

ADVANCED COURSE

Microbial Physiology and Fermentation Technology

15 - 26 January 2024

Course board:
Pascale Daran-Lapujade
Henk Noorman

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, ^{13}C -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 9 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
Industrial Biotechnology
Experimental Systems Biology/Synthetic Biology
Henk Noorman
Bioprocess Engineering
dsm-firmenich

FACULTY STAFF

Industrial Biotechnology
Rinke van Tatenhove-Pel
Jack Pronk
Djordje Bajić
Marieke Warmerdam
Bioprocess Engineering
Marieke Klijn
Cees Haringa
Ludovic Jourdin
Environmental Biotechnology
Robbert Kleerebezem
Martin Pabst
Rebeca Gonzalez Cabaleiro

Curator of the Beijerinck Museum
Lesley Robertson
Cell Systems Engineering
Sef Heijnen

COURSE COORDINATION

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

LECTURERS

Wouter van Winden
dsm-firmenich
Delft, the Netherlands

Bjorn Heijstra
LanzaTech B.V.
Amsterdam, the Netherlands

Anna-Leina Heins
University of Technology
Bioprocess and biosystems engineering
Hamburg, Germany

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Institute of Bio- and Geosciences
IBG-1: Biotechnology
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Amsterdam, the Netherlands

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MicroHarvest
Hamburg, Germany

Noelia Gudino
Geno
San Diego, USA

Ismahane Remmonay
Veolia
Strasbourg, France

Adam Feist
University of California / DTU, Denmark
San Diego, USA

Sarah Lieder
dsm-firmenich
Delft, the Netherlands



PROGRAM

MONDAY 15 JANUARY 2024

- Theme: Beginning with the end in mind, balances, conversion rates modes of fermenter operation
Coordinator Pascale Daran-Lapujade
- 08.45 Registration
 - 09.00 Outline of the course
Pascale Daran-Lapujade
 - 09.15 Microbial Physiology vs. Fermentation Technology
Jack Pronk / Henk Noorman
 - 10.30 Developing scalable bioprocesses: Lessons and examples from industry
Noelia Gudino
 - 11.30 Balances and rates
Sef Heijnen
 - 12.30 Lunch & Picture
 - 13.30 q: Biomass specific conversion rates
Sef Heijnen
 - 14.15 Exercises on balances and biomass specific conversion rates
Sef Heijnen
 - 16.45 Balances and modes of fermentation operation
Marieke Klijn
 - 17.40 Social drink and buffet

TUESDAY 16 JANUARY 2024

- Theme: Thermodynamics, stoichiometry and kinetics of growth, product formation and process design
Coordinator Sef Heijnen
- 09.00 Basic energetics of microbial metabolism
Robbert Kleerebezem
 - 10.00 Exercises on energetics of microbial metabolism
Robbert Kleerebezem
 - 12.30 Lunch
 - 13.15 Implications and applications of the thermodynamics of microbial metabolism
Ton van Maris
 - 14.15 Black Box model: kinetics/parametrization
Sef Heijnen
 - 15.30 Black Box model: stoichiometry/process reaction for design
Sef Heijnen
 - 17.00 Cellulosic Ethanol a Key Intermediate for Sustainable Mobility and Chemical Production
Henning Marckmann
 - 18.00 End of the day

WEDNESDAY 17 JANUARY 2024

- Theme: Fermentation: design, transport and data analysis
Coordinator Sef Heijnen
- 09.00 Introduction to bioprocess design using the process reaction
Sef Heijnen
 - 10.00 Exercises on bioprocess reactions in design
Sef Heijnen
 - 12.30 Lunch
 - 13.30 Fermentor O₂/CO₂ transport and fed-batch design
Sef Heijnen
 - 15.15 Exercises on data analysis of fermentation processes
Sef Heijnen
 - 17.40 Optional: Lab techniques tour department of Biotechnology

THURSDAY 18 JANUARY 2024

- Theme: Pathway stoichiometry, pathway-based models and glutamate fed-batch demo
Coordinator Wouter van Winden
- 09.00 Metabolic pathway stoichiometry: for energy, product, biomass
Djordje Bajić
 - 10.45 Exercise: Stoichiometry pathway model for glutamate fed-batch demo
Djordje Bajić / Wouter van Winden / Sef Heijnen
 - 12.30 Lunch
 - 13.15 Fed Batch: Glutamate Fed-batch *in silico* demo
Wouter van Winden / Sef Heijnen
 - 17.00 Fermentation feedstocks: beyond (pure) carbohydrates
Wouter van Winden
 - 18.00 End of the day

FRIDAY 19 JANUARY 2024

- Theme: Metabolic networks: model-based fed-batch, modelling of large-scale dynamics
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 Fed Batch: Feed phase: Interactive quantification of knowledge for microorganisms
Wouter van Winden / Sef Heijnen
 - 12.45 Lunch
 - 13.30 Fed Batch: Model-based optimization of the glutamate fed-batch
Wouter van Winden / Sef Heijnen
 - 16.15 Challenges of large scale fermentation
Cees Haringa
 - 17.00 Multi-scale modelling of process dynamics in large-scale bioreactors
Cees Haringa
 - 18.15 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 / Sef Heijnen
 - 12.45 Lunch
 - 13.25 (optional) Visit fermentation lab
 - 14.00 Continuation Case Study
Henk Noorman / Wouter van Winden / Sef Heijnen
 - 17.15 Gas Fermentation: a path to low carbon fuel and chemical production with impact
Bjorn Heijstra
 - 18.15 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 costs
Sef Heijnen
 - 12.30 Lunch
 - 12.55 (optional) Visit fermentation lab
 - 13.30 Metabolic Engineering: from bench to business
Irina Borodina
 - 14.45 Evolutionary Engineering highlighting Adaptive Laboratory Evolution
Adam Feist
 - 15.30 Engineering membrane transport
Jack Pronk / Marieke Warmerdam
 - 16.30 Fermentation Intensification
Henk Noorman
 - 17.30 End of the day

WEDNESDAY 24 JANUARY 2024

- Theme: Scale down: Single cell studies and heterogeneity, physiology in the screening stage
Coordinator Pascale Daran-Lapujade
- 09.00 Single cell studies of micro-organisms / Microfluidics
Frank Bruggeman
 - 10.00 Population heterogeneity in large-scale bioprocesses
Anna-Lena Heins
 - 11.15 Scale-down for understanding large scale performance and robust bioprocessing
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 Kohlheyer
 - 15.30 High-throughput strain construction and phenotype testing
Sarah Lieder
 - 16.30 Advances and developments in microbial proteomics
Martin Pabst
 - 17.30 End of the day

THURSDAY 25 JANUARY 2024

- Theme: Microbial protein production in an industrial context
Coordinator Henk Noorman
- 09.00 Microbial protein production, a complex system in an industrial context
Cees Sagt
 - 10.15 Microbial production of therapeutic proteins
Nico Callewaert
 - 11.30 Scale-up considerations for cellular agriculture
David Humbird
 - 12.30 Lunch
 - 13.30 Microbial proteins for food applications
Katelijne Bekers
 - 14.30 Field trip
 - 19.00 Course dinner

FRIDAY 26 JANUARY 2024

- Theme: Looking ahead: Microbial communities, Electrobiotechnology, Megatrends. Looking back: Antonie van Leeuwenhoek, MPFT 2024
Coordinator Pascale Daran-Lapujade
- 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: production of chemicals using renewable electricity as energy source
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
Jsmahane Remonnay
 - 15.00 What have we learned?
Jack Pronk / Henk Noorman / Pascale Daran-Lapujade

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

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Course coordination

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Advanced
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