

ADVANCED COURSE Bioprocess Design

16 - 20 September 2024

Henk Noorman
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AIM OF THE COURSE

With recent advances in molecular biology and a growing biomass availability for use as industrial feedstock, the bio-based economy is getting a wider range of inputs. Scaling up the bio(techno)logy innovations and implementation in large-scale factories or biorefineries clearly is a present bottleneck: industries are struggling to get the bio-opportunities to the market.

Teachers from universities and companies have joined forces and will present a program that in depth addresses industrial fermentation processes, and is flanked by overviews on upstream and downstream processing. The focus of the course is on design of innovative microbial fermentations, for bio-products such as amino acids and monomers for bio-plastics, complemented with examples of marine and mammalian processes, for micro-algae products and bio-pharmaceuticals. A substantial part (ca. 40% of the time) will be dedicated to a case study, executed in teams of 4-6 participants, on the design of a bioprocess for the production of a chemical (1,4-butanediol). In

this case, basic theory on thermodynamics, microbial stoichiometry and kinetics, transport phenomena and scale up/down will be extensively applied and integrated. The team with the best design performance wins the Genomatica Bioprocess Design prize. There are several guest lecturers from leading universities and industries in the bioprocess field, providing latest insights in technology innovations, non-conventional feedstocks and new bio-product categories, complemented with views from the industrial practice. The Advanced Course Bioprocess Design is cooperatively organised by BioTech Delft and graduate school VLAG.

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, case study) work is offered. Some online preparatory materials will be given to ensure all have the same basic knowledge.

LECTURES

The core lectures are mainly scheduled in the mornings and will focus on the following themes:

- Rates, thermodynamics and metabolism of micro organisms
- Transport processes in bioreactors
- Fermentation processes and their scale up features

In the early evenings, invited lectures are scheduled on e.g. examples of successful bioprocesses, downstream processing, upstream processing, novel feedstocks and economic aspects of bioprocessing.

EXERCISES AND CASE STUDY

For a better understanding of the lectures, the theory is applied in exercises on the Monday and Tuesday afternoons. From Wednesday on, the practical work continues in a 2.5 day case study on a real-life bioprocess design question where all theory will be needed. The course will be given in English.

WHO SHOULD ATTEND?

The course is primarily aimed at academic and industrial specialists (MSc, PhD or equivalent experience) who seek for refreshing and broadening their knowhow and practical insight in Bioprocess Design, to enable progress towards the biobased economy. A background in e.g. (bio)chemical engineering, microbiology or biochemistry and a basic working knowledge of the other disciplines is expected.

COURSE LEADER

Henk Noorman
DSM-Firmenich
Delft University of Technology
Delft, the Netherlands

COURSE BOARD

Sef Heijnen
Cell Systems Engineering,
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Department of Biotechnology
Delft, the Netherlands

Ruud Weusthuis
Bioprocess Engineering
Wageningen University & Research
Wageningen, the Netherlands

COURSE COORDINATION

Yvonne van Gameren
Jenifer Baptiste
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Technology
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GUEST LECTURERS

Cindy Gerhardt
Planet B.io

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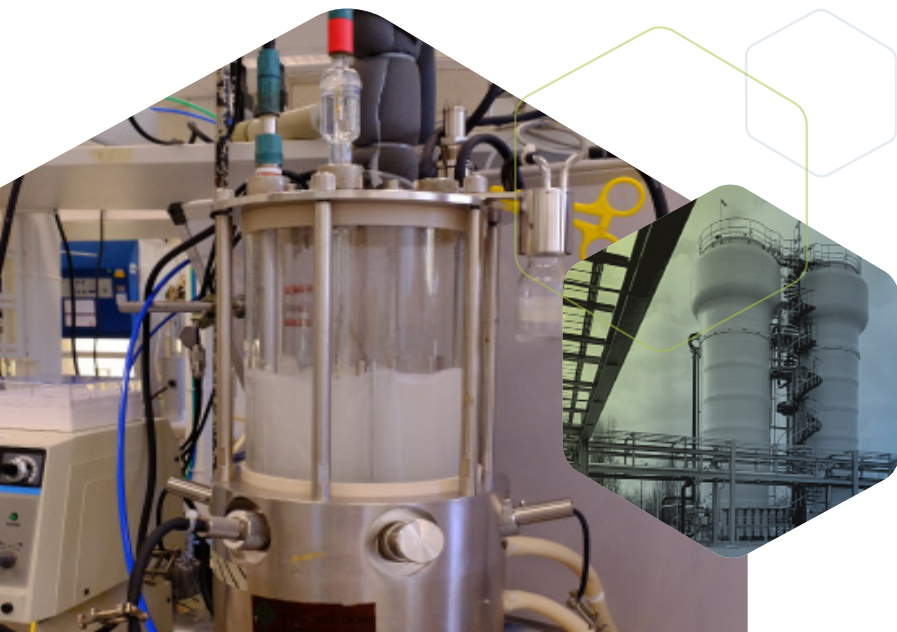
Liang Wu
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Delft, the Netherlands

Mark Bisschops
Wageningen University & Research
Wageningen, the Netherlands

Kirsten Steinbusch
CTO, DAB.bio
Delft, the Netherlands

CASE STUDY

Amit Deshmukh
DSM-Firmenich
Delft, the Netherlands



PROGRAM

MONDAY 16 SEPTEMBER 2024

Theme: Processes: DSP, pretreatment

Micro-organisms: rates and process reaction

08:45 Registration

09:00 Introduction

Cindy Gerhardt

09:25 Course introduction

Henk Noorman

09:45 Downstream Processing

Michel Eppink

11:00 The process reaction for bioprocess design:
a thermodynamic approach

Sef Heijnen

12:30 Lunch

13:30 Exercise: obtaining the process reaction

17:30 Precision fermentation

Mark Bisschops

18:35 Biotech Campus Delft tour (optional)

19:00 Social drink and buffet

TUESDAY 17 SEPTEMBER 2024

Theme: Fermentors: design of transport

09:00 Brief introduction to scale effects and gas-liquid flow

Henk Noorman

09:30 Mixing

Henk Noorman

10:30 Gas transport

Henk Noorman

11:30 A Game of Balances

Sef Heijnen

12:00 Lunch

13:00 Exercise: Design of in- and outflows

Sef Heijnen and Henk Noorman

14:30 Exercise: Transport processes

Sef Heijnen and Henk Noorman

15:45 Exercise: Mixing and gradients

Sef Heijnen and Henk Noorman

17:45 Industry lessons: fermentation with ISPR based on
Liquid-Liquid extraction, novel opportunities with
new reactor design

Kirsten Steinbusch

19:00 End of day

WEDNESDAY 18 SEPTEMBER 2024

Theme: Scale-up of fermentation processes,
case study

09:00 Industrial microbial fermentation

Henk Noorman

10:00 Hypes, hopes and the way forward for microalgal biotech

Rene Wijffels

11:00 Animal Cell Cultivation for Production of
Biopharmaceuticals

Dirk Martens

11:45 Introduction to the case study

Sef Heijnen, Henk Noorman and Amit Deshmukh

12:15 Lunch

13:15 Metabolic design: example and exercise I

Ruud Weusthuis

15:00 Part 1 of the case study

16:45 Part 1: reporting results

17:00 Scale-up/scale-down approach

Henk Noorman

18:00 Evaluation

Theme: Case study

09:00 Part 2: Quantification of in- and outputs (rates,
composition) and fermentor broth mass

10:45 Multilevel engineering of microbial ethyl acetate
production

Ruud Weusthuis

11:45 Part 2: Reporting results

12:15 Lunch

13:30 C1 fermentation feedstocks

Liang Wu

14:45 Part 3 of the case study

Vessel geometry and quantification of
transport processes inside the fermentor

17:15 Part 3: Reporting results

19:00 Course dinner

FRIDAY 20 SEPTEMBER 2024

Theme: Case study

09:00 Scale-up/scale-down: characteristic times and
gradients

Sef Heijnen

10:00 Part 4 of the case study

Full scale conditions and scale-up/scale-down

11:30 *Monascus ruber* as cell factory for lactic acid
production at low pH

Ruud Weusthuis

12:30 Lunch

13:30 Final presentations by the design teams

Genomatica design prize

15:30 Keynote Lecture

Lessons from the industry: developing scalable
bioprocesses

Noelia Gudino

16:15 Geno prize

16:30 Closure & certification

LOCATION

The course will be held at

DSM Biotechnology Center

Part of Biotech Campus Delft

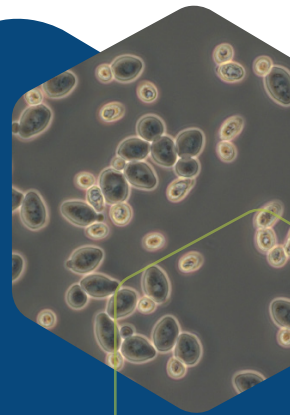
Alexander Fleminglaan 1

2613 AX Delft

The Netherlands

<http://www.biotechcampusdelft.nl>

THURSDAY 19 SEPTEMBER 2024



COURSE REGISTRATION

Please register via the website to attend the course. Deadline for application is 26 August 2024. Applicants will be handled in order of the date of receipt.

COURSE FEE

€ 2.500 in case of registration before 8 July 2024 or
€ 2.750 in case of registration after this date. In the event of cancellation before 22 July 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 € 1.250. 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 materials will be accessible a month before the start of the course, and after receipt of the course fee.

The complete 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)*
- *Modelling and Computation for Microorganisms in Bioprocesses (2018)*
- *Integrated Multi-Omics approaches for Improvement of Industrial Microbes (2020)*

FURTHER INFORMATION

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Course coordination

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