

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.

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
Environmental Biotechnology
Robbert Kleerebezem
Martin Pabst
Rebeca Gonzalez Cabaleiro
Cees Haringa
Ludovic Jourdin
Curator of the Beijerinck Museum
Lesley Robertson
Cell Systems Engineering
Sef Heijnen

COURSE COORDINATION

Yvonne van Gameren
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LECTURERS

Wouter van Winden
dsm-firmenich
Delft, the Netherlands

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Geno
San Diego, USA

Ismahane Remmonay
Veolia
Strasbourg, France

Adam Feist
University of California
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 Thermodynamics: membrane transport

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 and reverse engineering

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 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 Kohlheyer

15.30 High-throughput strain construction and phenotype testing

Sarah Lieder

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 in an industrial context

Coordinator Henk Noorman

09.00 Microbial protein production in an industrial context

Cees Sagt

10.15 Microbial production of therapeutic proteins

Nico Callewaert

11.30 Cultivated meat

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: 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 Remonay

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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