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
Prof. Henk Noorman
DSM Biotechnology Center and Delft University of Technology
Delft, the Netherlands

COURSE BOARD
Prof. Gerrit Eggink
Bioprocess Engineering
Wageningen University & Research
Wageningen, the Netherlands

Prof. Sef Heijnen
Cell Systems Engineering, Delft University of Technology
Delft, the Netherlands

Dr. Ruud Westhoff
Bioprocess Engineering
Wageningen University & Research
Wageningen, the Netherlands

COURSE COORDINATION
Vincent Renken, MSc, MSc(Ed)
Claudia Westhoff
BioTech Delft, Delft University of Technology
Delft, the Netherlands

Dr. Fré Pepping
Graduate School VLAG
Wageningen University & Research
Wageningen, the Netherlands

GUEST LECTURERS
Jason Crater
Genomatica Inc.
San Diego, CA, USA

Prof. Michiel Eppink
Synthon BV, Nijmegen and Bioprocess Engineering
Wageningen University & Research
Wageningen, the Netherlands

Dr. Dirk Martens
Bioprocess Engineering
Wageningen University & Research
Wageningen, the Netherlands

Prof. René Wijffels
Bioprocess Engineering
Wageningen University & Research
Wageningen, the Netherlands

Dr. Liang Wu
DSM Biotechnology Center
Delft, the Netherlands

EXERCISES
Dr. Amit Deshmukh
DSM Biotechnology Center
Delft, the Netherlands

EXCURSION
Dr. R. Bosma
AlgaePARC
Wageningen University & Research
Wageningen, the Netherlands
PROGRAM

MONDAY 19 MARCH 2018
Theme: Micro-organisms: Rates, process reaction and metabolism
08:45 Registration
09:00 Introduction and outline
Henk Noorman
09:30 Downstream Processing
Michel Eppink
11:00 The process reaction for bioprocess design: a thermodynamic approach
Sef Heijnen
12:15 Lunch
13:30 Calculation of fermentor in- and outflows and broth mass using the process reaction
Sef Heijnen
14:00 Exercise: obtaining the process reaction
15:45 Continuation of the exercise
17:30 Advances in pretreatment of biomass
Gerrit Eggink
18:30 Social drink and buffet

TUESDAY 20 MARCH 2018
Theme: Fermentors: transport
09:00 Gas transport
Henk Noorman
09:45 Heat transport
Henk Noorman
10:30 Mixing
Henk Noorman
11:30 Animal cell cultures
Dirk Martens
12:30 Lunch
13:30 Exercise: design in- and outflow, fermentor volume and transport processes
15:15 Continuation of the exercise
17:30 Bioprocess design: quick and dirty in 10 steps
Sef Heijnen
18:30 End of day

WEDNESDAY 21 MARCH 2018
Theme: Fermentation processes and their scale up features
09:00 Industrial microbial fermentation
Henk Noorman
09:45 Algal processes
René Wijffels
10:45 Animal cell cultures
Dirk Martens
11:30 Metabolic Design: examples and exercises I
Ruud Weusthuis
12:30 Lunch and excursion to Algea Parc
14:30 Metabolic Design: examples and exercises II
Ruud Weusthuis
15:30 Introduction to the case
Henk Noorman
Case study part 1:
Calculation of the process reaction stoichiometry
17:30 Scale-up/scale-down approach
Henk Noorman
18:30 End of day

THURSDAY 22 MARCH 2018
Theme: Case study
09:00 Case study part 2:
Quantification of in- and outputs (rates, composition) and fermentor broth mass
10:45 Microbial synthesis of reduced compounds for the chemical industry
Gerrit Eggink
12:30 Lunch
13:00 Case study part 3:
Vessel geometry and quantification of transport processes inside the fermentor
Strategies for improvements
Reporting results
17:00 C1 fermentation feedstocks
Liang Wu
19:00 Course dinner

FRIDAY 23 MARCH 2018
Theme: Case study
09:00 Scale-up/scale-down: characteristic times and gradients
Sef Heijnen
09:45 Case study part 4:
Full scale conditions and scale-up/scale-down
11:45 Ruber as cell factory for lactic acid production at low pH
Ruud Weusthuis
12:45 Lunch
13:45 Final presentations by the design teams
Genomatica design prize
15:15 Keynote Lecture
Process design and development: lessons from the industry
Jason Crater
16:15 Farewell drink

LOCATION
The course will be held at the Hof van Wageningen
Awicke Allee 9
6701 AN Wageningen
The Netherlands
www.hofvanwageningen.nl
P +31 317 490 133
E biotechdelft@tudelft.nl
W www.biotechnologycourses.nl

ACCOMMODATION
Hotel accommodation can be arranged at your request addressed to biotechdelft@tudelft.nl.
**COURSE REGISTRATION**

Please register via the website to attend the course. Deadline for application is **5 March 2018**. Applicants will be handled in order of the date of receipt.

**COURSE FEE**

€ 2,500 in case of registration before **8 January 2018** or € 2,750 in case of registration after this date. In the event of cancellation before **22 January 2018**, 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.

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**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 (1998)**
- **Downstream Processing (1989)**
- **Biocatalysis and Protein Engineering (1999)**
- **Environmental Biotechnology (1993)**
- **Genomics in Industrial Biotechnology (2005)**
- **Metabolomics for Microbial Systems Biology (2010)**
- **Bioprocess Design (2014)**

**FURTHER INFORMATION**

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Course coordination

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**Advanced Courses in Biotechnology**

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