnology	30	10	15	0	55	**4.5**
INDBIOT-05	Biofuels and biorefineries	20	15	15	10	60	**5**
INDBIOT-06	Waste management in bioprocess industry	20	10	10	10	50	**4**
	Total	160	75	115	20	370	**30**

L - Lectures, S - seminars, SE - seminary exercises, E - exercises (laboratory or computational), F-field exercises

IV semestar		**Number of teaching hours**					
Label	**Course**	**L**	**S, SE**	**E**	**F**	**Total**	**ECTS**
INDBIOT-07	Instrumental methods in biotechnology	20	15	15	0	50	**4**
INDBIOT-08	Bioprocess plant design	20	15	15	0	50	**4**
INDBIOT-09	Computer data analysis and visualisation	20	30	0	0	50	**4**
INDBIOT-MT	Master's thesis			100		100	**10**
	Elective course I					45	**4**
	Elective course II					45	**4**
	Total	60	60	30	0	340	**30**

L - Lectures, S - seminars, SE - seminary exercises, E - exercises (laboratory or computational), F-field exercises

Elective courses

		Number of teaching hours					
Label	**Course**	**L**	**S, SE**	**E**	**F**	**Total**	**ECTS**
INDBIOT-E01	Solid-state fermentation	20	10	15	0	45	**4**
INDBIOT-E02	Microreactors	20	10	15	0	45	**4**

INDBIOT-E03	Wastewater treatment	20	10	5	10	45	**4**
INDBIOT-E04	Extraction and isolation of bioactive compounds	20	10	15	0	45	**4**
INDBIOT-E05	Energy efficiency in biotechnological processing facilities	20	10	15	0	45	**4**
INDBIOT-E06	By-products in the biotechnological and food industry	20	10	15	0	45	**4**
INDBIOT-E07	Technology of probiotic starter culture	20	10	15	0	45	**4**
INDBIOT-E08	Good hygiene practice in bioprocess industry	20	10	15	0	45	**4**
INDBIOT-E09	Plant stress biology and biotechnology	20	10	15	0	45	**4**
INDBIOT-E10	Techno-economic assessment and risk analysis of biotechnological processes	20	10	15	0	45	**4**

* Out of the offered elective courses, a student must elect at least 2 at the first year of study**.**

L - Lectures, S - seminars, SE - seminary exercises, E - exercises (laboratory or computational), F-field exercises

MODULE: MEDICAL BIOTECHNOLOGY

III semestar		**Number of teaching hours**					
Label	**Course**	**L**	**S, SE**	**E**	**F**	**Total**	**ECTS**
MEDBIOT-01	Biotechnology in health care	15	15	0	0	30	**2**
MEDBIOT-02	Pharmacology	30	10	20	0	60	**5.5**
MEDBIOT-03	Experimental physiology for biotechnologists	30	5	15	0	50	**4**
MEDBIOT-04	Molecular immunology	30	10	15	0	55	**4.5**
MEDBIOT-05	Molecular medicine	30	5	15	0	50	**4**
MEDBIOT-06	Medical genetics	30	10	15	0	55	**4.5**
MEDBIOT-07	Biotechnology of pharmaceutical products	30	10	20	0	60	**5.5**
	Total	195	65	100	0	360	**30**

L - Lectures, S - seminars, SE - seminary exercises, E - exercises (laboratory or computational), F - field exercises

IV semestar		**Number of teaching hours**					
Label	**Course**	**L**	**S, SE**	**E**	**F**	**Total**	**ECTS**
MEDBIOT-08	*In vivo* and *in vitro* experimental models	30	5	15	0	50	**4**
MEDBIOT-09	Drug development	30	5	15	0	50	**4**
MEDBIOT-10	Tissue engineering	30	5	15	0	50	**4**
MEDBIOT-MT	Master's thesis	0	0	100	0	100	**10**
	Elective course I					45	**4**
	Elective course II					45	**4**
	Total	90	15	145	0	340	**30**

L - Lectures, S - seminars, SE - seminary exercises, E - exercises (laboratory or computational), F - field exercises

Elective courses

		Number of teaching hours					
Label	**Course**	**L**	**S, SE**	**E**	**F**	**Total**	**ECTS**
MEDBIOT-E01	Microscopy in biotechnology	15	15	15	0	45	**4**
MEDBIOT-E02	Tissue types	15	10	15	0	40	**4**
MEDBIOT-E03	Nutrigenomics	15	30	0	0	45	**4**
MEDBIOT-E04	Pharmacogenetics and pharmacogenomics	15	15	15	0	45	**4**
MEDBIOT-E05	Application of tissue engineering in clinical praxis	15	30	0	0	45	**4**
MEDBIOT-E06	Biologic drugs	15	15	15	0	45	**4**
MEDBIOT-E07	Application of flow cytometry in research	15	15	15	0	45	**4**

* Out of the offered elective courses, a student must elect at least 2 at the first year of study**.**

L - Lectures, S - seminars, SE - seminary exercises, E - exercises (laboratory or computational), F - field exercises

4.2. Course Catalogue with the Learning Outcomes

1st Year – Obligatory Courses

BIOTECH-01:	**INTRODUCTION TO BIOTECHNOLOGY**
GENERAL INFORMATION	
Course Coordinator(s)	Natalija Velić, PhD, assoc. prof.
Associate(s)	-
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 1st Semester
Credits (ECTS)	**1**
Teaching Method (number of classes)	Lectures 10; Seminars 5; Exercises 0
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The aim of the course is to introduce students to basic concepts of biotechnology, provide insight into the field of biotechnology and the importance of biotechnology.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-1; INDBIOT-1; INDBIOT-2	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Compare traditional and new biotechnological approaches. 2. Explain the industrial aspects of biotechnology. 3. Explain the biotechnology application areas ("rainbow code of biotechnology "). 4. Critically argue the importance of biotechnology for sustainable development. 5. Critically evaluate ethical, legal and social implications (ELSI) of biotechnology.	
Course Content	
Lectures. Biotechnology - definition and importance. Brief history and perspectives of biotechnology development. Traditional biotechnology *vs.* new biotechnology. Recombinant DNA technology: basic principles, applications and molecular techniques. Industrial aspects of biotechnology: general scheme and characteristics of biotechnological processes - microbial processes, enzymatic processes, processes in plant and animal tissue culture. Areas of application of biotechnology (rainbow code of biotechnology): white, red, green and blue biotechnology. **Seminars.** Industrial Biotechnology (White) - sustainable production of chemicals, fuels, materials. Medical biotechnology (red) - therapy and diagnostics, production of pharmaceuticals and nutraceuticals. Biotechnology in agriculture (green) and environmental protection. Marine Biotechnology (Blue) - use of marine resources in food production, isolation of new bioactive compounds and new materials, conservation of marine ecosystems. ELSI - ethical, legal and social implications of biotechnology.	
Teaching Methods	
Lectures; seminars	
Students' Obligations	

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes, seminars	0.1	1-6	Attendance at classes and seminars	Attendance records	5	10
Seminar work	0.5	4-6	Writing a seminar paper	Oral presentation of a seminar paper	15	40
Final exam	0,4	1-6	Studying for the final exam	Written exam	30	50
Total	**1**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Thieman WJ, Palladino MA: Introduction to Biotechnology, 4th Ed., Pearson, Boston, 2018.	-	-

Additional Literature

1. Godbey WT: An Introduction to Biotechnology, Elsevier, Amsterdam, 2014.
2. Ratledge C, Kristiansen B: Basic biotechnology, 3rd Ed., Cambridge University Press, Cambridge, 2013.
3. Khan FA: Biotechnology Fundamentals, 2nd Ed., CRC Press, Boca Raton, 2016.

4. Renneberg R: Biotechnology for Beginners, Academic Press, Burlington, 2008. 5. Scientific papers available on-line
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-02:	**MOLECULAR BIOLOGY WITH GENETIC ENGINEERING**
GENERAL INFORMATION	
Course Coordinator(s)	Teuta Opačak-Bernardi, PhD, assist. prof.
Associate(s)	Stana Tokić, PhD, assist. prof. Barbara Viljetić, PhD, assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 1st Semester
Credits (ECTS)	**5**
Teaching Method (number of classes)	Lectures: 20; Seminars: 15; Exercises: 15
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

Learning about the basic principles of molecular biology, organisation and maintenance of the genome and control of gene expression, introducing the students with cellular interactions and signalling, understanding the processes and mechanisms of cell survival and linking the disruptions in genome maintenance and basic cellular processes with the development of diseases. Adopting the basic principles and applications of molecular biology methods and genetic engineering.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-2; INDBIOT-1; INDBIOT-3; MEDBIOT-2

Learning Outcomes at the Course Level

After completing the course, the student will be able to:

1. Compare the organisation, maintenance and rearrangement methods for genomes of various species.
2. Explain different levels of gene expression regulation and ways to modulate gene expression
3. Connect the extracellular signals with control mechanisms and regulation of cell division and cell cycle
4. Explain the basis of genetic engineering and the methods used
5. Apply methods of genetic analysis and genetic engineering in research
6. Interpret the outcome of an experiment that includes using molecular biology methods, including genetic analysis and recombinant DNA methods

Course Content

Lectures. Molecular biology as the basis of biomedical and biotechnical science. Importance of molecular biology and genetic engineering. Organisation of cellular genome. Coding and non-coding DNA. Repetitive DNA sequences. Genome maintenance and rearranging. DNA repair. Excision repair. Translesion DNA synthesis. Double-strand repair. Homologous repair: models and enzymes. DNA rearrangement. Site specific DNA recombination. Regulation of gene expression. Regulation mechanisms in eukaryotes and prokaryotes. Tissue specific gene expression. Chromatin remodelling and epigenetic in gene expression. Cell cycle. Phases of cell cycle. Checkpoints. DNA repair. Cyclins and other protein involved in cell cycle regulation. Cell death. Programmed cell death. Caspases. Apoptosis. Regulators of programmed cell death. Basic cloning principles. Restriction endonucleases, polymerases, DNA ligase. Types of vectors. Selection markers. Plasmid vectors, α-complementation. Bacteriophage vectors. Hybrid vectors. Shuttle vectors. Expression systems.

Genetic engineering – basic principles and terms: transgene, transgenic organism, genetically modified organism. Transgenic animals. How to import a transgene. Transgene integration into the genome. Insect, herbicide and virus resistant plants. Advantages and shortcomings. Genetic engineering in biomedicine and industry. Commercial products made by recombinant microorganisms.
Seminars: Molecular biology methods. Types of DNA analysis: nucleotide sequence analysis and gene expression analysis. . Cloning and mutagenesis strategies. Random and targeted mutagenesis. PCR mutagenesis. Gene inactivation. Linkers and adaptors. Directed cloning. Serial cloning. Reporter genes.
Laboratory exercises. Polymerase chain reaction (PCR, real-time PCR, digital droplet PCR). Determining the nucleotide sequence (next generation sequencing). Hybridization.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes	0.5	1-6	Attendance	Keeping records	2	10
Seminars	1	1-6	Seminar – project presentation	Presentation	10	20
Laboratory practice	1	5.6	Practical work	Lab notes	8	20
Final exam	2.5	1-6	Studying for the final exam	Written exam	30	50
Total	**5**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-

79.99 grade points; D – sufficient (2): 50-64.99 grade points		
Mandatory Literature (available in the library and via other media)		
Title	Number of copies in the library	Availability via other media
Bruce Alberts and Alexander D. Johnson. Molecular Biology of the Cell. W. W. Norton & Company; 6th Ed., 2014	10	
D.S.T. Nicholl, An Introduction to Genetic Engineering, 3rd Ed., Oxford University Press, Oxford, 2008.		yes
Additional Literature		
M.R. Green, J. Sambrook, *Molecular Cloning: A Laboratory Manual*, 4th Ed., Cold Spring Harbor Laboratory Press, New York, 2012.		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or Faculty of Food Technology Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

BIOTECH-03:	**GENETICS AND GENOMICS**
GENERAL INFORMATION	
Course Coordinator(s)	Stana Tokić, PhD, assist. prof.
Associate(s)	Mario Štefanić, MD, PhD, assoc. prof. Jasminka Wagner, PhD, assoc. prof. Teuta Opačak-Bernardi, PhD, assist. prof. Barbara Viljetić, PhD, assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 1st Semester
Credits (ECTS)	**7**
Teaching Method (number of classes)	Lectures: 45; Seminars: 15; Exercises: 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The objective of the course is to broaden and improve the basic knowledge of classical genetics and genomics by applying various methods and bioinformatics tools that students can use in biological research and molecular biotechnology.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare.	
Learning Outcomes at the Programme Level Contributed by the Course	
MEDBIOT-1; INDBIOT-2; BIOTECH-7; MEDBIOT-3	
Learning Outcomes at the Course Level	
After completing the course the student will be able to: 1. Present the principles of inheritance 2. Apply practical knowledge for qualitative and quantitative genome analysis 3. Select appropriate statistical methods and bioinformatics tools for genome and transcriptome research 4. Assess the role of epigenetic factors in the development of complex diseases 5. Apply classical and molecular cytogenetic techniques and approaches in the diagnostics of hereditary diseases 6. Follow the scientific and professional literature and improve the acquired knowledge and skills	
Course Content	
Lectures. Model organisms - history, types and applications in genome research. Gene mapping and cloning techniques - classic gene crossing and complementation, restriction endonucleases, plasmids (pBR322, pUC19), bacteriophages (λ, M13) and cosmids, replication and expression vectors. Strategies for gene marking, genetic material transfer and genetic library screening. Numerical and structural chromosomal anomalies. Principles of inheritance: monogenic and polygenic, Mendelian laws of inheritance and allele types. Sex-linked and mitochondrial inheritance. Complications of the basic Mendelian mode of inheritance: incomplete penetration and gene expression, anticipation, pleiotropy, gene conversion, epistasis, genomic imprinting, mosaicism and chimerism. Population genetics: allelic and gene frequencies. Hardy-Weinberg equilibrium. Linkage disequilibrium (LD). Gene polymorphisms, haplotypes, LD blocks and taqSNPs. HapMap project. Quantitative trait loci (QTL). Linkage analyses in search of genes causing hereditary diseases - LOD and λ linkage measures. Genome wide association studies (GWAS). Factors shaping the genetic characteristics of a population - genetic drift, natural selection, inbreeding. Tools for human	

genome variability assessment and gene mapping - PCR (multiplex, nested, reverse-transcription, real-time, touchdown, asymmetric), RFLP, SNP and STR analysis, FISH chromosome mapping, genomic library search (BAC and YAC) and positional cloning, contig and restriction maps, candidate gene analysis, UCSC Human Genome Viewer. Evolution of DNA sequence analysis – Maxam and Gilbert method, Sanger method, next generation sequencing (NGS) - overview of experimental protocols and NGS platforms (Illumina, Roche, SOLiD, Ion Torrent, Nanopore, PacBio), and data analysis in comparison to reference genomic databases. Methods for gene expression (qPCR, microarray and mRNA / microRNA sequencing) and gene function analysis (knockout / knockdown transgenic animal models). The role of epigenetic factors in regulation of gene expression and disease occurrence. Clinical genetics and diagnostics of genetic diseases - cytogenetic testing, risk allele genotyping, predictive and prenatal testing, DNA profiling, genetic counselling and a personalized approach to therapy.

Seminars. Model organisms in biotechnology research. Principles and application of statistical methods in genetics. Whole-exome NGS analysis. Application of chromosomal microarray in diagnostics. Application of pharmacogenetics in personalized therapy.

Exercises. DNA isolation by affinity method, fragmentation by restriction enzymes and restriction fragment length polymorphism (RFLP) analysis using agarose gel electrophoresis. Qualitative and quantitative DNA analysis by agarose gel electrophoresis, Qubit fluorometer and qPCR analysis. STR analysis by capillary electrophoresis. RNA isolation, cDNA synthesis and gene expression analysis using TaqMan technology and RT-qPCR method. Chromosome karyotyping of peripheral mononuclear leukocytes by GTG banding. Detection of microdeletion syndromes by FISH method.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending and active participation (lectures)	0.5	1-6	Attendance at classes	Keeping records	2	10
Seminar work	1	1-6	Seminar work	Presentation of seminar work	10	20
Laboratory exercises	1	5,6	Work in laboratory	Written report	8	20
Final exam	3.5	1-6	Studying for the final exam	Written exam	30	50
Total	**6**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points.

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Strachan T, Read A: Human Molecular Genetics. 4th Edition. Wiley, 2003.	-	
Dale JW, von Schantz M: From Genes to genomes. John Wiley & Sons, LTD. University of Surrey, UK, 2002.	-	
Scientific and professional papers related to particular chapters (available online)		Yes

Additional Literature

M.R. Green, J. Sambrook, Molecular Cloning: A Laboratory Manual, 4th Ed., Cold Spring Harbor Laboratory Press, New York, 2012.

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-04:	**STRUCTURAL BIOCHEMISTRY**
GENERAL INFORMATION	
Course Coordinator(s)	Ivica Strelec, PhD, full prof.
Associate(s)	Franje Čačić Kenjerić, PhD, assist. prof. Tihomir Kovač, PhD Vesna Rastija, PhD, assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 1st Semester
Credits (ECTS)	**5**
Teaching Method (number of classes)	Lectures 25; Seminars 10; Exercises 15
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The aim of this course is to provide advanced knowledge on protein structure and function at molecular level, protein folding and stability, as well as to introduce students with molecular methods for protein structure determination. Understanding the molecular level underlying protein: ligand interactions, and development of practical skills in protein: ligand analysis.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme of Natural sciences (chemistry, biology), Biotechnical sciences, Biomedicine or Health.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-4; INDBIOT-3; INDBIOT-5

Learning Outcomes at the Course Level

After successful completion of this course students should be to:

1. Explain protein structure-function relationship at molecular level
2. Compare the most common structural motifs in proteins
3. Define and explain factors affecting protein stability
4. Compare folding of various types of proteins
5. Recommend methods for protein structure determination
6. Predict protein: ligand interactions at molecular level
7. Know how to select adequate methods for studying protein: ligand interactions
8. Determine and calculate dissociation constant (K_d) and maximum ligand binding capacity

Course Content

Lectures. Introduction to structural biochemistry. Non-covalent molecular interactions. Structure, properties and physiological function of amino acids. Primary structure of proteins. Secondary and super-secondary structure. Tertiary and quaternary structure. Protein folding and stability. Structure-function relationship. Structural portraits of proteins and common structural motifs. Primary websites (bioinformatics databases) on protein structure and properties. Physiological functions of proteins and peptides. Molecular methods for protein structure determination. Protein homology and evolution. Protein: protein, protein: nucleic acid, and protein: ligand interactions. Interactions in signal transduction. Computational methods for prediction and visualisation of protein structure and protein: ligand interaction.

Seminars. Protein folding and stability of various proteins; Structure and properties of selected proteins; Protein: ligand interactions in enzyme reactions and cellular processes.

Laboratory exercises. Determination of protein: ligand interactions by equilibrium dialysis method, gel filtration method, and spectroscopic methods.

Computational exercises. Identification on unknown protein and data acquisition on its structure and properties, visualisation and understanding of 3D structure of protein of interest.

Teaching Methods

Lectures; seminars; laboratory and computational exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up.

Monitoring the Activity of the Students (Connecting Learning Outcomes, Teaching Methods, and Grading)

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes	0.5	1-8	Attendance to classes	Keeping records	2	10
Seminars	1.0	1-8	Preparation of seminar presentation	Seminar presentation	10	24
Laboratory and computational exercises	0.5	6-8	Work in laboratory and computer classroom	Written report	8	16
Partial exams or final exam	3.0	1-8	Studying for the partial exams or final exam	Written exam	30	50
Total	**5**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade points
99.00 – 100.00	50
97.00 – 98.99	49
95.00 – 96.99	48
93.00 – 94.99	47
91.00 – 92.99	46
89.00 – 90.99	45
87.00 – 88.99	44
85.00 – 86.99	43
83.00 – 84.99	42
81.00 – 82.99	41
79.00 – 80.99	40
77.00 – 78.99	39
75.00 – 76.99	38
73.00 – 74.99	37
71.00 – 72.99	36
69.00 – 70.99	35
67.00 – 68.99	34
65.00 – 66.99	33
63.00 – 64.99	32

61.00 – 62.99	31
60.00 – 60.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Branden C, Tooze J: Introduction to Protein Structure, 2nd Ed., Garland Publishing Inc., New York, 1999	-	-
Kessel A, Ben-Tal N: Introduction to Proteins: Structure, Function, and Motion, 2nd Ed., CRC Press, Taylor & Francis Group, London, 2018	-	-

Additional Literature

1. Petsko GA, Ringe D: Protein Structure and Function, New Science Press Ltd, London, 2004
2. Buxbaum E: Fundamentals of Protein Structure and Function, Springer ScienceBusiness Media, LLC, 2007
3. Berg JM, Tymoczko JL, Gatto Jr. GJ, Stryer L: Biochemistry, 8th Ed., WH Freeman, New York, 2015
4. Scientific and professional papers related to the specific areas of the course

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-05:	**PROTEIN ENGINEERING**
GENERAL INFORMATION	
Course Coordinator(s)	Ivica Strelec, PhD, full prof. Barbara Viljetić, PhD, assist. prof.
Associate(s)	Hrvoje Brkić. PhD, assist. prof. Frane Čačić Kenjerić, PhD, assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 1st Semester
Credits (ECTS)	**6**
Teaching Method (number of classes)	Lectures 30; Seminars 20; Exercises 10
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The aim of this course is to provide advanced knowledge on molecular biology techniques and methods, and recombinant DNA technology used for protein engineering, with emphasis on application in biotechnology, medicine and pharmacy.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed undergraduate university study programme of Natural sciences (chemistry, biology), Biotechnical sciences, Biomedicine or Health.	
Learning Outcomes at the Programme Level Contributed by the Course	
INDBIOT-1; INDBIOT-2; INDBIOT-3; MEDBIOT-1	
Learning Outcomes at the Course Level	
After successful completion of this course students should be to: 1. Compare genomic, transcriptomic and proteomic research 2. Select appropriate expression systems for recombinant protein/enzyme production 3. Recommend manipulation of gene expression in prokaryotes and eukaryotes, including transgenic organisms 4. Suggest methods and techniques for production of enhanced and/or recombinant proteins 5. Critically evaluate different expression systems for recombinant protein/enzyme production 6. Evaluate application of protein engineering in biotechnology, medicine and pharmacy	
Course Content	
Lectures. Introduction to protein design and protein engineering. Experimental protein engineering. Chemical modifications. Protein overexpression in prokaryotes and eukaryotes. Direct mutagenesis. Protein and genetic engineering for production of therapeutic proteins (pharmaceuticals, nutraceuticals, enzymes, monoclonal antibodies, recombinant antibodies); production and stabilization of industrial enzymes (fusion proteins, mutant proteins with unusual amino acids, direct mutagenesis); synthesis of commercial products by recombinant microorganisms (restriction endonucleases, small biological molecules, antibiotics, polymers). Large-scale production of proteins and plasmid DNA from recombinant microorganisms. CRISP technology in genetic engineering of plants and animals. **Seminars.** Applicability of genetic and protein engineering in the production of selected pharmaceuticals, nutraceuticals and antibodies. Microfluidics based screening platforms. **Laboratory exercises**. High Throughput Screening. Fluorescence-activated cell sorting (FACS). **Computational exercises.** Computer algorithms in protein engineering.	
Teaching Methods	
Lectures; seminars; computational exercises	

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up.

Monitoring the Activity of the Students (Connecting Learning Outcomes, Teaching Methods, and Grading)

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes	0.5	1-6	Attendance to classes	Keeping records	2	10
Seminars	1.5	1-6	Preparation of seminar presentation	Seminar presentation	13	25
Laboratory/computer exercises	0.5	3-6	Practical work	Written report	5	15
Partial exams or final exam	3.5	1-6	Studying for the partial exams or final exam	Written exam	30	50
Total	**6.0**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade points
99.00 – 100.00	50
97.00 – 98.99	49
95.00 – 96.99	48
93.00 – 94.99	47
91.00 – 92.99	46
89.00 – 90.99	45
87.00 – 88.99	44
85.00 – 86.99	43
83.00 – 84.99	42
81.00 – 82.99	41
79.00 – 80.99	40
77.00 – 78.99	39
75.00 – 76.99	38
73.00 – 74.99	37
71.00 – 72.99	36
69.00 – 70.99	35
67.00 – 68.99	34
65.00 – 66.99	33
63.00 – 64.99	32
61.00 – 62.99	31
60.00 – 60.99	30

Forming the final grade:

The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:

A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Kaumaya P: Protein Engineering, InTech, Rijeka, 2012	-	yes
Park SJ, Cochran JR: Protein Engineering and Design, CRC Press, Boca Raton, 2009	-	-

Additional Literature

1. Albergina L: Protein Engineering in Industrial Biotechnology, Harwood Academic Publishers, Amsterdam, 2000
2. Glick BR, Patten CL: Molecular Biotechnology: principles and applications of recombinant DNA, 5th Ed., ASM Press, Herdon, 2017
3. Scientific and professional papers related to the specific areas of the course

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-06:	**BIOINFORMATICS AND BIOSTATISTICS**
GENERAL INFORMATION	
Course Coordinator(s)	Hrvoje Brkić, PhD, Assist. Prof. Dario Faj, PhD, Full Prof.
Associate(s)	-
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 1st Semester
Credits (ECTS)	**6**
Teaching Method (number of classes)	Lectures: 20 ; Seminars: 20 ; Exercises: 20
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

Teach students how to use bioinformatics tools, as well as search and process bioinformatics data bases. Introduce students with most common distributions in biosciences and theories of samples. Elaborate students' stochastic bond and mathematical modelling, application of statistical test and obtaining the results from the tests.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-4; BIOTECH-9; INDBIOT-6; MEDBIOT-3

Learning Outcomes at the Course Level

After completing the course, the student will be able to:

1. Independently use bioinformatics tools and operational systems that are commonly used in bioinformatics.
2. Use shell scripts for data analyses.
3. Transform and compare different types of biological structures.
4. Use web based tools, as well as their shell versions of most common bioinformatics tools that have application in biology and chemistry.
5. Interpret parameters of statistical set, and based on them use appropriate theoretical distribution and test it.
6. Use appropriate statistical test (expectation test, expectation comparison (t-test), variance comparison (F-test), ANOVA, proportion test, proportion comparison, $\chi 2$-model fit test data, $\chi 2$-independence test, $\chi 2$-homogeneity test), with and without usage of computers, and interpret results correctly.
7. Suggest method of specimen sampling, determine parameters of population samples conduct appropriate statistical tests and interpret solutions.
8. Critically judge laboratory experiments, and statistical analyses that are present in professional papers

Course Content

Lectures. History and introduction to bioinformatics; Bioinformatics operating systems. Shell programming. Descriptive statistics. Statistical characteristics. Tabular and graphical presentation of data. Mean values. Variability measures. Location measures. Basics of Probability Theory. Probability Space. Probability setting. Conditional probability. Independence. Discrete and continuous random variables. Mathematical expectation and variance of a random variable. Binomial distribution. Hypergeometric distribution. Poisson distribution. Normal distribution. Statistical test. Errors of the first and second kind. Expectation test. Reliable intervals for direction

parameters. Prediction. Reliable intervals for the predicted value of the dependent variable and for its mean.

Seminars. Bioinformatics operating systems: getting to know and working on one of the Linux operating system distributions; Shell programming: basic commands and ways to execute them, create and run executable scripts. Analysis of primary DNA and protein sequences using bioinformatics tools. Descriptive statistics: Statistical characteristics. Testing statistical hypotheses and reliable intervals: A random sample. Point estimates of parameters (expectations and variance). Expectation comparison test (t-test). Variance comparison test (F-test). One-factor analysis of variance (ANOVA). Proportion parameter test. Reliable interval for the proportion parameter. Proportion Comparison Test. χ^2 - model fit test. χ^2 - independence test. χ^2 - homogeneity test. Linear regression model: Direction adjustment; least squares method.

Exercises. Bioinformatics tools, downloading of tools from repositories, their installation and usege. Performing background jobs. Practical examples of using bioinformatics tools in research and statistics, biological databases. Tools for transforming coordinate systems used in the file formats of biological molecules, comparing different types of formats, and searching for them. Expectation test; sample from a normally distributed population, and a large sample. Reliable interval for the expectation parameter; sample from a normally distributed population, and a large sample. Pearson's correlation coefficient. Correlation coefficient test. Testing direction parameter hypotheses. Nonparametric tests: Wilcoxon rank sum test, Mann Whitney test. Designing and conducting experiments.

Teaching Methods

Lectures; seminars; exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	1.25	1-7	Attendance at classes	Keeping records	10	25
Seminar work	1.25	1-7	Practical work	Seminar task	10	25
Knowledge tests (partial tests)	1.5	1-8	Studying for partial knowledge tests	Written exam	6	10
Final exam	2	1-8	Studying for the final exam	Written final exam	24	40
Total	**6**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	40
90.00-94.99	38
85.00-89.99	36
80.00-84.99	34
75.00-79.99	32
70.00-74.99	30

65.00-69.99	27
60.00-64.99	24

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Lesk A: Introduction to bioinformatics. Oxford University Press, 2014.		
Bernard R: Fundamentals of Biostatistics, 7th Ed., Brooks/Cole, 2011.		

Additional Literature

Scripts available on www.physics.mefos.hr

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek Faculty and/or the Faculty of Food Technology Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-07:	**MOLECULAR ENZYMOLOGY**
GENERAL INFORMATION	
Course Coordinator(s)	Ljubica Glavaš-Obrovac, PhD, Full prof. with tenure
Associate(s)	Katarina Mišković Špoljarić, PhD, Assist. prof. Teuta Opačak-Bernardi, PhD, Assist. prof. Stana Tokić, PhD, Assist. prof. Barbara Viljetić, PhD, Assist. prof. Marijana Jukić, PhD
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 2nd Semester
Credits (ECTS)	**6**
Teaching Method (number of classes)	Lectures: 30; Seminars: 15; Exercises: 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The objective of this course is better understanding of enzymatic processes through learning about the structure, physicochemical and catalytic properties of enzymes, as well as learning about the phylogenetic and ontogenetic development of tissue enzymes, the topology and morphometry of enzymes. Knowledge of physiological classification and mechanisms of cellular enzyme exit and extracellular distribution.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-2; INDBIOT-2; INDBIOT-6; MEDBIOT-1; MEDBIOT-2	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Evaluate the relationship of structure and function in protein families. 2. Explain strategies in enzymatic catalysis and ways of collecting and analyzing enzymatic kinetic and thermodynamic data. 3. Classify enzymes significant in clinical practice. 4. Determine the correlation between epigenetic patterns, metabolism and disease development. 5. Analyze biological samples qualitatively and quantitatively using appropriate pre-analytical, analytical and post-analytical methods.	
Course Content	
Lectures. Protein synthesis and regulation. Relationship of structure and function in protein families. Enzymes: Classification and specificity. Interactions between enzymes and coenzymes and prosthetic groups. Mechanisms of enzymatic catalysis and regulation of enzymatic activity. Strategies in enzymatic catalysis: Proteases, carbonic anhydrases, restriction enzymes, NMP kinases. Kinetics of enzymatic reactions - problem solving. Metabolic relationships between tissues and organs. Principles and methods of enzymatic analysis. Collection and analysis of enzymatic kinetic and thermo-dynamic data. Clinical enzymology: Enzymes, isoenzymes and their importance in diagnosis. Clinical enzymology: Regulation of serum and plasma enzyme concentrations. Enzymes significant in clinical practice. Relationship between epigenetic patterns, metabolism and disease development. **Seminars.** Changes in metabolic patterns associated with disease development. Metabolism of	

xenobiotics. Cytochromes P450 and NO synthases. Xenobiotic metabolism - clinical correlations. Metabolome analytical platforms. Metabolic profiling as a tool in understanding metabolism.
Exercises. Isolation of enzymes of plant, animal or mycobacterial origin and determination of kinetics of enzymatic reaction. Quantitative analysis and role of inhibitors on enzyme activity.

Teaching Methods

Lectures; seminars; laboratory exercises; independent assignments

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending and active participation (lectures)	0.25	1-5	Attendance at classes	Keeping records	2	10
Seminar work	1.75	1-5	Seminar work	Presentation of seminar work	10	20
Laboratory exercises	1	5	Work in laboratory	Written report	8	20
Final exam	3	1-5	Studying for the final exam	Written exam	30	50
Total	**6**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points.

Mandatory Literature (available in the library and via other media)

Title	Number of	Availability via

	copies in the library	other media
Wharton CW, Eisenthal R: Molecular Enzymology (Tertiary Level Biology), Blackie & Son Limited, e-book. ISBN 978-1-4615-8532-9.	-	Yes
Additional Literature		
1. Murray RK, Bender DA, Botham KM, Kennelly PJ, Rodwell VW, Weil PA: *Harper's Illustrated*. *Biochemistry*, 28th Ed., McGraw Hill. Lange Basic Science, 2009. 2. Scientific and professional papers related to particular chapters (available online)		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

BIOTECH-08: **BIOCHEMISTRY AND PHYSIOLOGY OF INDUSTRIAL MICROORGANISMS**	
GENERAL INFORMATION	
Course Coordinator(s)	Ivica Strelec, PhD, full prof.
Associate(s)	Natalija Velić, PhD, assoc. prof. Hrvoje Pavlović, PhD, full prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 2nd Semester
Credits (ECTS)	**6.5**
Teaching Method (number of classes)	Lectures 30; Seminars 15; Exercises 30
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The aim of this course is to provide advanced knowledge on biochemistry, microbiology, genetics and molecular enzymology necessary in application, analysis and evaluation of methods and procedures used during preparation and performance of biotechnological processes for nutraceuticals and pharmaceuticals production.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme of Natural sciences (chemistry, biology), Biotechnical sciences, Biomedicine or Health.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-2; INDBIOT-1; INDBIOT-2; MEDBIOT-2

Learning Outcomes at the Course Level

After successful completion of this course students should be to:

1. Compare structure and morphology of most important industrial microorganisms
2. Select and explain adequate methods for studying physiology and biochemistry of industrial microorganisms
3. Explain in depth membrane transport of prokaryotes and eukaryotes
4. Compare mechanisms of communication between prokaryotic/eukaryotic cells and biofilm formation
5. Compare catabolic and anabolic pathways of various industrial microorganisms
6. Explain differences between primary and secondary metabolism of various industrial microorganisms, and differentiate key secondary metabolites
7. Explain in depth aerobic and anaerobic processes in biotechnological production

Course Content

Lectures. Introduction to biochemistry and physiology of industrial microorganisms. Structure of the most important industrial microorganisms: elemental composition of cells, structure and function of cells and organelles, morphology and classification of microorganisms. Microbial growth and development: cell cycle and cell division, physiology, monitoring and kinetics of microbial growth, batch and continuous cultivation, biomass yield. Biological membranes, membrane transport and bioenergetics: membrane structure, prokaryotes and eukaryotes membrane functions, passive and active membrane transport, endocytosis and exocytosis, membrane transport kinetics, bacterial transport systems, protein transport and secretion, chemiosmotic theory, electrochemical energy, ionophores, organization of the electron carries in mitochondria and bacteria. Bioenergetics in cytosol: high-energy molecules and group transfer potential, central role of group transfer potential reactions in biosynthesis, ATP synthesis by substrate level phosphorylation. Cell-cell communication mechanisms: bacterial signal molecules,

signalling by signal molecules, signalling that requires contact, microbial biofilms. Primary metabolism of industrial microorganisms: glycolysis, Entner–Doudoroff (ED) pathway, pentose phosphate pathway, tricarboxylic acid (TCA) cycle, glyoxylate cycle, fatty acid oxidation, transamination and oxidative deamination of amino acids, oxidation of hydrocarbons, nitrification and denitrification, gluconeogenesis, fatty acid biosynthesis, amino acid biosynthesis, nucleotide biosynthesis. Secondary metabolism of common industrial microorganisms: differences between primary and secondary metabolism, physiological and morphological aspects of secondary metabolism, secondary metabolites: classification, function and microbial sources, secondary metabolism of peptide antibiotics, ergot alkaloids, immunosuppressive drugs, insecticides, herbicides and enzyme inhibitors. Production of microbial biomass, alcohols, organic acids, organic solvents, vitamins, antibiotics, enzymes and others. **Seminars.** Structure and growth of selected industrial microorganisms, primary and secondary metabolisms, industrial production of microbial biomass, alcohols, organic acids, organic solvents, vitamins, antibiotics, enzymes and others.
Laboratory exercises. Submerged and solid state cultivation of filamentous fungi, aerobic and anaerobic cultivation of S. cerevisiae, microbial production of citric acid, actinomycete as antibiotic producer - isolation, selection and mutagenesis.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up.

Monitoring the Activity of the Students (Connecting Learning Outcomes, Teaching Methods, and Grading)

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes	0.5	1-7	Attendance to classes	Keeping records	2	10
Seminars	1.5	1-7	Preparation of seminar presentation	Seminar presentation	12	25
Laboratory exercises	1.5	1-7	Work in laboratory	Written report	6	15
Partial exams or final exam	3.5	1-7	Studying for the partial exams or final exam	Written exam	30	50
Total	**6.5**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade points
99.00 – 100.00	50
97.00 – 98.99	49
95.00 – 96.99	48
93.00 – 94.99	47
91.00 – 92.99	46
89.00 – 90.99	45
87.00 – 88.99	44
85.00 – 86.99	43
83.00 – 84.99	42

81.00 – 82.99	41
79.00 – 80.99	40
77.00 – 78.99	39
75.00 – 76.99	38
73.00 – 74.99	37
71.00 – 72.99	36
69.00 – 70.99	35
67.00 – 68.99	34
65.00 – 66.99	33
63.00 – 64.99	32
61.00 – 62.99	31
60.00 – 60.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-69.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
White D, Drummond J, Fuqua C: The Physiology and Biochemistry of Prokaryotes, 4th Ed., Oxford University Press, Oxford, 2012	-	-
Waites MJ, Morgan NL, Rockey JS, Hightoon G: Industrial Microbiology: An Introduction, Blackwell Science Ltd, Oxford, 2001	-	-

Additional Literature

1. Okafor N, Okeke BC: Modern Industrial Microbiology and Biotechnology, 2nd Ed., CRC Press, Boca Raton, 2018
2. Kim BH, Daad GM: Bacterial Physiology and Metabolism, Cambridge University Press, Cambridge, 2008
3. Scientific and professional papers related to the specific areas of the course

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-09:	**APPLIED MICROBIOLOGY**
GENERAL INFORMATION	
Course Coordinator(s)	Hrvoje Pavlović, PhD, full prof.
Associate(s)	Natalija Velić, PhD, assoc. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 2nd Semester
Credits (ECTS)	**6,5**
Teaching Method (number of classes)	Lectures 30; Seminars 15; Exercises 30
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The aim of this course is to advance basic knowledge in microbiology and genetics for the application, analysis and evaluation of methods and procedures used for biotechnological application of microorganisms in industry and medicine.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Undergraduate degree in natural sciences (chemistry, biology) or biotechnology or biomedicine and health.

Learning Outcomes at the Programme Level Contributed by the Course

INDBIOT-2; INDBIOT-3; MEDBIOT-2

Learning Outcomes at the Course Level

After successful completion of this course (lectures, seminars and exercises) and self-directed learning students are expected to be able to:

1. Classify microorganisms into taxonomic units and groups
2. Compare classical microbiological and molecular methods for identification of microorganisms.
3. Identify the interactions and actions of microorganisms in groups.
4. Select and apply isolation methods of microorganisms from natural habitats and preservation of pure cultures.
5. Critically evaluate different microbial modification procedures.
6. Argue the application of microorganisms in medicine, environment protection, agriculture and various industries.

Course Content

Lectures. Systematics of microorganisms, importance of identification and classification of microorganisms. Classical microbiological and molecular identification methods. Microbial ecology and interactions of microbial populations. Microbial communities - the interactions and function of microorganisms in groups. Microbial processes as a part of biogeochemical cycles. Microorganisms in their natural environment (soil, water, atmosphere, extreme environment, plants, animals, humans). Isolation and preservation of microbial pure cultures. Modification of industrial microorganisms (spontaneous and induced mutations, recombination, recombinant DNA technology) and maintenance of production strains. Application of microorganisms in medicine, environment protection, agriculture, production of food, chemicals, pharmaceuticals, nutraceuticals and enzymes. Vaccines and their production. Application of microorganisms for biosensor development.

Seminar. Interactions of microbial populations: microorganism-microorganism, plants-microorganisms, animals-microorganisms. Development of new vaccines. Medical use of biosensors.

Exercises. Application of aseptic technique, isolation and cultivation of microorganisms, pure

cultures growth, simple and differential staining, metabolic and chemical tests of selected microorganisms. Growth and environmental impact on microbial growth. Characteristics of selected microorganisms. Collection, processing and handling of different samples.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes	0.5	1-6	Attendance at classes and seminars	Keeping records	2	5
Seminar work	2	3,6	Writing a seminar paper	Oral presentation of a seminar paper	13	35
Laboratory exercises	1	1-4	Laboratory exercises	Submitting a report	5	10
Final exam	3.0	1-6	Studying for the final exam	Written exam	30	50
Total	**6.5**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media

Saxena S: Applied Microbiology, Springer, New Delhi, 2015.	-	-
Glazer AN, Nikaido H: Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Ed., Cambridge University Press, Cambridge, 2007.	-	-

Additional Literature

1. Barton LL, Northup DE: Microbial Ecology, Wiley-Blackwell, New Jersey, 2011.
2. Cooper GM, Hausman RE: The Cell: A Molecular Approach, 7th Ed., Sinauer Associates, London, 2015.
3. White D, Drummond J, Fuqua C: The Physiology and Biochemistry of Prokaryotes, 4th Ed., Oxford University Press, Oxford, 2012.
4. Kim BH, Daad GM: Bacterial Physiology and Metabolism, Cambridge University Press, Cambridge, 2008.
5. Scientific papers (available on-line)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of the Faculty of Medicine Osijek and the Food Technology Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-10:	**MOLECULAR MODELLING**
GENERAL INFORMATION	
Course Coordinator(s)	Hrvoje Brkić, PhD, Assist. prof.
Associate(s)	Dario Faj, PhD, Full prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 2nd Semester
Credits (ECTS)	**3**
Teaching Method (number of classes)	Lectures: 30 ; Seminars: 15 ; Exercises: -
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

Provide students with elementary of molecular modeling and usage of molecular modeling in biotechnology. Besides this students are going to be able to understand biophysical principles used in molecular modeling and in this way level up the knowledge about molecular modeling above just using bioinformatics tools. Students are going to be provided with sufficient amount of theoretical knowledge that is going to be used in choosing the method of molecular modeling in development of new bio-active molecules.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-9; INDBIOT-1; INDBIOT-5; MEDBIOT-2; MEDBIOT-3; MEDBIOT-4

Learning Outcomes at the Course Level

After completing the course, the student will be able to:

1. Understand how quantum mechanical calculations are used to describe chemical reactions.
2. Understand what approximations are used by semi-empirical calculations, and for what they are most commonly used.
3. Understand the methods of molecular mechanics and molecular dynamics, and know in which situations they can be applied.
4. Explain which approximations are used in molecular modelling and what are the advantages and disadvantages of each approximation
5. Use software packages and parameterize the system in the force field
6. Perform a simple protein simulation analysis
7. Graph the results of molecular dynamics and the resulting molecular structures

Course Content

Lectures. Useful concepts of molecular modelling. Coordinate systems, potential energy surfaces, computer hardware and software applicable in modelling. Mathematical concepts. Introduction to Computer Quantum Mechanics. Single-electron atoms, multi-electron atoms and molecules. Base sets, *ab initio* accounts. Empirical force fields, Molecular mechanics. General properties of molecular mechanics, bond elongation, bending angles, electrostatic interactions, van der Waals interactions, nonbonding interactions, hydrogen bonds in molecular mechanics, force fields.
Energy minimization and related methods for free energy surface research. First degree minimization, conjugate gradients, steepest descent method.
Seminars. Computer simulation methods. Phase space, calculation of simple thermodynamic parameters, boundary conditions. Basics of Statistical Mechanics. Molecular dynamics simulations. Topologies, simulations by simple methods, limitations in molecular dynamics. Conformational changes. Monte Carlo simulation methods. Statistical checks and variance reduction.

Processing and displaying results. Graphical representation of time-dependent parameters, three-dimensional representation of structures and chemical interactions over time.

Teaching Methods

Lectures; seminars;

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes (lectures)	0,2	1-7	Attendance at classes, and laboratory	Keeping records	1	5
Seminar work	1,8	4,6,7	Seminar work	Presentation of seminar work	29	45
Final exam	1	1-7	Studying for the final exam	Written exam	30	50
Total	**3**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points.

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Andrew R. Leach Molecular Modelling Principles and applications (2nd Ed.) Pearson Education Limited, 2001.	1	

Additional Literature

Cullity and Stock: Elements of X-ray diffraction (3rd Ed.) Pretience and Hall, 2001.
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

1st Year – Elective Courses

BIOTECH-E01:	**METHODOLOGY OF SCIENTIFIC-RESEARCH WORK**
GENERAL INFORMATION	
Course Coordinator(s)	Maja Miškulin, MD, PhD, Full Prof.
Associate(s)	Ivan Miškulin, PhD, Assist. Prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	1st year/ 2nd Semester
Credits (ECTS)	**3**
Teaching Method (number of classes)	Lectures: 20; Seminars: 10; Exercises: 0
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The aim of this course is to acquaint students with the basics of scientific methodology, the basics of scientific research work, scientific thinking and writing, as well as basic ethical principles in science and the basics of statistical methods. The ultimate goal of this course is to enable students to apply scientific methodology in independent scientific research work.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-4; BIOTECH-6; BIOTECH-7; BIOTECH-10	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Clarify and summarize the role and meaning of science and research. 2. Select and apply reliable types of sources and ways of accessing scientific and professional information's. 3. Identify and categorize relevant scientific literature. 4. Compare the types of scientific research and explain their particularities. 5. Describe experimental research and distinguish its characteristics, strengths and limitations. 6. Distinguish between ethical and unethical approaches in experimental work.	
Course Content	
Lectures: Scientific thinking. Basic features of scientific research and writing. Information in science. Primary publications. Secondary Publications. Tertiary publications. Citations. Indexing. Types of scientific research. Main features of basic research. Features of translational research. Characteristics and categorization of epidemiological researches. Experimental research. A randomized controlled clinical trial. Types of samples and sampling. Total population. Target population. Representativeness. Probability-based sampling. Convenient sampling. Simple random sample. Stratified random sample. Subgroup sample or cluster sample. Systematic sample. Questionnaire - a data collection instrument. Standard Questionnaire. Features of a good questionnaire. Basic ethical principles in researches. Informed consent. Privacy and confidentiality of information. Conflict of interest. Scientific virtue. Scientific journals and reports. Structure of scientific work. Types of data. Preparation of data for computer processing. Data processing. Data presentation. Statistical tests, p value and statistical inference. ***Seminars:*** Plan and conduction of scientific research. Presentation of results in a randomized controlled clinical trial. Electronic sources of information. Work of Ethics Committees. ***Methodical exercises:*** Relevant databases. Designing a survey questionnaire for one's own research. ***Independent project assigment***: Planning and conducting of one's own research.	

Teaching Methods

Lectures; seminars; methodical exercises; independent project assignment.

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes (lectures, seminars, exercises)	0.25	1-6	Attendance at classes	Keeping records.	2	10
Seminar paper	0.50	3	Seminar paper - production and presentation	Assessment of the quality of the written seminar paper and the presentation itself.	6	20
Methodical exercises	0.25	4-6	Practical work	Success in designing a survey questionnaire and using and searching databases within methodical exercises.	12	20
Final exam - project assignment	2.00	1-6	Project assignment preparation - planning and conducting one's own questionnaire survey	Assessment of the quality of the project assignment.	30	50
Total	**3**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
60.00-64.99	30
65.00-69.99	33
70.00-74.99	36
75.00-79.99	39
80.00-84.99	42
85.00-89.99	45

90.00-94.99	48
95.00-100.00	50

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Ferenczi E, Muirhead N: One Stop Doc Statistics and Epidemiology. London: Hodder Arnold, 2006.		yes
Walliman N: Research methods – the basics. London and New York: Routledge Taylor & Francis Group, 2011.		yes

Additional Literature

Laake P, Benestad H, Olsen, BR: Research Methodology in the Medical and Biological Sciences 1st Ed., London: Academic Press, 2007.

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.

Note

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BIOTECH-E02: **BIOETHICS, BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS IN BIOTECHNOLOGY**	
GENERAL INFORMATION	
Course Coordinator(s)	Natalija Velić, PhD, assoc. prof.
Associate(s)	Jure Mirat, MD, PhD, full prof. with tenure Domagoj Drenjančević, MD, PhD, Assoc. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	1st Year / 2nd Semester
Credits (ECTS)	**3**
Teaching Method (number of classes)	Lectures 20; Seminars 10; Exercises 0
Expected Number of Students in the Course	10-15
COURSE DESCRIPTION	
Course Aims	
Getting acquainted with basic concepts in the fields of bioethics, biosafety and intellectual property rights and gaining insight into their importance in the light of the rapid development of new molecular techniques.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-3; BIOTECH-4; BIOTECH-7; INDBIOT-1	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Critically evaluate the ethical, sociological and legal issues arising from the development of biotechnology. 2. Discuss different aspects of ethical conflicts in biotechnology (medical, research, etc.). 3. Distinguish between biosafety issues at different levels: individual, institutional, social. 4. Identify biosafety threats inside and outside the laboratory and implement security protocols to address them. 5. Review the criteria for patentability in biotechnology. 6. Outline the patent application process at national, European or international level.	
Course Content	
Lectures. *Bioethics*: basic bioethical concepts, bioethics development. Ethical, Legal and Social Issues Related to Biotechnology (ELSI). Ethical conflicts in biotechnology: medical bioethics (reproduction, euthanasia, prenatal diagnosis, transplantation, gene therapy, genetic screening, new eugenics); research bioethics (cloning, stem cells, human and animal research, bio-piracy); environmental impact; bioethics *vs.* business ethics. *Biosafety:* basic concepts. Biotechnology and the biosafety issues at different levels: individual, institutional, social, etc. Biosafety Protocol (Cartagena Protocol). Threats and challenges to biosafety inside and outside the laboratory. GRAS organisms, biosafety level of specific microorganisms, GMOs, LMOs, transgenic plants safety assessment, environmental risk assessment, food and feed safety risk assessment. Bioterrorism, biological weapons. Safety guidelines - good laboratory practice. *Intellectual property rights:* basic concept, role, significance and forms of intellectual property. Patent protection procedure, criteria for patentability in biotechnology. Routes to patents: national, European (European Patent Office - EPO), international (Patent Cooperation Treaty PCT - WIPO). **Seminars.** Bioethics, biosafety, intellectual property rights in biotechnology- case study.	
Teaching Methods	

Lectures; seminars

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes, seminars,	0.3	1-6	Attendance at classes and seminars	Attendance records	5	10
Seminar work	1.2	1-6	Writing a seminar paper	Oral presentation of a seminar paper	15	40
Final exam	1.5	1-6	Studying for the final exam	Written exam	30	50
Total	**3**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Nambisan P: An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology, Academic Press, Elsevier, 2017.	-	-
Scientific papers (available online)		yes

Additional Literature

1. Talbot M: Bioethics: An Introduction, Cambridge University Press, Cambridge, 2012.

2. Sandel MJ: The Case against Perfection – Ethics in the Age of Genetic Engineering, The Belknap Press of Harvard University Press, Cambridge, Massachusetts, 2007.
3. Thomas JA, Fuchs RL: Biotechnology and Safety Assessment, 3rd Ed., Academic Press, Elsevier, 2003.
4. Singh KK: Biotechnology And Intellectual Property Rights: Legal and Social Implications, Springer, New Delhi, 2015.

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-E03:	**PROTEIN PURIFICATION**
GENERAL INFORMATION	
Course Coordinator(s)	Ivica Strelec, PhD, full prof.
Associate(s)	-
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	1st Year / 2nd Semester
Credits (ECTS)	**3**
Teaching Method (number of classes)	Lectures 15; Seminars 5; Exercises 10
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The aim of this course is to provide advanced knowledge on biochemical and molecular biology techniques and methods used for protein purification on different scales of production (from laboratory to large-scale production), as well as to introduce the students to up-to-date techniques and methods of protein purification. In addition, course provides understanding of molecular interactions underlying protein separation processes, enables rational planning of protein purification, as well as acquisition of practical skills in protein purification and qualitative and quantitative evaluation of experimental data of purification process.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme of Natural sciences (chemistry, biology), Biotechnical sciences, Biomedicine or Health.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-3; INDBIOT-3

Learning Outcomes at the Course Level

After successful completion of this course students should be to:

1. Critically evaluate from start to finish the entire process of protein purification on different scales of production (from laboratory to large-scale production)
2. Recommend methods of protein isolation, extraction, concentration and purification
3. Plan and explain protein purification process with respect to protein molecular properties and demands of its purity
4. Select and design protein purification with respect to starting material and production scale
5. Know how to choose and use different methods for qualitative and quantitative analysis (evaluation) of protein purification process in respect to demands of protein purity and production costs
6. Critically examine large scale industrial protein production process and suggest improvements
7. Perform protein purification and critically evaluate experimental results by qualitative and quantitative analysis of protein purification process

Course Content

Lectures. Protein purification strategies – general guidelines and principles. Protein extraction and subcellular fractionation. Protein concentration and/or fractionation. Chromatographic methods of protein purification: Ion-exchange chromatography, Gel filtration, Hydrophobic and Reverse-Phase chromatography, Affinity and Immuno-affinity chromatography, Multidimensional chromatography of intact proteins, High performance liquid chromatography. Biomagnetic protein purification. Electrophoretic methods of protein purification and characterisation: one-dimensional electrophoretic techniques, 2D-electrohoresis. Protein quantification methods and techniques. Strategic planning for large-scale protein production (upstream and downstream

processing). Common methods and techniques in large-scale protein production.
Seminars. Protein purification in biotechnological and pharmaceutical industry.
Laboratory exercises. Isolation and purification of specific protein of animal, plant or microbial origin. Qualitative and quantitative evaluation of experimental data of protein purification process.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up.

Monitoring the Activity of the Students (Connecting Learning Outcomes, Teaching Methods, and Grading)

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes	0.25	1-7	Attendance to classes	Keeping records	2	10
Seminars	0.25	1-7	Preparation of seminar presentation	Seminar presentation	5	15
Laboratory exercises	0.50	3, 7	Work in laboratory	Written report	13	25
Final exam	2.00	1-7	Studying for the final exam	Written exam	30	50
Total	**3**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade points
99.00 – 100.00	50
97.00 – 98.99	49
95.00 – 96.99	48
93.00 – 94.99	47
91.00 – 92.99	46
89.00 – 90.99	45
87.00 – 88.99	44
85.00 – 86.99	43
83.00 – 84.99	42
81.00 – 82.99	41
79.00 – 80.99	40
77.00 – 78.99	39
75.00 – 76.99	38
73.00 – 74.99	37
71.00 – 72.99	36
69.00 – 70.99	35
67.00 – 68.99	34
65.00 – 66.99	33
63.00 – 64.99	32
61.00 – 62.99	31
60.00 – 60.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Simpson RJ, Adams PD, Golemis EA: Basic Methods in Protein Purification and Analysis, Cold Spring Harbor Laboratory Press, New York, 2009	-	-
Dennison C: A Guide to Protein Isolation, 2nd Ed., Kluwer Academic Publishers, London, 2003	-	-

Additional Literature

1. Labrou NE: Protein Downstream Processing: Design, Development and Application of High and Low-Resolution Methods. Humana Press, London, 2014.
2. Roe S: Protein Purification Techniques, 2nd Ed., Oxford University Press, Oxford, 2001.
3. Healthcare GE: Strategies for Protein Purification Handbook, GE Healthcare, Uppsala, 2010.
4. Healthcare GE: Design of Experiments in Protein Production and Purification Handbook, GE Healthcare, Uppsala, 2014.
5. Healthcare GE: Purifying Challenging Proteins. Principles and Methods, GE Healthcare, Uppsala, 2007.
6. Healthcare GE: Protein Sample Preparation Handbook, GE Healthcare, Uppsala, 2014
7. Scientific and professional papers related to the specific areas of the course

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-E04 : **EXPERIMENTAL MOLECULAR BIOLOGY**	
GENERAL INFORMATION	
Course Coordinator(s)	Barbara Viljetić, PhD, assist. prof.
Associate(s)	Teuta Opačak Bernardi, PhD, assist. prof. Stana Tokić, PhD, assist. prof. Marijana Jukić, PhD, Postdoctoral fellow
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	1st Year/ 2nd Semester
Credits (ECTS)	**3**
Teaching Method (number of classes)	Lectures: 10; Seminars: 10; Exercises: 10
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The aim of the course is to expand the existing knowledge about molecular biology and to acquire new knowledge and skills related to experimental molecular biology.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-7; BIOTECH-10; MEDBIOT-1; MEDBIOT-2; INDBIOT-1; INDBIOT-2	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Present how biological systems (cell lines and organisms) can be genetically modified. 2. Present how genetically modified cell lines and organisms can be used in medicine, pharmacy and agriculture. 3. Develop practical skills and knowledge through experimental work in the laboratory; learn general safety routines in the laboratory, independently use the equipment, evaluate, demonstrate and discuss the experimental results. 4. Refer to the empirical basis of research in the field of biotechnology through critical reading of original scientific articles. 5. Evaluate achievements of biotechnology and discuss the ethical issues that may arise from the application of biotechnology in various fields. 6. Critically evaluate the scientific literature.	
Course Content	
Lectures. Recombinant DNA technology. Construction and screening of gene libraries. Cloning vectors. Molecular cloning. Genetic transformation of prokaryotes. Genomics and proteomics tools and techniques. Directed mutagenesis and synthesis of modified proteins. Monoclonal antibodies, biofluorescent and bioluminescent systems. Proteins and nucleic acids as therapeutics. Gene manipulation. Transgenic organisms. Ethical issues. **Seminars.** Recombinant DNA technology; transfection, selection, DNA sequencing, establishment of transgenic organisms and applications. **Exercises.** Total RNA Isolation. Measuring gene expression using qPCR. Detection of particular gene expression in a genetically modified organism. Analysis and presentation of the results.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time	

students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes (lectures, seminars, exercises)	1	1-6	Attendance at classes, Seminars and laboratory work	Keeping records Presentation and reports	1 19	5 45
Final exam	2	1-5	Studying for the final exam	Written exam	30	50
Total	**3**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
R. Rapley, D. Whitehouse (Ed.) Molecular Biology and Biotechnology: 6th Ed. Royal Society of Chemistry, 2015.		
Stephenson FH: Calculations for Molecular Biology and Biotechnology, 3rd Edition. Academic Press, 2016.		

Additional Literature

1. Glick BR, Patten CL: Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th Edition. ASM Press, 2017
2. Bansal MP: Molecular Biology and Biotechnology: Basic experimental protocols. The Energy and Resources Institute, TERI, New Delhi 2013

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-E05:	**BIOTECHNOLOGY ENTREPRENEURSHIP**
GENERAL INFORMATION	
Course Coordinator(s)	Jurislav Babić, PhD, full prof.
Associate(s)	Borislav Miličević, PhD, full prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	1st Year / 2nd Semester
Credits (ECTS)	**3**
Teaching Method (number of classes)	Lectures 20; Seminars 10; Exercises 0
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The aim of the course is providing students with the knowledge of entrepreneurship and entrepreneurial processes, with emphasis on entrepreneurship based on biotechnology, as well as explaining the importance of business ethics and socially responsible business practices.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

-

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-4; BIOTECH-5; BIOTECH-6; BIOTECH-8

Learning Outcomes at the Course Level

After successful completion of this course students should be to:

1. Critically argue the roles of entrepreneurship and their responsibility in the wider social context**.**
2. Define the basic components of a company.
3. Define the basic skills, roles, and functions of company management.
4. To analyse market for selected biotechnology product/service and provide relevant marketing activities.
5. Determine the factors that affect the successful business performance of biotechnology companies.

Course Content

Lectures. Role of entrepreneurship in the economic development with the special emphasis on biotechnology companies (midsize and big) and start-up biotechnology companies. Setting up a company: Term and role of the business plan. Business plan development: Company description. Products and services plan. Marketing plan. Management plan. Plan of the activities. Financial plan. Plan of the legalization. The elements and processes of business activates.
Term and content of market analysis. Marketing and sales. Financial report and financial situation of the company. Intellectual property. Bioethical requirements and problems related to biotechnology companies. Innovations and management of the research and development activities. Potentials and development of the biotechnology based industry.
Seminar. Specificity of selected biotechnology companies (start-up, midsize and big) - study cases.

Teaching Methods

Lectures; seminars

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. A seminar which

has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes (lectures)	0.3	1-5	Attendance at classes	Keeping records	5	10
Seminars	0.7	5	Preparation of seminar presentation	Seminar presentation	15	40
Partial exams or final exam	2	1-5	Studying for the partial exams or final exam	Written exam	30	50
Total	**3**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	**Grade**
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Shimasaki C: Biotechnology Entrepreneurship: Leading, Managing, and Commercializing Innovative Technologies, second edition. Academic press, 2020	-	-

Additional Literature

Francoise and Glen Giovannetti. Managing Biotechnology: From Science to Market in the Digital Age 1st Ed., Wiley, 2017.

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

BIOTECH-E06:	**ENZYME IMMOBILIZATION TECHNIQUES**
GENERAL INFORMATION	
Course Coordinator(s)	Ivica Strelec, PhD, full prof. Sandra Budžaki, PhD, assoc. prof.
Associate(s)	Marta Ostojčić, MSc
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	1st Year / 2nd Semester
Credits (ECTS)	**3**
Teaching Method (number of classes)	Lectures 15; Seminars 5; Exercises 10
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The aim of this course is to provide advanced knowledge of enzyme immobilization techniques on molecular level, as well as to introduce the students with up-to-date immobilization techniques. In addition, course provides in depth understanding of molecular interactions underlying enzyme carrier interactions, enables rational planning of enzyme immobilization process, as well as acquisition of practical skills in enzyme immobilization and qualitative and quantitative evaluation of experimental data of immobilization process.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme of Natural sciences (chemistry, biology), Biotechnical sciences, Biomedicine or Health.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-2; INDBIOT-2; INDBIOT-3

Learning Outcomes at the Course Level

After successful completion of this course students should be to:

1. Critically evaluate from start to finish the entire process of enzyme immobilization on different scales of production (from laboratory to large-scale production)
2. Recommend various techniques of enzyme immobilization
3. Plan and explain enzyme immobilization process with respect to the enzyme and carrier molecular properties and type of their interaction
4. Select and design enzyme immobilization process with respect to starting material and demands on reuse of immobilized enzyme
5. Know how to choose and use different methods for qualitative and quantitative analysis (evaluation) of enzyme immobilization process and immobilized enzyme reuse
6. Perform enzyme immobilization and critically evaluate experimental results by qualitative and quantitative analysis of immobilization process

Course Content

Lectures. Introduction to enzyme immobilization (*practical reasons for enzyme immobilization, history of enzyme immobilization, important patent of industrial applications, commercialisation of enzyme immobilization*). Techniques of enzyme immobilization (*adsorption, covalent linking, entrapment, enzyme cross-linking*). Intermolecular interactions and/or bonds between enzymes and carriers. Enzyme carriers. Immobilized enzyme properties. Evaluation of immobilization process. Application of immobilised enzymes in biotechnology, pharmacy and biomedicine.
Seminars. Production of enzyme carriers from agro-food industrial waste. Effect of immobilization on kinetic properties and stability of immobilized enzymes.
Laboratory exercises. Enzyme immobilization by adsorption, covalent linking and entrapment.

Determination of reusability of immobilized enzyme. Qualitative and quantitative evaluation of immobilization process.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up.

Monitoring the Activity of the Students (Connecting Learning Outcomes, Teaching Methods, and Grading)

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes	0.25	1-6	Attendance to classes	Keeping records	2	10
Seminars	0.25	1-6	Preparation of seminar presentation	Seminar presentation	5	15
Laboratory exercises	1	3, 6	Work in laboratory	Written report	13	25
Final exam	1.5	1-6	Studying for the final exam	Written exam	30	50
Total	**3**				**50**	**100**

Table 2. Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade points
99.00 – 100.00	50
97.00 – 98.99	49
95.00 – 96.99	48
93.00 – 94.99	47
91.00 – 92.99	46
89.00 – 90.99	45
87.00 – 88.99	44
85.00 – 86.99	43
83.00 – 84.99	42
81.00 – 82.99	41
79.00 – 80.99	40
77.00 – 78.99	39
75.00 – 76.99	38
73.00 – 74.99	37
71.00 – 72.99	36
69.00 – 70.99	35
67.00 – 68.99	34
65.00 – 66.99	33
63.00 – 64.99	32
61.00 – 62.99	31
60.00 – 60.99	30

Forming the final grade:

The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Dwevedi A, Enzyme Immobilization-Advances in Industry, Agriculture, Medicine, and the Environment, Springer International Publishing Switzerland, Zurich, 2016	-	-
Cao L, Carrier-bound Immobilized Enzymes - Principles, Applications and Design, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2006	-	-

Additional Literature

1. Guisan JM, Immobilization of enzymes and Cells, 3rd Ed., Humana Press/Springer Science+Business Media, New York, 2013
2. Minteer SD, Enzyme Immobilization and Stabilization – Methods and Protocols, 2nd Ed., Humana Press/Springer Science+Business Media, New York, 2017
3. Scientific and professional papers related to the specific areas of the course

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

2nd Year – Module: Industrial Biotechnology – Obligatory Courses

INDBIOT-01:	**BIOPROCESS ENGINEERING**
GENERAL INFORMATION	
Course Coordinator(s)	Vinko Krstanović, PhD, full prof. Kristina Mastanjević, PhD, assist. prof.
Associate(s)	
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**6**
Teaching Method (number of classes)	Lectures 30; Seminars 15; Exercises 30
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The objective of this course is to gain basic knowledge of biotechnological processes through learning about the structure and functioning of biocatalysts, the properties of the production medium and unit operations of the upstream phase, the cultivation phase in the bioreactor and the downstream phase.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-1; INDBIOT-2	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Differentiate and compare different types of bioprocess: batch, feed- batch, semi-continuous and continuous bioprocesses; 2. Suggest equipment for running the selected bioprocess. 3. Select a system for monitoring and regulating bioprocesses and the type and conditions of sterilization, depending on the type of nutrient medium. 4. Calculate bioprocess performance parameters. 5. Critically evaluate different bioprocessing systems using first- and second-generation immobilized biocatalysts. 6. Predict upstream and downstream processes for the selected bioprocess.	
Course Content	
Lectures. Phases and types of biotechnological processes; microbial growth kinetics; kinetics of enzymes and immobilized enzymes; biomass cultivation; mass balance of batch, fed- batch, semi-continuous and continuous bioprocesses; microbial growth stoichiometry, and product formation; evaluation of bioprocess performance; bioprocess control and control equipment; sterilization; aeration and mixing processes; regulation and optimization of bioprocesses; bioreactor systems with immobilized biocatalysts; and bioprocess product separation processes. **Seminars**. Creating a balance sheet for preparation of batch, fed-batch bioprocess, semi-continuous and continuous bioprocess; calculating the specific growth rate of microorganisms and success of product formation. **Laboratory exercises**. Aerobic process (acetic acid production); anaerobic batch process (ethanol production); fed-batch process (bioethanol production) on a laboratory scale, and calculation of success indicators of microbial process; immobilization of yeast cells in matrix.	
Teaching Methods	

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Min.
Attending classes	0.5	1- 6	Attendance at classes	Keeping records	2	10
Seminars	1.5	1,4	Seminar work preparation	Presentation of seminar work	10	20
Laboratory exercises	1.5	1,4-5	Practical work	Laboratory exercises report	8	20
Knowledge tests (partial tests/or final written exam)	2.5	1-6	Studying for the partial tests or final written exam	Written exams	30	50
Total	**6**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade points
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Doran PM: Bioprocess Engineering Principles, 2nd Ed., Academic Press, 2013.	1	yes
Das D, Das D, Biochemical Engineering: An Introductory	1	yes

Textbook, Jenny Stanford Publishing Pte. Ltd., 2019.		
Additional Literature		
James M L, Biochemical Engineering, eBook Version 2.2, 2006. Katoh S, Horiuchi J-i, Yoshida F, Biochemical Engineering: A Textbook for Engineers, Chemists and Biologists, 2nd Ed., Wiley-VCH Verlag GmbH & Co. KGaA, 2015.		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

INDBIOT-02:	**FERMENTATION TECHNOLOGIES**
GENERAL INFORMATION	
Course Coordinator(s)	Borislav Miličević, PhD, full prof. Vinko Krstanović, PhD, full prof.
Associate(s)	Antun Jozinović, PhD, assist. prof. Kristina Mastanjević, PhD, assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**6**
Teaching Method (number of classes)	Lectures 30; Seminars 15; Exercises 30
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The aim of this course is to gain knowledge about fermentation technologies, application of microorganisms, enzymes, animal and plant cells and their analogues in biotechnological production of different products.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-2; INDBIOT-3	
Learning Outcomes at the Course Level	
After completion of lectures, seminars and exercises, self-study and the passed exam students will: 1. Compare different types of fermentations. 2. Distinguish the role of microorganisms, enzymes, animal and plant cells and their analogues in fermentation processes. 3. Compare production technologies for different types of fermentation processes. 4. Propose process conditions for selected fermentation processes. 5. Apply acquired analytical and critical skills to develop and implement technological solutions during conducting the fermentation.	
Course Content	
Lectures. Historical development and perspectives of fermentation technology. Introduction to fermentation processes, biological pathways, kinetics, microorganisms and enzymes - opportunities and limitations of metabolite production, microbial cultures for fermentation processes. Media formulation, inoculum development, process optimization. Classification and characteristics of individual fermentation processes. Types and basic concepts for the selection, design and operation of fermenters. Selected technological fermentation processes for the production of selected products (alcohols, SCPs, enzymes, organic acids, amino acids, vitamins, antibiotics, hormones and alkaloids). **Seminar.** Calculation for the production of the microbial biomass of *Saccharomyces cerevisiae*. Microbial enzyme production. Production and application of amino acids. Production and application of antibiotics. Production and application of vitamins. Biotransformation. Application of microorganisms in food production. **Laboratory exercises.** Production and isolation of alcohol fermentation metabolites. Quantitative and qualitative analysis. Microaerophilic production process to produce lactic acid. Crabtree effect in *Saccharomyces cerevisiae*.	
Teaching Methods	
Lectures; seminars; laboratory exercises	

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.50	1-5	Attendance at classes	Keeping records	2	10
Seminars	1.50	1-2	Seminar work preparation	Presentation of seminar work	10	20
Laboratory exercises	1	3-4	Practical work	Laboratory exercises report	8	20
Final exam	3	1-5	Studying for the final exam	Written exam	30	50
Total	**6**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Okafor N, Okeke BC: Modern Industrial Microbiology and Biotechnology, 2nd Ed., CRC Press, Boca Raton, 2018.	-	yes
Additional Literature		

1. Stanbury PF, Whitaker A, Hall SJ: Principles of Fermentation Technology, 3rd Ed., Butterworth-Heinemann, 2017.
2. Bamforth CW, Ward RE: The Oxford Handbook of Food Fermentations. Oxford, 2014.

3. Bamforth CW: Food, Fermentation, and Micro-organisms. Oxford: Blackwell Science, 2005.
4. Pometto A, Shetty K, Paliyath G, Levin RE: Food Biotechnology 2nd Ed., CRC Press, 2005.
5. Scientific and professional papers related to particular chapters (available online)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

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INDBIOT-03	**BIOCATALYSTS AND BIOTRANSFORMATION**
GENERAL INFORMATION	
Course Coordinator(s)	Marina Tišma, PhD, assoc. prof.
Associate(s)	-
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**4.5**
Teaching Method (number of classes)	Lectures 30; Seminars 10; Exercises 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
This course aims to provide knowledge on application of enzymes and whole cells in industrial biotechnology with the aim of sustainable development (to change chemical processes with ecologically and economically friendlier processes).	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
INDBIOT-2; INDBIOT-4; INDBIOT-6	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Compare differences between homogeneous and heterogeneous biocatalysis. 2. Compare different bioreactor types used in biotransformation. 3. Critically argue advantages and disadvantages of heterogeneous biocatalysts. 4. Predict applications of immobilized enzymes or immobilized whole cells. 5. Estimate enzyme kinetics parameters. 6. Select appropriate bioseparation steps for the isolation of desired product. 7. Compare industrially important biotransformation.	
Course Content	
Lectures. Definition of homogeneous and heterogeneous biocatalysis. Types of reactors for enzymatic catalysed reactions. Application of homogeneous and heterogeneous biocatalysis in industry. Development of mathematical model for enzymatic catalysed process. Integral and differential methods for kinetic parameter estimation. Kinetics of microorganism's growth. Estimation of kinetic parameters. Bioseparation processes (separation of microbial cells, intracellular and extracellular products, concentration and purification of bioproducts). Examples of industrially important biotransformation. **Seminars**. PowerPoint presentation in the field of industrial biotransformation. **Laboratory exercises.** Phenolic compounds oxidation catalysed by laccase.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.	
Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and*	

Grading)

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.5	1-7	Attendance at classes	Keeping records	2	10
Seminars	1	7	Seminar work preparation	Presentation of seminar work	10	20
Laboratory exercises	0.5	5-6	Practical work	Laboratory exercises report	8	10
Final exam	2.5	1-5	Studying for the final exam	Written exam	30	50
Total	**4.5**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Straathof AJJ, Adlercreutz P: Applied Biocatalysis, Harwood Academic Publisher, 2nd Ed., 2000.		

Additional Literature

Liese A, Seelbach K, Wandrey C: Industrial biotransformation, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, Springer, 2006.
Buchholz K, Kasche V, Bornscheuer, UT: Biocatalysts and Enzyme Technology, Wiley, 2012.

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-04:	**GENERAL PLANT BIOTECHNOLOGY**
GENERAL INFORMATION	
Course Coordinator	Tihana Marček, PhD, assist. prof.
Associate(s)	Maja Ižaković, assistant
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**4.5**
Teaching Method (number of classes)	Lectures 30; Seminars 10; Exercises 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
To teach students with the basic principles of *in vitro* plant cultivation in order to produce healthy plants, preservation of the parental plants (gene pool) as well as application of micropropagation in isolation of biotechnological important metabolites. Furthermore, course aim is to give basic knowledge about the usage of plant hydroponic systems in Biotechnology.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-6; INDBIOT-1	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Explain the organisation of the plant cell and plant tissue types and adopt a basic knowledge of plant cell proliferation and differentiation. 2. Learn and be able to distinguish different types of plant cell and tissue cultures. 3. Perform the subcultivation of plant material *in vitro*. 4. Realize the importance of photosynthesis in primary metabolite biosynthesis. 5. Recognize the basic interactions among primary and secondary metabolism. 6. Explain the basic principles of hydrophone plant cultivation and raise the plants in hydroponic conditions.	
Course Content	
Lectures. Plant cell and the tissues. Cell proliferation and callus growth. Plant cell differentiation, totipotency, organogenesis and apomixis. Nutrition media composition. Vegetative propagation *in vitro*. Plant cell and tissue culture. Organised and unorganised explant growth of explants *in vitro*. Micropropagation; axillar buds, culture of embrio, meristem and protoplast. Incision of meristem and inoculation of explants for micropropagation. Multiplication of plant material. Haploids and androgenesis. Somatic embryogenesis. Hydroponic plant cultivation application in biotechnology and industry. Hoagland's nutritive solution. Carbon and nitrogen metabolism. Photosynthesis - a source of primary metabolite synthesis. Primary and secondary metabolic pathways in plants. Plant cell culture – a source of secondary metabolites. **Seminars.** Choose one secondary metabolite (or group) which is important in biotechnology. Explain the role, application, metabolite pathways and plant species (or plant family) in which this metabolite is produced. **Exercises.** Murashige and Skoog nutrition medium preparation. Inoculation of explants on nutrition medium and multiplication of the plant material. Inoculation of plant material in a	

hydroponic nutrient solution.

Teaching Methods

Lectures, seminars, exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending lectures	0.5	1-6	Class presence	Tracking records	5	10
Seminars	1.5	4-5	Seminar completed	Presentation of seminar	10	30
Exercises	0.5	3,6	Pratical work	Exercise done and signed	5	10
Final exam	1	1-6	Learning for exam	Written exam	30	50
Total	**4.5**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The grade points accumulated during the classes will be added to the points achieved from the final exam. The grading will be done by absolute distribution, i.e. on the basis of the final results, and it will be compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Bahatla SC, Lal MA: Plant Physiology, Development and Metabolism. Springer Singapore, 2018	-	No

Anis M, Ahmad N: Plant Tissue Culture: Propagation, Conservation and Crop Improvement. Springer Singapore, 2016	-	No
Additional course literature		
1. Trigiano RN, Gray DJ: Plant Development and Biotechnology. Boca Raton, CRC Press, 2004 2. Scientific papers (available on-line)		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

INDBIOT-05:	**BIOFUELS AND BIOREFINERIES**
GENERAL INFORMATION	
Course Coordinator(s)	Marina Tišma, PhD, assoc. prof.
Associate(s)	Sandra Budžaki, PhD, assoc. prof. Ana Bucić-Kojić, PhD, full prof. Mirela Planinić, PhD, full prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**5**
Teaching Method (number of classes)	Lectures 30; Seminars 15; Exercises 15; Field Excercises: 10
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
This course aims to provide basic knowledge on the concepts of biorefinery and sustainable development, biovalorization of waste from different industries, types and characterization of the raw materials in biofuel production, existing and advanced technologies in biofuels production.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-5; BIOTECH-6; INDBIOT-4	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Understand concept of biorefinery as the main scenario for the future of fossil fuels non-dependence 2. Differentiate alternative methods of biovalorization of waste from food industry, agriculture, forestry, as well as biodegradable fractions of municipal waste 3. Explain the types, methods of production and basic characteristics of biofuels (biogas, bioethanol, biodiesel) 4. Differentiate biofuels of first, second and third generation 5. Perform biocatalytic synthesis of biodiesel in different bioreactor systems 6. Connect theory with the good industry practise	
Course Content	
Lectures. Sustainable energy sources. Overview of biorafineries. Basic information on type and characteristics of biofuels. Types of raw materials, its characteristics and possible application in biofuel / value-added products production. Industrial production of bioethanol. Industrial production of biodiesel. Industrial production of biogas. Advanced technologies in biofuels production. Lignocellulose pretreatment in biofuels production. Application of enzymes and microorganisms in lignocellulose pretreatment. Energy balance and life cycle analysis in biofuels production. **Seminar**. Case study. **Laboratory exercise.** Biodiesel production in different reactors catalysed by lipase. **Field exercise.** Visit to biofuel industrial process and biotechnological start-ups.	
Teaching Methods	
Lectures; seminars; laboratory exercises; field course	
Students' Obligations	

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.25	1-6	Attendance at classes	records	2	10
Seminars	0.75	2-4	Seminar work preparation	Presentation of seminar work	10	20
Laboratory exercise	1	5-6	Practical work	Laboratory exercises report	8	20
Final exam	3	1-5	Studying for the final exam	Oral exam	30	50
Total	**5**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Drapcho CM, Nhuan NP, Walker TH: Biofuels Engineering Process Technology, McGraw-Hill, 2020.		

Additional Literature

1. Brar SK, Dhillon GS, Soccol CR: Biotransformation of Waste Biomass into High Value Biochemicals, Springer, 2013.
2. Khanal SK, Surumpalli RY, Zhang TC, Lamsal BP, Tyagi RD, Kao CM: Bioenergy and Biofuels from Biowasates and Biomass. Virginia, USA: American Society of Civil Engineers, 2010.

3. Mousdale DM: Biofuels: Biotechnology, Chemistry, and Sustainable Development, Boca Raton, USA: CRC Press, 2008.
4. Rittmann BE, McCarty PL: Environmental Biotechnology: Principles and Applications. New York, USA: McGraw-Hill, 2001.
5. Scientific and professional papers (available on-line)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-06:	**WASTE MANAGEMENT IN BIOPROCESS INDUSTRY**
GENERAL INFORMATION	
Course Coordinator(s)	Natalija Velić, PhD, assoc. prof.
Associate(s)	Marina Tišma, PhD, assoc.prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; Seminars 10; Exercises 10; Field Exercises: 10
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

Introduce students to methods of proper waste management generated during the production process in different bioprocess industries with the aim of environmental protection, and introduce them to methods of waste treatment and the possibilities of reuse.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

-

Learning Outcomes at the Programme Level Contributed by the Course

INDBIOT-4; BIOTECH-7

Learning Outcomes at the Course Level

After attending lectures and successfully completing seminars and exercises, learning independently, and passing the exam, the students will be able to:

1. Compare different waste management systems
2. Interpret and compare national and international waste management legislation and regulations
3. Identify the methods of sustainable waste management
4. Classify waste materials of bioprocess industries, analyse the waste generation points and costs of removal, treatment, reuse, recycle and disposal
5. Differentiate treatment methods of bioprocess industry waste
6. Suggest the appropriate treatment methods and waste management systems based on the available data on production process (case study)

Course Content

Lectures. Global environmental issues, the role and the importance of biotechnology in environmental protection. Waste management systems. Overview of national and EU legislation and regulations related to waste management of bioprocess industry. Waste classification and analysis of waste composition. Bioprocess industry solid waste treatment. Biological methods of solid waste treatment - status and trends. Case studies. Risk assessment and management of production waste involving the use of recombinant or pathogenic microorganisms. Bioprocess industry wastewater characteristics (production of microbial biomass, enzymes, organic solvents and acids, amino acids, antibiotics, vaccines, hormones, etc.). Physico-chemical and biological methods of wastewater treatment applied in the industrial environment. Waste gases treatment methods. Biological treatment of industrial waste gases (biofilters, bioscrubbers).

Seminar. Bioremediation, mycoremediation, phytoremediation. Treatment of wastewater contaminated with xenobiotics. The role of biosensors in environmental pollutants monitoring. GMO- benefits and risk assessment.

Exercises. Lignocellulosic waste degradation by white rot fungi. Biological treatment of wastewater: degradation of xenobiotics (synthetic dyes). Removal of pollutants from wastewater

by biosorption. **Field exercises**: Composting plant, biogas plant (anaerobic waste treatment) and wastewater treatment plants visits

Teaching Methods

Lectures; seminars, exercises, field course

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes	0.3	1-6	Attendance at classes	Keeping records	3	8
Seminar work	1.2	6	Writing a seminar paper	Presentation of seminar work	10	30
Exercises	0.5	3-6	Attendance at exercises	Laboratory exercises report	7	12
Final exam	2	1-6	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Woodard & Curran Inc., Industrial Waste Treatment Handbook, 2nd Ed., Butterworth-Heinemann, 2006.	-	-

Singh RL, Principles and applications of Environmental Biotechnology for a Sustainable Future, Springer, Singapore, 2017.		yes

Additional Literature

1. Cheremisinoff NP: Handbook of solid waste management and waste minimization technologies. Butterworth Heinemann, Amsterdam; Boston, 2003.
2. Jördening H-J, Winter J: Environmental Biotechnology – Concepts and Applications, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2005.
3. Scientific and professional papers (available on-line)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-07:	**INSTRUMENTAL METHODS IN BIOTECHNOLOGY**
GENERAL INFORMATION	
Course Coordinator(s)	Daniela Čačić Kenjerić, PhD, full prof. Lidija Jakobek Barron, PhD, full prof.
Associate(s)	Ivana Tomac, PhD, postdoc. Petra Matić, BSc
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; Seminars 15; Laboratory Exercises 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
Familiarity with analytical methods that can be used in biotechnology to determine concentrations of sample constituents and presence of contaminants.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-6; INDBIOT-3; INDBIOT-6; MEDBIOT-2	
Learning Outcomes at the Course Level	
After successful completion of lectures, seminars, laboratory exercises, and after passed exam, students will be able to: 1. Compare analytical methods suitable for the determination of a specific analyte 2. Present the selected analytical method 3. Point out the most appropriate, from all acceptable methods, for analyzing the selected component based on the given criteria 4. Solely complete an analysis of the selected real sample 5. Present the results obtained by analysis	
Course Content	
Lectures. Electroanalytical methods: conductometry, coulometry, potentiometry, voltammetric methods. Electrokinetic zeta potential. Chromatographic methods: high-performance thin layer chromatography (HPTLC), gas chromatography (GC), high-performance liquid chromatography (HPLC), supercritical fluid chromatography (SFC), capillary electrochromatography (CEC). Electrophoresis. Spectroscopy: visible (Vis), ultraviolet (UV), infrared (IR, FTIR) atomic absorption spectroscopy (AAS). Mass spectrometry (MS, MS/MS), ionization in MS systems (ESI, APCI, APPI, MALDI), analyzer types, fragmentation in MS systems. Nuclear magnetic resonance spectroscopy (NMR). Combined instrumental systems (GC-MS, (U)HPLC-MS, HPLC-FTIR). Quality assurance of the results obtained: validation of analytical methods. All techniques will be presented through a combination of theoretical principles, presentation of instrumental techniques and examples from biotechnology production. **Seminars.** Individual student tasks: selecting and presenting an analytical method for the analysis of a selected compound (groups of compounds) (description of the instrumental technique, analytical method parameters, expected results, application of the method for the analysis of specific samples)	

Laboratory exercises. Analysis of selected compounds (sampling, sample preparation, separation, physicochemical characterization). Instrumental techniques that will be used for that purpose are: electroanalytical techniques (conductometry, potentiometry, voltammetry), zetasizer for zeta-potential determination, high-performance liquid chromatography, UV/Vis spectroscopy, IR spectroscopy, and gas chromatography.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up.

Monitoring the Activity of the Students
(*Connecting Learning Outcomes, Teaching Methods, and Grading*)

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes (lectures, seminars, laboratory exercises)	0.5	1-5	Attendance at classes, seminars and laboratory exercises	Attendance records	5	20
Knowledge tests (partial tests)	2.5	1-3	Studying for the partial knowledge test	Written exam	30	50
Final exam	1	1-3	Studying for the final exam	Oral exam	15	30
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points awarded during class, seminar and laboratory exercise attendance are added to the grade points granted for the final exam. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of	Availability via

	copies in the library	other media
Skoog DA, Holler FJ, Crouch SR: Principles of Instrumental analysis, 7th Ed., Cengage Learning, USA, 2018.	-	-
Additional Literature		
Vitha MF: Spectroscopy: Principles and Instrumentation, 1st Ed., Wiley, 2017.		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

INDBIOT-08	**BIOPROCESS PLANT DESIGN**
GENERAL INFORMATION	
Course Coordinator(s)	Darko Velić, PhD, full prof.
Associate(s)	Krunoslav Aladić, PhD, assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	4
Teaching Method (number of classes)	Lectures 20; Seminars 15; Exercises 15
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The aim of this course is to get acquainted with the crucial stages of bioprocess plant design; from project design, procurement and installation of bioprocess equipment to production start-up. Furthermore, the goal is to introduce students to pre-design and design conditions of the bioprocess plant.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

-

Learning Outcomes at the Programme Level Contributed by the Course

INDBIOT-5; BIOTECH-7; BIOTECH-9

Learning Outcomes at the Course Level

After successful completion of this course students are expected to be able to:

1. Properly interpret, compare and differentiate the individual stages of bioprocess plant design.
2. Describe and analyse possible project solutions and define the project task.
3. Define and determine production standards, select optimal process solutions and estimate costs.
4. Analyse and optimise the heat exchanger network.
5. Properly interpret and differentiate legal provisions related to bioprocess plant design.
6. Compare, analyse and apply the acquired knowledge in the design of the bioprocess plant project.

Course Content

Lectures. Phases and hierarchy of bioprocess plant design. Bioprocess research and development. Scale-up of bioprocesses and bioprocess equipment. Bioprocess flowsheet - norms and standards. The material and energy balances, capacity selection. Specification of bioprocess equipment. Bioprocess measurement, regulation and automation. Simulation programs and models. Thermo-economic analysis and energy integration of bioprocesses. The pinch technology and optimisation of the heat exchanger network. Estimation of the cost of process equipment and total investment. Bioprocess security. Waste minimisation and management. Investment program. Bioprocess plant design and legislation.
Seminars. Calculate and analyse material and energy balances of for the selected bioprocess plant.
Exercises. Draw process diagrams and layout plans for the bioprocess plant using MS Visio® and CAD software.

Teaching Methods

Lectures; seminars and computer exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all

knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes (lectures, exercises)	0.3	1-6	Attendance at classes	Keeping records	5	10
Seminars	1.2	3-4	Seminar work	Oral presentation	10	30
Computer exercises	0.5	6	Attendance at exercises	Exercises report	5	10
Final exam	2	1-8	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Odum J, Flickinger MC: Process Architecture in Biomanufacturing Facility Design, Wiley, 2017.	-	-

Additional Literature

1. Jacobs T, Signore AA: Good Design Practices for GMP Pharmaceutical Facilities, 2nd Ed., CRC Press, 2017.
2. Jagschies G, Lindskog E, Lacki K, Galliher P: Biopharmaceutical Processing: Development, Design, and Implementation of Manufacturing Processes, 1st Ed., Elsevier, 2017.

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-09:	**COMPUTER DATA ANALYSIS AND VISUALISATION**
GENERAL INFORMATION	
Course Coordinator(s)	Frane Čačić Kenjerić, PhD, assist. prof.
Associate(s)	-
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	4
Teaching Method (number of classes)	Lectures 20; Seminars 30; Exercises 0
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

Aim of this course is introduction to methods and procedures involved in dana acquisition, pre-processing, storage, analysis and visualisation by means of digital computer.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

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Learning Outcomes at the Programme Level Contributed by the Course

INDBIOT-6; BIOTECH-6

Learning Outcomes at the Course Level

After the lectures, seminars and exercises, self-study and passed exam students will be able to:

1. Distinguish and understand different types of statistical data processing applications
2. Select tools and create an environment for computer processing, analysis and data visualization (based on free open source software)
3. Understand ways to retrieve and be able to retrieve data from different sources and prepare it for analysis
4. Distinguish between applying different graphical representations of results
5. Present the results of the analyses in a tabular and graphical format in a format suitable for publication and exchange

Course Content

Introduction. Data structures (list, arrays, dictionaries, data frames, …), manipulation with data, Graphing 2D&3D, Interactive data representation, Formatting for publication, Different platforms for data publication, Sampling for Estimation of Finite Population Quantities, Sampling plans for product inspection, Statistical process control, Design and analysis of Experiments, Reliability and Survival analysis.

Teaching Methods

Lectures; Seminars

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related	ECTS	Learning	Student activity	Evaluation	Grade points

activity		outcome		method	Min.	Max.
Attending classes (lectures, exercises)	0.5	1-5	Attendance at classes	Attendance records	5	10
Seminars	1.5	1-5	Seminar work	Oral presentation, written paper	15	40
Final exam	2	1-5	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90.00-100.00 grade points; B – Very Good (4): 80.00-89.99 grade points; C – Good (3): 65.00-79.99 grade points; D – sufficient (2): 50.00-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Kenett RS: Modern Industrial Statistics with applications in R, MINITAB and JMP, 2nd Ed., Wiley 2014.	-	

Additional Literature

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Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-MT:	**MASTER'S THESIS**
GENERAL INFORMATION	
Course Coordinator(s)	Teachers in the science-teaching titles who teach at this graduate study program
Associate(s)	-
Study Program	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd year / 4th Semester
Credits (ECTS)	**10**
Teaching Method (number of classes)	Lectures: 0; Seminars: 0; Exercises: 100
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The objective of the course is to make the student able to analyze and solve given problem/s from a theoretical and practical point of view through work on a thesis topic.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed courses from the second year of graduate study.

Learning Outcomes at the Program Level Contributed by the Course

-

Learning Outcomes at the Course Level

After completing the course, the student will be able to:

1. Relate the knowledge and skills acquired during the studies and develop the ability to further learn from the relevant literature with the advice of a mentor
2. Perform experiments independently and analyze and interpret the obtained results
3. Select, explain and vindicate the proposed solution
4. Formulate and write a master's thesis in accordance with the instructions and make conclusions in a linguistically and ethically correct manner
5. Present obtained results publicly using a presentation prepared on a computer with twenty minutes of oral presentation

Course Content

Work on master's thesis

Teaching Methods

-

Students' Obligations

Complete all the defined tasks of the thesis. A student whose diploma thesis is positively evaluated by a mentor defends his work in front of the Graduate Defense Committee.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

The student independently creates the experimental part of the work and with the help of relevant scientific literature and suggestions of the mentor presents the solution of the given problem in written form, all by applying the knowledge gained from the subjects that he passed during this graduate study. The student presents his work in written and oral form.

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
In accordance with thesis work		

Additional Literature
-
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

2nd Year – Module: Industrial Biotechnology – Elective Courses

INDBIOT-E01:	**SOLID-STATE FERMENTATION**
GENERAL INFORMATION	
Course Coordinator(s)	Marina Tišma, PhD, assoc. prof.
Associate(s)	Ana Bucić-Kojić, PhD, full prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; Seminars 10 Exercises 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
This course aims to provide knowledge on solid-state fermentation, reactor design with the aim to production of different products	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
INDBIOT-2	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Enumerate type and characteristics of substrate for microorganism cultivation in solid-state conditions 2. Know basics on physiology of filamentous fungi 3. Enumerate and explain the principle of bioreactors operating in solid-state conditions 4. Enumerate and know the advantages and disadvantages of microorganism cultivation in solid-state fermentation compared to submerge cultivation 5. Know the methods of substrate and biomass cultivation during solid-state fermentation.	
Course Content	
Lectures. Type and characteristics of solid-state fermentation. Basics on physiology of filamentous fungi. Type of bioreactors for solid-state fermentation. Mathematical model development for solid-state fermentation. Industrial application. **Seminar:** Application of solid-state fermentations for the production of biotechnologically important products or bioremediation - case study. **Exercises:** Cultivation of filamentous fungi under solid-state conditions in a bioreactor.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise which has not been completed must be made up through a midterm exam.	
Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*	

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.25	1-5	Attendance at classes	Keeping records	2	5
Seminars	1	5	Seminar work	Presentation of seminar work	13	35
Laboratory exercise	0.75	4-5	Attendance at exercises	Laboratory exercises report	5	10
Final exam	2	1-5	Studying for the final exam	Oral exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Mitchell DA, Krieger N, Berovič M, Solid-State Fermentation Bioreactors, Springer, 2006.		

Additional Literature

1. Pandey A, Soccol CR, Larroche lC, Current Developments in Solid-state Fermentation, Springer 2008.
2. Scientific literature (available on-line).

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-E02:	**MICROREACTORS**
GENERAL INFORMATION	
Course Coordinator(s)	Marina Tišma, PhD, assoc. prof.
Associate(s)	Mirela Planinić, PhD, full prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; Seminars 10; Exercises 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
This course aims to provide knowledge on basic principles and application of microreactors.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-1; INDBIOT-3	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Enumerate and understand advantages and disadvantages of microreactors over classical reactors. 2. Differentiate and explain flow in microchannels. 3. Understand the scale-up process in microfluidics. 4. Enumerate and understand the application of free and immobilized in microreactors. 5. Enumerate and understand the application of microreactors in analytics and bioseperation processes. 6. Perform biocatalysis in microreactors.	
Course Content	
Lectures. Introduction to microreactors. Advantages of microreactor technology over classical reactors. Flow in microreactors. Methods of constructions. Application of microreactors in biotechnology. Enzymatic microreactors. Application of microreactors in analytics. Application of microreactors in bioseparation processes. Industrial application of microreactors. **Seminar**. Case study **Laboratory exercise**. Oxidation of gallic acid catalysed by laccase in a different microchannels	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise hich has not been completed must be made up through a midterm exam.	
Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*	

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.25	1-6	Attendance at classes	Keeping records	2	10
Seminars	0.75	3-5	Seminar work	Presentation of seminar work	10	20
Laboratory exercise	1	6	Practical work	Laboratory exercises report	8	20
Final exam	2	1-6	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Ehrfeld W, Hessel V, Löwe H: Microreactors: New Technology for Modern Chemistry, Wiley, 2000		

Additional Literature

Scientific literature available on-line.

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-E03:	**WASTEWATER TREATMENT**
GENERAL INFORMATION	
Course Coordinator(s)	Natalija Velić, PhD, assoc. prof.
Associate(s)	-
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; Seminars 10; Exercises 5; Field Exercises 10
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
Introducing students to different methods and processes used for the treatment of industrial wastewaters with the aim of protecting aquatic ecosystems (natural recipients) into which treated wastewaters are discharged.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
INDBIOT-4; BIOTECH-7; BIOTECH-8	
Learning Outcomes at the Course Level	
After attending lectures and successfully completing seminars and exercises, learning independently, and passing the exam, the students will be able to: 1. Interpret and compare national and international (EU) water legislation. 2. Classify wastewaters by origin and quality indicators. 3. Compare wastewater treatment processes (primary, secondary and tertiary). 4. Differentiate microbiological processes underlying biological wastewater treatment. 5. Compare different technologies and equipment used for wastewater treatment and monitoring. 6. Suggest the appropriate wastewater treatment methods based on the available data on the wastewater quality indicators, origin, volume and other available and relevant information.	
Course Content	
Lectures. Overview of national and international water legislation. Wastewater - classification and characterisation by origin. Physico-chemical methods of wastewater treatment. Preliminary and primary wastewater treatment. Biochemistry, microbiology and kinetics of biological wastewater treatment processes. Aerobic wastewater treatment. Biological and chemical removal of nutrients, nitrogen (nitrification, denitrification) and phosphorus (EBPR). Anaerobic wastewater treatment, anaerobic sludge stabilisation. Biological removal/degradation of xenobiotics. Tertiary treatment. Sludge disposal. Monitoring, modelling, design and optimization of wastewater treatment processes. **Seminar.** Biological removal/degradation of xenobiotics from wastewater. Application of genetically modified microorganisms in biological wastewater treatment. **Exercises.** Experimental methods for wastewater analysis. **Field exercises.** Visits to communal and industrial wastewater treatment plants.	
Teaching Methods	
Lectures; seminars, exercises, field course	
Students' Obligations	

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise hich has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes, seminars	0.3	1-5	Attendance at classes	Attendance records	2	5
Seminar work	1.2	6	Writing a seminar paper	Oral presentation of a seminar	13	30
Exercises	0.5	2-3, 5-6	Attendance at exercises	Exercises report	5	15
Final exam	2	1-6	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Burton FL, Tchobanoglous G, Tsuchihashi R, Stensel HD: Wastewater Engineering:Treatment and Resource Recovery, 5th Ed., Mcgraw-Hill Education: Metcalf & Eddy, Inc., 2013	-	-
van Loosdrecht MCM, Nielsen PH, Lopez-Vazquez CM, Brdjanovic D: Experimental Methods in Wastewater Treatment, IWA Publishing, London, 2016.		yes

Additional Literature
Bitton G*:* Wastewater microbiology, 4th Ed., Wiley-Blackwell, New Jersey, 2011. Cheremisinoff NP: Handbook of Water and Wastewater Treatment Technologies, Butterworth-Heinemann, Woburn, MA, 2002. Scientific papers (available on-line)
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-E04: **EXTRACTION AND ISOLATION OF BIOACTIVE COMPOUNDS**	
GENERAL INFORMATION	
Course Coordinator(s)	Stela Jokić, PhD, full prof.
Associate(s)	Maja Molnar, PhD, assoc. prof. Martina Jakovljević, MSc
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; Seminars 10; Exercises 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
This course aims to provide knowledge on various extraction processes and their applicability in extracting and isolating specific bioactive compounds from various plant-based materials, with emphasis on modern extraction and isolation techniques in laboratories and for industrial purposes.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
INDBIOT-4; BIOTECH-3; BIOTECH-7; BIOTECH-8	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Classified the groups of bioactive compounds and compare the role of bioactive compounds and the importance of the process for the extraction and isolation of active compounds. 2. Compare the basic principle of various extraction, isolation, and purification techniques used on active compounds in laboratory and industrial conditions. 3. Define the modern extraction procedures and the devices used in the extraction process. 4. Differentiate the methods for the isolation of active compounds and define the identification methods. 5. Apply the appropriate extraction and isolation methods for the targeted active compounds in the original materials.	
Course Content	
Lectures. Role and significance of bioactive compounds. Preparation of plant-based materials for extraction (procedures of drying, milling, and others). Standard extraction procedure techniques. Distillation procedures for the isolation of volatile substances. Isolation and characterisation of essential oils. Modern extraction methods: Supercritical fluid extraction, Subcritical water extraction, Microwave assisted extraction, Ultrasound assisted extraction, Extraction using eutectic solvents. Production of dry extracts. Application of chromatographic techniques for the isolation and characterisation of active compounds. Chemical and analytical process control. **Seminars**. Operating principle of laboratory equipment used for standard and modern extraction procedures. Operating principle of chromatographic techniques used for identifying and quantifying natural compounds. Calculations of specific compounds in extracts based on the HPLC analysis. Application of GC/MS for the analysis of essential oils. **Laboratory exercises.** Preparing tinctures and macerates using standard extraction processes. Ultrasound and microwave assisted extraction of active compounds from plant-based materials. Extraction of various plant-based materials by applying supercritical CO_2 and subcritical water.	

Production of essential oils from medicinal plants. Production of extracts from marine organisms. Extraction using deep eutectic solvents. Production of dry extracts using the lyophilisation process and spray drying. Analysis of the extracts using chromatographic analyses (HPLC, GC-MS). Isolation of bioactive compounds using modern chromatographic methods**.** Investigating the antioxidation properties of the extracts.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise hich has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.3	1-5	Attendance at classes	Keeping records	5	10
Seminars	1.2	2-4	Seminar work preparation	Presentation of seminar work	10	30
Laboratory exercises	0.5	5	Practical work	Laboratory exercises report	5	10
Final exam	2	1-5	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of	Availability via

	copies in the library	other media
Rostagno MA, Prado JM: Natural Product Extraction Principles and Applications. RSC Publishing, 2013.		yes
Additional Literature		
Ibanez E, Cifuentes A: Green Extraction Techniques: Principles, Advances and Applications, Volume 76. Elsevier, 2017. Scientific papers demonstrating new methods for the extraction of active substances from various materials (available on-line)		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

INDBIOT-E05 **ENERGY EFFICIENCY IN BIOTECHNOLOGICAL PROCESSING FACILITIES**	
GENERAL INFORMATION	
Course Coordinator(s)	Darko Velić, PhD, full prof. Sandra Budžaki, PhD, assoc. prof.
Associate(s)	Marta Ostojčić, MSc
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; Seminars 10; Exercises 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The objective of this course is to upgrade the existing and acquire new knowledge in the field of heat management in biotechnological facilities with the aim of better energy management and to estimate the consumption of the existing process as well as to recommend energy efficiency measures.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-7; INDBIOT-4	
After successful completion of this course students are expected to be able to: 1. Interpret the requirements of the European Energy Efficiency Directives. 2. Critically evaluate the concept of energy management and its environmental impact. 3. Determine the relationship between energy consumption and production. 4. Identify sources of waste heat and possibilities of their utilization. 5. Analyse industrial energy systems: steam systems, compressed air systems, refrigeration systems. 6. Analyse and valorise cogeneration systems.	
Course Content	
Lectures. Introduction. Legal framework for energy management. European Energy Efficiency Directives. System and concept of energy and environmental management. Relationship between energy consumption and production. Technical aspects of industrial energy management - Industrial energy systems. Sources of waste heat and its potential applications. Process integration - a heuristic approach. Energy integration. Analysis of industrial energy systems: steam systems, compressed air systems, refrigeration systems. Industrial cogeneration. Thermoeconomic analysis and exergoeconomic cost theory. **Seminars.** Engineering calculations of the energy efficiency of equipment, processes and plants that form a single whole with lectures: The pinch technology and optimization of the heat exchanger network in the bioprocessing industry. **Exercises.** Numerical examples (accompanying the course material).	
Teaching Methods	
Lectures; seminars; exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time	

students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.2	1-6	Attendance at classes	Keeping records	5	10
Seminars	1	3-6	Seminar paper	Oral presentation	10	25
Exercises	0.8	4-6	Attendance at exercises	Report	5	15
Final exam	2	1-6	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Capehart BL, Turner CW, Kennedy WJ. Guide to Energy Management, The Fairmont Press, Inc., 2016.	-	-
Kreith K, Goswami DY. Energy Management and Conversation Handbook. Taylor & Francis Group, LLC, CRP Press, 2017.	-	-

Additional Literature

1. Rossiter AP, Jones BP. Energy Management and Efficiency for the Process Industries. John Wiley & Sons, Inc., Hoboken, New Jersey, 2015.
2. LaGrega MD, Buckingham PL, Evans JC, Hazardous Waste Management, 2nd Ed., Waveland Press, Inc., 2010.

3. Çangel YA, Boles MA. Thermodynamics – an engineering approach. McGraw-Hill Publishing Co. Ltd., 2002.
4. Smith R. Chemical Process Design. McGraw Hill, 1995.
5. Seider WD, Seader JD, Lewin DR. Proces Design Principles Synthesis, Analysis and Evaluation of Process Flowsheets. J. Wiley & Sons, 2000.
6. Scientific and professional papers presenting an analysis of energy management and efficiency of biotechnological processes (available online)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-E06: **BY-PRODUCTS IN THE BIOTECHNOLOGICAL AND FOOD INDUSTRY**	
GENERAL INFORMATION	
Course Coordinator(s)	Drago Šubarić, PhD, full prof.
Associate(s)	Antun Jozinović, PhD, assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; Seminars 10; Exercises 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The aim of this course is to upgrade the existing and acquire new knowledge in the field of occurrence of various by-products in food and biotechnological industries with the aim of their better disposal and potential utilization for the production of new products.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTEH-7; INDBIOT-4	
Learning Outcomes at the Course Level	
After completion of lectures, seminars and exercises, self-study and the passed exam students will: 1. Interpret the applicable European and world waste management regulations; 2. Analyze and categorize the waste / by-products of the biotechnology and food industries; 3. Compare the basic characteristics of the individual by-products; 4. Analyze the most common ways of disposing of certain types of by-products; 5. Suggest potential ways of utilizing by-products to produce new products.	
Course Content	
Lectures. Legal framework and directives for waste management. Relationship between production and generation of waste / by-products in biotechnology and food industries. Waste / by-product - definitions and differences. Ways to dispose of waste / by-products from the biotechnology and food industries. Characteristics of various by-products (from sugar and oil industries, by-products of fruit and vegetable processing, by-products of wine production, brewing industry and grain processing) and the possibility of utilizing different by-products to produce new products. **Seminar**. By-products of different industries and potential of their applications. **Laboratory exercises**. Determination of physical and chemical properties of various by-products from biotechnology and food industry (color, protein content, fats, dietary fiber, total polyphenols, antioxidant activity). Preparation of various by-products for potential further application (drying, milling, sieving). Use of prepared by-products in the production of new products.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise hich has not been completed must be made up through a midterm exam.	
Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*	

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.125	1-5	Attendance at classes	Keeping records	5	10
Seminars	0.75	1-5	Seminar work preparation	Presentation of seminar work	10	20
Laboratory exercises	0.125	1-5	Attendance at exercises	Laboratory exercises report	5	20
Final exam	3	1-5	Studying for the final exam	Written and oral exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Nigam PS, Pandey A. Biotechnology for Agro-Industrial Residues Utilisation. Springer, 2009.	-	-

Additional Literature

Oreopoulou V, Russ W. Utilization of By-Products and Treatment of Waste in the Food Industry. Springer, 2007.
Chandrasekaran M. Valorization of Food Processing By-Products. CRC Press, 2013.
Scientific and professional papers (available online)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work

implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-E07:	**TECHNOLOGY OF PROBIOTIC STARTER CULTURE**
GENERAL INFORMATION	
Course Coordinator(s)	Mirela Lučan Čolić, PhD, assist. prof.
Associate(s)	-
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; Seminars 10; Exercises 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The aim of the course is to introduce students to the concept of probiotics, the selection criteria for a probiotic strain, the procedure for evaluation of probiotic potential of microbial strain, the conditions in production and preservation of probiotic starter cultures, with an emphasis on modern processes in probiotic technology. Also, gaining knowledge of probiotic applications in various industries.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
INDBIOT-2; INDBIOT-4	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Explain the concept of probiotics 2. Relate the mechanism of action to the functional properties of probiotics 3. List the criteria for the selection of probiotics and chart the procedure for evaluating the potential probiotic 4. Describe the process of production of probiotic starter cultures 5. Explain the benefits of applying new trends in the production of probiotics 6. Differentiate and compare the use of probiotics in different industries 7. Identify possible problems in the production, storage and administration of probiotics and identify possible solutions	
Course Content	
Lectures. The concept of probiotics: definition and development of probiotics. Taxonomy of probiotic starter cultures. Functional properties of probiotic microorganisms; clinically approved health benefits. The mechanism of action of probiotic. Sources of potential probiotic strains. Isolation, identification and characterization of potential novel probiotics. Selection criteria for probiotic strains (general, technological, functional). Procedure for evaluation of probiotic. Genetically modified probiotics. The industrial aspect of probiotic production. The probiotic bacterial biomass growth, isolation and concentration. Freezing, lyophilization, lyoprotectors. Alternative drying processes for probiotics and starter cultures. Microencapsulation. Stability of probiotics during storage. Application of probiotic starter cultures. Functional food. Prebiotics. Milk probiotic products. Non-dairy probiotic products. Food bio-preservative. Bacteriocins. Biotherapeutics. Legislation; marking. **Seminars.** Possible solutions for current and future challenges in the production, storage and administration of probiotics. **Laboratory exercises.** Isolation, identification and characterization of potential new probiotics.	

Production of probiotic foods. Stability of probiotics during storage.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students (*Connecting Learning Outcomes, Teaching Methods, and Grading*)

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.2	1-6	Attendance at classes	Keeping records	2	10
Seminars	1.0	1-6	Seminar work	Presentation of seminar work	10	20
Laboratory exercises	0.8	7	Practical work	Laboratory exercises report	8	20
Final exam	2.0	1-7	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade points
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The grade points awarded during class attendance are added to the points granted for the final exam. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Foerst P, Santivarangkna C: Advances in Probiotic Technology, CRC Press, New York, 2016.	-	-
Silva JPS, Freitas AC: Probiotic Bacteria: Fundamentals,	-	-

Therapy, and Technological Aspects, CRC Press, New York, 2014.		

Additional Literature

1. Liong M-T: Probiotics: Biology, Genetics and Health Aspects, Springer, New York, 2019.
2. Charalampopoulos D, Rastall RA: Prebiotics and Probiotics Science and Technology, Springer, New York, 2009.
3. Lee YK, Salminen S: Handbook of probiotics and prebiotics, Wiley Blackwell, New York, 2009.
4. Tamime AY, Thomas LV: Probiotic Dairy Products, Wiley Blackwell, New York, 2018.
5. Scientific and professional papers related to specified chapters (available online)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-E08: **GOOD HYGIENE PRACTICE IN BIOPROCESS INDUSTRY**	
GENERAL INFORMATION	
Course Coordinator(s)	Đurđica Ačkar, PhD, assoc. prof.
Associate(s)	Jurislav Babić, PhD, full prof. Drago Šubarić, PhD, full prof. Antun Jozinović, PhD, assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year /4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 30; Seminars 10; Exercises 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
This course aims to provide knowledge on basic principles of hygiene and sanitation with regard to specificities of bioprocess industry – production of food and pharmaceutical products.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-2; BIOTECH-5; BIOTECH-8	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Differentiate basic hygienic requirements for bioprocess facilities. 2. Describe “clean rooms” and give examples of their application in bioprocess industry 3. Categorize types of types of cleaning compounds with respect to types of soils 4. Compare systems for cleaning and disinfection 5. Explain biofilms and their formation 6. Select suitable waste treatment with respect to waste types generated during production 7. Explain basic principles of HACCP	
Course Content	
Basic hygienic requirements for bioprocess industry, Clean rooms, Requirements for production of food and pharmaceutical products, Basic hygienic principles of manipulation with GMO microorganisms, Cleaning and disinfection (types of soil, cleaning compounds and systems), Control of hygiene (rapid testing vs. traditional methods), Biofilms, Waste treatment, Personal hygiene, Contaminants and pests, Good manufacturing practice, HACCP.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students’ Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.	
Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*	

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes (lectures)	0.2	1-7	Attendance at classes, and laboratory	Keeping records	2	10
Seminars	1	1-7	Seminar work – writing and presentation	Paper and oral presentation	13	28
Laboratory exercise	0.3	1,3,4	Attendance, writing report	Report	5	12
Final exam	2.5	1-7	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Whyte W: Cleanroom Technology: Fundamentals of Design, Testing and Operation, 2nd Ed., Wiley, 2011.	0	-
Stanga M: Sanitation: cleaning and disinfection in the food industry, Wiley-VCH, 2010.	1	-

Additional Literature

1. Okafor N, Sterility in Industrial Microbiology, In: *Modern Industrial Microbiology and Biotechnology* Poglavlja: Treatment of Wastes in Industry, 2007, pp 221-236; 505-519.
2. Sandle T, Pharmaceutical Microbiology, Essentials for Quality Assurance and Quality Control, Woodhead Publishing, 2016.
3. Walsh G, Biopharmaceuticals Biochemistry and Biotechnology, John Wiley and Sons, Ltd, West Sussex, England, 2003.
4. Scientific and professional papers from the field (available on-line).

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and the Faculty of Medicine Osijek.
Note
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INDBIOT-E09:	**PLANT STRESS BIOLOGY AND BIOTECHNOLOGY**
GENERAL INFORMATION	
Course Coordinator	Tihana Marček, PhD, assist. prof.
Associate(s)	Maja Ižaković, assistant
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; seminars 10; exercises 15
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The course aim is to introduce the students with the importance of plant involvement in the biotechnology since the environmental factors can seriously endanger the potential and yield of crops, industrial and medical plants.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

-

Learning Outcomes at the Course Level

INDBIOT-1; INDBIOT-4

Learning Outcomes at the Course Level

After successful completion of this course students are expected to be able to:

1. Provide a fundamental knowledge of biochemical, molecular, physiological and morphological plant stress response and explain the interaction among them;
2. Present the signal transduction under stress;
3. Distinguish the terms tolerance, resistance, avoidance, acclimation and adaption to stress;
4. Predict the effect of stress on primary metabolism;
5. Connect the stress impact with a synthesis of secondary metabolites and production of biological active substances;
6. Compare the methods for stress detection in plants.

Course Content

Lectures. Abiotic and biotic stress factors in plants. Stress detection, signal molecules and signal transduction network. Gene expression and stress protein detection. Antioxidative response. The stress impact on the photosynthesis. Hypersensitive reaction. Specific and non-specific resistance. Compatible and incompatible response. Role of primary and secondary metabolism in stress detection. Stress adaptive and avoiding mechanisms. Phytohormones synergistic and antagonistic stress regulation. Ecological aspects in tolerance improvement.
Seminars. Plant response to one type of stress (*by choice*). Define specific changes on cellular, physiological and biochemical level. Define the specific stress important for biotechnology.
Exercises. Tissue extraction for the biochemical analyses (determination of antioxidative enzymes activity, determination of stress markers- membrane damage indicators, hydrogen peroxide and proline concentration). The application of physical treatment in the improvement of seed viability under stress.

Teaching Methods

Lectures, seminars, exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all

knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending lectures	0.25	1-6	Class presence	Keeping records	5	10
Seminar	1.5	3-4	Seminar work	Presentation of seminar work	10	30
Exercises	0.25	6	Practical work	Laboratory exercises report	5	10
Final exam	2	1-6	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The grade points accumulated during the classes will be added to the points achieved from the final exam. The grading will be done by absolute distribution, i.e. on the basis of the final results, and it will be compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Ramakrishna A, Gill SS, Metabolic Adaptations in Plants During Abiotic Stress. Boca Raton; CRC Press, 2019		No
Shabala S, Plant Stress Physiology. CABI, Oxfordshire, UK, 2012.		No

Additional course literature

1. Rao KVM, Raghavendra AS, Reddy KJ: Physiology and Molecular Biology of Stress Tolerance in

Plants. Springer Science & Business Media, 2006. 2. Scientific Papers (available on-line).
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

INDBIOT-E10:	**TECHNO-ECONOMIC ASSESSMENT AND RISK ANALYSIS OF BIOTECHNOLOGICAL PROCESSES**
GENERAL INFORMATION	
Course Coordinator(s)	Sandra Budžaki, PhD, assoc. prof.
Associate(s)	Marta Ostojčić, MSc
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures 20; Seminars 10; Exercises 15
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The objective of this course is to acquire basic knowledge to analyse the costs of different settings of biotechnological processes based on which the cost-effectiveness assessment will be carried out, and identification the possible risks that affect the decrease in profitability.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Passed the exam Biofuels and Biorefinery

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-4; BIOTECH-5; BIOTECH-6; INDBIOT-3; INDBIOT-6

Learning Outcomes at the Course Level

After successful completion of this course students are expected to be able to:

1. Rationally select, define and design a biotechnological process through a case study
2. Simulate and validate the process with the Aspen Plus software package
3. Perform cost analysis using the Aspen Process Economic Analyzer software package
4. Conduct a sensitivity analysis
5. Identify and define possible process risks
6. Analyse, interpret and present the results obtained through the project assignment

Course Content

Lectures. Introduction. Methods for evaluating cost effectiveness. Cash flows. Operating expenses (OPEX). Capital Expenditure (CAPEX). Methods for assessing financial capacity. Cost of capital. Sensitivity analysis. Net present value (NPV). Internal Rate of Return (IRR).

Seminars. Defining different settings of biotechnological processes: case studies (minimum two cases).

Exercises. Simulation of biotechnological processes (balance of matter and energy) and cost analysis using Aspen Plus and Aspen Process Economic Analyzer software packages

Teaching Methods

Lectures; seminars; exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.25	1-6	Attendance at classes	Keeping records	5	10
Seminars	0.75	1	Defining the biotechnological process as a case study	Report	10	25
Exercises	0.5	1-6	Cost analysis of case study	Report	5	15
Final exam	1.5	1-6	A project assignment	Oral presentation	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:

The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:

A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Sadhukhan J, Ng KS, Hernandez EM: Biorefineries and Chemical Processes: Design, Integration and Sustainability Analysis. United Kingdom: John Wiley & Sons Ltd, 2014.	-	-

Additional Literature

1. Stuart PR, El-Halwagi MM: Green chemistry and chemical engineering: integrated biorefineries design, analysis, and optimization. CRC Press, Taylor & Francis Group, Boca Raton, FL, 2012.
2. Scientific and professional papers presenting case studies of different biotechnological processes from a techno-economic point of view (available on line)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

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2nd Year of the study – Modul: Medical biotechnology - Obligatory Courses

MEDBIOT-01: **BIOTECHNOLOGY IN HEALTH CARE**	
GENERAL INFORMATION	
Course Coordinator(s)	Ljubica Glavaš-Obrovac, PhD, full prof. with tenure
Associate(s)	Teuta Opačak-Bernardi, PhD, Assist. prof. Stana Tokić, PhD, Assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**2**
Teaching Method (number of classes)	Lectures: 15; Seminars: 15; Exercises: -
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The objective of this course is better understanding the application of achievements of biotechnology in the health care and disease management.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare. Completed and passed courses from 1st year of the study.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-1; BIOTECH-2; BIOTECH-4; MEDBIOT-1	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Critically evaluate the scope and role of medical biotechnology in healthcare 2. Relate the molecular basis in the development of disease with molecular and genetic markers 3. Evaluate the role of biotechnological methods and tools in the development of new therapeutic and diagnostic approaches	
Course Content	
Lectures and Seminars: Introduction to medical biotechnology. Molecular basis of diseases. Molecular and genetic markers. Application of transgenic animals. Drug transfer systems. Gene therapy. Pharmacogenomics. Biochips and tissue chips. Production of monoclonal antibodies. Gene therapies. Stem cell technology. Social acceptability of medical biotechnology.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.	
Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*	

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes (lectures and seminars)	0.5	1-3	Attendance at classes Seminar work	Keeping records Presentation	1 4	5 35
Final exam	1.5	1-3	Studying for the final exam	Written exam	35	60
Total	**2**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95	60
90.00-94.99	57
85.00-89.99	54
80.00-84.99	51
75.00-79.99	48
70.00-74.99	45
65.00-69.99	40
60.00-64.99	35

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Pongratz J., M. Keen: Medical Biotechnology, Elsevier Health Sciences; 2009**.; eBook ISBN:** 9780702050855	-	Yes
Medical Biotechnology (ASM Books) 1st Edition; (Ed. Glick, B.R., Delovitch T.R., Patten C.L); 2013. ISBN-13: 978-1555817053 ISBN-10: 155581705X		Yes

Additional Literature

Scientific and professional papers related to particular chapters (available online)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

MEDBIOT-02:	**PHARMACOLOGY**
GENERAL INFORMATION	
Course Coordinator(s)	Martina Smolić, MD, PhD, Assoc. Prof.
Associate(s)	Ines Bilić-Ćurčić, MD, PhD, Assoc. Prof. Hrvoje Roguljić, MD, PhD Vjera Ninčević, MD Tea Omanović Kolarić, MD
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**5.5**
Teaching Method (number of classes)	Lectures 30; Seminars: 15; Exercises: 30
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course objectives	
Evaluation of basic concepts and principles of pharmacodynamics and pharmacokinetics. To train students in the interpretation of molecular and cellular mechanisms of action, routes of administration, indications, therapeutic effects, side effects and contraindications for the administration of particular drug groups. Evaluation of basic concepts in toxicology and principles of procedures for poisoning and application of specific antidotes. Introduce students to the role and impact of biotechnology on pharmacology, as well as to the basic principles of new drug development and the development of new pharmacotherapy-biotechnology strategies for the treatment of currently incurable diseases.	
Enrolment requirements and requiredentry competences for the course	
Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare. Completed and passed courses from 1st year of the study.	
Learning outcomes at the level of the study programme to which the course contributes	
BIOTECH-1; BIOTECH-3; BIOTECH10; MEDBIOT-5	
Expected learning outcomes at the level of the course	
After the lectures, seminars and labs, self-study and the passed exam students will be able to: 1. Explain the basic principles of pharmacokinetics and pharmacodynamics 2. Distinguish between the basic groups of drugs, their use, contraindications, side effects and interactions. 3. Outline the basic concepts in toxicology. 4. Demonstrate the application of biotechnology and molecular biology methods in pharmacology. 5. Interpret the principles of new drug development	
Course Content	
Lectures: General principles of Pharmacology. Basic concepts and history of pharmacology. Drugs legislation. Original and generic drugs. Herbal preparations and homeopathy. Mechanism of action of drugs. The fate of the drug in the body. Exploring new drugs from molecule to drug. Lists of drugs. How drugs work. The autonomic nervous system. General principles of chemical transmission. Neurochemical transmission (drugs acting sites). Cardiovascular drugs. Antiarrhythmics. Cardioactive glycosides. Antihypertensives. Control of smooth muscle tone of blood vessels. Pharmacology of central nervous system. Chemical signalisation in central nervous	

system. Target sites of drug action. Amino acid transmitters and other transmitters. Pain. Analgesics. Anesthetics. Chemical mediators for signal transmission. Pharmacology of the digestive system. Tumor biology and drug used in treatment of neoplasms. Pathogenesis of malignancy, principles of cytotoxic drugs. Possible new approaches in the treatment of malignancies.
Antimicrobial drugs and chemotherapy for infectious diseases. Molecular basis of chemotherapy.
Introduction to Toxicology. Toxicological terms and definitions. Specific chemical substances. Pesticides. Genomics, pharmacogenomics, personalized medicine. Drug development, molecular biotechnology, economics in medical biotechnology.
Problem seminars: Drug binding to molecules in the cell. Drug specificity. Receptor classification. Drug-receptor interaction. Movement of drug molecules through cellular barriers. Absorption and distribution of drugs. Drug availability. Drug metabolism. Biotransformation reactions.
Receptor proteins. Ion channels as sites of action of drugs. Cellular mechanisms (excitation, contraction, secretion). Regulation of intracellular calcium. Muscular contraction. Excretion of drugs and their metabolites. The peripheral nervous system. Cholinergic receptor agonists and antagonists. Effects of drugs on cholinergic transmission. Adrenergic receptor agonists and antagonists, drugs that affect noradrenergic transmission.
The action of different drug groups. Diuretics and RAAS inhibitors. Transport mechanisms. Pharmacology of diuretics and RAAS inhibitors. Calcium channel blockers, vasodilators.
Asthma medications. Drugs used in chronic bowel disease. Antiseizure drugs. Mechanism of antiseizure drugs action. Antidepressants. Addictive drugs and drug abuse. Psychomotor stimulants. Psychomimetics. The nature of drug addiction. Ethanol. Cannabis. Anesthetics. Non-steroidal anti-inflammatory drugs, anti-rheumatics. Treatment of chronic pain. Drugs with effect on the reproductive system. Endocrine reproduction control and medications that affect it. Contraceptives. Pancreatic hormones and diabetes treatment. Antibacterial drug resistance. Antimicrobial activity, resistance, pharmacokinetics, clinical use of antimicrobials. Antiviral drugs. Biological drugs. Pancreatic hormones and diabetes treatment.
Laboratory excercises: Pharmacokinetics. Excretion of drugs and their metabolites. Monitoring of antiepileptic therapy. Monitoring of immunosuppressive therapy. Mechanism of action of antipsychotics. Monitoring the effect and side effects of opioid analgesics. The effect of anesthetics. Drugs for the treatment of coagulation disorders and dyslipidemia.
New tumor drugs, kinase inhibitors and growth factors. Mechanism of action, clinical application. Monoclonal antibodies, from structure to therapeutic use. Vaccines.

Type of instruction

Lectures; Problem seminars; laboratory exercises

Student responsibilities

Attending all forms of teaching is compulsory, and the student must attend all knowledge tests. The student can justify absenteeism with 30% (full-time students) or 50% (part-time students) of each form of teaching. For every undrafted seminar student must pass preliminary exam on. The student is required to access all forms of assessment.

Screening of student's work *(Correlation between learning outcomes, teaching methods and grading)*

Type of activity	ECTS	Learning Outcome	Student activity	Assessment methods	Rating points	
					Min.	Max.
Class attendance (lectures, seminars, excercises)	2	2.5	Class attendance, Seminar essay	Seminar presentation Seminar preliminar exams Laboratory exrcises	1.5 1.5 3	5 7 8
Knowledge assess-	3.5	1-5	Partial tests	-	44	80

ment (partial tests)						
Final exam	3.5	1-5	Learning for the final exam	Written exam (unless they have passed partial test I, II)	44	80
Total	**5.5**				**50**	**100**

Evaluation of the partial exams

Percentage of correctly completed tasks (%)	Grade
55-69.99	22-26
70-79.99	27 - 31
80-92.49	32- 36
92.50-100	37 - 40

The final exam is required for students who did not pass one of the partial test I and II during the year.

Evaluation of the written part of the final exam

Percentage of correctly completed tasks (%)	Grade
55-69.99	44-55
70-79.99	56-63
80-92.49	64-73
92.5-100	74-80

Formation of the final grades:
The points earned during the class were joined by the points earned at the final exam. The rating is absolutely absolutely distributed, that is, based on the final achievement and is compared with the numerical system as follows*:*
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability through other media
Trevor AJ, Katzung BG et al. Pharmacology (examination and board review). 12th Ed., The McGraw-Hill Companies. Inc., 2019.		
Crommelin DJA, Sindelar RD, Meibohm B: Pharmaceutical Biotechnology: Fundamentals and Applications. 5th Ed., Springer International Publishing, 2018.		

Optional literature

Katzung B.G. Basic and Clinical Pharmacology, 14th Ed., The McGraw-Hill Companies, Inc., 2018.

Methods of monitoring quality that ensure acquisition of exit competences

Anonymous, quantitative, standardized student survey on the subject and work of teachers conducted by the Office for Quality of the Faculty of Medicine in Osijek and/or the Faculty of Food Technology Osijek.

Note

E-learning is not within the standard of hourly rate the class, but is used in class and contains links to various pages, videos and audio materials available on the web pages.

MEDBIOT-03: **EXPERIMENTAL PHYSIOLOGY FOR BIOTECHNOLOGISTS**	
GENERAL INFORMATION	
Course Coordinator(s)	Ines Drenjančević, MD, PhD, full prof. with tenure
Associate(s)	Martina Mihalj, MD, PhD, assoc. prof. Ana Stupin, MD, PhD, assist. prof. Ivana Grizelj MD, PhD, assist. prof. Aleksandar Kibel MD, PhD, assist . prof. Anita Matić PhD, assist. prof. Marko Stupin MD, PhD Zrinka Mihaljević PhD Nataša Kozina, BSc
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd year / 3rd Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures: 30; Seminars: 5; Exercises: 20
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The objective of the course is to enable to students to obtain the knowledge on physiological mechanisms of homeostasis, to introduce students to various experimental approaches in research in animal and human physiology and to get knowledge on in vivo and in vitro research methods. Additional aim is to enable students to acquire practical skills in experiments and to get knowledge and skills of planning and conducting experiments, analysis and interpretation of results of research obtained by learnt methods.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare. Completed and passed courses from 1st year of the study.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-6; BIOTECH-7; MEDBIOT-1; MEDBIOT-2; MEDBIOT-5	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Discuss physiological mechanisms involved in the homeostasis of the human organism 2. Solve practical problems and implement new protocols and methods appropriate for laboratory biomedicine 3. Implement acquired knowledge on planning the experiments, conducting experiments, acquiring and interpretation of results of research with learnt methods. 4. Conduct qualitative and quantitative analysis of biological samples with appropriate research methods 5. Critically evaluate results of various research studies available in scientific and professional literature	
Course Content	
Lectures. General mechanisms of homeostasis. Cell- organisation and function. Organs and organic systems (cardiovascular, resporatory, metabolism, urogenital system, endocrinological system). General principles and methodology in scientific research in physiology. Implementation of laboratory methods in experimental physiology- the principles of good laboratory practice, ethical principles in human and laboratory animals studies. Work with laboratory experimental animal	

models (rats, mice). Flow cytometry. Molecular methods in experimental physiology (Western blot, gene expression). Biochemical methods in experimental physiology (spectrophotometry-enzyme activity, ELISA; oxidative stress measuremenes). Specific methods in cardiovascular physiology.
Seminars. Experimental design, data interpretation.
Exercises. In vitro aortic rings experiments, in vitro isolated pressurized resistance blood vessels. Laser Doppler Flowmetry (human model), flow cytometry. Protein expression analysis by Western blot, gene expression analysis with PCR.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes (lectures, seminars, exercises)	2	1-5	Attendance at classes, Seminar work Laboratory excercises	Keeping records	0 10 10	5 20 25
Final exam	2	1-5	Studying for the final exam	Oral exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of	Availability via

	copies in the library	other media
Rastogi SC: Experimental Physiology. New Age International (P), Limited, 2005.	10	yes
Pflanzer RG: Experimental and Applied Physiology. 8th Ed., McGraw-Hill Science/Engineering/Math, 2005.	10	yes
Additional Literature		
Woodman DA, Tharp GD: Experiments in Physiology, 11th Ed., 2014.		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

MEDBIOT-04:	**MOLECULAR IMMUNOLOGY**
GENERAL INFORMATION	
Course Coordinator(s)	Stana Tokić, PhD, Assist Prof.
Associate(s)	Martina Mihalj, MD, PhD, Assoc.Prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd year / 3rd Semester
Credits (ECTS)	**4.5**
Teaching Method (number of classes)	Lectures: 30; Seminars: 5; Exercises: 20
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The course objective is to broaden and upgrade specific knowledge and practical skills regarding genetic and molecular factors that underline cellular differentiation, immunological function and regulation of innate and acquired immunity. Students will be introduced with the basic concepts of immunogenetics, the mechanisms of autoimmunity and immunodeficiency, and the principles of molecular immunotherapy.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare. Completed and passed courses from 1st year of the study.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-6; BIOTECH-7; BIOTECH-10;MEDBIOT-1; MEDBIOT-5

Learning Outcomes at the Course Level

After completing the course the student will be able to:

1. Categorize the principles and mechanisms of immune cell migration and chemotaxis
2. Explain the molecular mechanisms underlying the development of T and B cell receptors
3. Asses the role of key signaling pathways, transcription factors, cytokine and chemokine receptors in the development and function of the CD4 + and CD8 + T lymphocyte effector lines
4. Explain the molecular basis of the humoral immunity
5. Asses the role of key genetic factors in the development of specific immune disorders
6. Critically evaluate the scientific literature in the field of immunology
7. Apply the acquired practical knowledge for the purpose of immune cell isolation, phenotyping and functional analysis of peripheral leukocytes

Course Content

Lectures. Immune system organization and physiology of immune response. Immune cells and tissues. Cellular components, cytokine representatives, and molecular mechanisms underlying innate immune response. Development of acquired immunity and molecular mechanisms in the synthesis of receptors and antibodies. Antigen presentation - MHC dependent and MHC independent mechanisms. Major histocompatibility complex - organization, expression and epigenetic mechanisms in the control of HLA gene expression. Biochemical background of ligand-receptor interaction. Immunological synapse and lymphocyte activation. Transduction of activation signal and signalling cascades. Synthesis and regulation of cytokine, chemokine and adhesion molecule expression. Chemotaxis and leukocyte tissue homing. Molecular mechanisms underlying development and function of CD4 + and CD8 + T lymphocyte effector lines. Activation of B lymphocytes and germinal centre development. Effective mechanisms of humoral immunity. Molecular basis and mechanisms of central and peripheral immunotolerance. Humoral and cellular components of the autoreactive immune response in the aetiology of autoimmune and allergic

diseases. Genetic background of autoimmunity and allergy. Hereditary and acquired immunodeficiencies. Immune response to tumor antigens. Molecular immunotherapy.
Seminars: Functional analyses of T and B lymphocytes. Laboratory methods and technologies in immunogenetics. Diagnostics and therapeutic strategies of autoimmune diseases. Diagnostics and therapeutic strategies of allergic diseases. Diagnostics and therapeutic strategies of hereditary and acquired immunodeficiencies.
Exercises: Isolation of peripheral mononuclear cells by density gradient centrifugation. Leukocyte activation *in vitro*. Quantification of cytokines in the cell culture supernatant using ELISA or Luminex immunoassay. Leukocyte labelling and phenotyping using flow cytometry. Data analysis using computer tools like FlowLogic or FloJo.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.2	1-7	Attendance at classes, and laboratory	Keeping records	2	10
Seminars	0.8	2-5	Creation of seminar paper	Presentation	10	20
Laboratory exercises	0.5	6,7	Laboratory exercises	Report	8	20
Final exam	3	1-7	Studying for the final exam	Written exam	30	50
Total	4.5				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total

achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Abbas A, Lichtman AH, Pillai S: Cellular and molecular immunology. 9th Ed., Elsevier, Philadelphia, USA, 2018.	-	
Scientific and professional papers related to particular chapters (available online)		Yes

Additional Literature

Timothy M. Cox, John Sinclair: The Molecular Biology in Medicine (Wiley-Blackwell), 1997.

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

MEDBIOT-05:	**MOLECULAR MEDICINE**
GENERAL INFORMATION	
Course Coordinator(s)	Teuta Opačak-Bernardi, PhD, Assist. Prof.
Associate(s)	Ljubica Glavaš-Obrovac, PhD, full prof. with tenure Stana Tokić, PhD, Assist. Prof. Marijana Jukić, PhD
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures: 30; Seminars: 5; Exercises: 20
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
Aim of this course is to introduce the students with the basis of molecular biology, means of regulating gene expression and the connection between disease and changes in gene regulation. They will be introduced to the most recent discoveries about molecular and cellular mechanisms that can lead to a disease, including genetic and epigenetic factors. Students will also familiarise themselves with the newest methods in molecular diagnostics and advances in molecular therapeutic approaches.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed and passed course of Molecular biology with genetic engineering and Genetics and genomics	
Learning Outcomes at the Programme Level Contributed by the Course	
MEDBIOT-2; MEDBIOT-3; MEDBIOT-5; BIOTECH-6; BIOTECH-7; BIOTECH-10	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Compare the role of main cellular mechanisms in the development of a disease. 2. Rank the genetic and epigenetic elements responsible for regulating the key genetic responses to changes in diseased states. 3. Explain the connection between a person's genetic profile and their susceptibility to disease and response to therapy 4. Choose the appropriate molecular diagnostic method according to set parameters. 5. Critically evaluate approaches that use molecular changes in therapeutic approaches. 6. Qualitatively and quantitatively analyse biologic samples implementing appropriate research methods. 7. Critically evaluate the results of different studies available in scientific literature.	
Course Content	
DNA structure and maintaining sequence. Transcription and translation. Regulation of gene expression. Epigenetics. Post translational modifications. What is molecular medicine? Development of molecular medicine. SNPs and their effect on gene regulation. SNP profile analysis. Monogenetic diseases. Polygenetic diseases. Molecular diagnostics – methods and applications. Analysis of gene expression. The role of non-coding sequences and snRNA in modification of gene expression. Molecular therapeutic approaches. Recombinant medications. Stem cells and cell-based therapy. Basis of gene therapy. Molecular medicine in everyday clinical practice. Ethics in molecular medicine.	
Teaching Methods	

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes			Attendance at classes	Keeping records	5	10
Lectures,	0.5	1-5,7		Presentations	5	15
Seminars	0.5		Seminars			
Laboratory practice	0.5	4,6	Practical work	Lab notes	10	25
Final exam	2.5	1-7	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points.

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Kurreck J, Stein CA: Molecular Medicine: An Introduction. Wiley-Blackwell, 2016.		yes

Additional Literature

Timothy M. Cox, John Sinclair: The Molecular Biology in Medicine (Wiley-Blackwell), 1997.

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and

Competencies
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

MEDBIOT-06:	**MEDICAL GENETICS**
GENERAL INFORMATION	
Course lecturer	Marija Heffer, MD, PhD, full prof. with tenure
Associates	Jasenka Wagner, PhD, Assoc. Prof. Vedrana Ivić, PhD
Study programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course status	Obligatory
Year of study, semester	2nd Year / 3rd Semester
Credit value (ECTS)	**4.5**
Teaching schedule (number of classes)	Lectures: 30; Seminars: 10; Exercises:15
Expected number of students for the course	25-30
DESCRIPTION OF THE COURSE	
Aims of the course	
The aim of the course is to gain knowledge in genomics, as a basic tool of precision medicine, which determines the risk of disease, response to therapy and suggests a lifestyle correction. Through learning about the structure of the genome, the consequences of genomic variation, multifactorial inheritance, epigenetic alterations, mitochondrial biology and pharmacogenomics, students will get an overview of the methods used to create large databases and bioinformatics tools for their diagnostic and scientific search.	
Requirements for course enrolment and starting competencies required for the course	
Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare. Completed and passed courses from 1st year of the study.	
Learning outcomes achieved at the level of the course programme	
MEDBIOT-2; MEDBIOT-3; MEDBIOT-5; BIOTECH-6; BIOTECH-7; BIOTECH-10	
Expected learning outcomes at the course level (5-10 outcomes)	
After completing the course the student will be able to: 1. Discern the cause-and-effect relationship between disease pathogenesis and changes at the gene and genome levels of an individual or population; 2. Link genome maintenance mechanisms to metabolic processes, physiological mechanisms, behavioural adaptations, and disease pathogenesis; 3. Identify genes, mutation sites and epigenetic changes that contribute to pathophysiological mechanisms of disease development, which may serve for diagnostic purposes or as targets of therapy; 4. Select appropriate genomic analyses required for research or diagnosis; 5. Critically evaluate the results of various genetic analyses and comment on valid evidence; 6. Find a suitable bioinformatics tool for analysing sequencing results, comparing two genomes or population analysis; 7. Comment the results of genomic scientific research.	
Course content	
Lectures. Factors in genetics, environment and lifestyle in the etiology of disease. Personalized medicines and therapeutic interventions. Integration of genomic and phenotypic data with digital tools to evaluate disease risk or monitor patient status. Epigenetic mechanisms, genomic reprogramming and inactivation of X chromosomes. Mutations in epigens. Genomic variability and congenital diseases. Mutations, insertions, deletions, and copy number variations. Inheritance patterns (recessive, dominant, sexually linked, penetrant). Statistics for geneticists. Connection	

analysis. Bioinformatics. Chromosomal anomalies. Unique inheritance. Multifactorial inheritance and complex diseases. HapMap and GWS. Population genetics. Comparative genomics. Pathogenesis of genomic diseases. Loci that accelerate or slow down aging. Progeria. Genetic counselling and bioethics.

Seminars. Nature and frequency of hereditary diseases in various parts of the world. Genomic imprinting. Cancer epigenetics. Environmental impact on the occurrence of epigenetic markers. Genotype and phenotype correlation. Searching for genomic bases. Mitochondrial inheritance. Gene therapy of mitochondrial diseases. Inheritance calculation and risk assessment within families and populations.

Exercises. Preparation and submission of DNA samples for various genomic analyses and assays. Isolation of DNA samples from biological traces, very old or contaminated samples. Family trees from genomic analyses. DNA sequencing techniques. The methods for SNP detection. Methods for the analysis of epigenetic markers. Techniques for determining chromosomal anomalies. Methods for mitochondrial DNA analysis.

Types of classes

Lectures; Seminars; Laboratory exercises

Student obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the students' work *(Connecting learning outcomes, teaching methods, and grading)*

Teaching activity	ECTS	Learning outcome	Student activities	Evaluation methods	Grade points	
					Min.	Max.
Attendance (lectures, seminars, Exercises)	1	1-7	Presence in class, Seminar paper Practical work	Record	1 10 12	5 20 25
Knowledge assessment (partial tests)	1	1-7	Learning for a partial test	Written exam	10	20
Final exam	2.5	1-7	Learning for the final exam	Written exam	18	30
Total	**4.5**				**50**	**100**

Table 2. Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	30
90.00-94.99	29
85.00-89.99	28
80.00-84.99	26
75.00-79.99	24
70.00-74.99	22
65.00-69.99	20
60.00-64.99	18

Forming the final grade:

The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total

achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory course literature (available at the library and in other media)

Title	Number of copies in the library	Availability in other media
Emery and Rimoin's Principles and Practice of Medical Genetics and Genomics. Foundation, Academic Press, 7th Ed., 2019.	10	

Additional course literature

Turnpenny PD, Sian E: Emery's Elements and Medical Genetics. Student Consult. Elsevier, 2017.

Methods for monitoring quality that ensure the acquisition of outcomes and competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.

Note

E-learning is not within the standard of the class, but is used in teaching and contains links to various pages, videos and audio materials available on the web pages.

MEDBIOT-07: **BIOTECHNOLOGY OF PHARMACEUTICAL PRODUCTS**	
GENERAL INFORMATION	
Course Coordinator(s)	Stela Jokić, PhD, full prof.
Associate(s)	Krunoslav Aladić, PhD, assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**5.5**
Teaching Method (number of classes)	Lectures 30; Seminars 15; Exercises 30
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
Familiarisation with the basic operations and processes in the pharmaceutical industry, as well as the operational principles of specific devices. Acquiring basic knowledge about the types of pharmaceutical forms, their properties, production technology, and product control, as well as advanced engineering knowledge in the area of pharmaceutical industry.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
-	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-1; MEDBIOT-1; MEDBIOT-2	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Estimate the basic principles of mechanical operations in the pharmaceutical industry. 2. Critically explain the influence of process parameters on the implementation of a specific operation. 3. List the most commonly used devices for implementing specific operations in the pharmaceutical industry and describe their operating principles in detail. 4. List the most common problems encountered in practice, in the course of implementing specific operations in the pharmaceutical industry. 5. Apply their knowledge in the process of producing specific pharmaceutical forms.	
Course Content	
Lectures. Basics of Pharmaceutical Technology. Demand and Requirements of the Pharmaceutical Industry. Process Schematics – Devices, Symbols. Sterilisation in the Pharmaceutical Industry – Procedures, Processes. Powders – Grinding, Sieving, Mixing, Homogenisation. Granulation – Granulation Procedures; Wet, Dry. Centrifugation and Filtration Operations – Devices. Emulsions in the Pharmaceutical Industry – Liquid Emulsions, Cremes. Heat Transfer Devices in the Pharmaceutical Industry (Heat Exchangers). Distillation – Basic Principles, Methods and Devices. Traditional and Modern Extraction Procedures (Maceration, Digestion, Percolation, Re-Percolation, Evacolation and Diacolation; Soxhlet Extraction, Liquid-Liquid Extraction, Ultrasound-Assisted Extraction, Microwave-Assisted Extraction, Accelerated Solvent Extraction, Supercritical Fluid Extraction, Subcritical Water Extraction). Drying – Basic Principles, Methods and Devices. Spray Drying and Lyophilisation. Tableting – Procedures and Devices. Capsuling – Procedures and Devices, Types of Capsules. Basics of Pharmacopeia. Pharmacologically Active Substances. Forms and Preparation of Medicinal Drugs in Pharmacy. Natural Cosmetic Pharmaceutics. **Seminars.** Calculations for Heat Exchangers, Distillers, Extractors, Driers. Forms and preparation of pharmaceutical drugs. **Laboratory exercises.** Grinding and Determining the Particle size distribution – Granulometric Analysis. Production of Macerates and Tinctures. Isolation of Essential Oil from Various Medicinal	

Plants Using a Hydrodistillation Apparatus Described in the European Pharmacopeia. Isolation of Essential Oils from Various Medicinal Plants Using Steam Distillation in a Pilot Facility. Modern Extraction Procedures (Supercritical CO_2 Extraction, Subcritical Water Extraction, Microwave-Assisted Extraction, Ultrasound-Assisted Extraction). Production of Dry Extracts using Spray Drying and the Lyophilisation Procedure. Capsuling and Tableting – Production of Herbal Food Additives. Development and Production of Api-Syrup. Production of Natural Herbal Cosmetics. Optimisation of the Pharmaceutical Industrial Process with the Application of Computer Program Suites.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.5	1-5	Attendance at classes	Keeping records	2	10
Seminars	1.5	2-4	Seminar work preparation	Presentation of seminar work	16	30
Laboratory exercises	0.5	5	Practical work	Laboratory exercises report	2	10
Final exam	3	1-5	Studying for the final exam	Written exam	30	50
Total	**5.5**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)		
Title	Number of copies in the library	Availability via other media
Tekade RK: Dosage form Design considerations (Advances in pharmaceutical product Development and research series), Elsevier Inc., 2018.		yes
Hickey AJ, Ganderton D: Process Engineering (Drugs and the Pharmaceutical Sciences) 2nd ed. CRC Press, 2009.		yes
Additional Literature		
European Pharmacopoeia (Ph. Eur.) 2018 Scientific and professional papers related to specific chapters (available online)		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

MEDBIOT-08:	***IN VIVO* AND *IN VITRO* EXPERIMENTAL MODELS**
GENERAL INFORMATION	
Course Coordinator(s)	Nikola Bijelić, MD, PhD, Assist. prof.
Associate(s)	Katarina Mišković Špoljarić, PhD, Assist. prof. Barbara Viljetić, PhD, Assist. prof. Marijana Jukić, PhD Edi Rođak, MSc
Study Program	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures: 30; Seminars: 5; Exercises: 20
Expected Number of Students in the Course	30
COURSE DESCRIPTION	
Course Aims	
The objective of this course is to introduce students to the most important *in vivo* and *in vitro* experimental models, explain the reasons and means of using certain experimental models and legal and ethical issues related to using them in biomedicine and biotechnology. The objective is also to make students capable of planning and participating in research conducted on experimental models.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed and passed courses from 1st year of study.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-1; BIOTECH-6; MEDBIOT-1; MEDBIOT-2; MEDBIOT-5	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Compare the most important *in vivo* and *in vitro* experimental models 2. Explain the importance and need for experimental models in biomedical research 3. Apply the principles pf management and safety while working with experimental models 4. Evaluate legal and ethical issues related to working with experimental models 5. Apply the principles for choosing a model and make a plan of research on experimental models	
Course Content	
Lectures. Bacterial culture, growing and application. Bacteriophages and bacteriophage infections. Yeast as a model organism. Plant cell and tissue culture. Animal cell and tissue culture: primary and continuous cell cultures. Transgenic cell lines. TERT cells. *In vivo* models in biomedical and biotechnology research. Types, properties, advantages, drawbacks and choice of *in vivo* models. Types of research on *in vivo* models. Research planning, concept and/or choice of experimental model. Genetically altered animals (transgenic and knock-out animals). Collection, processing and analysis of tissues and body liquids. Care, management and safety while working with experimental animals. Legal regulations and ethical aspects of animal experiments. **Seminars.** Practical application of experimental models *in vivo* and *in vitro*. **Exercises.** Isolation, culture and application of cells *in vitro*.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.2	1-5	Attendance	Keeping records	3	10
Seminars	0.6	1-5	Seminar drafting and presentation	Seminar presentation	2	10
Laboratory exercises	0.8	3, 5	Practical exercises	Laboratory exercises	5	20
Final exam	2.4	1-5	Studying for the final exam	Written exam	40	60
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade points
>95.00	60
90.00-94.99	58
85.00-89.99	55
80.00-84.99	52
75.00-79.99	49
70.00-74.99	46
65.00-69.99	43
60.00-64.99	40

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points.

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
McInnes EF: Background Lesions in Laboratory Animals. 1st Ed., Saunders Ltd, 2011.		
Freshny R. Culture of Animal Cells: A Manual of Basic Techni-que and Specialized Applications. 7th Ed., Wiley-Blackwell, 2016.	7	

Additional Literature

Scientific and professional papers related to certain chapters (available on-line).

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

MEDBIOT-09:	**DRUG DEVELOPMENT**
GENERAL INFORMATION	
Course Coordinator(s)	Katarina Mišković Špoljarić, PhD, Assist. Prof. Hrvoje Brkić, PhD, Assist. Prof.
Associate(s)	Suzana Mimica Matanović, MD, PhD, Assist. Prof. Teuta Opačak-Bernardi, PhD, Assist. Prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures: 30; Seminars: 5; Exercises:20
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

Introduce students to an interdisciplinary research approach to new drug development. Application and development of models based on aimed molecular targets and interactions, and contemporary approaches in the evaluation of biological activity. In terms of its content, the course is an upgrade to the knowledge gained in the course Molecular Modeling, Molecular Enzymology, Genetics and Genomics and connects with the course Experimental Models *in vivo* and *in vitro*.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme from the area of natural sciences (chemistry, biology) or biotechnical sciences, or biomedicine and healthcare. Completed and passed courses from 1st year of study.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-1; BIOTECH-7; BIOTECH-10; MEDBIOT-1; MEDBIOT-2; MEDBIOT-4

Learning Outcomes at the Course Level

After completing the course, the student will be able to:

1. Predict the physicochemical properties of the designed molecule
2. Apply acquired knowledge in analyzing and creating / modifying new medicines at the level of personalized medicine.
3. Identify the parts in the structure of the drug that are important for the action (pharmacophores) and physicochemical properties of the drug
4. Calculate and predict the activity, metabolism and toxicity of the new molecule using computer programs
5. Suggest computer programs for fitting of ligand into the active site (docking)
6. Critically evaluate laboratory experiments and statistical analyzes that appear in the professional literature

Course Content

Lectures. I) basics in drug development: drug development yesterday, today, tomorrow; the classic approach to development; protein-ligand interaction as the basis of activity; optical activity and biological effect; screening technology in drug development; prodrug design, peptidomimetics; II) experimental and theoretical methods: determination of the energetically most favorable position of the small molecule at the end target (scoring function); molecular modeling and 3D structure; protein visualization; protein databases; gene technology in drug development; III) drug activity: pharmacophore significance and molecular comparison; the link between structure and activity; in vitro and in vivo activity; ADME optimization and toxicology; activity of drugs by groups (metalloenzymes, hydrolases inhibitors, proteases, oxidoreductases, transferases, agonists and

antagonists of core receptors, membrane receptors)
Seminars. (Problem seminar) protein modeling based on end target; inhibitor modeling for t-RNA-guanine transglycosylase
Exercises. PDB database search, structure editing, homologous modeling, comparison of the primary structure of the protein (sequence similarity), tools for scoring function, protein visualization tools (pymol, WMD), AMES test.

Teaching Methods

Lectures; Seminars; Laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.25	1-6	Attendance	Keeping records	0.5	4
Seminars	1.0	5	Seminar drafting and presentation	Seminar presentation	8	20
Exercises	0.75	6	Practical exercises	Keeping records	5.5	16
Final exam	2.0	1-6	Studying for the final exam	Written exam	36	60
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	60
90.00-94.99	57
85.00-89.99	54
80.00-84.99	51
75.00-79.99	47
70.00-74.99	43
65.00-69.99	39
60.00-64.99	36

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the	Availability via other media

	library	
Gerhard K: Drug design: Methodology, Concepts, and Mode-of-Action. Springer-Verlag Berlin Heidelberg, 2013.		yes
Di L, Kerns EH: Drug-Like Properties: Concepts, Structure Design and Methods from ADME to Toxicity Optimization. 2nd Ed., Academic Press, 2016.		no
Additional Literature		
1. Drugs: From Discovery to Approval. 3rd Ed., Wiley-Blackwell, 2015. 2. Fischer J, Childers WE: Successful Drug Discovery. 1st Ed., Wiley-VCH, 2017. 3. Scientific and professional papers related to particular chapters (available online)		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

MEDBIOT-10:	**TISSUE ENGINEERING**
GENERAL INFORMATION	
Course Coordinator(s)	Teuta Opačak-Bernardi, PhD, assist. prof.
Associate(s)	Ljubica Glavaš-Obrovac, PhD, full prof. with tenure Katarina Mišković Špoljarić, PhD, assist. prof. Barbara Viljetić, PhD, assist. prof. Nikola Bijelić, PhD, assist. prof. Marijana Jukić, PhD
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures: 30; Seminars: 5; Exercises: 20
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The aim of this course is to introduce students with the principles and applications of tissue engineering in biomedicine, as well as ways to model tissue transcripts. Introduce them to the process of development and classification of tissue and the basis of cell culturing for tissue engineering.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed and passed courses from the first year of this graduate study.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-2; BIOTECH-7; BIOTECH-10; MEDBIOT-1; MEDBIOT-2; MEDBIOT-5	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Explain how cells are grown and selected for tissue engineering. 2. Classify types of support materials for growing tissue constructs 3. Explain the use of tissue constructs in practical applications 4. Differentiate between tissue samples 5. Apply tissue engineering methods in preparation of spheroids in vitro 6. Critically evaluate laboratory experiments and statistical analysis in bioscience literature	
Course Content	
Lectures: Basic principles and ethical aspects of tissues engineering. Tissue morphology: epithelial, muscle and nerve tissue. Cellular dynamics: intercellular communications, nutrient distribution. Cell culture. Bases of cell culturing. Cell culture selection. Stem cells in tissue engineering. Basic approaches to organ engineering: organ culture, organ-type culture, tissue-type culture. Support materials: natural, synthetic, alternatives. The role of extracellular matrix in cell communications. Systems for growing cells and developing tissues. Maturation and tissue quality control. Making and applying 3D support. 3D printers in biomedicine. Engineering in tissue biomedicine. Bioreactors. Microcarriers. Nanotechnology in tissue engineering. Implementing tissue constructs in regenerative medicine. Application of artificial organ culture in clinical practice. Challenges in tissue engineering. **Problem seminari**: Use of tissue engineering in: gene therapy, transplant medicine, drug development, cosmetics, etc. Histology sample analysis. Culturing spheroids using various methods. **Exercises:** Microscopy of histological preparations. Cultivation and cultivation of cellular spheroids by different cultivation methods.	

Teaching Methods

Lectures; Seminars; Laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.25	1-6	Attendance	Attendance records	2	10
Seminar	0.75	1-6	Seminar	Seminar presentation	10	20
Laboratory practice	1	5	Practical work	Laboratory exercises	8	20
Final exam	2	1-6	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:

The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Blitterswijk CV, Boer JD: Tissue Engineering, 2nd Ed., Academic Press, 2014.		yes
Mescher A: Junqueira's Basic Histology: Text and Atlas. 15th		yes

Ed., McGraw-Hill , 2018.		
Additional Literature		
R. Pignatello. Biomaterials Science and Engineering. ISBN 978-953-307-609-6. (E-book) D. Eberli. Tissue Engineering of Tissue and Organ Regeneration. ISBN 978-953-307-688-1 (E-book) S. Li, N. L'Heureux, J. Elisseeff. Stem cell and Tissue Engineering. ISBN-13 978-981-4317-05-4, ISBN-10 981-4317-05-5. (E-book)		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

MEDBIOT-MT:	**MASTER'S THESIS**
GENERAL INFORMATION	
Course Coordinator(s)	Teachers in the science-teaching titles who teach at this graduate study program
Associate(s)	-
Study Program	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd year / 4th Semester
Credits (ECTS)	**10**
Teaching Method (number of classes)	Lectures: 0; Seminars: 0; Exercises: 100
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The objective of the course is to make the student able to analyze and solve given problem/s from a theoretical and practical point of view through work on a thesis topic.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed courses from the second year of graduate study.

Learning Outcomes at the Program Level Contributed by the Course

Learning Outcomes at the Course Level

After completing the course, the student will be able to:

1. Relate the knowledge and skills acquired during the studies and develop the ability to further learn from the relevant literature with the advice of a mentor
2. Perform experiments independently and analyze and interpret the obtained results
3. Select, explain and vindicate the proposed solution
4. Formulate and write a master's thesis in accordance with the instructions and make conclusions in a linguistically and ethically correct manner
5. Present obtained results publicly using a presentation prepared on a computer with twenty minutes of oral presentation

Course Content

Work on master's thesis

Teaching Methods

-

Students' Obligations

Complete all the defined tasks of the thesis. A student whose diploma thesis is positively evaluated by a mentor defends his work in front of the Graduate Defense Committee.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

The student independently creates the experimental part of the work and with the help of relevant scientific literature and suggestions of the mentor presents the solution of the given problem in written form, all by applying the knowledge gained from the subjects that he passed during this graduate study. The student presents his work in written and oral form.

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
In accordance with thesis work		

Additional Literature
-
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

2nd Year of the study – Modul: Medical biotechnology - Elective Courses

MEDBIOT-E01:	**MICROSCOPY IN BIOTECHNOLOGY**
GENERAL INFORMATION	
Course Coordinator(s)	Tatjana Belovari, PhD, full prof. with tenure Nikola Bijelić, PhD, assist. prof.
Associate(s)	Hrvoje Brkić, assist. prof. Edi Rođak, MSc
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures: 15; Seminars: 15; Exercises: 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The objective of this course is to learn how to apply microscopy techniques in biomedical and biotechnology research.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed and passed courses from 1st year of this study.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-2; BIOTECH-6; BIOTECH-7; MEDBIOT-2; MEDBIOT-4	
Learning Outcomes at the Course Level	
1. After completing the course, the student will be able to: 2. Reasonably explain the principles of operation of the most important types of microscope. 3. To evaluate the possibilities of application of the most important microscopy methods in biotechnology. 4. Predict which microscopic methods could be applied in the given cases. 5. Apply the lessons learned in independent work. 6. Critically evaluate the results of the various studies available in the scientific and professional literature.	
Course Content	
Lectures. Physical fundamentals of microscopy. Interaction of light and matter. Types of microscopes and their application. Parts of microscope and their function. **Seminars.** Light microscope, phase-contrast microscope, polarization microscope. Fluorescent microscopy. Immunohistochemistry and immunofluorescence. Confocal microscope. Electron microscope (SEM, TEM). Other types of microscopy and modern techniques in microscopy (FLIM-FRET, super-resolution microscopy etc.) **Exercises.** Preparation of samples for basic microscopy analysis. Digital photography in microscopy and processing of photographs.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a	

seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.2	1-5	Attendance	Keeping records	1	5
Seminars	0.6	1-5	Seminar drafting and presentation	Seminar presentation	3	15
Laboratory exercises	0.8	2-4	Practical exercises	Laboratory exercises	10	20
Final exam	2.4	1-5	Studying for the final exam	Written exam	36	60
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade
>95.00	60
90.00-94.99	58
85.00-89.99	55
80.00-84.99	52
75.00-79.99	48
70.00-74.99	44
65.00-69.99	40
60.00-64.99	36

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Murphy DB, Davidson MW: Fundamentals of Light Microscopy and Electronic Imaging. 2nd Ed., Wiley-Blackwell, 2013.		
Mescher A: Junqueira's Basic Histology: Text and Atlas. 15th Ed., McGraw-Hill, 2018.		

Additional Literature

1. Suvarna SK, Layton C, Bancroft JD: Bancroft's theory and practice of histological techniques. 7th Ed., Churchill Livingstone Elsevier, 2013.
2. Scientific and professional papers related to certain chapters (available on-line).

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardized student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.

Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

MEDBIOT-02:	**TISSUE TYPES**
GENERAL INFORMATION	
Course Coordinator(s)	Nikola Bijelić, PhD, Assist. Prof.
Associate(s)	Edi Rođak, MSc
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	4
Teaching Method (number of classes)	Lectures: 15; Seminars: 10; Exercises: 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The objective of this course is to train students in recognizing basic tissue types and their morphological properties using light microscopy.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed and passed courses from 1st year of this study.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-2; BIOTECH-3	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Present morphological properties of basic tissue types 2. Independently sort subtypes of tissue into four main types 3. Associate morphological properties of basic tissue types with their function 4. Demonstrate knowledge of key elements of specific tissue types using light microscopy 5. Make a drawing of the structure of tissue observed under a light microscope and mark key structures on his/her drawing	
Course Content	
Lectures: Cells and extracellular matrix. Epithelial tissue. Connective tissue. Muscle tissue. Nervous tissue. Selected chapters from special histology. **Seminars:** Main tissue types, their structure and function in different organs and organ systems. Review of the material. **Exercises:** Lining and glandular epithelium. Proper connective tissue, supportive connective tissues. Skeletal, cardiac and smooth muscle tissue. Nervous tissue of central and peripheral nervous system. Selected examples from special histology.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.	
Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*	

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.2	1-5	Attendance	Keeping records	2	5
Seminars	0.6	1-5	Seminar drafting and presentation	Seminar presentation	7	15
Laboratory exercises	0.8	4, 5	Practical exercises	Laboratory exercises	10	20
Final exam	2.4	1-5	Studying for the final exam	Written exam	30	50
Total	4				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Mescher A.: Junqueira's Basic Histology: Text and Atlas. 15th Ed., McGraw-Hill, 2018.		

Additional Literature

1. Eroschenko V.P.: DiFiore's Atlas of Histology: with Functional Correlations. 12th Ed., 2013 Lippincot Williams & Wilkins. ISBN-13: 978-1451113419
2. Scientific and professional papers related to certain chapters (available on-line).

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardized student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

MEDBIOT-E03:	**NUTRIGENOMICS**
GENERAL INFORMATION	
Course Coordinator(s)	Ljubica Glavaš-Obrovac, PhD, full prof. with tenure
Associate(s)	Mario Štefanić, MD, PhD, Assoc. Prof. Teuta Opačak-Bernardi, PhD, Assist. Prof. Stana Tokić, PhD, Assist. Prof. Barbara Viljetić, PhD, Assist. Prof. Marijana Jukić, PhD
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures: 15; Seminars: 30; Exercises: -
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
To introduce students how food components affect gene expression directly or indirectly, thereby altering metabolic pathways. Also, introduce students to the importance of certain polymorphisms and their role in the susceptibility of some genotypes to changes in diet and cell homeostasis.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed and passed courses from 1st year of the study.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-2; BIOTECH-4; BIOTECH-7; BIOTECH-10; MEDBIOT-2; MEDBIOT-3	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Link the impact of macro and micronutrients on the gene expression 2. Assess the importance of polymorphisms in dietary adjustment 3. Recommend bioinformatics tools for genome analysis 4. Recommend possible applications of bioinformatics tools in nutrigenomics 5. Based on the results of scientific studies, provide a reasoned explanation how dietary adjustments can contribute to improving the overall condition of human organisms	
Course Content	
Lectures: An introduction to nutrigenomics; The role of micronutrients and macronutrients in metabolism; SNP and bioinformatics; Tools for genome analysis and their applications in nutrigenomics; Gene polymorphisms and genotype sensitivity to diet type; Transcription factors and how they may mediate food-gene interactions; Nutrition and genes associated with disease onset; Functional food and nutrition adapted to sensitive genotype; The role of nutraceuticals in health promotion and their mechanism of action; Benefits and questionable effects of nutraceuticals. **Seminars:** Tools for genome analysis and their application in nutragenomics; Gene variants; Nutrition and complex diseases; Evidence for gene-food interactions.	
Teaching Methods	
Lectures and e-learning based seminars	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.	
Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and*	

Grading)

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending and active participation (lectures and seminars)	1.6	3,4	Attendance at classes Seminar work	Keeping records Presentation of seminar work	2 12	5 35
Final exam	2.4	1-5	Studying for the final exam	Written exam	36	60
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	60
90.00-94.99	55
85.00-89.99	51
80.00-84.99	48
75.00-79.99	45
70.00-74.99	42
65.00-69.99	39
60.00-64.99	36

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Mocchegiani and M. Malavolta (Ed):Molecular Basis of Nutrition and Aging. A Volume in the Molecular Nutrition Series; ISBN: 978-0-12-801816-3; print. Academic Press; 2016;	-	Yes

Additional Literature

1. L. R. Ferguson (Ed). Nutrigenomics and Nutrigenetics in Functional Foods and Personalized Nutrition, 1st Ed, 2013.
2. Scientific and professional papers related to particular chapters (available online)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardized student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

MEDBIOT-E04: **PHARMACOGENETICS AND PHARMACOGENOMICS**	
GENERAL INFORMATION	
Course Coordinator(s)	Martina Smolić, MD, PhD, Assoc. Prof.
Associate(s)	Ines Bilić-Ćurčić, MD, PhD, Assoc. Prof. Stana Tokić, PhD, Assist. Prof. Marijana Jukić, PhD Vjera Ninčević, MD Tea Omanović Kolarić, MD
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year /4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures: 15; Seminars: 15; Exercises: 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
To elaborate the role of genes that determine how people respond to medication and how innate variation determines response to drug therapy and metabolism. Introduce students to analyses that elucidate the complex picture of the metabolic pathways of drugs and the enzymes tested and the risks of drug interactions and analyzes of the therapy procedure.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed and passed courses from 1st year of the study.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-2; BIOTECH-4; BIOTECH-7; BIOTECH-10; MEDBIOT-2; MEDBIOT-5	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Interpret the impact of individual genetic variation on individual differences in pharmacokinetics and pharmacodynamics of drugs 2. Interpret the association between SNPs and other polymorphisms and clinical phenotypes of therapeutic response 3. Demonstrate levels of genetic polymorphisms with functional significance in pharmacogenetics 4. Apply genotyping methods 5. Recognize the possibilities and limitations in the clinical application of pharmacogenetic testing. 6. Apply acquired knowledge when planning experiments, conducting experiments, collecting and interpreting research results by learned methods.	
Course Content	
Lectures: Demonstration of the development of pharmacogenetics / pharmacogenomics, the human genome and the modern application of DNA-related drug. Ethical issues related to personal genetics data. Introduction and research of analysis of pharmacogenetic data, data quality, prediction and confirmation of different drug responses caused by pharmacogenetic particularities. **Seminars**: Polymorphisms of single nucleotides and other genetic variations and their potential impact on the pharmacodynamics, pharmacokinetics of drugs, the occurrence of drug interactions and adverse reactions. Interpreting the results of population genetics studies, genomic association studies in individual variability in drug administration. Application of pharmacogenomics in clinical practice: **practicums and discussion** of specific case	

reports. Possibilities and limitations of implementing pharmacogenomics into clinical practice.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.2	1-5	Attendance at classes	Keeping records	2	5
Seminar work	0.6	1-5	Seminar preparation and presentation	Presentation	3	15
Laboratory exercises	0.8	4, 6	Laboratory exercises	Report	5	20
Final exam	2.4	1-6	Studying for the final exam	Written exam	40	60
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	60
90.00-94.99	58
85.00-89.99	55
80.00-84.99	52
75.00-79.99	49
70.00-74.99	46
65.00-69.99	43
60.00-64.99	40

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Höppner W., Primorac D.: Pharmacogenetics in Cinical Practice BioGlobe GmbH, Hamburg, 2016.	6	

Altman R., Flockhart D., Goldstein DB., Principles of Pharmaco-genetics and Pharmacogenomics. Cambridge University Press, 2012.	10	
Additional Literature		
Cohen N., Pharmacogenomics and Personalized Medicine-Methods in Pharmacology and Toxicology. Humana Press, 2010.		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardized student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

MEDBIOT-E05: **APPLICATION OF TISSUE ENGINEERING IN CLINICAL PRAXIS**	
GENERAL INFORMATION	
Course Coordinator(s)	Jure Mirat, MD, PhD, full prof. with tenure
Associate(s)	Ljubica Glavaš-Obrovac, PhD, full prof. with tenure Teuta Opačak-Bernardi, PhD, assist. prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd year / 4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures:15; Seminars: 30; Exercises: 0
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The aim of this study is to analyze the state of the art of Tissue Engineering and some of its application fields such are heart, vascular, bone, cartilage, and cancer.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed and passed courses from 1st year of the study.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-3; BIOTECH-6; BIOTECH-10; MEDBIOT-2; MEDBIOT-5	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Assess the importance of tissue engineering and the achievements of regenerative medicine in the regeneration of damaged tissues. 2. Evaluate the physical and biochemical techniques available for the evaluation and development of tissue engineer and regenerative medicine products for clinical use. 3. Recommend method of bioengineering in tissue development. 4. Critically evaluate the results of the various studies available in the scientific and professional literature.	
Course Content	
Lectures: Tissue bioengineering. Types of tissue that can be regenerated. Regenerative medicine. Tissue engineering in the regeneration of damaged tissues. Tissue Engineering in Cardiology. Tissue Engineering of the Vascular System. Pancreatic tissue engineering. Tissue Engineering of Bone Tissue and Cartilage. Tissue Engineering in Modeling Human Physiology. Drug discovery. **Seminars:** Tissue engineering in the regeneration of damaged tissues. Tissue Engineering in Cardiology. Tissue Engineering of the Vascular System. Pancreatic tissue engineering. Tissue Engineering of Bone Tissue and Cartilage.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.	
Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*	

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes (lectures, seminars, exercises)	1.6	1-4	Attendance at classes Seminar preparation and presentation	Keeping records Presentation	2 8	5 35
Final exam	2.4	1-4	Studying for the final exam	Written exam	40	60
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	60
90.00-94.99	58
85.00-89.99	55
80.00-84.99	52
75.00-79.99	49
70.00-74.99	46
65.00-69.99	43
60.00-64.99	40

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Blitterswijk CV, Boer JD: Tissue Engineering. 2nd Ed., 2014.		Yes
Quan Wang: Smart Materials for Tissue Engineering: Applications. The Royal Society of Chemistry, 2017.		Yes

Additional Literature

Scientific and professional papers related to individual chapters (available online.

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardized student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

MEDBIOT-E06:	**BIOLOGIC DRUGS**
GENERAL INFORMATION	
Course Coordinator(s)	Jasminka Milas-Ahić, MD, PhD, full prof.
Associate(s)	Suzana Mimica, MD, PhD, assist. prof. Vlatka Periša, MD, PhD Željka Kardum, MD
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year /4th Semester
Credits (ECTS)	**4**
Teaching Method (number of classes)	Lectures:15; Seminars: 15; Exercises: 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
1. Introducing the student to the characteristics and mechanisms of action of biologic drugs (biologics) and the treatment options with different biologics in various diseases. 2. Encouraging the student to integrate and critically interpret the properties of biologic drugs, to adopt theoretical frameworks, in addition to obtain practical knowledge and skills regarding drug administration, monitoring the effect and possible side effects of biologic drugs in patients.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed and passed courses from 1st year of the study.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-2; MEDBIOT-2; MEDBIOT-4; BIOTECH-6; BIOTECH-10	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Link the general principles of action of biologics (pharmacodynamics) and the fate of the drug in the body (pharmacokinetics) 2. Critically evaluate the process of biologic medicines development and research of biologic and biosimilar drugs 3. Justify the mechanism of action of biologic drugs 4. Obtain the knowledge of biologic and biosimilar medicines development and approval process in the European Union 5. Apply acquired knowledge when planning experiments, conducting experiments, collecting and interpreting research results by learned methods. 6. Analyze biological samples qualitatively and quantitatively using appropriate research methods.	
Course Content	
Lectures. Introduction: development and types of biologic drugs in innovative medicine. The importance of clinical trials in the biologic medicine development. Characteristics and production of biologic drugs. Mechanisms of action of biologic drugs. The effectiveness of biologics. Safety of biologic drugs administration. Immunogenicity of biologic therapy. Characteristics and production of biosimilar drugs. Biologic therapy in clinical use. Biologic drugs in cancer patients. Biologics in rheumatology. Biologics in haematology. Biologics in gastroenterology. Biologics in dermatology. Biologics in neurology. **Seminars.** Types and methods of biologic drugs production. Methods of recombinant technology. Types of monoclonal antibodies. Mechanisms of action of biologic drugs. Side effects of biologic drugs. Biologic drugs in pregnancy. Administration of biologics and risk of infection. Biologic drugs and malignancies. Development and approval of biologic and biosimilar medicines in the European	

Union. Biologic drugs in the treatment of allergic diseases. Application of biologic drugs in endocrinology. Osteoporosis and growth disorders.
Exercises: Types of administration of biologic drugs. Analysis and interpretation of laboratory findings in addition to other diagnostic procedures to get patients prepared for biologic treatment.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes - Lectures	0.1	1-6	Attendance at classes	Keeping records	2	5
Seminars	0.4	1-4	Seminar preparation and presentation	Presentation	8	20
Exercises	1	5,6	Laboratory exercises	Report	10	25
Final exam	2.5	1-6	Studying for the final exam	Written exam	30	50
Total	4				50	100

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the	Availability via other media

	library	
Nagel, KM: Introduction to Biologic and Biosimilar Product Development and Analysis. Springer, 2018**.**		yes
Additional Literature		
European Medicines Agency: Biosimilars in the EU. Information guide for healthcare professionals, 2017. (available on-line)		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardized student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		

MEDBIOT-E07: **APPLICATION OF FLOW CYTOMETRY IN RESEARCH**	
GENERAL INFORMATION	
Course Coordinator(s)	Martina Mihalj, PhD, Assoc. Prof.
Associate(s)	Ines Drenjančević, PhD, Full Prof. Anita Matić, PhD, Assist. Prof. Zrinka Mihaljević, PhD
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	2nd Year / 4th Semester
Credits (ECTS)	4
Teaching Method (number of classes)	Lectures: 15; Seminars: 15; Exercises: 15
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The aim of this course is to introduce students to the possibilities of applying flow cytometry in biomedical research and medical diagnostics. Students should acquire the basic knowledge and practical skills necessary to plan and perform flow cytometry, and to analyse, present and interpret the gained results.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
Completed and passed 1st year exams.	
Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-2; BIOTECH-7; MEDBIOT-2; MEDBIOT-3; MEDBIOT-5	
Learning Outcomes at the Course Level	
After completing the course, the student will be able to: 1. Explain argumentatively basic principles underlying flow cytometry, including instrument set-up – fluidics, optics, electronics and software. 2. Recommend mandatory controls in flow cytometry and methods used to exclude non-specific signals. 3. Critically evaluate the results of immunophenotyping of peripheral blood leukocytes by using specialized FACS data analysis software. 4. Analyse gained results by using specialized FACS data analysis software. 5. Critically evaluate the results of the various studies available in the scientific and professional literature.	
Course Content	
Lectures: Introduction to Flow Cytometry; Preparation of samples for flow cytometry, antibody selection, fluorochromes; compensation; Flow cytometry controls; Application of flow cytometry in biomedical research and medical diagnostics. **Seminars:** Experiment planning on given in-vivo / in-vitro models I; Experiment planning on default *in vivo* / *in vitro* models II **Exercises:** Experiment planning – introduction to flow cytometer, antibody panels planning, selection of antibodies; setup of the sample aquisition settings on the device, compensation, antibody titration; Peripheral blood leukocyte immunophenotyping – Cell surface staining; Determination of cytokines and transcription factors - intracellular staining; Analysis of the obtained data, presentation and interpretation of the results.	
Teaching Methods	
Lectures; seminars; laboratory exercises	
Students' Obligations	
Attendance at all forms of classes is mandatory and the students are obligated to attend all	

knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Attending classes	0.2	1-5	Attendance at classes	Keeping records	2	10
Seminars	1	1-5	Seminar preparation and presentation	Presentation	10	20
Lab. practice	0.8	4	Laboratory exercises	Report	8	20
Final exam	2	1-5	Studying for the final exam	Written exam	30	50
Total	**4**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Roth B: Flow Cytometry: Current Aspects. Callisto Reference, 2015.	10	yes
Hawley TS, Hawley RG: Flow Cytometry Protocols. 4th Ed., Springer Protocols, 2018.	10	yes

Additional Literature

Scientific and professional papers related to particular chapters (available online)

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of Faculty of Medicine Osijek and/or the Faculty of Food Technology Osijek.
Note
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.

4.3. Structure of the study programme

The study programme consists of 4 semesters. The number of students in a class is 30 for lectures, 30 for seminars, 10 for seminar exercises, and 10 for laboratory exercises.

Contact classes via lectures, seminars, and exercises: at least twenty-five and at most thirty classes per week. The classes will be conducted as lectures, seminars (standard and problem seminars), practical classes, consultations, mentorships, permanent knowledge tests, partial exams, exams, and the diploma exam. Field work and other forms of education contribute to the acquisition of the required knowledge, skills, and habits.

After enrolling in the first year of the study programme, the Faculty Council, pursuant to the proposal from the Vice-Dean for Education and Students, will appoint an assigned person for every student among the teachers and associates at the Faculty. The assigned person will monitor the student's work throughout the study programme and help the student with managing their workload. The assigned person will be meeting the student once per month, or more frequently if requested by the student. The assigned person will be trying to resolve any problems the student may have by providing advice and guidance, and if they are unsuccessful, they will contact the Vice-Dean for Education and Students to seek help in resolving the problem.

During a semester, a student may be absent with justification from up to thirty percent of the total number of classes determined for a specific course within the study programme. The course teacher must establish the methods for compensating for the justified absences from classes at the beginning of every semester. A teacher may withhold their signature for a student if they have been absent from more than 30% of the classes determined for the study programme, and that student would not be able to take the exam. Every course teacher will decide on the method for keeping attendance records. In exceptional circumstances, the students may be provided with an option of compensating for up to 50% of the classes, pursuant to the Regulation on Study Programmes and Studying of the University of Osijek. This provision also applies to student athletes.

The students' knowledge will be evaluated and graded throughout the academic year, and the final grade will be determined at the exam. A student will have the status of a full-time student during the regulated period while the study programme is being implemented, and at most during a period which is one third of the time longer than the regulated period in which the study programme is being implemented, i.e. until the end of the academic year during which this period would expire. A student will have the right to enrol into the following year of the study programme if they have fulfilled all of their obligations determined for the study programme, following the "consecutive years" principle. Considering that the second year of the study programme offers two modules, fully separate from each other, the students will have to make a decision before enrolling in the second year, between the module Industrial Biotechnology and the module Medical Biotechnology, which includes elective courses (the students will not be able to combine the offered courses, mandatory and elective, from both modules).

Regarding particularly successful students, they can receive approval for completing the study programme in a shorter-than-regulated period, pursuant to the Statute of the University and the general acts of the Faculty.

A student may re-enrol into the same year of the study programme only once, and only if they have accumulated at least 24 ECTS credits for the year being repeated. If a student does not meet these requirements, they will lose the status of a full-time student.

The offered study programme will be fully implemented by our own teaching staff. However, there is definitely a plan to include outside stakeholders (visiting teachers), those with industry experience as well as teachers and scientists from Croatian and European universities and research institutes, for the purpose of encouraging the establishment and dissemination of scientific-academic cooperation and the network of personal contacts within the profession. The realisation of visiting lectures is also possible within the ERASMUS programme for the mobility of teaching staff.

4.4. Requirements for enrolment into the following year of the study programme
A student will acquire the right to enrol into the following year of the study programme if they accumulate at least 51 ECTS credits from the previous year of the study programme, provided that they must complete semester reviews, attend classes, and participate in exercises (seminars), they must write seminar papers where such requirements have been determined. In addition, they must pass course exams which are a prerequisite for taking and passing courses from the following year of the study programme. If a student fails to fulfil the conditions for enrolment into the following year of the study programme, they can re-enrol into the same year, provided that they have accumulated at least 24 ECTS credits from the year being repeated. A student may re-enrol into the same year of the study programme only once, otherwise they will lose the status of a full-time student. The University Regulation on Study Programmes and Studying regulates other matters related to the study programme (issues related to exams, appeals against grades, the procedure for retaking exams, on public access to the exams, and other).
4.5. List of courses and/or modules that may be implemented in a foreign language
All the courses will also be implemented in English
4.6. Completion of the study programme

The method for completing the study programme	Diploma paper
Application conditions for a diploma paper	A student may apply for a diploma paper during the final year of the study programme, and they can defend the paper after passing all the exams at the study programme.
Procedure for the evaluation and defence of the diploma paper	Each of the three members of the Committee will grade the completed diploma paper (0-50 points), as well as the public defence of the diploma paper (0-50 points). The final grade is based on the median value of the total number of points from the three-member committee. 0-55: (insufficient (1); 56-65: sufficient (2); 66-75: good (3); 76-85: very good (4); 86-100: excellent (5).

4.7. Optimal number of students
30 students
4.8. Estimated costs of the study programme per student:
5000 euros/year
4.9. List of course teachers and associates and teacher information
Employees at the Faculty of Medicine Osijek

No	**Teacher**	**Title**	**Academic Degree**	**Institution of Higher Education that Issued the Qualification**	**Field**

1.	Belovari, Tatjana	Full professor, tenured	PhD	Faculty of Medicine Zagreb	Basic Medical Sciences
2.	Drenjančević, Ines	Full professor, tenured	PhD	University of Wisconsin	Basic Medical Sciences
3.	Glavaš-Obrovac, Ljubica	Full professor, tenured	PhD	Faculty of Medicine Zagreb	Basic Medical Sciences
4.	Hefer, Marija	Full professor, tenured	PhD	Faculty of Medicine Zagreb	Basic Medical Sciences
5.	Mirat, Jure	Full professor, tenured	PhD	Faculty of Medicine Zagreb	Clinical Medical Sciences
6.	Faj, Dario	Full professor	PhD	Faculty of Science Zagreb	Physics
7.	Milas Ahić, Jasminka	Full professor	PhD	Faculty of Medicine Zagreb	Basic Medical Sciences
8.	Miškulin Maja	Full professor	PhD	Faculty of Medicine Osijek	Public Health and Healthcare
9.	Bilić Ćurčić, Ines	Associate professor	PhD	Faculty of Medicine Osijek	Basic Medical Sciences
10.	Drenjančević, Domagoj	Associate professor	PhD	Faculty of Medicine Osijek	Clinical Medical Sciences
11.	Mihalj, Martina	Associate professor	PhD	Faculty of Medicine Osijek	Basic Medical Sciences
12.	Smolić, Martina	Associate professor	PhD	Faculty of Medicine Osijek	Basic Medical Sciences
13.	Štefanić, Mario	Associate professor	PhD	Faculty of Medicine Osijek	Clinical Medical Sciences
14.	Wagner Kostadinović, Jasenka	Associate professor	PhD	Faculty of Pharmacy and Biochemistry Zagreb	Basic Medical Sciences
15.	Bijelić, Nikola	Assistant professor	PhD	Faculty of Medicine Osijek	Basic Medical Sciences
16.	Brkić, Hrvoje	Assistant professor	PhD	Faculty of Science Zagreb	Physics
17.	Jukić, Ivana	Assistant professor	PhD	Faculty of Medicine Osijek	Basic Medical Sciences
18.	Kasabašić, Mladen	Assistant professor	PhD	Faculty of Science Zagreb	Physics
19.	Kibel, Aleksandar	Assistant professor	PhD	Faculty of Medicine Osijek	Clinical Medical Sciences
20.	Matić, Anita	Assistant professor	PhD	Faculty of Medicine Osijek	Basic Medical Sciences
21.	Mimica Matanović Suzana	Assistant professor	PhD	Faculty of Medicine Osijek	Clinical Medical Sciences

22.	Miškulin, Ivan	Assistant professor	PhD	Faculty of Economics Osijek	Social Sciences
23.	Mišković Špoljarić, Katarina	Assistant professor	PhD	University of Osijek – Molecular Biosciences	Interdisciplinary Sciences
24.	Opačak Bernardi, Teuta	Assistant professor	PhD	University of Osijek – Molecular Biosciences	Interdisciplinary Sciences
25.	Periša, Vlatka	Assistant professor	PhD	Faculty of Medicine Osijek	Clinical Medical Sciences
26.	Stupin, Ana	Assistant professor	PhD	Faculty of Medicine Osijek	Basic Medical Sciences
27.	Tokić Stana	Assistant professor	PhD	Faculty of Science Zagreb	Natural Sciences, Biology
28.	Viljetić, Barbara	Assistant professor	PhD	Faculty of Science Zagreb	Interdisciplinary Sciences
29.	Ivić, Vedrana	Postdoctoral student	PhD	University of Osijek – Molecular Biosciences	Basic Medical Sciences
30.	Jukić, Marijana	Postdoctoral student	PhD	University of Osijek – Molecular Biosciences	Basic Medical Sciences
31.	Mihaljević, Zrinka	Postdoctoral student	PhD	Faculty of Medicine Osijek	Basic Medical Sciences
32.	Roguljić, Hrvoje	Postdoctoral student	PhD	Faculty of Medicine Osijek	Basic Medical Sciences
33.	Stupin, Marko	Postdoctoral student	PhD	Faculty of Medicine Osijek	Clinical Medical Sciences
34.	Ninčević, Vjera	Assistant	Doctor of medicine	Faculty of Medicine Osijek	Basic Medical Sciences
35.	Kozina, Nataša	Assistant	Master of education in biology and chemstry	Faculty of Humanities and Social Sciences	Social Sciences and Natural Sciences
36.	Omanović Kolarić, Tea	Assistant	Doctor of medicine	Faculty of Medicine Osijek	Basic Medical Sciences
37.	Rođak, Edi	Assistant	Master of experimental biology	Faculty of Science Zagreb	Natural Sciences, Biology

Employees at the Faculty of Food Technology Osijek

No	Teacher	Title	Academic degree	Institution of Higher Education that Issued the Qualification	Field
1.	Šubarić, Drago	Full professor, tenured	PhD	Faculty of Food Technology and Biotechnology Zagreb	Biotechnical Sciences, Food Technology

2.	Jurislav Babić	Full professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
3.	Miličević, Borislav	Full professor	PhD	Faculty of Food Technology and Biotechnology Zagreb	Biotechnical Sciences, Biotechnology
4.	Čačić Kenjerić, Daniela	Full professor	PhD	Faculty of Food Technology and Biotechnology Zagreb	Biotechnical Sciences, Nutrition
5.	Jakobek Barron, Lidija	Full professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
6.	Jokić, Stela	Full professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
7.	Strelec, Ivica	Full professor	PhD	Faculty of Food Technology and Biotechnology Zagreb	Biotechnical Sciences, Biotechnology
8.	Velić, Darko	Full professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
9.	Krstanović, Vinko	Full professor	PhD	Faculty of Food Technology and Biotechnology Zagreb	Biotechnical Sciences, Biotechnology
10.	Planinić, Mirela	Full professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
11.	Bucić Kojić, Ana	Full professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
12.	Pavlović, Hrvoje	Full professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
13.	Ačkar, Đurđica	Associate professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
14.	Budžaki, Sandra	Associate professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
15.	Molnar, Maja	Associate professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
16.	Velić, Natalija	Associate professor	PhD	Faculty of Food Technology and Biotechnology Zagreb	Biotechnical Sciences, Biotechnology
17.	Tišma, Marina	Associate professor	PhD	Faculty of Food Technology and Biotechnology Zagreb	Biotechnical Sciences, Biotechnology
18.	Čačić Kenjerić, Frane	Assistant professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food

					Technology
19.	Jozinović, Antun	Assistant professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
20.	Lučan Čolić, Mirela	Assistant professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
21.	Marček, Tihana	Assistant professor	PhD	Faculty of Science Zagreb	Biotechnical Sciences, Biotechnology
22.	Mastanjević, Kristina	Assistant professor	PhD	Faculty of Food Technology and Biotechnology Zagreb	Biotechnical Sciences, Biotechnology
23.	Aladić, Krunoslav	Assistant professor	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
24.	Tomac, Ivana	Postdoctoral student	PhD	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
25.	Kovač, Tihomir	Postdoctoral student	PhD	Faculty of Food Technology and Biotechnology Zagreb	Biotechnical Sciences, Biotechnology
26.	Ižaković, Maja	Assistant	Master of Nutrition	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
27.	Jakovljević, Martina	Assistant	Master of Nutrition	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
28.	Matić, Petra	Assistant	Master of Nutrition	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology
29.	Ostojčić, Marta	Assistant	Master of Nutrition	Faculty of Food Technology Osijek	Biotechnical Sciences, Food Technology

The resumes of the teachers are in the attachment as the document titled "IDS na engleskom jeziku_Biotehnologija_zivotopisi nastavnika"

4.10. Location where the study programme will be implemented	
Constituent unit's buildings	
Building identification	**Faculty of Food Technology Osijek** Cadastral plot number 5713, cadastral municipality Osijek
Building location	Franje Kuhača 18 and 20, Osijek
Year of construction	18th and 19th century
Total surface area in m^2	4,873
Building identification	Cadastral plot number 5787/1, cadastral municipality Osijek
Building location	**Part of the space located in the Rectorate of the University of Osijek**, Trg Svetog Trojstva 3, Osijek
Year of construction	18th and 19th century
Total surface area in m^2	600
Building identification	Cadastral plot number 6660/1, cadastral municipality Osijek
Building location	University campus
Year of construction	**Construction of the new Faculty of Food Technology building, planned to be finished in 5 years**
Total surface area in m^2	Approx. 12,000
Building identification	**Basic medical sciences building of the Faculty of Medicine Osijek**; cadastral plot number 6685/4, cadastral municipality Osijek
Building location	Josipa Huttlera 4, Osijek
Year of construction	1998.
Total surface area in m^2	4,153.79

5. Quality and performance monitoring methods for the study programme
The system of quality assurance and improvement at the Josip Juraj Strossmayer University of Osijek is based on the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) and its structure adheres to the requirements of the standard HRN EN ISO 9001 for the management of educational, scientific-research, and business processes.
Documents used as the basis for the quality assurance system at the Faculty of Medicine Osijek and the Faculty of Food Technology Osijek:
Regulation on the Organisation and Operation of the Quality Assurance System of the Josip Juraj Strossmayer University of Osijek: http://www.unios.hr/kvaliteta/wp-content/uploads/sites/2/2015/09/49Pravilnik-o-kvaliteti-HR-1.pdf
Quality Policy of the Josip Juraj Strossmayer University of Osijek: http://www.unios.hr/kvaliteta/wp-content/uploads/sites/2/2015/09/Politika-kvalitete-2018.pdf
Quality Manual of the Josip Juraj Strossmayer University of Osijek: http://www.unios.hr/kvaliteta/wp-content/uploads/sites/2/2016/03/Priru%C4%8Dnik-kvalitete.pdf
Regulation on the Organisation of the System of Quality in Higher Education of the Faculty of Medicine Osijek: http://www.mefos.unios.hr/images/dokumenti/pravilnici_i_dokumenti/dokumenti_fakultet/pravilnici/pravilnik_o_organizaciji_sustava_kvalitete_visokog_obrazovanja_medicinskog_fakulteta_osijek.pdf
Regulation on the Organisation of the System of Quality in Higher Education of the Faculty of Food Technology Osijek: http://www.ptfos.unios.hr/images/dokumenti/sustav-kvalitete/dokumenti//pravilnik-o-organizaciji-sustava-kvalitete-visokog-obrazovanja.pdf
Quality Policy of the Faculty of Medicine Osijek: http://www.mefos.unios.hr/images/dokumenti/pravilnici_i_dokumenti/dokumenti_fakultet/POLITIKA_KVALITETE_02_2018.pdf
Practice Guidelines on Publishing and Announcing the Results of the Unified University Student Survey: http://www.mefos.unios.hr/images/dokumenti/pravilnici_i_dokumenti/dokumenti_fakultet/pravilnici/postupnik_o_izdavanju_i_objavljivanju_rezultata_jedinstvene_sveucilisne_studentske_ankete.pdf
Manual for Monitoring and Assurance of Quality in Higher Education of the Faculty of Food Technology Osijek: http://www.ptfos.unios.hr/images/dokumenti/na-razini-fakulteta/prirucnik-za-osiguranje-kvalitete.pdf
Quality Policy of the Faculty of Food Technology Osijek: http://www.ptfos.unios.hr/images/dokumenti/sustav-kvalitete/Politika-kvalitete-Fakulteta.pdf
Professional Practice Manual for the Students at the Undergraduate Study Programme Food Technology: http://web.ptfos.hr/images/dokumenti/na-razini-fakulteta/pravilnik_o_strucnoj_praksi.pdf
Description of the procedures used to evaluate the performance quality of a study programme: • The method must be described for every procedure (usually a student or teacher survey, self-evaluation questionnaire), note who is performing the procedure (constituent unit, university office), what is the method for processing the results and the time schedule for the implementation • If it has been described in an attached document, note the name of the document and the article

Performance evaluation of teachers and associates	Performance evaluation of teachers and associates is implemented in cycles, through a student survey for evaluating the performance of teachers and associates, teacher self-evaluation, evaluations implemented by teachers, and in other ways, pursuant to the regulations and manuals on the quality assurance system of the University of Osijek, as well as the Faculty of Medicine Osijek and the Faculty of Food Technology Osijek. The unified university student survey, which enables all students to participate anonymously and evaluate the teaching performance of teachers and associates, as well as the education process, is implemented and organised by the Centre for the Improvement and Assurance of Quality in Higher Education at the Josip Juraj Strossmayer University of Osijek (UNIOS), the Office for Quality of the Faculty of Medicine Osijek (MEFOS) and the Faculty of Food Technology Osijek (PTFOS). The Manual for Monitoring and Assurance of Quality in Higher Education of the Faculty of Food Technology Osijek and the Practice Guidelines on Publishing and Announcing the Results of the Unified University Student Survey at the Faculty of Medicine Osijek regulate the procedure for processing the results of the student survey, which includes the analysis of results at the department, institute, and faculty levels. The UNIOS is publishing aggregated results of the student survey at their website. The unified university survey is implemented annually.
Monitoring the evaluation and the conformance of the evaluation with expected learning outcomes	The monitoring of the evaluation process and the conformance of the evaluation process with expected learning outcomes is implemented according to pre-set performance indicators for achieving learning outcomes, which are based on general needs of the society, continuation of education, the labour market, professional associations, and employer requirements. The learning outcomes are published at the website of the study programme and conformance monitoring and evaluation is implemented during classes and after the conformance analysis with the implementation plan of the study programme has been completed. The methods for monitoring and the evaluation of students must be planned and published for every course of the study programme.
Evaluation of the availability of resources (space, human, information) for the learning and teaching process	All the resources (classrooms, laboratories, computer classrooms, library, computer equipment, personnel resources as support and similar, the system for supporting e-learning and teaching) are easily available to the students, they are sufficient for their needs, and are receptive to feedback. The evaluation of the availability of resources is implemented through student surveys and reports from the Committees for Quality Management at MEFOS and PTFOS.
Availability and evaluation of student support (mentoring, tutoring, counselling)	Students are an important factor for ensuring operational quality; therefore, continuous activities toward providing more favourable conditions for studying, as well as for the active participation of

	students in scientific and research work, are being conducted. Student support is provided in the form of consultation, mentoring, administrative service, student registry, and the Student Assembly. The indicators include good exam pass rate and performance of the students, the learning system availability to all students, and the equal status of the student members of the Faculty Council. Apart from that, the students receive awards and recognitions for notable scientific-research work, humanitarian work, and success in sporting activities. Funds have been ensured for participation in scientific and professional meetings, sporting competitions, and space has been provided for the activities of the Student Assembly and student associations. Every teacher is available for student consultations during periods which have been communicated to students at the beginning of the academic year.
Monitoring the student exam pass rate per course and for the study programme in general	The successful completion of a study programme is a personal goal of every single student, but also of the institution implementing the study programme. It speaks of the quality of the enrolled students, their continuous work throughout the study programme, but also of the support received by the students from the teaching staff as part of the study programme. The analyses conducted include the exam pass rate of students throughout the academic year, the achievement of learning outcomes, and the results of the student survey, with the goal of determining the number of students who have completed the study programme successfully, the number of students completing the study programme within the projected time period in comparison to the number of students initially enrolled in the study programme, the average duration of the study programme, and the average grade during the study programme. The method for the implementation of the activities includes gathering information by the student registry on the number of students within the class who have successfully completed the study programme and the number of students within the class who are leaving the study programme, when compared to the number of students who have initially enrolled in the study programme, the number of enrolled students in the previous year, the average duration of the study programme, the average grade during the study programme, the share of students who have successfully completed the study programme within the projected period according to the standing regulations, as well as the number of graduated students within an academic year. All of this is supervised by the vice-dean for education and students, the head of the student registry, and the Committee for Education and Students. The results are available to all interested parties and the performance analysis of the study process (study process performance according to the number of passed exams) is implemented after the end of the academic year and delivered to all the interested participants of the education process. All of the above is the basis for the proposals regarding any necessary amendments to the implementation plan at the study

	programme level. The committees for education and students, as well as the vice-dean for education and students discuss the results of the exam pass rate and if necessary, they propose the amendments of the implementation plan at the study programme level.
Student satisfaction with the programme in its entirety	Student satisfaction with the programme in its entirety is evaluated with an anonymous student survey questionnaire at the student offices, after the completion of the study programme. The survey questionnaire includes observations from the students considering the content and the quality of the mandatory and elective courses, the implementation of the teaching process and knowledge evaluation, usefulness of the lectures, practical work, clear definitions of the course outcomes, clear definitions of the criteria for the evaluation of knowledge, continuous knowledge checks, schedule and frequency of exam dates, general satisfaction with the implementation of the study programme and similar, behaviour toward the students, support in the study process, and the general evaluation of outcomes. For the purpose of quality preparation of the amendments of the study programmes, information is gathered from former students who are employed in the profession for which they graduated. By surveying former students, we are able to obtain information on the acquired knowledge and skills with regard to the required job competencies. Committees for quality assurance are authorised to implement the activities. The results of the surveys among former students are available to all interested parties. The activity is conducted according to an internal schedule, once per year. The former student survey provides the former students with the opportunity to indirectly participate in the continuous improvement of educational programmes and their implementation, and by answering the survey questions, the former students are contributing to the higher quality of amendments to the programme which conform to the standards of the occupations matching the qualifications acquired at the faculties.
Procedures for obtaining feedback from external stakeholders (alumni, employers, labour market and other relevant organisations)	The alumni survey questionnaire is used to monitor the employment successfulness of the graduated students with the employers and their advancement in the profession. Surveys and interviews with the employers are used to monitor the satisfaction of the employers regarding the acquired knowledge and competencies of graduated students.
Evaluation of student practice, if it exists (short description of the methods for implementation and evaluation, and quality assurance)	The professional practice at the MEFOS and PTFOS is implemented according to the lesson plan, so the students could apply the knowledge they acquired in a business environment as they are studying. The duration of the professional practice is defined through lesson plans and programmes. The students attend professional practice during the period while they have no other educational obligations related to the study programme.

	The supervising teacher confirms the appropriate completion of the task by providing their signature and evaluation.
Other evaluation procedures implemented by the applicant	The students are also included in the activities of the Faculty Council, the Committee for Monitoring and Assurance of Quality of Higher Education, the Ethics Committee, the Committee for Education and Students, as well as the Committee for Final and Diploma Papers. External stakeholders are also included in the activities of the Committee for Monitoring and Assurance of Quality of Higher Education. Students and external stakeholders participate in all discussions, propose the items for the agenda, and vote under equal terms for the proposed conclusions of the mentioned committees. In addition, the implemented quality system at the MEFOS adheres to the standards *ISO* 9001 and HRN EN *ISO* 14000, and the quality system implemented at the faculty laboratories adheres to the standards applicable to medical laboratories (HRN EN ISO 15189:2012).
Description of the information system for external stakeholders on the study programme (students, employers, alumni)	The external stakeholders (secondary school students, university students, employers, alumni, and others) are informed about the study programme via the MEFOS and PTFOS websites, as well as via brochures, informative leaflets on the faculties and study programmes, through presentations for secondary school seniors, presentations of graduate study programmes to 3rd year undergraduate students, University Show, Science Night at the PTFOS, Science Festival, publication of articles in publications like the university periodicals, and similar.