Autumn semester

BIOSYNTHETIC BIOLOGY COURSES

Systems and Synthetic Biology for biotechnologies	12 credits	109h
Design project	12 credits	233h
Human Resources Management and Group Work	6 credits	75h

MICROBIOLOGY AND BIOCATALYSIS COURSES

Microbiology and biocatalysis for industry	12 credits	265h
Design project	12 credits	233h
Human Resources Management and Group Work	6 credits	75h

Systems and Synthetic Biology for biotechnologies

ECTS
12 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
109h

In brief

Teaching language(s): Français, Anglais

Presentation

Description

Programme (detailed contents) (62h) :

1) *Generalities concerning Systems Biology* (23h) :

. Why ? => Complexity of the cell (especially in terms of regulation) and of higher organisms, importance of network biology

. How ? => Approaches and methods, genetic tools, modelling tools and statistics, -omics technologies, informatics tools.

2) *Systems Biology for health* (12h) :

. Relevance for studying complex diseases

. Focus on cancer which is archetypal (complexity of intra-cellular factors (genetic and epigenetic complexity…) and extra-cellular factors (influence of other cell types, angiogenesis…)) illustrated by examples.

3) *Generalities, principles and field of application of synthetic biology* (15h)

- definition(s) and advantages of synthetic biology

- methods of synthetic biology

- identification and engineering of enzymes and metabolic pathways adapted to the final goal

- description of specific genetic tools developed for synthetic biology, presentation of host organisms to use, description of tools for optimization of metabolic fluxes to achieve high product titers

4) *Synthetic biology for industrial biotechnologies* (12h)

Interest for the biological production of existing bulk chemicals. Presentation of the challenges, the complexity but also the industrial success stories of this approach through several industrial examples.

Organisation:

The theoretical courses will be distributed the first semester (the corresponding lab work is performed at the end of the semester).

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

- how Systems Biology is changing the way biological systems are studied by allowing us to examine the cell

and organism as a whole, especially Systems Biotechnology that allows optimal design and development of upstream to downstream bioprocesses by taking a systems-approach (with *Escherichia coli* as the main bacterial producer studied), and Systems Medicine that considers diseases as 'perturbations of networks', and transforms the way drugs are developed by targeting multiple components of networks and pathways perturbed in diseases ;

- why Synthetic Biology an emerging field is located at the intersection of life science and engineering and is the application of the principles of engineering to the construction of life with desired properties in a rational and systematic way ; - what are the wide objectives of synthetic biology and their application for biomedicine, the cheaper synthesis of biopharmaceuticals, sustainable chemical synthesis by efficient biotransformation, environment and energy

The student will be able to:

- consider a biological question by applying a systems biology approach and study the mechanisms underlying complex biological processes as integrated systems of many interacting components. Systems biology involves (1) collection of large sets of experimental data, (2) proposal of mathematical models that might account for at least some significant aspects of this data set, (3) accurate computer solution of the mathematical equations to obtain numerical predictions, and (4) assessment of the quality of the model by comparing numerical simulations with the experimental data. Thus the student will acquire skills in network biology and genetic engineering, but also in mathematics (statistics, modelling), computer sciences and 'omics' technologies allowing acquisition of large-scale biological data.

- conceive of and purpose a synthetic biology approach to introduce novel functionality into engineered organisms for production purposes or for building new materials. The student should be able to develop the most appropriate strategy and choose the adapted technical methods to reach the goal of engineered biological systems with optimized biosynthetic pathways and develop efficient routes for producing pharmacologically active compounds, industrially important bulk chemicals, and liquid fuels for transportation

Useful info

Place

Toulouse

Design project

ECTS
12 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
233h

In brief

Teaching language(s): Français, Anglais

Presentation

Description

With the help of a tutor, students carry out part of an industrial process design/ This work involves a literature survey, getting technical data and design of the process using acquired knowledge on coupled heat and mass transfer, unit operations and associated processes.

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

To allow students to apply their knowledge to the design of a practical project in biochemical engineering.

The student will be able to:

- propose an installation flowsheet
- to write global balances on a process in order to calculate matter and energy flows
- make an critical analysis of a process

Pre-requisites

Bioreactor ; Unit operations

Useful info

Place

Toulouse

Human Resources Management and Group Work

ECTS
6 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
75h

Presentation

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts) :

Human Resource Management

Aims and organisation of a Human Resources position, job analysis and forecasting, recruiting, work motivation, skills, salary, training, career management, conflict mitigation, work contract

Social Psychology

Groups, what they are, their influences and dynamics

The student will be able to analyse a group situation

Pre-requisites

None

Place

Toulouse

Useful info

Microbiology and biocatalysis for industry

ECTS
12 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
265h

In brief

Teaching language(s): Français, Anglais

Presentation

Description

Program (detailed contents):

Microbial physiology

- Physiological behavior for industrial production (starter, proteins, polysaccharides, amino acids, antibiotics,...)

- Cell energetics and constraints for industrial implementation

Modelling

- Modelling strategy for the microbial reaction

- Phenomenological models

- Metabolic flux models

- Structured models

Behavior of high cell density bioreactor

- continuous culture reactors, recycled cell reactors

- Fed-batch reactors

Bioreactor control

- Fed-batch control for limiting conditions

- Optimization strategy for no limiting conditions

Distillation - heat exchange - chemical and biological reactors

Biocatalysis

New ways of modifying properties of biocatalysts

Use of enzymes in industry

Bioseparation techniques for proteins

Organisation:

- lectures

- projects

- Lab work

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts) :

- High cell density microbial cultures for industrial production, integrating the physiological constraints

- Modelling the biological reaction

- Controlling the fermentation process

- The design of an industrial process

- Applied enzyme catalysis

The student will be able to:

- design and simulate models describing the microbial productions

- design and implement microbial cultures for high performance reactors

- apply enzyme engineering techniques

Pre-requisites

Structural and metabolic biochemistry - Microbiology - Microbiological engineering -Bioreactor engineering

Useful info

Place

Toulouse