UCLouvain

lbirc2108

2025

Biochemical and Microbial Engineering

5.00 credits	30.0 h + 22.5 h	Q2

Teacher(s)	Stenuit Benoît ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Main themes	From design to scale-up on a pilot scale of microbial and enzymatic processes. Theoretical and methodological foundations of applied chemical kinetics and design of chemical reactors with the characteristics (kinetics and transport phenomena) of biochemical and microbiological processes in order to systematize the principles underlying the analysis and design/sizing of bioreactors. Specifics: (Micro)biological processes characterized kinetically and thermodynamically : cell growth, its measurement or estimation, use of substrate(s), formation of product(s). Yields. Productivities. Kinetic models. Parameter estimation. The methodology of material and energy balances for the analysis of biotechnological systems and of their performance. Batch, continuous, semi- continuous reactors. Transport phenomena applied to the analysis of aeration, agitation, rheology, scale-up and sterilization of bioreactors.
Learning outcomes	**At the end of this learning unit, the student is able to :** a. Contribution de l'activité au référentiel AA (AA du programme) 1.2 ; 2.1 ; 2.2 ; 2.4 ; 4.1 ; 4.2 ; 4.5 ; 8.5 b. Formulation spécifique pour cette activité des AA du programme At the end of this activity, the student is able to: 1. Apply the methodology of material balances to the analysis of biotechnological systems 2. Apply the methodology of energy balance to the analysis of biotechnological systems 3. Apply the methodology of reactor design to the analysis and design/sizing of bioreactors (area of biochemical and microbiological processes) in the specific case of batch reactors 4. Apply the methodology of reactor design to the analysis and design/sizing of bioreactors in the specific case of CSTR (continuous stirred tank reactor). 5. Apply the methodology of reactor design to the analysis and design/sizing of bioreactors in the specific case of semi-continuous reactors (fed-batch). 1 6. Apply mass transfer phenomena in the analysis of different operations (aeration, agitation, etc.) that can take place in bioreactors. 7. Apply the phenomena of energy transfer to the analysis of different operations (aeration, agitation, etc.) that can take place in bioreactors. 8. Apply the phenomena of transfer of momentum to the analysis of different operations (aeration, agitation, etc.) can take place in bioreactors. 9. Apply the methodology of chemical kinetics applied to the analysis and design/sizing of bioreactors (area of biochemical and microbiological processes). 10. Search for real values of constants "or of other parameters in correlations that are essential to the design/sizing of biological reactors. 11. As part of the design of a new biological reactor propose in a reasoned manner (with its advantages and limitations) the design of the most appropriate reactor with respect to the industrial context under consideration.
Evaluation methods	Written exam based on theoretical development and problem solving.
Teaching methods	1. Lectures, lectures with guided questions, including presentations of concrete examples from industry with case analysis by the instructor [conventional lectures, interactive presentations using audiovisual equipment (video projections, powerpoint)]. 2. Exercise sessions in teams, guided. These exercises are designed to familiarize the student with the methodology of solving quantitative problems in the design and analysis of bioprocesses: makes use of calculations for sizing or performance, construction of flow sheets combining unit operations, search of real values of constants or other parameters of correlations useful in design or modeling / optimization of bioprocesses.
Content	Definitions: Industrial and environmental biotechnology - bioprocess engineering - physical quantities and reactors - titer, rate and yield (TRY) targets for microbial processes in bioreactors. Black-box stoichiometry and kinetic models of microbial growth. Modeling of batch reactors, fed-batch reactors and completely mixed flow reactors with and without cell recycling. Modeling of two-stage continuous stirred systems. Enzymatic process reactors. Design, operation and performance. Transport processes: mass transfer, heat transfer and liquid mixing. Sterilization

	processes. Scale-up from laboratory scale through pilot scale to industrial scale. Bioseparation engineering. Separation devices in industrial cell culture: continuous perfusion reactor with cell retention. Advantages and limitations of each design in an industrial context.
Inline resources	Moodle
Bibliography	- Bioprocess Engineering Principles, 2013, Pauline M. Doran. - Bioprocess Engineering, 2002, Michael L. Shuler & Fikret Kargi.
Other infos	This course can be given in English.
Faculty or entity in charge	AGRO

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Chemical and Materials Engineering	KIMA2M	5		
Master [120] in Biochemistry and Molecular and Cell Biology	BBMC2M	5		
Master [120] in Biomedical Engineering	GBIO2M	5		
Master [120] in Chemistry and Bioindustries	BIRC2M	5		