ChE-437

Bioprocesses and downstream processing

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Cursus	Sem.	Type
Biotechnology minor	E	Opt.
Ing.-chim.	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	4 weekly
Number of positions	

Summary

This course aims at a more advanced coverage of the basic aspects discussed in module ChE-311. It is however of a stand-alone nature, and even students who have little knowledge on bioprocess development shall benefit as well from this module.

Content

Manfred Zinn

- Upstream processing: introduction and basics in cultivation
- Bioprocess design for batch, fed-batch and chemostat cultures
- Special bioprocesses and applications
- Paper studies including short presentations by students

Kurt Eyer

- Bioreactors & Fermenters: Basics
- Characterization of biological reactor systems
- Scale-up procedure: science or art?
- Applied examples and economic aspects of industrial bioprocesses

Simon Crelier

- Downstream processing: introduction and liquid-solid separation
- Cell lysis and precipitation
- Liquid-liquid extraction
- Adsorption and chromatography
- Membrane-based separations
- Polishing steps and latest trends

Keywords

Bioprocess engineering: Basic function of a bioreactor, different types of bioreactors, agitation and oxygen transfer, upstream processing, sterilization techniques, bioprocess automation, PAT, Liebig's law, mass and energy balances, oxygen requirements, yield coefficients, growth kinetics, Monod kinetics, microbial growth on defined and complex media, substrate inhibition, feed strategies, product formation, high cell-density fed-batches, chemostat, nutrient limitation, wash-out, optimal productivity, scale-up.
Downstream processing: significance of DSP; chemical and biotechnological DSP; purity; yield; (bio)activity retention; physical and thermal separations; equilibrium; kinetics, sedimentation; centrifugation; filtration; cake and filter resistance;

cell lysis; high pressure homogenizator; bead mill;raffinate; extract; partition coefficient; equilibrium line; operating line; graphical solutions; ATPS; precipitation; precipitation agents; Cohn equation; adsorbent and adsorbate; adsorption isotherm; Langmuir; Freundlich; adsorption kinetics; breakthrough curve; ion exchange; hydrophobic interaction; affinity chromatography; SEC; van Deemter equation; cross-flow; membranes; transmembrane pressure; osmotic pressure; retention factor; molecular weight cut-off; downstream bottleneck; convection vs diffusion; monolith and membrane chromatography; single-use equipment; ABC approach.

Learning Prerequisites

Required courses

Since this lecture is open to students from various backgrounds, no course is required as a mandatory prerequisite.

Recommended courses

ChE-311 Biochemical Engineering
Phénomènes de transfert
Introduction au génie chimique I, II
Techniques de séparation I, II
Basic knowledge in microbiology, biochemistry and process engineering would constitute a helpful background (although not mandatory) for a better understanding and mastering of the material to be presented in this lecture (a short list of recommended readings can be made available if desired).

Important concepts to start the course

This course heavily relies on the basic concepts of process engineering, mass and heat transfer, equilibrium and kinetics.

Learning Outcomes

By the end of the course, the student must be able to:

- Integrate Concepts and knowledge from various domains (biology, process engineering, (bio)chemistry)
- Discuss the merits, disadvantages and characteristics of the different types of bioreactors as well as their mode of operation
- Dimension unit operations
- Interpret data or observations from case studies
- Choose an appropriate fermentation or purification strategy
- Predict the outcome or the performance of a unit operation or specific equipment
- Justify your choices and assumptions
- Solve calculation problems

Transversal skills

- Use a work methodology appropriate to the task.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Manage priorities.
- Use both general and domain specific IT resources and tools

Teaching methods

The course will be held under the form of lectures also featuring the treatment of examples, the discussion of case studies and exercises.

Expected student activities

Regularly attending the course is the best way to achieve the learning goals with a minimal amount of personal work at

home. The proposed exercises and case studies are integrated to the lectures. They illustrate and complete the theoretical aspects presented during the course, and playing an active part in their resolution will make the learning process more efficient.

Assessment methods

An examination will take place at the end of the semester. The exam will be written if 9 candidates or more have signed up, and oral otherwise.

Supervision

Office hours	No
Assistants	No
Forum	No
Others	The three lecturers shall be available for enquiries or questions, be it per e-mail or telephone.

Resources

Bibliography

- M. L. Shuler & F. Kargi. Bioprocess engineering - basic concepts. 2nd edition, Prentice Hall, 2002
- P. M. Doran. Bioprocess engineering principles. Academic Press Ltd., 2012
- H. Chmiel. Bioprozesstechnik. 2. Auflage, Spektrum Akad. Verlag, 2006

Ressources en bibliothèque

- Bioprocess Engineering Principles / Doran
- Bioprocess engineering basic concepts / Kargi
- Bioprozesstechnik / Chmiel

Notes/Handbook

There is no manuscript for the course. However, all the material that is presented (copies of transparencies, additonal material, exercises and correction thereof) is available and can be downloaded from the Moodle platform.

Websites

- http://scgc.epfl.ch/telechargement_cours_chimie