

ADVANCED COURSE

Microbial Physiology and Fermentation Technology

15 - 26 January 2024

Course board:
Pascale Daran-Lapujade
Sef Heijnen

AIM OF THE COURSE

The aim of the course is to familiarize participants with the integrated, interdisciplinary approach required in modern biotechnology. The course will cover intensive and in-depth presentations of the state of the art. At the same time, the course provides the necessary link between, on one hand, fundamental subjects (thermodynamics, stoichiometry, kinetics, genetics, system biology, fermentor transport and modeling) and, on the other hand, practical aspects (cultivation, (¹³C-)metabolomics, measurements) and applications in large-scale biotechnological processes.

The course provides lectures in fundamental aspects, followed by extensive exercises, made in groups, to stimulate interdisciplinary teamwork.

Subsequently the integration of biological and engineering concepts will be experienced in a design task.

It will be possible to visit research projects and discuss topics of interest (technical aspects of fermentation, sampling, analytics) with scientific/technical staff.

At the end of the course you have learned to integrate life science and technology to achieve effective development/optimisation of new and existing fermentation processes.



BioTechDelft
POSTGRADUATE EDUCATION

TUDelft

COURSE DESCRIPTION

This 10 day course is taught in English and has intensive days. To ensure active participation by those attending, a combination of theoretical (lectures) and practical (exercises, computer simulations, design case study) work is offered. Some online preparatory materials will be given to facilitate all participants to have the same basic knowledge.

LECTURES

The lectures are mainly scheduled in the mornings and sometimes the early evenings. In the lectures, attention will be paid to the following themes:

- Thermodynamics and balances
- Kinetics and stoichiometry (process reaction), membrane transport
- Regulation of metabolism by environmental parameters
- High-cell-density fed batch fermentation
- Metabolic networks: modelling, regulation and stoichiometry
- Case study, Rate based design
- Metabolic engineering, strategy and applications

EXERCISES, DESIGN CASE STUDY, COMPUTER SIMULATIONS

- The exercises by hand cover thermodynamics, balances, kinetics, stoichiometry analysis of fermentation data, metabolomics pathway stoichiometry.
- Tutorials in setting-up and simulating computer models of metabolic networks.
- The case study is on design of a syngas fermentation

CONTACT WITH FACULTY STAFF

- There will be possibilities to visit the research projects of the Department of Biotechnology of Delft University of Technology.
- There will be possibilities to make appointments with faculty staff. Please contact us before hand.

WHO SHOULD ATTEND?

This Advanced Course is aimed at professionals (MSc, PhD or equivalent experience) in microbiology, biochemistry or biochemical engineering with a basic working knowledge of the two other disciplines. Also, molecular biologists with a microbial background may apply. The course is primarily aimed at those already employed in industry and academia who wish to update their theoretical knowledge and practical insight in this field. In addition, this Advanced Course is an option in the two-year postgraduate programs of Delft University of Technology.

COURSE BOARD

Pascale Daran-Lapujade
Experimental Systems Biology/Synthetic Biology
Sef Heijnen
Cell Systems Engineering
Delft University of Technology
Delft, the Netherlands

FACULTY STAFF

Industrial Biotechnology
Rinke van Tatenhove-Pel
Jack Pronk
Djordje Bajić
Marieke Warmerdam
Environmental Biotechnology
Robbert Kleerebezem
Martin Pabst
Rebeca Gonzalez Cabaleiro
Bioprocess Engineering
Henk Noorman (DSM)
Cees Haringa
Ludovic Jourdin
Curator of the Beijerinck Museum
Lesley Robertson

COURSE COORDINATION

Yvonne van Gameren
Jenifer Baptiste
BioTech Delft, Delft University of Technology
Department of Biotechnology, the Netherlands

LECTURERS

Wouter van Winden
DSM Biotechnology Center
Delft, the Netherlands

Bjorn Heijstra
LanzaTech B.V.
Amsterdam, the Netherlands

Anna-Leina Heins
Technische Universität München
München, Germany

Dietrich Kohlheyer
Institute of Bio- and Geosciences
IBG-1: Biotechnology
Microscale Bioengineering Group
Forschungszentrum Jülich GmbH
Germany

Irina Borodina
DTU Biosustain
Copenhagen, Denmark

Jan Marienhagen
Institute of Bio- and Geosciences
IBG-1: Biotechnology
Forschungszentrum Jülich GmbH
Germany

Jens Nielsen
BioInnovation Institute
Copenhagen, Denmark

Ton van Maris
KTH
Stockholm, Sweden

David Humbird
DWH Process Consulting
Denver, USA

Nico Callewaert
VIB-Ugent center for medical Biotechnology
Zwijnaarde, Belgium

Henning Marckmann
Clariant
Bayern, Germany

Cees Sagt
DSM Biotechnology Center
Delft, the Netherlands

Frank Bruggeman
Vrije Universiteit Amsterdam
Amsterdam, the Netherlands

Katelijne Bekers
MicroHarvest
Hamburg, Germany

Noelia Gudino
Geno
San Diego, USA

Ismahane Remmonay
Veolia
Strasbourg, France

Adam Feist
University of California
San Diego, USA



PROGRAM

MONDAY 15 JANUARY 2024

Theme: Beginning with the end in mind, balances, conversion rates

Coordinator Henk Noorman / Jack Pronk

- 08:45 Registration
- 09:00 Outline of the course
Sef Heijnen
- 09:15 Microbial Physiology vs. Fermentation Technology
Jack Pronk / Henk Noorman
- 10:30 Real-life example
Noelia Gudino
- 11:30 Balances
Sef Heijnen
- 12:30 Lunch & Picture
- 13:30 Biomass specific conversion rates
Sef Heijnen
- 14:15 Exercises on balances and biomass specific conversion rates
Sef Heijnen
- 17:15 Social drink and buffet

TUESDAY 16 JANUARY 2024

Theme: Thermodynamics, stoichiometry and kinetics of growth, product formation and process design

Coordinator tba

- 09:00 Basic energetics of microbial metabolism
Robbert Kleerebezem
- 10:00 Exercises on energetics of microbial metabolism
Robbert Kleerebezem
- 12:30 Lunch
- 13:30 Applications of thermodynamics, what can you do with it?
Ton van Maris
- 15:30 Black Box model: stoichiometry
Sef Heijnen
- 16:30 Real-life example
Henning Marckmann
- 17:30 End of the day

WEDNESDAY 17 JANUARY 2024

Theme: Modes of operation, fermentation design and the effect of environmental parameters, intensification and feedstocks

Coordinator Henk Noorman

- 09:00 Modes of operation: Batch, fed-batch and continuous cultivation
Sef Heijnen
- 10:15 Introduction to bioprocess design (batch, continuous)
Sef Heijnen
- 11:00 Exercises on bioprocess reactions in design
Sef Heijnen
- 12:30 Lunch
- 13:30 Fed-batch fermentation and transport phenomena
Sef Heijnen
- 14:30 Exercises on data analysis of fermentation processes
Sef Heijnen
- 16:45 Fermentation intensification
Henk Noorman
- 17:40 Optional: Lab techniques tour department of Biotechnology

THURSDAY 18 JANUARY 2024

Theme: Metabolic networks, pathways stoichiometry, metabolic network models and fed-batch demo

Coordinator Wouter van Winden

- 09:00 Metabolic network analysis
Djordje Bajić
- 10:30 Exercises: Metabolic pathway stoichiometry
Djordje Bajić
- 12:30 Lunch
- 13:30 Fed-batch *in silico* demo
Wouter van Winden
- 16:15 Feedstocks: beyond (pure) carbohydrates
Wouter van Winden
- 17:30 End of the day

FRIDAY 19 JANUARY 2024

Theme: Metabolic networks: modelling, rapid sampling, regulation

Coordinator Wouter van Winden

- 09:00 Metabolic network models, ME-models, resource allocation
Jens Nielsen
- 10:00 Metabolic studies in the industrial contexts
Jens Nielsen
- 11:15 Metabolic flux balancing: theory and applications
Wouter van Winden
- 12:15 Lunch
- 13:15 Computer exercises on metabolic network analysis
Wouter van Winden
- 16:00 Challenges of large scale fermentation
Cees Haringa
- 16:45 Multi-scale modelling of process dynamics in large-scale bioreactors
Cees Haringa
- 17:40 Social drink

MONDAY 22 JANUARY 2024

Theme: Case study: Ethanol from syngas

Coordinator Henk Noorman

- 09:00 Rate-based design of biosystems
Sef Heijnen
- 09:30 Case study: Ethanol from syngas
Henk Noorman / Wouter van Winden
- 12:45 Lunch
- 13:25 (optional) Visit fermentation lab
- 14:00 Continuation Case Study
Henk Noorman / Amit Deshmukh / Sef Heijnen
- 17:00 End of the day

TUESDAY 23 JANUARY 2024

Theme: Metabolic engineering: Strategies and applications

Coordinator Henk Noorman

- 09:00 Metabolic engineering strategies for reducing costs
Sef Heijnen
- 10:30 Exercises on metabolic engineering strategies for reducing cost
Sef Heijnen
- 12:30 Lunch
- 12:55 (optional) Visit fermentation lab
- 13:30 Metabolic Engineering: from bench to business
Irina Borodina
- 14:45 Evolutionary and reverse engineering of *S. cerevisiae*
Adam Feist
- 15:30 Engineering membrane transport
Jack Pronk / Marieke Warmerdam
- 16:30 Gas fermentation: a path to low carbon fuel and chemical production with impact
Björn Heijstra
- 17:55 End of the day

WEDNESDAY 24 JANUARY 2024

Theme: Single cell studies and heterogeneity, physiology in the screening stage

Coordinator tba

- 09:00 Single cell studies of micro-organisms / Microfluidics
Frank Bruggeman
- 10:00 Population heterogeneity in large-scale processes
Anna-Lena Heins
- 11:15 Scale-down part of scale-up/scale-down, screening
Cees Haringa / Anna-Lena Heins
- 12:15 Lunch
- 12:40 (optional) Visit fermentation lab
- 13:15 Transcription factor-based biosensors for strain development
Jan Marienhagen
- 14:15 Spatio-temporal single-cell analysis in picoliter reactors
Dietrich Kohltheyer
- 15:30 High-throughput strain construction and phenotype testing
tba
- 16:30 Latest advancements in high-resolution microbial mass spectrometry
Martin Pabst
- 17:30 End of the day

THURSDAY 25 JANUARY 2024

Theme: Microbial protein production

Coordinator tba

- 09:00 Microbial protein production in an industrial context
Cees Sagt
- 10:15 Microbial proteins for food applications
Katelijne Bekers
- 11:30 Cultivated meat
David Humbird
- 12:30 Lunch
- 13:30 Microbial production of therapeutic proteins
Nico Callewaert
- 14:30 Field trip
- 19:00 Course dinner

FRIDAY 26 JANUARY 2024

Theme: Looking ahead Microbial communities, electrobiotechnology and looking back on Origins of life, Antonie van Leeuwenhoek

Coordinator tba

- 09:00 Microbial community engineering for production of chemicals and bioenergy
Robbert Kleerebezem / Rebeca Gonzalez Cabaleiro
- 10:15 Synthetic consortia: new options for industrial biotechnology
Rinke van Tatenhove-Pel
- 11:15 Electrobiotechnology: high potential tool or laboratory toy?
Ludovic Jourdin
- 12:15 Lunch
- 13:15 The Vanishing Link Between Van Leeuwenhoek's Animalcules and Disease before the 19th Century
Lesley Robertson
- 14:15 Global megatrends and Partnerships: Relevance for Biotechnology
Ismahane Remonnay
- 15:00 What have we learned?
Henk Noorman / Pascale Daran-Lapujade
- 15:00 (optional) Practical labtour regarding Chemostat

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>



COURSE REGISTRATION

Please register via the website to attend the course. Deadline for application is 25 December 2023. Applications will be handled in order of the date of receipt.

COURSE FEE

€ 4.250 in case of registration before 6 November 2023 or
€ 4.500 in case of registration after this date. In the event of cancellation before 20 November 2023, 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 € 2.100. 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)*
- *Environmental Biotechnology (1993)*
- *Biocatalysis and Protein Engineering (1999)*
- *Bioprocess Design (2014)*
- *Modelling and Computation for Microorganisms in Bioprocesses (2018)*
- *Integrated Multi-Omics approaches for Improvement of Industrial Microbes (2020)*

FURTHER INFORMATION

Jenifer Baptiste, BA

Course coordination

T +31 15 278 1922 / 2342

E biotechdelft@tudelft.nl

W biotechdelft.com

Advanced
Courses in
Biotechnology

biotechdelft.com

Department of Biotechnology, Delft University of Technology
Van der Maasweg 9, 2629 HZ Delft, The Netherlands

T +31 (0)15 278 1922 E biotechdelft@tudelft.nl