

ADVANCED COURSE

Microbial Physiology and Fermentation Technology

13 - 24 January 2025

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, (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.

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
Industrial Biotechnology
Experimental Systems Biology/Synthetic
Biology
Henk Noorman
Bioprocess Engineering
dsm-firmenich

FACULTY STAFF

Industrial Biotechnology
Jack Pronk
Djordje Bajić
Bioprocess Engineering
Marieke Klijn
Cees Haringa
Ludovic Jourdin
Environmental Biotechnology
Robbert Kleerebezem
Martin Pabst
Lesley Robertson

Cell Systems Engineering
Sef Heijnen

COURSE COORDINATION

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LECTURERS

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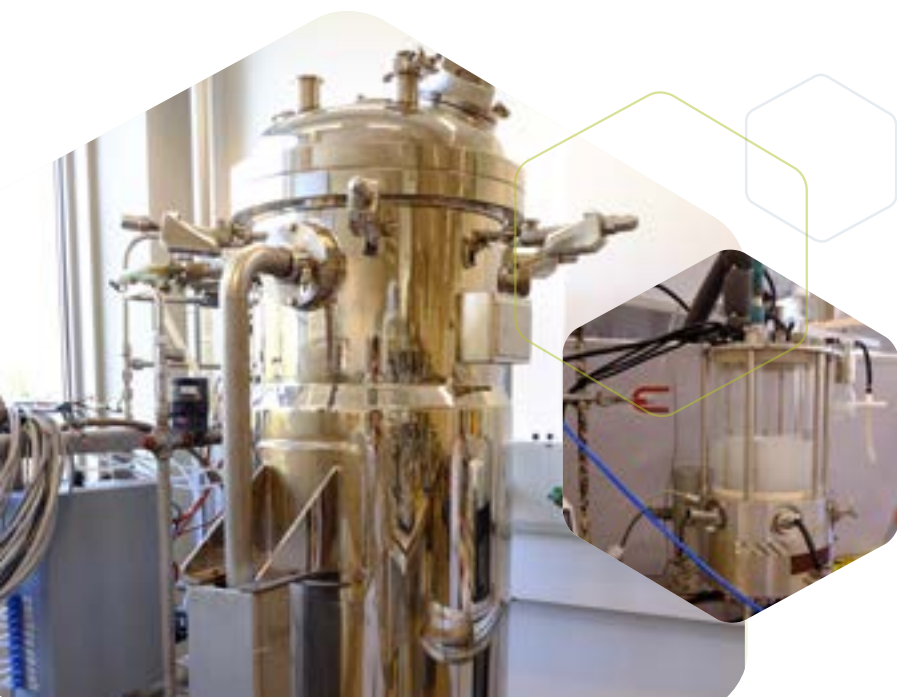
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Wageningen, the Netherlands

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



PROGRAM

MONDAY 13 JANUARY 2025

- 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
Chris Mehrer
- 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 14 JANUARY 2025

- Theme: Thermodynamics, stoichiometry and kinetics of growth, product formation and process design
Coordinator Robbert Kleerebezem
- 09.00 Basic energetics of microbial metabolism
Robbert Kleerebezem
- 10.00 Exercises on energetics of microbial metabolism
Robbert Kleerebezem
- 12.30 Lunch
- 13.15 Thermodynamics
Mark Bisschops
- 14.15 Black Box model: kinetics/parametrization
Sef Heijnen
- 15.30 Black Box model: stoichiometry/process reaction for design
Sef Heijnen
- 17.00 Engineering yeast for 1st and 2nd generation bioethanol production
Jack Pronk
- 18.00 End of the day

WEDNESDAY 15 JANUARY 2025

- 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
- 17.00 Genome-scale metabolic networks, proteome constrained models and resource allocation
Bas Teusink
- 18.00 End of the day

THURSDAY 16 JANUARY 2025

- 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
- 11.10 Exercise: Stoichiometry pathway model for glutamate fed-batch demo
Djordje Bajić / Wouter van Winden / Sef Heijnen
- 12.30 Lunch
- 13.15 Continuation Exercise
- 14.00 Interactive exercise: Design calculation of glutamate fed-batch demo
Wouter van Winden
- 16.10 Simulation exercise: Introducing the fed-batch simulator and carrying out the designed fed-batch fermentation *in silico*
Wouter van Winden
- 17.20 Interactive exercise: Discussion on measurements
Sef Heijnen
- 18.30 End of the day

FRIDAY 17 JANUARY 2025

- Theme: Metabolic networks: model-based fed-batch, modelling of large-scale dynamics
Coordinator Wouter van Winden
- 09.00 Fermentation feedstocks: beyond (pure) carbohydrates
Wouter van Winden
- 10.00 Metabolic Engineering in industrial contexts
Ruud Weusthuis
- 11.15 Simulation exercise: Use simulated fed-batch data to calculate performance
Wouter van Winden
- 12.15 Interactive exercise: Batch phase: quantification of knowledge for microorganism and fermentor using balance calculations with only online data
Sef Heijnen
- 12.45 Lunch
- 13.30 Interactive exercise: Feed phase: quantification of knowledge for microorganism and fermentor using balance calculations with only online data
Sef Heijnen
- 15.00 Simulation exercise: *In silico* optimization of the glutamate fed-batch
Wouter van Winden
- 16.30 Challenges of large-scale fermentation
Cees Haringa
- 17.15 Multi-scale modelling of process dynamics in large-scale bioreactors
Cees Haringa
- 18.30 Social drink

MONDAY 20 JANUARY 2025

- 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 / Sef Heijnen
- 12.45 Lunch
- 13.25 (optional) Visit fermentation lab
- 14.00 Continuation Case Study
Henk Noorman / 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 21 JANUARY 2025

- 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
Jack Pronk
- 15.30 Engineering membrane transport
Jack Pronk
- 16.30 Fermentation intensification
Henk Noorman
- 17.30 End of the day

WEDNESDAY 22 JANUARY 2025

- Theme: Scale down: Single cell studies and heterogeneity, physiology in the screening stage
Coordinator Pascale Daran-Lapujade
- 09.00 Spatio-temporal single-cell analysis in picoliter reactors
Dietrich Kohlheyer
- 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 Single cell studies of micro-organisms / Microfluidics
Frank Bruggeman
- 15.30 High Throughput Strain Phenotype Testing
Sarah Lieder
- 16.30 Advances and developments in microbial proteomics
Martin Pabst
- 17.30 End of the day

THURSDAY 23 JANUARY 2025

- Theme: Microbial protein production: excretion and intracellular accumulation
Coordinator Henk Noorman
- 09.00 Why is biology so difficult to engineer?
Cees Sagt
- 10.15 Microbial production of therapeutic proteins
Nico Callewaert
- 11.30 Microbial proteins for food applications
Katelijne Bekers
- 12.30 Lunch
- 13.30 Field trip
- 19.00 Course dinner

FRIDAY 24 JANUARY 2025

- Theme: Looking ahead: Microbial communities, Electrobiotechnology, Megatrends. Looking back: Antonie van Leeuwenhoek, MPFT 2025
Coordinator Pascale Daran-Lapujade
- 09.00 Microbial community engineering for production of chemicals and bioenergy
Robbert Kleerebezem
- 10.15 Synthetic consortia: new options for industrial biotechnology
Djordje Bajić
- 11.15 Electrobiotechnology: production of chemicals using renewable electricity as energy source
Ludovic Jourdin
- 12.15 Lunch
- 13.15 Microscope modification and use by Antoni van Leeuwenhoek
Lesley Robertson
- 14.15 Verdezyne: A Case Study in Beginning with the End in Mind
Brett Schreyer
- 15.15 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



COURSE REGISTRATION

Please register via the website to attend the course. Applications will be handled in order of the date of receipt.

COURSE FEE

The course fee can be found on the [website](#). 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.

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)*
- *Bioprocess Design (2014)*
- *Modelling and Computation for Microorganisms in Bioprocesses (2018)*
- *Integrated Multi-Omics approaches for Improvement of Industrial Microbes (2020)*
- *Cellular Agriculture: Precision fermentation and cultured meat (2024)*
- *EPS for resource recovery (2025)*
- *Biopharmaceutical Bioprocessing (2025)*

FURTHER INFORMATION

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Course coordination

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