Education Committee

MSc (Laurea Magistrale)

Molecular and Industrial Biotechnology

Laurea Magistrale in Biotecnologie Molecolari e Industriali

Classe delle Lauree Magistrali LM-8

Biotecnologie Industriali Federico II

BiotecnologieindustrialiFII

www.biotecnologieindustriali.unina.it/en/page/didattica-ed-orientamento/laurea-magistrale.html

July 2021

The aim of the MSc in Molecular and Industrial Biotechnology

The MSc programme aims to educate graduated students for high profile positions in research centres, enterprises and industries operating in industrial biotechnology field. The programme:

- includes activities aimed at acquiring: (a) knowledge on the structure and function of biological systems, interpreted according to molecular and informational logics, from the cellular level to that of the organisms; (b) fundamental knowledge and techniques in various fields of industrial biotechnology, with particular attention to multidisciplinary approaches; (c) specialist skills in specific sectors of industrial biotechnology;
- provides the opportunity of external activities (e.g. internships in companies, public or private research institutes, traineeships in Italian and European universities) to strengthen skills in specific sectors of industrial biotechnology;
- includes - as a qualifying moment of the training - an experimental thesis carried out in academic research laboratories and/or in other public/private structures, including the results of an original scientific and technological research.

Potential fields of activity of MSc graduated students are biotechnological enterprises, chemical, pharmaceutical/cosmetic and nutraceutical industries, as well as the environmental technology sector. The MSc graduated students will be able to operate covering positions of high responsibility, including technical, economic and legal implications.

The programme includes two curricula:

"Birre - Biotechnology for Renewable Resources"
"ProBio - Biotechnology productions"

The lessons of the Birre curriculum are in **English and Italian languages**: 6 courses - for a total of 57 CFU spread over a period of one year – are provided in English language and 4 courses - for a total of 30 CFU spread over a period of one year – are provided in Italian language. The topics of Birre curriculum are focused on molecular and industrial issues of biotechnology to prepare students to the construction of new products and services based on the exploitation of renewable resources. Students are provided with the interdisciplinary concepts of industrial biotechnology to convert renewable resources in consumables (e.g. energy vectors, bioplastics, pigments, nutraceuticals). Both classes of biotechnology products, i.e. high value products (e.g. antioxidants) and high massive products (e.g. energy vectors, bioplastics) are addressed.

The lessons of the ProBio curriculum are provided in **Italian language:** 9 courses, for a total of 87 CFU spread over a period of half a year. The topics of ProBio curriculum are focused on molecular and industrial aspects of biotechnology to educate students to a general integrated approach to consolidated and emerging technologies.

The structure of the MSc in Molecular and Industrial Biotechnology

Course	Module (if present)	ECTS
I Year – I semester		
Industrial microbiology and fermentation chemistry (IT)		6
Microalgal exploitation	Genetic engineering	6
	Microalgal resource	6
Industrial biotechnologies and environment protection (IT)	Industrial biotechnologies	6
	Environmental safety biotechnologies	6
I Year – II semester		
Transport phenomena for biotechnological applications		9
Biopolymers and bioplastics	Polyester based bioplastics	6
	Polysaccharide- and protein- based bioplastics	6
Biorefinery processes		6
II Year – I semester		
Hygiene background for biotechnologies (IT)		6
Design of conversion processes	Bioreactors	6
	Process simulation	6
Biosensors and Biochips (IT)		6
Environmental economy		6
II Year – II semester		
Free selection proposed by the student		12
Practical training		18
Final project and exam		3

(IT) – course language: Italian

Education period (typical):

I Semester – From the end of September up to the beginning of Christmas holiday
II Semester – From the beginning of March up to the beginning of June

Exams – January to March. June, July, September and October

Details of each course/module are reported at the webpage of the professor.

The list of records of course/modules is reported hereafter.

OVERVIEW OF THE COURSE: GENETIC ENGINEERING
Module of: MICROALGAL EXPLOITATION

Study programme name		Course		Master degree	A.A.	2021/22
Molecular and Industrial Biotechnology			X			

Teacher: Prof. Marco Salvemini	☎ 081.2535004	email: marco.salvemini@unina.it

SSD	BIO/18	CFU	6	Year	I	Term	I

Prerequisites: none

EXPECTED LEARNING RESULTS/RISULTATI DI APPRENDIMENTO ATTESI

Knowledge and understanding skills/Conoscenza e capacità di comprensione
The student has to demonstrate knowledge of the methods of recombinant DNA technology, both basic and advanced, and of genetic engineering of prokaryotic and eukaryotic organisms.
Applied knowledge and understanding skills/Conoscenza e capacità di comprensione applicate
The student must demonstrate the capacity to design modified or transgenic strains aimed at the optimization of animal and plant species for biotechnological purposes.
Any further learning outcomes expected in relation to/Eventuali ulteriori risultati di apprendimento attesi, relativamente a
• **Autonomy of judgment/Autonomia di giudizio:** The student has to be able to evaluate which methodology to use and which type of strain (modified or transgenic) to produce on the basis of specific objectives proposed.
• **Communication skills/Abilità comunicative:** The student must be able to interact simultaneously with different professional figures (such as industrial chemists, physicists, biologists, bioinformaticians, pharmaceutical chemists) to optimize the applicative aspects related to the design of the modified or transgenic strains. He/she must be able to write down and present a report on selected genetic engineering case studies.
• **Learning skills/Capacità di apprendimento:** The student must be able to expand his/her knowledge by reading material (scientific papers, on-line courses, tutorials) related to genetic engineering applications. The student must be able to independently find detailed information on genetic pathways useful for the production of modified or transgenic strains to be produced by genome editing.

COURSE MAIN CONTENTS/PROGRAMMA

- Recombinant DNA molecules: design and production.
- Optimization of the expression of recombinant DNA molecules.
- Molecular cloning of genes: molecular hybridization, genomic and cDNA libraries, screening of a library.
- DNA sequencing from Sanger sequencing to high-throughput techniques.
- Basic principles for genomic and transcriptomic assembly and in silico analysis.
- In silico differential expression analysis to identify genes of interests.
- Gene transfer techniques in animal and vegetal species: methods and basic principles.
- Genetic transformation markers.
- The analysis of gene function using RNAi.
- The genome editing through the use of site-specific nucleases (ZNFs, TALENs, CRISPR-Cas9).
- CRISPR-Cas9 in silico target identification.
- Homologous recombination and the use of site-specific recombination systems.

COURSE MATERIAL

- An introduction to genetic engineering (2008) D.S.T. Nicholl – Cambridge University Press
- Genome editing and engineering (2018) K. Appasani – Cambridge University Press
- Lecture notes provided during the course.

TARGET AND MODALITY AIMED TO ASSESS THE LEARNING RESULTS

a) Learning results to be verified/Risultati di apprendimento che si intende verificare:
The student should be able to demonstrate the full knowledge of the topics covered by the course program and to be able to simulate an algal genome / transcriptome assembly, a differential expression analysis and a CRISPR-Cas9 target sites in silico search, using data from public databases.

b) Assessment method/Modalità di esame:

Examination includes	Written test and oral		Written test	x	Oral	x
Project report discussion						
Exam on laboratory of bioinformatics				x		

Written test - questions ask for (*)	Multiple answers	x	Free answers	x	Numerical exercises	x

OVERVIEW OF THE COURSE: MICROALGAL RESOURCE
Module of: Microalgal exploitation

Study programme name Molecular and Industrial Biotechnology		Course	X	Master degree	A.A.	2021/22

Teacher: Prof. Daria Maria Monti	☎ 081.679150	email: dariamaria.monti@unina.it

SSD	BIO/10	CFU	6	Year	I	Term	I

Prerequisites: none

EXPECTED LEARNING RESULTS/RISULTATI DI APPRENDIMENTO ATTESI

Knowledge and understanding skills/Conoscenza e capacità di comprensione
The student must demonstrate to know the fundamental bases of algal cultivation and the production of biomass with biochemical characteristics of interest. The student must know the global environmental issues (climate change, depletion of energy and non-energy resources) that require an innovative biotechnological approach.
Applied knowledge and understanding skills/Conoscenza e capacità di comprensione applicate
The student must acquire the ability to select the microalga of interest and cultivate it on a small or large scale; the student must be able to propose innovative approaches in the context of the exploitation of algal biomass to obtain high added value molecules.
Any further learning outcomes expected in relation to/Eventuali ulteriori risultati di apprendimento attesi, relativamente a
• **Autonomy of judgment/Autonomia di giudizio:** the student must be able to assess which microalga has to be used, on the basis of commercial requests. He/She will have to select the appropriate growth conditions to maximize the production of the molecules of interest.
• **Communication skills/Abilità comunicative:** The student must be able to express himself with correct terminology in the context of industrial bioremediation processes
• **Learning skills/Capacità di apprendimento:** The student must be able to independently find information for the development of cultivation of algal biomass to obtain the products of interest.

COURSE MAIN CONTENTS/PROGRAMMA

- Structure and metabolism of the algal cell. Pigments and reserve substances. Cultivation: batch crops, semi-continuous and continuous crops; culture media in autotrophy, mixotrophy and heterotrophy. Physiological responses to changes in CO_2, temperature and pH.
- Classification of the main algal groups. Algae from extreme environments.
- Criteria for the selection of algal strains and techniques for the extraction of molecules with high added value.
- Microalgae: from cells to photobioreactors. The concept of biorefinery: cascade extraction for the production of molecules of biotechnological interest. Potential uses of plant biomass: production of biofuels, CO_2 sequestration from exhaust gas, treatment of waste waters, production, purification and characterization of high added value molecules, to be used in nanotechnology, human and animal nutrition.
- From the laboratory to industrial plants: open tanks, photobioreactors.

COURSE MATERIAL

- Richmond, Handbook of microalgal culture, 2013, Wiley.
- Andersen, Algal culturing techniques, 2005, Elsevier.
- Biologia cellulare & Biotecnologie Vegetali, Pasqua, 2011, Piccin.
- Lecture notes provided during the course.

TARGET AND MODALITY AIMED TO ASSESS THE LEARNING RESULTS

a) Learning results to be verified/Risultati di apprendimento che si intende verificare:
The student must be able to hypothesize an experimental scheme for the extraction of high added value molecules.

b) Assessment method/Modalità di esame:

Examination includes	Written test and oral		Written test		Oral	x
Project report discussion						
Other procedures (specify)						

Written test - questions ask for (*)	Multiple answers		Free answers		Numerical exercises	

OVERVIEW OF THE COURSE: TRANSPORT PHENOMENA For BIOTECHNOLOGICAL APPLICATIONS

Module of the main course: no main course

Study programme name Molecular and Industrial Biotechnology	X	**Course**	X	**Master degree**	**A.A.**	**2021/22**

Teacher: Ing. Giuseppe Toscano	☎ **081.7682278**	**email: giuseppe.toscano@unina.it**

SSD	**ING-IND/24**	**CFU**	**9**	**Year**	**I**	**Term**	**II**

Prerequisites: none

EXPECTED LEARNING RESULTS/RISULTATI DI APPRENDIMENTO ATTESI

Knowledge and understanding skills/Conoscenza e capacità di comprensione
The student must demonstrate to know and understand mass, heat, and momentum transport phenomena occurring in industrial biotechnological processes.
Applied knowledge and understanding skills/Conoscenza e capacità di comprensione applicate
The student must demonstrate to be able to solve problems relevant for the design of industrial biotechnological processes where mass, heat, and momentum transport phenomena play a significant role.
Any further learning outcomes expected in relation to/Eventuali ulteriori risultati di apprendimento attesi, relativamente a
• **Autonomy of judgment/Autonomia di giudizio:** The student must demonstrate to be able to correctly write mass, heat and momentum balances and to adopt the appropriate simplifying assumptions in order to effectively analyse industrial biotechnological processes
• **Communication skills/Abilità comunicative:** The student must be able to write down and present a report on the mass, heat and momentum balance equations required for the design of industrial biotechnological processes.
• **Learning skills/Capacità di apprendimento:** The student must be able to expand his/her knowledge by reading material (books, on-line courses) related to mass, heat and momentum balances

COURSE MAIN CONTENTS/PROGRAMMA

- Diffusion in dilute solutions. Fick's Law. Differential mass balances. Differential equations with separation of variables. Diffusion in geometries with variable section. Diffusion through porous and non-porous membranes. Phase equilibrium at the interface. Partition coefficient. Experimental determination of diffusion coefficients: diaphragm cell. Unsteady mass balances. The pseudo-steady-state assumption. Concentration-dependent diffusion coefficient. Diffusion processes in series and in parallel.
- Diffusion with chemical reaction. Porous catalyst and immobilised enzymes. Effectiveness factor and Thiele modulus. Various kinetics and geometries. Reactors with immobilised enzymes.
- Convective mass transfer. Transport equation and transport coefficient. Nondimensional correlations for transport coefficients. Experimental determination of transport coefficients. Oxygen-balance method and dynamic method. Mass transfer in an aeration column. Various examples.
- Diffusion in biological systems. Facilited diffusion. Fast reactions. Diffusion limited problems in biotechnologies. Diffusion of electrolytes. Nernst-Planck equation. Diffusion potential. Mass transfer with electrical fields.
- Momentum transfer. Bioprocess fluid mechanics. Flow of biological fluids. Bioengineering problems with simultaneous transfer of heat, mass, and momentum. Applications to surfactants and bioplastic production processes. Processing and stabilization of multiphase fluids. Processing of drug delivery systems. Bioactive scaffolds for industrial applications. Nano-functionalization. Synthesis of nanoparticles for biotechnological applications.
- Temperature control in bioreactors. Heat transfer. Heat conduction and Fourier's law. Forced and natural convective transfer. Transfer coefficients. Transport in series. Applications to bioreactors.

COURSE MATERIAL

- E.L. Cussler, "Diffusion. Mass transfer in fluid systems", Cambridge University Press (2009).
- P. M. Doran, "Bioprocess Engineering Principles", Academic Press (2012).
- G.A. Truskey, F. Yuan, D.E. Katz, "Transport phenomena in biological systems", Prentice Hall (2009).
- Lecture notes provided during the course.

TARGET AND MODALITY AIMED TO ASSESS THE LEARNING RESULTS

a) Learning results to be verified/Risultati di apprendimento che si intende verificare:
The student must be able (i) to write down mass, heat, and momentum balance equations relevant in industrial biotechnological processes, (ii) to identify controlling transport mechanisms, (iii) to introduce simplifying assumptions wherever appropriate.

b) Assessment method/Modalità di esame:

Examination includes	**Written test and oral**		**Written test**	x	**Oral**	
Project report discussion						
Other procedures (specify)						

Written test - questions ask for (*)	**Multiple answers**		**Free answers**	x	**Numerical exercises**	x

OVERVIEW OF THE COURSE: POLYESTER BASED BIOPLASTICS
Module of: Biopolymers and Bioplastics

Study programme name					
Molecular and Industrial Biotechnology		Course	X	Master degree	A.A. 2021/22

Teacher: Prof.ssa Cinzia Pezzella	☎ 081.674475	email: cinzia.pezzella@unina.it

SSD CHIM/11 CFU 6 Year I Term II

Prerequisites: none

EXPECTED LEARNING RESULTS/RISULTATI DI APPRENDIMENTO ATTESI

Knowledge and understanding skills/Conoscenza e capacità di comprensione
The student has to acquire the knowledge and to comprehend the issues related to the design, synthesis and application of natural polymers and bioplastics form renewable sources. He/She has to demonstrate to be able to discuss about the biotechnological strategies aimed at producing biopolymers in sustainable manner.
Applied knowledge and understanding skills/Conoscenza e capacità di comprensione applicate
The student has to be able to design processes for the production and functionalization of biopolymers, through the application of biotechnological and green strategies. He/She has to be able to apply the acquired methodologies to the designing of biopolymers for specific industrial applications.
Any further learning outcomes expected in relation to/Eventuali ulteriori risultati di apprendimento attesi, relativamente a
• **Autonomy of judgment/Autonomia di giudizio:** The student will be able to autonomously evaluate the different issues related to the sustainable biopolymer production and to elaborate new solutions for the optimization of the main process parameters (cost and environmental impact, yield and product recovery, etc..) and for the tailoring of polymer properties.
• **Communication skills/Abilità comunicative:** The student will prove to have acquired the scientific/technical communication skills required to interact with different professional profiles (process engineer, material engineer) and useful for the optimization of the production and application of the biopolymer of interest.
• **Learning skills/Capacità di apprendimento:** The student has to be able to update and broaden his/her background, drawing on books, high-level scientific papers in English language, focused on the production and application of bioplastics. The course will provide guidance and suggestions in order to allow the student to tackle topics related to the course contents, by fostering his/her participation to interdisciplinary events organized with representatives of Biotechnological companies

COURSE MAIN CONTENTS/PROGRAMMA

- Introduction to polymeric materials: physical, thermal and mechanical properties
- Bioplastics from renewable feedstocks: production processes, market and sustainability of bioplastics;
- Polyester based bioplastics: examples and applications;
- Microbial biopolymers: natural and synthetic routes for biopolymer production from bacteria
- Biopolymer biodegradation: definitions and biodegradation tests;
- Biomaterial processing and functionalization: nanoparticles and nanofibers
- Biopolymers applications to different sectors: packaging, healthcare, textile, etc.
- Laboratory activities: Synthesis and characterization of microbial polyhydroxyalkanoates based films

COURSE MATERIAL

- Handbook of Biopolymers and Biodegradable Plastics- 1st Edition. Properties, Processing and Applications. Editors: Sina Ebnesajjad eBook ISBN: 9781455730032; Hardcover ISBN: 9781455728343
- Course slides, scientific papers and learning material provided by the lecturer

TARGET AND MODALITY AIMED TO ASSESS THE LEARNING RESULTS

a) Learning results to be verified/Risultati di apprendimento che si intende verificare:

The student has to be able to elaborate and design solutions and processes for the production and application of biopolymers in different fields (packaging, biomedical, agriculture, pharmaceutical, textile, etc..).

b) Assessment method/Modalità di esame:

Examination includes	**Written test and oral**		**Written test**		**Oral**	X
Project report discussion						
Other procedures (specify)						

Written test - questions ask for (*)	**Multiple answers**		**Free answers**		**Numerical exercises**	

OVERVIEW OF THE COURSE: POLYSACCHARIDE- AND PROTEIN- BASED BIOPLASTICS
Module of: Biopolymers and Bioplastics

Study programme name					
Molecular and Industrial Biotechnology		Course	X	Master degree	A.A. 2021/22

Teacher: Dr. Giosafatto Concetta Valeria Lucia	☎ 081.2539470	email: giosafat@unina.it

SSD	BIO/10	CFU	6	Year	I	Term	II

Prerequisites: none

EXPECTED LEARNING RESULTS/RISULTATI DI APPRENDIMENTO ATTESI

Knowledge and understanding skills/Conoscenza e capacità di comprensione
At the end of the course the student will be able to 1) know the main methods for the production of hydrocolloid bioplastics derived from polysaccharides and proteins; 2) characterize the bioplastics for their potential industrial application; 3) know the methods to improve the properties of bioplastics by means of enzymes, different plasticizers and/or nanoparticles of different nature.
Applied knowledge and understanding skills/Conoscenza e capacità di comprensione applicate
The course will allow students to 1) face the problems concerning the pollution caused by the over-production of traditional plastics; 2) identify the main biotechnological processes for the production of environmentally friendly packaging; 2) to hypothesize changes in the bioplastic main properties (mechanical, biological and barrier) in order to identify their industrial application.
Any further learning outcomes expected in relation to/Eventuali ulteriori risultati di apprendimento attesi, relativamente a
• **Autonomy of judgment/Autonomia di giudizio:** The student should be able to know the innovative processes for the production of bioplastics and to indicate the main methodologies relevant for obtaining bioplastics with improved mechanical and barrier properties, possessing specific biological activities. The student should also be able to define the impact of different bioplastics at a production level.
• **Communication skills/Abilità comunicative:** The student should be able to interact with different professional figures (such as process engineers, industrial chemists) to optimize the application aspects related to bioplastic design. Furthermore, he/she will have to know how to present a scientific paper and summarize in a complete and concise way the results achieved by using a proper technical language.
• **Learning skills/Capacità di apprendimento:** At the end of the course the student should be able to autonomously draw further information on the methods of production and characterization of bioplastics from different scientific publications, and be able to follow workshops, conference reports and to attend interviews with main exponents of the industrial world.

COURSE MAIN CONTENTS/PROGRAMMA

- Pollution caused by the over-production of traditional plastics and possible biotechnological tools to counteract such phenomenon.
- Biodegradable plastics as eco-sustainable alternatives to plastics of petrochemical origin.
- Production and characterization of the main hydrocolloid bioplastics.
- Use of different methods (casting, dipping, spraying) for the preparation of polysaccharide- and protein-based bioplastics.
- Zeta potential analysis to study the stability of the film forming solutions. Experimental determination of the properties of hydrocolloid biomaterials: mechanical (tensile strength, elongation at break, Young's modulus) and barrier features towards gases (CO_2 and O_2) and against water vapour).
- Improvements of bioplastic properties through the use of enzymes, different plasticizers, various nanoparticles or by "blending" with other polymers.
- Recent industrial applications of hydrocolloid bioplastics.
- Case study: production by casting method of a kind of protein-based bioplastics prepared in the presence of the enzyme transglutaminase.

COURSE MATERIAL

- Book “Bioplastics, basics, applications, markets , Michael Thielen, Polymedia Publ.
- Material distributed by the lecturer.
- Scientific papers regarding the specific topics of the course.
- Course slides.

TARGET AND MODALITY AIMED TO ASSESS THE LEARNING RESULTS

a) Learning results to be verified/Risultati di apprendimento che si intende verificare:

The student should be able to: a) use polysaccharides, proteins (either or not enzymatically modified) and additives of different nature for the production of different bioplastics; b) to determine the main chemical-physical, morphological and biological properties of hydrocolloid bioplastics.

b) Assessment method/Modalità di esame:

Examination includes	Written test and oral		Written test		Oral	X
Project report discussion						
Other procedures (specify)						

Written test - questions ask for (*)	Multiple answers		Free answers		Numerical exercises	x

OVERVIEW OF THE COURSE: BIOREFINERY PROCESSES

Module of the main course: no main course

Study programme name Molecular and Industrial Biotechnology	X	**Course**	X	**Master degree**	**A.A.**	**2021/22**

Teacher: Ing. Francesca Raganati	☎ **081.7682218**	**email: francesca.raganati@unina.it**

SSD ING-IND/25	**CFU** 6	**Year** I	**Term** II

Prerequisites: none

EXPECTED LEARNING RESULTS/RISULTATI DI APPRENDIMENTO ATTESI

Knowledge and understanding skills/Conoscenza e capacità di comprensione

The student must demonstrate to know and to understand the problems related to the selection and the design of units dedicated to processing industrial material and efficient utilization of renewable products

Applied knowledge and understanding skills/Conoscenza e capacità di comprensione applicate

The student must demonstrate to be able to apply concepts for designing bioprocess flowsheets for the production of products by combining: 1) operation units dedicated to the exploitation of renewable resources; 2) fermentation units; 3) recovery and purification units. The design should include assessments regarding the sustainability of the process.

Any further learning outcomes expected in relation to/Eventuali ulteriori risultati di apprendimento attesi, relativamente a

- **Autonomy of judgment/Autonomia di giudizio:** The student must demonstrate to be able to correctly identify the critical issues for the exploitation of renewable resources. The student must demonstrate to identify the optimal configuration and operating conditions to exploit the renewable resources protecting the (bio)features of products.
- **Communication skills/Abilità comunicative:** The student must be able to develop a flowsheet and to discuss the main features of the flowsheet. The student must be able to present the proposed selection of operation units pointing out the role of the selected unit/operating conditions with respect the (bio)features of products.
- **Learning skills/Capacità di apprendimento:** The student must be able to expand his/her knowledge by looking up documents (scientific papers, on-line courses, tutorials) related to the selection of units for the exploitation of renewable resources and the selection of the optimal operating conditions.

COURSE MAIN CONTENTS/PROGRAMMA

Biorefinery concept - current scenario, definition, examples. Overview of the main biorefinery concepts and platforms. **Recovery, yield, selectivity, pureness** – concepts for operation units dedicated to biotechnological processes. **Downstream processes in biotechnological industries** - Removal of insolubles (filtration and centrifugation), isolation of product, purification and polishing.

Liquid-liquid extraction: Consolidate processes and innovative liquids. Mass balances, thermodynamic equilibrium and role of the extracting liquid for the features of the products. Extraction strategies (single/multiple stage, cross/counter current). Design of selected units.**Membrane filtration** - Mass balances, mechanical and transport phenomena. Criteria for the selection of the filtration unit. Filtration strategy.

Adsorption - Mass balances, thermodynamic equilibrium and role of the adsorbent material for the features of the products. Adsorption strategies (batch, continuous, ...). Design of selected units. **Chromatography** - Mass balances and thermodynamic. Strategies and techniques. Industrial design: Simulated Moving Bed.

Precipitation/Crystallization - Mass balances, kinetics and main principles. Strategies and techniques. Industrial design.

Flowsheet development – Sequence of operation units to exploit renewable resources. Objective function of the flowsheet.

Techno-economic analysis in biorefinery processes - CAPEX and OPEX, Lang factor method, OPEX analysis in labour, utilities, materials, waste and consumables.

Case studies - Energy from Biomass and Waste, Bioproducts from biomass and waste and examples of biorefinery concepts.

COURSE MATERIAL

- Coulson & Richardson's Chemical Engineering: Chemical Engineering Design, Butterworth-Heinemann 1999.
- McCabe&Smith - Unit Operations of Chemical Engineering, John Wiley and Sons 1999.
- Belter, Cussler & Wei-Shou Hu - Bioseparations: Downstream Processing for Biotechnology, Wiley-Interscience 1988.
- Harrison, Separation Process Design, Wiley, 2003.
- Lecture notes provided during the course.

TARGET AND MODALITY AIMED TO ASSESS THE LEARNING RESULTS

a) Learning results to be verified/Risultati di apprendimento che si intende verificare:

The student must be able to select unit operations to exploit renewable resources and to design selected units.

b) Assessment method/Modalità di esame:

Examination includes	**Written test and oral**		**Written test**	x	**Oral**	
Project report discussion						
Other procedures (specify)						

Written test - questions ask for (*)	**Multiple answers**		**Free answers**		**Numerical exercises**	x

OVERVIEW OF THE COURSE: BIOREACTORS
Module of: Design of Conversion Processes

Study programme name					
Molecular and Industrial Biotechnology		Course	X	Master degree	A.A. 2021/22

Teacher: Prof. Piero Salatino	☎ 081.7682258	email: salatino@unina.it

SSD	ING-IND/25	CFU	6	Year	II	Term	I

Prerequisites: none

EXPECTED LEARNING RESULTS/RISULTATI DI APPRENDIMENTO ATTESI

Knowledge and understanding skills/Conoscenza e capacità di comprensione
The student must demonstrate to know and to understand the selection and the design of bioreactors to exploit the resources taking into account the features of the proposed reactive biosystem (enzymes and/or microorganisms), of the feedstock and of the bioreactors.
Applied knowledge and understanding skills/Conoscenza e capacità di comprensione applicate
The student must demonstrate to be able to design/optimize the performance of the bioreactors taking into account the features of the feedstock, of the proposed reactive biosystem (enzymes and/or microorganisms) and of the bioreactors. He/she must demonstrate to carry out the design/optimization by also using numerical simulations.
Any further learning outcomes expected in relation to/Eventuali ulteriori risultati di apprendimento attesi, relativamente a
• **Autonomy of judgment/Autonomia di giudizio:** The student must demonstrate to be able to correctly identify the optimal bioreactor configuration and the simplifying assumptions to design/optimize the bioreactor. He/she must be also able to judge the obtained results obtained from sustainable point of view.
• **Communication skills/Abilità comunicative:** The student must be able to write down and present a report on the optimal bioreactor configuration and the criteria selected to design/optimize the bioreactor taking into account the features of the proposed reactive biosystem (enzymes and/or microorganisms), of the feedstock, and of the bioreactors.
• **Learning skills/Capacità di apprendimento:** The student must be able to expand his/her knowledge by looking up documents (scientific papers, on-line courses, tutorials) related to the selection of bioreactors for the exploitation of feedstocks and the selection of the optimal operating conditions.

COURSE MAIN CONTENTS/PROGRAMMA

Continuous and discontinuous ideal reactors. Reactor systems based on the combination of ideal reactors. Optimization of reaction systems for different kinetics. Applications to systems for industrial application and development of case studies.
Reagent systems in the presence of reaction networks. Definition of yield and global selectivity and use. Analysis of simple reaction networks.
Optimization of process conditions (mixed / segregated flow, composition of reagent stream) in relation to yield and selectivity
Exploring the main functional aspects of chemical reactors. Issues associated to mixing/segregation of homogeneous phases.
Mass transfer phenomena in bioreactors: main issues of coupling mass transport rate and chemical kinetics.
Review of the types of reactors (enzymatic and fermentative) used in industrial bioprocesses.
Case study: e.g. production of biofuels, production of green chemicals, bioremediation.

COURSE MATERIAL

- Villadsen J, Nielsen J, and Lidén G. (2011) BIOREACTION ENGINEERING PRINCIPLES. Springer

To look up:

- Levenspiel, O., Chemical Reaction Engineering, 3rd Ed., Jhon Wiley & Sons, 1999
- Lecture notes provided during the course.

TARGET AND MODALITY AIMED TO ASSESS THE LEARNING RESULTS

a) Learning results to be verified/Risultati di apprendimento che si intende verificare:
The student must be able to carry out to identify the optimal bioreactor configuration and the simplifying assumptions to design/optimize a bioreactor.

b) Assessment method/Modalità di esame:

Examination includes	Written test and oral		Written test	x	Oral	
Project report discussion						
Other procedures (specify)						

Written test - questions ask for (*)	Multiple answers		Free answers		Numerical exercises	x

OVERVIEW OF THE COURSE: PROCESS SIMULATION
Module of: DESIGN OF CONVERSION PROCESSES

Study programme name					
Molecular and Industrial Biotechnology		Course	X	Master degree	A.A. 2021/22

Teacher: Ing. Tammaro Daniele	☎ 081……	email: daniele.tammaro@unina.it

SSD ING-IND/26 CFU 6 Year II Term I

Prerequisites: none

EXPECTED LEARNING RESULTS/RISULTATI DI APPRENDIMENTO ATTESI

Knowledge and understanding skills/Conoscenza e capacità di comprensione

The student must demonstrate to know and understand the problems related to the formulation and numerical solution of mathematical models of interest of industrial biotechnology and to the analysis of experimental data through statistical techniques.

Applied knowledge and understanding skills/Conoscenza e capacità di comprensione applicate

The student must demonstrate to be able to use a software to solve complex equations modelling the dynamics of systems of interest of industrial biotechnology. He/she must also be able to carry out statistical analysis and parameter estimation from experimental data.

Any further learning outcomes expected in relation to/Eventuali ulteriori risultati di apprendimento attesi, relativamente a

- **Autonomy of judgment/Autonomia di giudizio:** The student must demonstrate to be able to correctly identify the mathematical model and the simplifying assumptions of a specific problem, as well as the correct numerical technique to solve it. He/she must be also able to correctly understand the results obtained from a numerical simulation. Furthermore, he/she must demonstrate to be able to evaluate the reliability of the parameters evaluated through a regression technique.
- **Communication skills/Abilità comunicative:** The student must be able to write down and present a report on the numerical simulation and parameter estimation of a mathematical model of a process of interest of industrial biotechnology.
- **Learning skills/Capacità di apprendimento:** The student must be able to expand his/her knowledge by reading material (scientific papers, on-line courses, tutorials) related to the use of Matlab, to the numerical solution of equations and regression techniques.

COURSE MAIN CONTENTS/PROGRAMMA

- An introduction to Matlab: variables, vectors and matrices, M-files, functions, graphics.
- Simulation of processes of interest of industrial biotechnology: typology of mathematical models (steady/unsteady, linear/non-linear, ordinary/partial differential equations, etc.), introduction to the numerical techniques.
- Numerical solution of linear and non-linear systems of equations: back-substitution, method of Gaussian elimination, pivoting, Newton's method, stopping criteria, problems with Newton's method.
- Numerical solution of ordinary differential equations: temporal discretization, explicit and implicit Euler's method, method of Crank-Nicolson, methods of Runge-Kutta, multi-step methods, predictor-corrector methods, Gear's methods.
- Application of the numerical techniques for simulating complex systems such as: bioreactors in series or parallel, adsorption, ultrafiltration, etc.
- Descriptive statistics: mean, median, mode, standard deviation, variance, quartiles, percentiles, box-plot, skewness, kurtosis.
- Random variables: the model of the experiment and the process, kinds of random variables, distributions, mean of a random variable.
- Linear and multilinear regressions: estimation and estimator, properties of estimators, least-square method, evaluation of linear and multilinear regression coefficients, evaluation of error variance.
- Adequacy of the regression: residual analysis, coefficient of determination, correlation matrix.
- Non-linear regression: minimization algorithms, model linearization, weighted least-square method, simultaneous regression of multiple models.

COURSE MATERIAL

- Montgomery and Runger, *Applied Statistics and Probability for Engineers*, John Wiley & Sons, 2003.
- Quarteroni, Sacco and Saleri, *Numerical Mathematics*, Springer, 2007.
- Lecture notes provided during the course.

TARGET AND MODALITY AIMED TO ASSESS THE LEARNING RESULTS

a) Learning results to be verified/Risultati di apprendimento che si intende verificare:
The student must be able to carry out statistical data analysis and to solve the equations governing the dynamics of systems of interest of industrial biotechnology by using numerical software.

b) Assessment method/Modalità di esame:

Examination includes	Written test and oral		Written test	x	Oral	
Project report discussion						
Other procedures (specify)						

Written test - questions ask for (*)	Multiple answers		Free answers		Numerical exercises	x

OVERVIEW OF THE COURSE: ENVIRONMENTAL ECONOMICS
Module of: no main course

Study programme name							
Molecular and Industrial Biotechnology	X	Course	X	Master degree	A.A.	2021/22

Teacher: Prof. Marcello D'Amato	☎ 320 422 6743	email: marcello.damato@unisob.na.it

SSD	SECS-P/02	CFU	6	Year	II	Term	II

Prerequisites: none

EXPECTED LEARNING RESULTS/RISULTATI DI APPRENDIMENTO ATTESI

Knowledge and understanding skills/Conoscenza e capacità di comprensione

The student has to demonstrate to know the economics principles for the allocation and management of renewable and non renewable. The student will be able to apply these notions in relation to the main possible field of economic applications of biotechnological processing. Knwoledge of cost benefit analysis will also allow student to understand principles of economic evaluation (cost benefit analysis) of private investment and policy internvention

Applied knowledge and understanding skills/Conoscenza e capacità di comprensione applicate

The student has to demonstrate the capacity to understand principles of economic analysis applied to the case of environmental issues and policies and to renewable and non renewable resources. The course will allow the student to understand the contribution of biotechnologies to issues such as the energy transition or mitigation or adaptation policies towards climate change and to meet environmental standards.

Any further learning outcomes expected in relation to/Eventuali ulteriori risultati di apprendimento attesi, relativamente a

- **Autonomy of judgment/Autonomia di giudizio:** The student should be able to evaluate the effect of the most common public policy instruments on natural resource exploitation.
- **Communication skills/Abilità comunicative:** The course will help students to interact with different professional figures (bureaucrats, employers, unions, third sectors, ecologists) operating in the area of environmental policies or firms operating in related sectors
- **Learning skills/Capacità di apprendimento:** The student should be able to develop an independent attitude to competently frame economically meaningful policy and empirical questions addressing environmental policies and the role of firms and markets in renewable and non renewable resources. The student should also be able to develop basic skills in cost benefit analysis in the presence of environmental externalities.

COURSE MAIN CONTENTS/PROGRAMMA

1. Review of the Economic Approach to the environment and natural resources. Market Allocation, Property rights, Externalities
2. Economic Foundations of Cost Benefit Analysis
3. Economic Models of the energy transition
4. Dynamic Efficiency and Sustainable Development
5. Non Renewable and Renewable Resources

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COURSE MATERIAL

- Environmental and Natural Resource Economics, Tietenberg and Lewis, Routledge Edition
- Slides and or Lecture notes provided during the course.

TARGET AND MODALITY AIMED TO ASSESS THE LEARNING RESULTS

a) Learning results to be verified/Risultati di apprendimento che si intende verificare:
The student should be able to demonstrate the full knowledge of the topics covered by the course program and to be able to assess cost benefits analysis. As well as to recognize the ideal setting for environmental policy evaluation.

b) Assessment method/Modalità di esame:

Examination includes	Written test and oral		Written test	x	Oral	
Project report discussion						
Other procedures (specify)						

Written test - questions ask for (*)	Multiple answers		Free answers		Numerical exercises	x