Università degli Studi di Napoli Federico II

Scuola Politecnica e delle Scienze di Base

LM - “Biotecnologie Molecolari e Industriali”

Classe LM-8

MSc - “Molecular and Industrial Biotechnology”

Master group LM-8

www.biotecnologieindustriali.unina.it/it/

www.biotecnologieindustriali.unina.it/en/

Biotecnologie Industriali Federico II

BiotecnologieindustrialiFII

May 2020

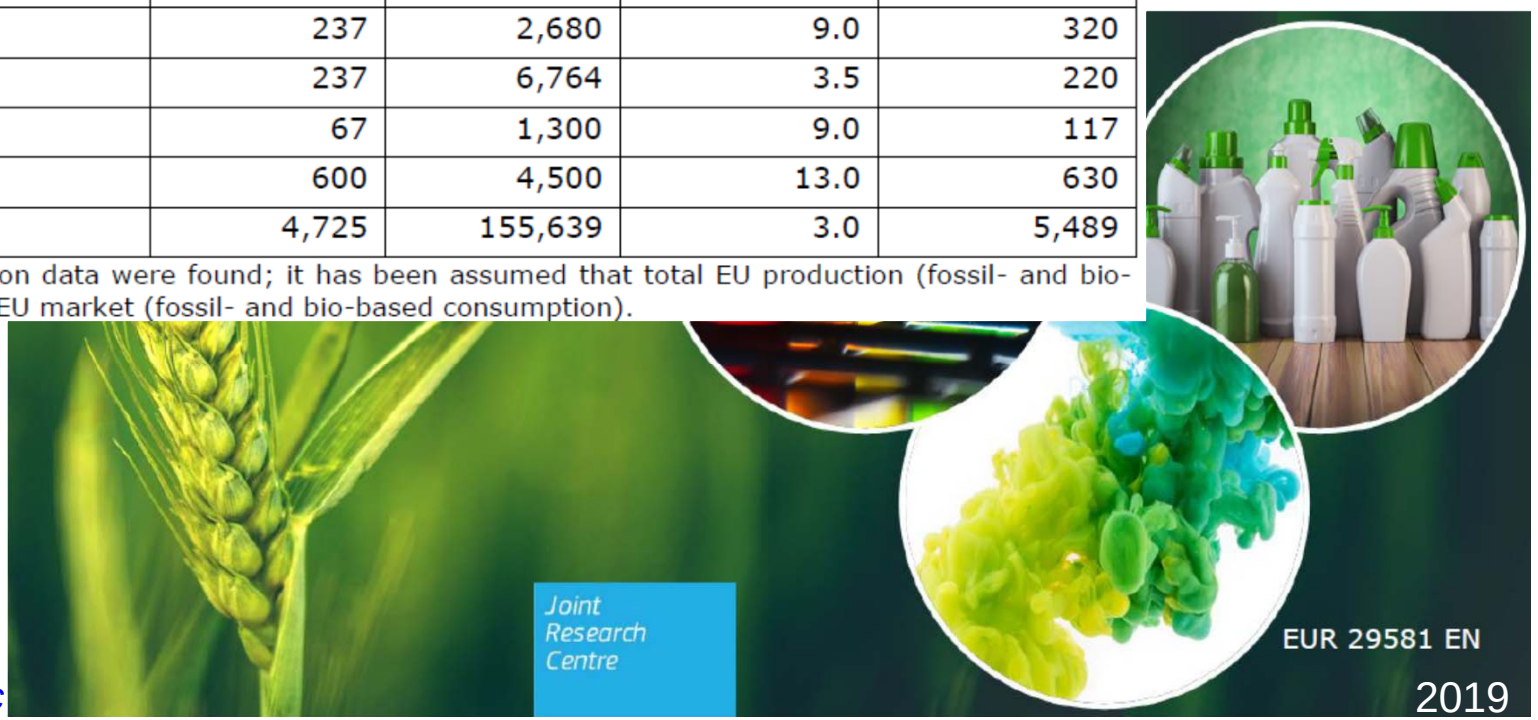
The strength of the Master

- The potential of biotechnological products (e.g. antioxidants, pigments, antimicrobial, …) to be safely used in a wide spectrum of applications, from the **daily life** (e.g. cosmetics, detergents, ..) to the **technological devices** (e.g. biosensors, cutlery, …..).
- Progressive (and expected massive) affirmation of experts in the **exploitation of renewable resources** for the production of "consumables" (energy carriers, plastics, lubricants, pigments, nutraceuticals, etc.) via biotechnological processes.
- Companies, enterprises, and R&D centers ASK for industrial biotechnologists characterized by knowledge in specific skills.
- Training must take into account pure **biological-genetic aspects, biochemical aspects, methodologies for industrial development, and economic perspective** that takes into account the balance between **environmental and entrepreneurial benefits**.

Bio-based chemical market

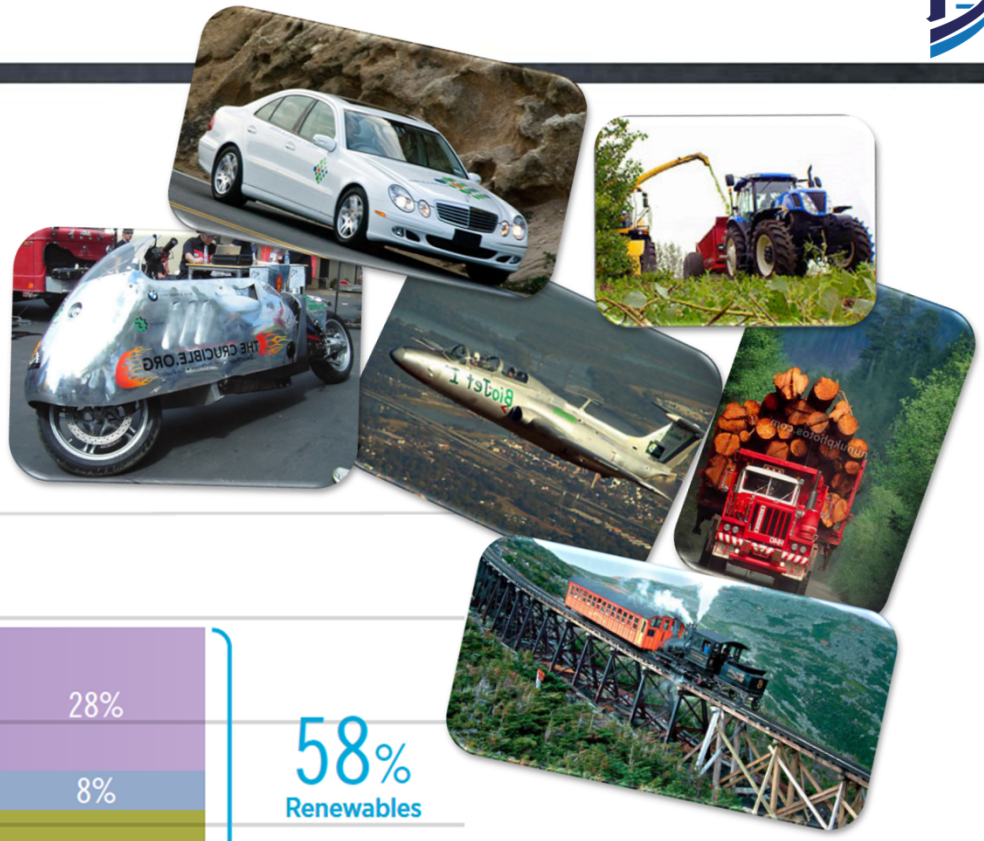
Product category	EU bio-based production (kt/a)	Total EU production (kt/a)	EU bio-based production share (%)	EU bio-based consumption (kt/a)
Platform chemicals	181	60,791	0.3	197
Solvents	75	5,000	1.5	107
Polymers for plastics	268	60,000	0.4	247
Paints, coatings, inks and dyes ([a])	1,002	10,340	12.5	1,293
Surfactants	1,500	3,000	50.0	1,800
Cosmetics and personal care products ([a])	558	1,263	44.0	558
Adhesives ([a])	237	2,680	9.0	320
Lubricants ([a])	237	6,764	3.5	220
Plasticisers ([a])	67	1,300	9.0	117
Man-made fibres	600	4,500	13.0	630
Total	4,725	155,639	3.0	5,489

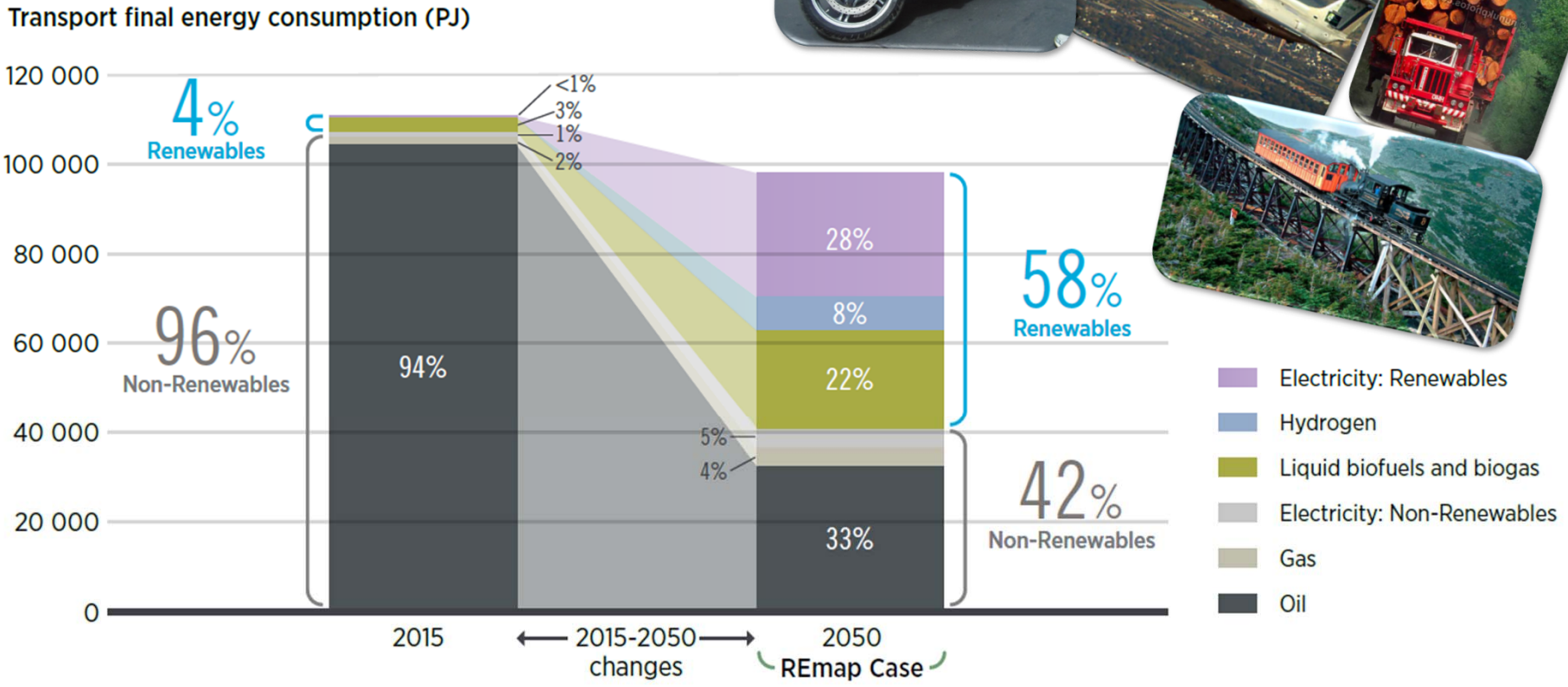
([a]) No total EU production data were found; it has been assumed that total EU production (fossil- and bio-based) equals the total EU market (fossil- and bio-based consumption).



https://ec.europa.eu/jrc

Transforming energy demand in the transport sector





IRENA 2018: Global Energy Transformation: A roadmap to 2050

Sustainable Development GOALS

The Goals and targets will stimulate action over the next 15 years in areas of critical importance for humanity and the planet

- …….
- 6. Ensure availability and sustainable management of **water** and sanitation for all
- 7. Ensure access to affordable, reliable, sustainable and modern **energy** for all
- ……
- 12. **Minimize inputs and waste**. Source materials and products responsibly. Plan for **technology recycling** from early stages of project development….
- 13. Take urgent action to **combat climate change** and its impacts
- ……
- 15. Protect, restore and promote **sustainable use** of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- ……..

LM “Biotecnologie Molecolari e Industriali”
Curriculum: Produzioni Biotecnologiche - ProBio

Insegnamenti	Moduli (se presenti)	CFU
Anno I – I semestre		
Biotecnologie microbiche industriali		6
Biologia dei sistemi e bioinformatica	Biologia dei sistemi	6
	Bioinformatica e modellistica molecolare	6
Biotecnologie industriali e per la salvaguardia dell'ambiente	Biotecnologie industriali	6
	Biotecnologie per la salvaguardia dell'ambiente	6
Anno I – II semestre		
Fenomeni di trasporto in sistemi biologici		9
Biotecnologie biochimiche	Biotecnologie ricombinanti	6
	Ingegneria proteica e metabolica	6
Bioreattori		6
Anno II – I semester		
Principi di igiene nelle biotecnologie		6
Processi biotecnologici	Teoria dello sviluppo dei processi biotecnologici	6
	Impianti e processi biotecnologici	6
Biochip e biosensori		6
Bioeconomia e proprietà intellettuale		6
Anno II – II semestre		
Attività formative a scelta autonoma dello studente		12
Tirocinio formativo e orientamento al mondo del lavoro		18
Prova finale		3

LM “Biotecnologie Molecolari e Industriali”

Curriculum: Biotechnology for Renewable Resources

(English language: 57 ECTS)

Course	Module (if present)	ECTS
Year I – 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
Year I – II semester		
Transport Phenomena for Biotechnological Applications		9
Biopolymers and Bioplastics	Polyester based bioplastics	6
	Polysaccharide- and protein- based bioplastics	6
Biorefinery processes		6
Year II – 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
Year II – II semester		
Free selection proposed by the student		12
Practical training		18
Final project and exam		3

(IT) – course language: Italian

Sbocchi occupazionali

centri di ricerca

controllo di qualità

Società di sviluppo

imprese di servizi

pubblica amministrazione, insegnamento

sedi per la protezione ambientale

depurazione acqua

industrie biotecnologiche

industrie chimiche, farmaceutiche, agroalimentari etc.

Graduated students @ Federico II Industrial Biotech.

	Degree in 2017 (1 year)	Degree in 2015 (3 years)	Degree in 2013 (5 years)
# graduated students	24	14	12
# of interviews	20	12	7
Fraction of graduated students that have attended training/formation activities (%)	95,0	83,3	100,0
Working condition (%)			
Engaged	30,0	41,7	42,9
No work - no work-research	35,0	25,0	-
No work - work-research	35,0	33,3	57,1
Engaged - wait from the degree (months)			
Time degree-first job	3,8	7,6	30,0
Job typology (%)			
open-ended contract	-	40,0	33,3
no-standard	50,0	-	-

Graduated students in Italy

	Degree in 2017 (1 year)	Degree in 2015 (3 years)	Degree in 2013 (5 years)
Job typology (%)			
Sector			
Public	-	-	-
Private	100,0	100,0	100,0
Chemical/Energy	50,0	60,0	33,3
Education & research	33,3	-	-
Job geographic localization (%)			
Nord-West	33,3	-	33,3
Nord-Est	-	20,0	-
Center	-	20,0	-
South	50,0	60,0	66,7
Islands	-	-	-
Abroad	16,7	-	-

Annuario dei Laureati Magistrali

Biotecnologie Industriali
SCUOLA POLITECNICA E DELLE SCIENZE DI BASE

Università degli Studi di Napoli Federico II
Scuola Politecnica e delle Scienze di Base

cerca

LA STRUTTURA | DIDATTICA ED ORIENTAMENTO | MONDO DEL LAVORO | ERASMUS ED INTERNAZIONALIZZAZIONE | CONTATTI E FAQ

Annuario

Mi piace 0 | Tweet | Condividi

Anno accademico: Tutti | Laurea: Tutti

CAPUTO FABIO — Laurea — Anno Accademico: **2014/2015** — Linkedin

D'ANGELO CATERINA — Laurea — Anno Accademico: **2013/2014**

DI MARTINO GIOVANNI MARCO — Laurea — Anno Accademico: **2014/2015** — Linkedin

Requisiti di ammissione

- Laurea, purché si sia in possesso di conoscenze sufficienti:

  a) discipline matematiche, chimiche e fisiche;

  b) discipline biologiche (biochimica, biologia molecolare, genetica);

  c) discipline del settore fermentativo (microbiologia e chimica delle fermentazioni);

  d) discipline di tecnologie di processo (termodinamica e fenomeni di trasporto, fondamenti di operazioni unitarie per le biotecnologie).

- Lo studente che intende immatricolarsi al corso di Laurea Magistrale in Biotecnologie Molecolari e Industriali deve fornire in allegato alla domanda i dettagli della sua formazione pregressa, ossia la lista di tutte le attività formative effettuate per il conseguimento della laurea.

- Competenze linguistiche richieste: documentata competenza di utilizzo corretto della lingua Inglese **equiparabile al livello B2**.

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infobiotecnologieindustriali@unina.it

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BiotecnologieindustrialiFII

Università degli Studi di Napoli Federico II

Scuola Politecnica e delle Scienze di Base

Iscrizione al primo anno dei corsi di Laurea Magistrale (biennali): a.a. 2020/21

Tassativamente entro il termine perentorio del 31 dicembre 2020.

Dopo il **31 dicembre 2020**:
gli studenti potranno iscriversi entro il 31 marzo 2021 **solo se abbiano conseguito**, entro lo stesso termine, **12 CFU** relativi ad esami di profitto previsti per il primo semestre del corso di laurea magistrale.

- Per conseguire i CFU richiesti è necessario provvedere all'iscrizione ed alla frequenza dei corsi singoli relativi a ciascun insegnamento.
- Agli studenti che conseguono i CFU previsti presso l'Ateneo Federico II e che si iscrivono entro il termine del 31 marzo 2021 ai corsi di laurea magistrale, verranno rimborsati gli importi pagati per le iscrizioni ai corsi singoli.
- A partire dall'1 gennaio 2021, le iscrizioni ai corsi di laurea magistrale di cui sopra dovranno essere effettuate, esclusivamente, in modalità cartacea agli sportelli delle Segreterie Studenti, che dovranno verificare la presenza dei requisiti citati per l'iscrizione stessa.

Supporto all'ingresso nel mondo del lavoro

- Commissione Orientamento e Placement
- Piattaforma «**Job Service**» per favorire la comunicazione tra aziende e studenti
- Seminari e laboratori finalizzati a facilitare il processo di creazione di un'identità lavorativa e a far acquisire strumenti e tecniche utili nella definizione di un progetto professionale e nella ricerca attiva del lavoro (**soft skills**)
- Organizzazione di giornate di presentazione aziendale e recruitment
- Career day di Ateneo «**Federico II JobFair**»
- Career day dedicato «**La Scuola incontra le Imprese**»

http://www.scuolapsb.unina.it/

GENETIC ENGINEERING

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.

COURSE MAIN CONTENTS

- 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.

MICROALGAL EXPLOITATION

MICROALGAL RESOURCE

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

COURSE MAIN CONTENTS

- 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 CO2, 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, CO2 sequestration from exhaust gas, treatment of waste waters, production of high added value molecules, nanotechnologies, human and animal nutrition.
- From the laboratory to industrial plants: open tanks, photobioreactors.

TRANSPORT PHENOMENA For BIOTECHNOLOGICAL APPLICATIONS

The student must demonstrate to know and understand mass, heat, and momentum transport phenomena occurring in industrial biotechnological processes.

COURSE MAIN CONTENTS

- Diffusion in dilute solutions. Fick's Law. Differential mass balances. 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.
- 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

BIOPOLYMERS AND BIOPLASTICS

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.

COURSE MAIN CONTENTS

- Biopolymers, bioplastics and polymeric materials: resources, demands and sustainability;
- Plastic pollution and green solutions;
- Bioplastics from renewable feedstocks
- Production processes, market and sustainability of bioplastics;
- Microbial biopolymers;
- Polyester based bioplastics;
- Biopolymer characterization: main properties;
- Biopolymer biodegradability;
- Biomaterial functionalization;
- Biopolymers applications to different sectors: packaging, healthcare, textile, etc.

POLYESTER BASED BIOPLASTICS

POLYSACCHARIDE- AND PROTEIN- BASED BIOPLASTICS

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.

COURSE MAIN CONTENTS

- 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.

BIOREFINERY PROCESSES

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

COURSE MAIN CONTENTS

Recovery, yield, selectivity, pureness – concepts for operation units dedicated to biotechnological processes.
Lignocellulosic pretreatment processes: overview of the main current processes (mechanical, chemical, biotechnological and combination of these). Criteria for the selection of the process. Mass and energy assessment. Design of selected units.
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.
Chromatography - Mass balances and thermodynamic. Chromatography strategies and techniques. Industrial Chromatogarphy: Simulated Moving Bed.
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 study - Energy from Biomass and Waste, Bioproducts from biomass and waste and examples of biorefinery concepts.

DESIGN OF CONVERSION PROCESSES

BIOREACTORS

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

COURSE MAIN CONTENTS

- 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.

PROCESS SIMULATION

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

COURSE MAIN CONTENTS

- An introduction to Matlab: variables, vectors and matrices, M-files, functions, graphics.
- Simulation of processes of interest of industrial biotechnology: typology of mathematical models, 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.

ENVIRONMENTAL ECONOMICS

The student has to demonstrate to know the economy related to renewable (and non renewable) resources and to the exploitation of the renewable (and non renewable) resources via biotechnological processing. The student should be able to demonstrate to know cost benefit analysis

COURSE MAIN CONTENTS

- Notes on the interaction between the environment and the economy. Social selections and the optimal level of environmental protection. Perfect competition, efficiency and market failures (e.g. externalities).
- Public goods, public ills and market failures.
- Main policies and programs for environmental protection. Main criteria and techniques for public decisions on environmental issues.
- The demand for environmental goods and renewable resources.
- Main regulatory instruments: containment of primary emissions, costs, penalty and fee. Intellectual property.
- Optimal production of environmental resources.
- Valorisation of renewable resources via biotechnological routes. Cost benefits analysis.