Module handbook, Biotechnology, semester MBT2 "Biotechnology in environmental sciences", module numbers MBT-21 and MBT-22

Semes-ter	Module No.	Module Title	C	Cours e No.	Course Title	Course Type	Hours per Week	C	Exam	Weight
MBT2[i)]	MBT-21	Biotechnology in environmental sciences	25.0		Biorefineries and bioproducts	V/L	3	3	K90, LA, HA	3/30
					Application of molecular techniques in environmental engineering	V/L	2	2	LA, HA	2/30
					Environmental technology	V/L/P	5	4.5	K90, LA, HA	5/30
					Membrane processes in industry	V/L	1.33	1	LA, HA	1/30
					Environmental monitoring	V/L	2	1.5	LA, HA	2/30
					Enzyme technology and bioinformatics	V/L	4	3	K90, LA, HA	4/30
					Applied biotechnology	V/L	3	3	K90, LA, HA	3/30
					Electives environmental and industrial biotechnology	V/L/P	5.3	5	HA, LA	5/30
					Information technologies in environmental engineering	V/L	2	2	HA, LA	2/30
	MBT-22	Complementary subjects	5.0		Writing scientific papers	S	2	2	HA	2/30
					Design thinking	S	1.33	1.5	HA	1/30
					Obligatory UWM subjects	S	0.8	1.5		-

Abbreviations:

Workload:
C = credit points (ECTS)
1 C = 30 h
SWS = contact hours per week (at 45 minutes each)
weight = weight of grade within the module

Course type:
L = laboratory class
P = practical work
S = seminar
V = lecture
WA = scientific work

Examination type:
AA = Master's thesis
HA = scientific homework
K60/K90/K120 = written exam of 60/90/120 minutes duration
LA = laboratory report
RE = oral presentation
OE = oral exam

Electives environmental and industrial biotechnology

Block of Electives Solid Waste Management – 1 subject

Lp.	Subject	ECTS	Total Hours	Lectures	Classes proj
1.	Biotechnology of Solid Waste	1.5	20	5	15
2.	Reuse And Recycling of Solid Waste	1.5	20	5	15

Block of Electives Environmental Toxicology - 1 subject

Lp.	Subject	ECTS	Total Hours	Lectures	Classes lab
1.	Biomarkers of Environmental Contamination	1.5	20	5	15
2.	Toxic Chemical Risk	1.5	20	5	15

Block of Electives Industrial Biotechnology - 2 subjects

Lp.	Subject	ECTS	Total Hours	Lectures	Classes lab
1.	Biofilms	1	20	5	15
2.	By-Products Management in Food Industry	1	20	5	15
3.	Nanobiotechnology	1	20	5	15
4.	Analysis of High-Throughput Sequencing Data	1	20	5	15
5.	Cell Culture Model Systems in vitro and Reporter Systems	1	20	5	15
6.	Metagenomics in Ecological Engineering	1	20	5	15
7.	Industrial Microbiology	1	20	5	15
8.	Micropollutants and Pharmaceuticals	1	20	5	15

Subject description

Environmental Monitoring

Educational objective: to learn about the concepts and methods used in environmental monitoring and the organisational structure of State Environmental Monitoring.

Course syllabus: the specific nature of the work and laboratory facilities of the units involved in environmental monitoring; methods for taking measurements to assess the condition of environmental components; analysis of the measurement data under monitoring; interpretation of monitoring research results.

Learning outcomes:

Knowledge (student knows and understands): principles of measurement and interpretation of monitoring data; indicators of pollutants considered in environmental research; and determination methods.

Skills (student can): use the principles of monitoring as an integral component of environmental protection, design, and management; plan measurements, select methods for processing monitoring data, and interpret the results obtained; assess the quality of environmental components.

Social competence (student is prepared to): communicate to the public the principles of sustainable use of the environment and the role of environmental engineering in the conservation of natural resources.

Instructional method: lectures and classes.

Information Technologies in Environmental Engineering

Educational objective: to learn about the methods used to develop mathematical models of processes in environmental engineering.

Course syllabus: introduction to the environment of mathematical modelling of selected processes in environmental engineering. Discussion of modelling objectives. Presentation of the methodology of mathematical model development (stages). Modelling of the microorganism population growth kinetics. Monod model. Modelling of biochemical transformations. Mass and energetic balances of aerobic and anaerobic cultures. Mathematical modelling of selected processes in environmental engineering. Optimisation of process parameters and bioreactor design.

Learning outcomes:

Knowledge (student knows and understands): principles of the development of mathematical process models and their optimisation. Principles of the application of mathematical modelling methods in research on selected production processes.

Skills (student can): make calculations of the microorganism growth kinetics and of the gas release during selected biomass treatment processes; use a computing environment.

Social competence (student is prepared to): promote the significance of mathematical modelling and computer simulation in the design of systems incorporating bioreactors.

Instructional method: lectures and classes.

Environmental Technology

Educational objective: to learn about the technologies used in environmental engineering and to develop skills in the selection of technological concepts.

Course syllabus: municipal technology design systems. Unit processes in technological systems for water treatment, wastewater treatment, and sewage sludge treatment. Design of selected technological systems used in environmental engineering.

Learning outcomes:

Knowledge (student knows and understands): the technologies used in environmental engineering; selection criteria for particular unit processes depending on the quality of water and wastewater as well as the requirements for their treatment; the principles of the selection and design of technological systems used in environmental engineering.

Skills (student can): design technological systems used in environmental engineering, calculate technological parameters in particular unit processes, and select a technology to solve an environmental problem.

Social competence (student is prepared to): consider the significance of background and applied knowledge in the design and introduction of technologies to prevent environmental degradation.

Instructional method: classes.

Application of Molecular Techniques in Environmental Engineering

Educational objective: to present the theory and practice of using molecular biology methods in environmental engineering.

Course syllabus: organisation of cells and cellular structures. RNA and DNA structure and function. DNA replication and transcription mechanisms. Basic molecular biology methods used to analyse RNA, DNA, and proteins. DNA cloning. Electrophoretic methods for analysing microorganism biodiversity. Application of molecular biology methods for monitoring biotechnological processes. Bioinformatic methods for nucleotide sequence analysis. Application of meta-omic methods (metagenomics, metatranscriptomics, and metaproteomics) in environmental engineering.

Learning outcomes:

Knowledge (student knows and understands): the basics of organism functioning at the molecular level. Nucleic acid properties. Basic molecular biology methods and their potential for use in biotechnology and environmental engineering. Meta-omic methods and their potential for use in environmental research.

Skills (student can): carry out DNA purification, quantification, and amplification; apply molecular biology methods for genotyping and monitoring biotechnological processes; draw up a report on the research conducted.

Social competence (student is prepared to): make informed use of molecular biology methods for monitoring biotechnological processes; consider the hazards arising from the use of genetic engineering methods in environmental bioremediation and the possible entry of genetically modified microorganisms into the natural environment.

Instructional method: lectures and classes.

Applied Biotechnology

Educational objective: to learn about technical and technological aspects of the implementation of biotechnological processes using microorganisms and enzymes.

Course syllabus: unit operations and processes in biotechnology. Examples of the use of microorganisms and enzymes. Microorganism culture techniques. Microorganism and enzyme modification. Biocatalysis and biotransformation. Industrial-scale biotechnologies. Environmental impact of biotechnology.

Learning outcomes:

Knowledge (student knows and understands): the relevance of techniques and technologies in the implementation of biotechnological processes. Methods, techniques, tools, and materials used in the implementation of biotechnological processes. Principles of conducting biotechnological processes. Introduction to industrial process organisation.

Skills (student can): apply the knowledge of basic sciences and biotechnology for the implementation of production tasks; properly select methods and tools to implement bioprocesses.

Social competence (student is prepared to): verify information and its sources, and perform critical analysis; evaluate their own knowledge and skills.

Instructional method: lectures and classes.

Biorefineries and Bioproducts

Educational objective: to learn about unit processes and operations used in biorefineries and the basics of their operation; to acquire the ability to select a biorefinery concept for the production of bioproducts from specific types of substrates and to assess the technological complexity of the solutions proposed.

Course syllabus: biorefinery design concepts and principles. Biorefinery classification system and types. Characteristics of raw materials processed in biorefineries; technologies for the production of sample bioproducts – theoretical basis; unit processes and operations; types of bioproducts produced in biorefineries, and their separation methods. Current status and trends in biorefinery development.

Learning outcomes:

Knowledge (student knows and understands): fundamentals and principles for biorefinery design and operation. Technological solutions used to convert various types of waste biomass into products of useable value. Unit processes and technologies for producing useful bioproducts from waste.

Skills (student can): characterise basic processes and operations used in biorefineries; classify biorefineries depending on the type of substrates processed, bioproducts produced, and unit processes used; select and evaluate technical solutions in bioproduct production technologies; present and justify

the selection of proposed bioproduct technology concepts; make calculations of the technological concept of a sample biorefinery.
Social competence (student is prepared to): recognise the need for resource recovery from waste biomass and for the development of a circular economy.
Instructional method: lectures and classes.

Design Thinking

Educational objective: to learn about selected design thinking methods; to develop design skills, creativity, and trend analysis.
Course syllabus: development of three design projects over several sessions. Each design project is supported by seminars demonstrating different design thinking methods and tools. General project themes include new trends in concept development and trends in biotechnology.
Learning outcomes:
Knowledge (student knows and understands): current trends in a particular field.
Skills (student can): extract information from available databases and analyse it critically; use selected design thinking tools.
Social competence (student is prepared to): take action to improve the quality of life. *Instructional method*: classes.

Enzyme Technology and Bioinformatics

Educational objective: to acquire knowledge of the structure and functions of biomacromolecules and enzymes and the methods of their isolation, identification, and bioinformatic analysis; to get acquainted with methods for using microorganisms and enzymes.
Course syllabus: characterisation of the *in silico*, *in vitro*, and *in vivo* methods used in modern natural science. Enzyme purification and isolation methods, mechanisms of enzyme action, and enzyme specificity and kinetics of action. Practical application of bioinformatics in environmental science. Databases of high- and low-molecular-weight compounds. Defining similarities between biomolecules. Analysis of proteins as a biologically and functionally active peptide source. Searching databases of chemical compounds.
Learning outcomes: Knowledge (student knows and understands): enzyme structure and functions, enzymatic activity modification methods, enzyme isolation and purification methods. Issues concerning protein families and enzyme selection, purification and immobilisation.
Skills (student can): analyse the biomacromolecule structure and function. Use bioinformatic tools in enzymatic analysis; plan and conduct analyses in the laboratory; prepare an *in silico* project to obtain functional peptides.
Social competence (student is prepared to): organise work, plan and conduct an experiment, cooperate in a group, and take responsibility for work carried out by a research team.
Instructional method: lectures and classes.

Membrane Processes in Industry

Educational objective: to acquire knowledge of the characteristics of membrane processes and their application in industry, wastewater treatment, and water treatment.

Course syllabus: general characteristics of membrane processes. Membrane design, properties, and operation principles. Diaphragm transport theory. Factors affecting membrane separation. Performance characteristics, design, and analysis of operational parameters of pilot membrane systems using polymer and ceramic membranes. Technical characteristics of membrane separation processes and calculation of membrane module operational parameters. Technical characteristics of membranes, operational parameters, and washing procedures. Membrane configuration (modules). Process design – modes of operation. Water treatment by the reverse osmosis method. Use of membranes in industry, wastewater treatment, and water treatment.

Learning outcomes: Knowledge (student knows and understands): the basic issues concerning membrane separation and the potential use of membranes in environmental engineering and industry.

Skills (student can): design and operate a membrane system, analyse the operational parameters, carry out a mass balance, and assess the efficiency of distribution of membrane separation processes.

Social competence (student is prepared to): make decisions on the use of membrane separation processes and the operation and maintenance of membrane systems.

Instructional method: lectures and classes.

21. Biotechnology of Solid Waste

Educational objective: to learn about the unit processes used in municipal waste processing, including the biotechnologies used for organic municipal waste processing; to acquire the ability to select the concepts and the assessment of the solutions applied in the biotechnological processing of organic municipal waste.

Course syllabus: municipal waste management. Sources, quantities, morphological composition, and properties of municipal waste. The proportion of recyclable raw materials. Mechanical biological treatment (MBT) systems for municipal waste processing. Technical and technological solutions applied in MBT. Biotechnologies (aerobic and anaerobic stabilisation) for the processing of the organic fraction of solid waste mechanically separated from mixed municipal waste. Anaerobic digestion and composting of biowaste. The process of municipal waste organic fraction fermentation in energy piles. Models used to calculate biogas quantities, including those based on operational data.

Learning outcomes:

Knowledge (student knows and understands): issues concerning the generation of organic municipal waste. Problems associated with municipal organic waste management. Trends and solutions in the biotechnological processing of organic municipal waste.

Skills (student can): assess the quantity and quality of municipal waste, including organic fractions and raw recyclable material fractions, generated in the municipal waste management systems; select biotechnological solutions depending on the quality of organic municipal waste and the required

operational strategies and regulations in municipal waste management; determine biogas quantities, including based on operational data.
Social competence (student is prepared to): consider the hazards arising from inadequate management of municipal waste, including organic waste; raise awareness of the need for the application of biotechnologies in the processing of organic municipal waste to prevent environmental degradation.
Instructional method: lectures and classes.

Reuse and Recycling of Solid Waste

Educational objective: to learn about the processes used in municipal waste (MW) processing, including the technologies for mechanical processing and recycling of raw material and organic fractions of MW; to acquire the ability to evaluate the solutions used in technologies, including recycling and biotechnologies for MW processing.
Course syllabus: definitions of MW recycling, recovery, and disposal. MW quantities. The proportion of raw material fractions in MW. The recovery levels for the separately collected MW. Recycling technologies. Organic MW recycling. Technological solutions applied in mechanical biological treatment (MBT) of MW. Composting of separately collected organic waste in a two-stage system involving a biological reactor and piles turned over periodically. Stabilisation of the organic fraction of waste using the fermentation process in energy piles. Calculation of the quantities of biogas generated using models and based on operational data.
Learning outcomes:
Knowledge (student knows and understands): issues concerning the generation of MW, including recyclable raw material and organic fractions. Problems associated with organic MW management. Trends and solutions in the processing of selected MW fractions.
Skills (student can): assess the quantity and quality of MW, including recyclable raw material and organic fractions, generated in MW management systems. Select technological and biotechnological solutions depending on the quality of MW and the required operational strategies and regulations in MW management. Determine biogas quantities.
Social competence (student is prepared to): consider the hazards arising from inadequate management of MW, including recyclable raw material and organic fractions of MW; raise awareness of the need for the application of technologies and biotechnologies in the processing of MW fractions to prevent environmental degradation and of the significance of recycling, including organic, and the selected MW fractions to enhance the environmental quality.
Instructional method: lectures and classes.

Biomarkers of Environmental Contamination

Educational objective: to learn about biomarkers of organisms’ exposure to environmental stress factors and their potential for use in biomonitoring.
Course syllabus: basic toxicology issues. Pollutant sources and fate in the environment. Definition and classification of biomarkers, their significance and specific nature. Anatomical, physiological, and

behavioural effects of pollutant impact. Plant response to environmental changes. Role of biomarkers in environmental risk assessment and biomonitoring. The use of biotests in the assessment of aquatic environment quality: response analysis. Preparation of the exposure of zebrafish embryos to a selected chemical compound. Analysis of the molecular basis of the compound impact.

Learning outcomes:

Knowledge (student knows and understands): hazards to aquatic and terrestrial ecosystems. Possible environmental effects due to pollution with anthropogenic and natural compounds. Mechanisms of interaction of the main environmental pollutant groups on different biological organisation levels.

Skills (student can): biological assessment methods to determine the effects of pollutant action on aquatic organisms. Interpret experimental results by combining knowledge of natural and technical sciences.

Competence (student is prepared to): anticipate the risk and potential effects associated with environmental pollution.

Instructional method: lectures and classes.

Toxic Chemical Risk Assessment

Educational objective: to learn about the factors of chemical substance toxicity risks and the risk assessment process.

Course syllabus: pollutants and their fate in ecosystems. Dose effect. Animal toxicity studies. The body's defence against toxicity. Toxicity mechanisms and health effects. Assessment of risks to human health. Environmental risk assessment. Chemical risk management.

Learning outcomes:

Knowledge (student knows and understands): the risk assessment process. Background and effects of the toxic action of selected chemical substances.

Skills (student can): identify and characterise risks to humans and the environment, associated with the presence of selected pollutants; carry out the toxicity risk assessment process.

Competence (student is prepared to): consider toxicological hazards; formulate recommendations/decisions in favour of the environmental well-being; the student is also prepared to introduce technologies to enable the anticipation of the environmental substance toxicity risks.

Instructional method: lectures and classes.

Writing Scientific Papers

Educational objective: to convey enhanced knowledge of scientific communication.

Course syllabus: the principles applied in drawing up scientific papers; linguistic culture and interpersonal communication; the ethical basis of professionalism; body language and voice projection.

Learning outcomes:

Knowledge (student knows and understands): the principles of preparation, writing, and presentation of scientific papers.

Skills (student can): draw up a paper or prepare a scientific presentation.
Social competence (student is prepared to): demonstrate creativity in scientific work and cooperate in a team; act in accordance with ethical principles; systematically improve their professional competence.
Instructional method: classes.

Biofilms
Educational objective: to acquire knowledge of the role of biofilms in industry and environmental biotechnology; to learn about biofilm research techniques.
Course syllabus: undesirable and desirable effects of biological membrane growth (development of microorganisms on the surfaces of industrial facilities and in water distribution systems; the use in wastewater treatment, bioremediation, biofertilisation, biofuel production, and biofiltration). Imaging methods and molecular biology tools in biofilm research. Methods for biofilm prevention and eradication. Biofilm-forming microorganisms. Assessment of the selected strains' biofilm-forming ability. Deposition and development of microorganisms on abiotic surfaces. Identification of surfaces at high risk of biofilm formation. Evaluation of the effectiveness of biofilm control methods. Microscopic imaging of biofilm structure and physiology.
Learning outcomes:
Knowledge (student knows and understands): microorganisms' characteristics favouring sedentary life. Negative and positive effects of biofilm development in technologies applied in environmental engineering.
Skills (student can): plan, prepare, and carry out biofilm testing, and discuss the positive and negative aspects of biofilm development in technologies applied in environmental engineering.
Social competence (student is prepared to): develop and disseminate the practical output in the field of biofilms and work in a biofilm research laboratory.
Instructional method: lectures and classes.

By-Product Management in Food Industry
Educational objective: to learn about management methods and legislation concerning by-products in the food industry; to learn about the principles of the circular economy.
Course syllabus: by-products of animal origin and from plant processing and their potential for use. Regulations concerning waste of animal origin and their disposal methods. Use of food waste in bioethanol production. Processing methods, safety, recovery, and the potential for recycling or disposal of dairy waste. Field classes in food processing plants, with a focus on by-product generation sites, waste management, and environmental solutions. Use of by-products from the processing of plant and cereal raw materials in bread baking.
Learning outcomes: Knowledge (student knows and understands): the principles of sustainable development and the relationship between food production and environmental exploitation.

Technologies to minimise the impact of the food industry on the natural environment and the by-product and waste management methods.
Skills (student can): select technologies to minimise the impact of the food industry on the natural environment, including technologies of processing by-products and waste disposal.
Social competence (student is prepared to): speak about the principles of the sustainable use of the environment; continue education, inspire others, and convey knowledge. *Instructional method:* lectures and classes.

Nanobiotechnology
Educational objective: to learn about the fundamentals of nanotechnology and nanobiotechnology; to acquire skills in handling nanomaterials.
Course syllabus: basic definitions and terms in the field of nanotechnology. Obtaining nanomaterials and characterising their properties. Effect of nanomaterials on microorganisms. Analytical methods applied in nanotechnology; nanotechnology application. Practical aspects of nanotechnology application.
Learning outcomes:
Knowledge (student knows and understands): basic terms in the fields of nanotechnology and nanobiotechnology. Analytical and biotechnological methods applied in nanotechnology and nanobiotechnology. Effect of nanomaterials on microorganisms and the environment. Possibilities and problems of applying nanotechnology. Effect of nanomaterials on the environment.
Skills (student can): obtain nanomaterials using natural raw materials and microorganisms; apply appropriate techniques for nanomaterial analysis; use an atomic force microscope.
Social competence (student is prepared to): critically assess their own and others' knowledge, verify and expand knowledge in the field of nanobiotechnology and related sciences. Share knowledge and exchange views.
Instructional method: lectures and classes.

***In vitro* cell culture model systems and reporter systems**
Educational objective: to learn about cell culture laboratory techniques and their application in biotechnological research.
Course syllabus:
Lectures: a plan of a cell culture laboratory: the layout, equipment, and materials used from the laboratory. Cell culture and lines. Reporter analysis: principles, reagents, preparation. Screening a library of synthetic RNA ligands with regard to gene expression silencing.
Classes: sterile techniques, safety, culture vessels, growth media, culture media, and supplements. Preparation of the laboratory and sterilisation of equipment. Cell culture and lines, preparation of complete culture medium, observation

of the cells cultured, cell enumeration, culture plate preparation. Transfection (pmirGLO vector), co-transfection (vector + mimic). Reporter analysis and screening of a library of synthetic RNA ligands with regard to microRNA 92b-3p silencing using an original authors' reporter system.

Learning outcomes:

Knowledge (student knows and understands): model cell lines, cell line handling techniques, and their application in biological and biotechnological research.

Skills (student can): carry out a simple experiment involving a cell line and the reporter system.

Competence (student is prepared to): introduce the technologies using *in vitro* cell culture in biotechnological projects.

Instructional method: lectures and classes.

Micropollutants and Pharmaceuticals

Educational objective: to learn about the hazards associated with the presence of micropollutants in the environment and the biotechnological processes used to remove micropollutants from wastewater.

Course syllabus:

Lectures: main micropollutant groups in the environment – spread and hazards. Micropollutant biotransformation and co-biotransformation. Micropollutant removal in wastewater treatment plants.

Classes: Assessment of the effect of micropollutants on the microorganisms' activity in wastewater treatment systems. Biotechnologies used in the removal of micropollutants.

Learning outcomes:

Knowledge (student knows and understands): the hazards associated with the presence of micropollutants in the environment, and the biotechnological methods used to remove micropollutants from wastewater.

Skills (student can): select a technology to effectively remove micropollutants from wastewater.

Social competence (student is prepared to): optimise the operational parameters of selected biotechnologies used in micropollutant removal.

Instructional method: lectures and classes.

Analysis of High-Throughput Sequencing Data

Educational objective: to acquire knowledge and skills required to carry out a computerised analysis of high-throughput sequencing data and to understand the potential for the use of bioinformatic tools and large-scale data analysis in comprehensive biotechnological research.

Course syllabus:

Lectures: Introduction to high-throughput sequencing. The main sequencing technologies and platforms and their potential for use. Best practices in experiment planning using high-throughput sequencing. The most common tools and procedures. Bioinformatics in the "*multi-omic*" era.

Classes: Introduction to the environment and selected R packages. Data download. Quality control, pre-processing and mapping of readings. Data standardisation. Differential analysis of expressions. Data annotation and functional gene analysis. Result visualisation.

Learning outcomes:

Knowledge (student knows and understands): the main technologies and platforms for high-throughput sequencing and their potential for use as a tool for solving complex research problems.

Skills (student can): use bioinformatic tools, write scripts and create workflows in a programming environment for the processing and analysis of large-scale biological datasets, effectively plan an experiment involving high-throughput sequencing, and assess the results obtained.

Social competence (student is prepared to): update knowledge in the field of computerised data analysis and is aware of its practical importance in modern research.

Instructional method: lectures and classes.

Metagenomics in Ecological Engineering

Educational objective: to learn about metagenomic techniques to characterise microorganism associations in the systems used in environmental engineering.

Course syllabus:

Lectures: DNA sequencing methods, functional and structural metagenomics, metataxonomics, bioinformatic tools, metagenomic databases.

Classes: searching databases, and analysis of DNA sequences using bioinformatic tools.

Learning outcomes:

Knowledge (student knows and understands): the complexity of microorganism associations in the context of the functioning of different environments, research approaches that enable characterisation of microorganism associations

Skills (student can): carry out basic analyses of species diversity of environmental samples and search databases for information on the functioning of environments.

Social competence (student is prepared to): communicate to the public the latest achievements in the field of metagenomics and make use of objective sources of scientific information on the analysis of environmental samples.

Instructional method: lectures and classes.

Industrial Microbiology

Educational objective: to acquire knowledge in the field of industrial microbiology, in particular, the production of biopreparations used in engineering and environmental protection.

Course syllabus:

Lectures: Microorganism isolation. Microorganism culture methods. Culture media. Control of microbial metabolism. Fermentation product separation and purification. Genetically modified microorganisms.

Classes: Microorganism culture. Bacterial culture monitoring. Extraction of culture products.

Learning outcomes:

Knowledge (student knows and understands): student has a general knowledge of industrial microbiology, in particular of microbiological production of biopreparations useful in environmental protection.
Skills (student can): culture microorganisms and use properly selected culture parameters to achieve the planned effect.
Social competence (student is prepared to): take responsibility for the safety of their own work and that of others, and assess the hazards arising from culturing microorganisms and employing modern methods to obtain bioproducts.
Instructional method: lectures and classes.

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[i] According to regulations at host institution