ADVANCED COURSE

Downstream Processing

1 - 5 July 2024

Course board:
Marcel Ottens
Luuk van der Wielen

AIM OF THE COURSE

The aim of the course is to provide and explain the tools to quantitatively and systematically design integrated downstream processes. Biotechnological engineers need to design compact and clean processes to efficiently separate bioproducts, such as proteins, from dilute complex fermentation broths to the required pharmaceutical degree of purity. Therefore, the general theme of this Advanced Course is the quantitative systematic design of integrated downstream processes.

The course presents the state of the art in downstream processing of biotechnological products. It provides knowledge of different techniques for solid-liquid separation, product release, refolding, concentration and purification of precious biotechnology products with a focus on the total integrated process. An international group of experts from both industry and academia will lecture to assure an optimal balance of practical knowledge and theoretical insight. Subsequently participants will be trained via exercises into the quantitative engineering aspects of bioseparations. At the end of the course, the participants should be able to estimate main equipment dimensions, know qualitative constraints to the integrated bioprocess and have a quantitative insight in process streams, structure and economics.

The course starts with an overview of possibilities and problems typically associated with the recovery of bioproducts. Physico-chemical characteristics of the products, as well as the fermentation broth with its multiple contaminants, are discussed in relation to possibilities for selective separation. Using this information, the general structure of large scale industrial processes will be outlined.

BioTechDelft
POSTGRADUATE EDUCATION

TU Delft

COURSE DESCRIPTION

This one-week course is intensive and has long days. To ensure active participation by those attending, a combination of theoretical (lectures) and practical (exercises, computer simulations and case study) work is offered. Some online preparatory materials will be given to ensure all have the same basic knowledge.

LECTURES

The thermodynamical basics and bioseperation principles will be introduced and developed during the course. Special attention will be paid to the unit operations typically used in this field of industry. Every day will be focused around a central theme.
The following subjects will be adressed:

- Various solid-liquid separation techniques and cell disruption
- application of major concentration techniques such as extraction, adsorption and membrane separation
- scientific and industrial aspects of purification by means of precipitation and chromatography
- release of intracellular products as well as protein folding in industrial protein processes.

EXERCISES AND CASE STUDY

Process integration is the binding element in the course. During the course, a case study on the design of an integrated purification process for a recombinant protein will offer the participants the opportunity to practice on the individual unit operations as well as on the integrated process. Finally, possibilities of computer-aided, rational design of integrated separation processes will be demonstrated. The course will be given in English.

WHO SHOULD ATTEND?

This Advanced Course is aimed at professionals (MSc or PhD level) in (bio)chemical engineering, or in microbiology or biochemistry with a basic knowledge in chemical engineering. The course is primarily aimed at those already employed in industry and who are interested in the separation of biotechnological products. In addition, this Advanced Course is an option in the two-year postgraduate programs of Delft University of Technology.

COURSE BOARD

Prof. Marcel Ottens
Bioprocess Engineering
Delft University of Technology
Delft, The Netherlands

Prof. Luuk A.M. van der Wielen
Bioprocess Engineering
Delft University of Technology
Delft, The Netherlands
Bernal Institute and Chair of Biosystems Engineering
University of Limerick
Limerick, Ireland

COURSE COORDINATION

Jenifer Baptiste, BA
BioTech Delft
Delft University of Technology
Delft, The Netherlands

LECTURERS

Prof. Raquel Aires Barros
Institute Superior Tecnico
Lisboa, Portugal

Dr. Jurgen Hubbuch
Karlsruhe Institute for Technology
Karlsruhe, Germany

Maarten Pennings
BiosanaPharma
Leiden, the Netherlands

Prof. Michel Eppink
Byondis BV
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Dr. Reinoud Noordman
Pentair X-Flow
Enschede, The Netherlands

Dr. Matthias Wiendahl
NOVO Nordisk A/S
Gentofte, Denmark

COURSE ASSISTANTS

Mariana Cesar Carvalho, Msc
Tim Neijenhuis, MSc
Delft University of Technology
Bioprocess Engineering
Delft, The Netherlands

PROGRAM

MONDAY 1 JULY 2024

Theme: Today's bioseparation processes.
Mechanical separations: solid-liquid separation

08:30 Registration
09:00 Introduction to the separation processes
Pitfalls and challenges in bioseparation processes
Luuk van der Wielen
10:00 Engineering fundamentals: Mass balances:
from batch to continuous counter current processes
Luuk van der Wielen
11:15 Case study: industrial protein production (I)
Marcel Ottens and Course Assistants
12.30 Group picture and lunch
13:30 Solid-liquid separation: filtration and centrifugation
Marcel Ottens
14:15 Assignment: design of filtration equipment
Marcel Ottens and Course Assistants
15:15 Predicting molecular properties. Molecular properties and selection of separation conditions: Equilibrium calculations
Luuk van der Wielen
16:15 Case study: industrial protein production (II)
Marcel Ottens and Course Assistants
18:15 Social drink and buffet

TUESDAY 2 JULY 2024

Theme: Mechanical separations: solid liquid separation.
Concentration and design

09:00 Harvest Clarification by centrifugation:
design consideration for biopharmaceutical industry
Manuel van Leusden
10:30 Assignment: centrifugation
Marcel Ottens and Course Assistants
11:30 Liquid-Liquid Extraction & Aqueous two phase extraction
Raquel Aires Barros
12.45 Lunch
13:45 Assignment: extraction
Marcel Ottens and Course Assistants
14:45 Membrane technology: theory, design & industrial application
Reinoud Noordman
16:15 Case study: industrial protein production (III)
Marcel Ottens and Course Assistants
18:05 Lab tour: High Throughput Facilities
19:00 Social Drink and Poster presentation

WEDNESDAY 3 JULY 2024

Theme: Purification processes

09:00 Design of chromatographic separations.
Equilibrium theory and column design
Non-linear and mass transfer effects
Marcel Ottens
10:15 Assignment: ultrafiltration
Marcel Ottens and Course Assistants
11:15 Large-scale Continuous Chromatography and Simulated Moving Bed (SMB) technology for biotechnological products
Maarten Pennings
12.30 Lunch
13:30 Industrial cases and applications of chromatography
Column design and operation from theory and practice
Alexander Hanke
14.15 Assignment: chromatography
Marcel Ottens and Course Assistants
15:45 Quality by Design
Danielle Horneman
17:00 Case study: industrial protein production (IV)
Marcel Ottens and Course Assistants
18:00 End of the day

THURSDAY 4 JULY 2024

Theme: Purification & formulation processes

9:00 Bulk crystallization: Unit operation design for the crystallization of small and large biomolecules
Marcel Ottens
10:15 Assignment: crystallization
Marcel Ottens and Course Assistants
11:15 Industrial crystallization: Real life examples
Rob Geertman
12.15 Lunch
13:15 High Throughput techniques in downsream process development
Jurgen Hubbuch
14:15 Panel discussion
15:00 Case study: industrial protein production (V)
Marcel Ottens and Course Assistants
18:00 Course dinner

FRIDAY 5 JULY 2024

Theme: Process development & process integration

9:00 Design of an industrial process for purification of biologicals
Michel Eppink
10:15 Viral Vectors Process Development for Gene Therapy Applications: Approach, Challenges and Opportunities
Beckley Nfor
11:30 Process integration in industry
Matthias Wiendahl
12.30 Lunch
13:30 Case study: industrial protein production (VI)
Presentations of the three winning teams:
the strategy & DSP award ceremony
Marcel Ottens and Course Assistants
14:15 Closure of the course
Marcel Ottens

LOCATION

The course will be held at the
Delft University of Technology
Department of Biotechnology
Van der Maasweg 9
2629 HZ Delft, The Netherlands
http://bt.tudelft.nl

ACCOMMODATION

For more information check our website or email us at biotechdelft@tudelft.nl.

COURSE REGISTRATION

Please register via the website to attend the course. Deadline for application is **10 June 2024**. Applicants will be handled in order of the date of receipt.

COURSE FEE

€ 2.750 in case of payment received before **24 April 2024** or € 3.000 in case of payment received after this date. In the event of cancellation before **6 May 2024**, a full refund will be granted, after this date, a 25% fee charge can be made.
To facilitate enrolment of young PhD-students from universities, a limited number of fellowships is available. The course fee with fellowship is € 1.375. To apply, please include a copy of your registration as a PhD-student from your university.

The fee includes course materials, lunches, the buffet on Monday and the course dinner on Thursday. The fee does not cover other meals and lodging.

When the number of participants is too low to have a fruitful course, BioTech Delft will cancel the event no later than six weeks before the start of the course. The course fee will be reimbursed within three weeks after cancellation.
In case a speaker will not be able to present his/her lecture due to unforeseen circumstances, BioTech Delft will arrange an equivalent replacement.

Hotel accommodation can be arranged at your request.

Preparatory texts will be sent after receipt of the course fee, a month before the start of the course. The complete digital course book will be supplied at the start of the course.

BioTech Delft organises biotechnology education at postgraduate level. BioTech Delft closely cooperates with the department of Biotechnology of Delft University of Technology. Since its foundation, in 1987, BioTech Delft has very successfully organised various types of postdoctoral education.

Currently BioTech Delft offers Advanced Courses given each year, covering the multidisciplinary spectrum of biotechnology. The courses have a long track-record dating back to 1988.

- *Microbial Physiology and Fermentation Technology (1988)*
- *Downstream Processing (1989)*
- *Biocatalysis and Protein Engineering (1999)*
- *Environmental Biotechnology (1993)*
- *Bioprocess Design (2014)*
- *Multiscale Computational Methods in Bioprocesses (2018)*
- *Integrated Multi-Omics approaches for Improvement of Industrial Microbes (2020)*

FURTHER INFORMATION

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Advanced Courses in Biotechnology

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