

# Advanced Course

## Environmental Biotechnology

13 June – 23 June 2017

### **Aim of the course**

To learn how to go from microbial opportunity to a full scale process.

Environmental Biotechnology is a rapidly developing, increasingly important branch of science that has implications for both the prevention and clean-up of pollution in domestic and industrial waste streams. This international training course will introduce mixed microbial culture theory and reactor technology in relation to the design and scale-up of advanced treatment processes from the laboratory to the full scale implementation.

The course integrates fundamental aspects of microbiology and biochemical engineering with consideration of practical applications towards process design and scale-up. The advantages and pitfalls of applying biotechnological methods to environmental problems will be emphasized. Microbiological topics include thermodynamics, kinetics and ecophysiology of pure and mixed cultures, (geo)biochemical element cycles and biofilm formation. Biochemical engineering subjects will include mathematical modelling, biomass retention by various separation techniques, mass transport in biofilms and three phase reactors, scale up/scale down, integration of processes and process control, and process design from flask to full scale and back.

### **The course**

The course has already been held 21 times since 1993 and is based on the profound expertise of the microbiologists and process engineers within the Environmental Biotechnology Group at Delft University of Technology. Internationally known experts from other universities and industry will present the guest lectures.

For a better understanding of the lectures and to enhance active participation by those attending, this intensive training course consists of lectures, exercises, computer simulations (existing, widely used simulation programs) and an excursion to the full-scale Nerada Waste Water Treatment Plant in Utrecht.

### **Lectures**

The core lectures are mainly scheduled in the first week. In the first week we will focus on the following themes:

- Basic microbiology, stoichiometry and kinetics
- thermodynamics and competition
- (Bio)process engineering principles
- Scale up

In the second week we will focus on the computer simulation and case study.

### **Case study**

A three-day case study will offer the participants the opportunity to practice on the integration of the different topics and to design a process for the treatment of a C, S and N containing industrial waste stream. The results and conclusions will be discussed in a plenary session (Friday).

### **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 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.

## Program, 13 – 23 June 2017

### Tuesday 13 June 2017

Theme: Fundamentals of environmental biotechnology: basic microbiology, stoichiometry and kinetics

08:45	Registration
09:00	Welcome: outline of the course <i>Mark van Loosdrecht</i>
09:15	Community systems microbiology in environmental biotechnology <i>David Weissbrodt</i>
10:15	Stoichiometry of microbial growth <i>Mark van Loosdrecht</i>
11:45	Kinetic description of microbial growth in axenic and mixed cultures <i>Mark van Loosdrecht</i>
12:45	Lunch
13:30	Exercises: stoichiometry and kinetics of microbial systems
18:00	Social drink and buffet

### Wednesday 14 June 2017

Theme: Fundamentals of environmental biotechnology: thermodynamics and competition

09:00	Basic thermodynamics of biological systems <i>Robbert Kleerebezem</i>
10:15	Bioenergetics of microbial growth <i>Robbert Kleerebezem</i>
11:30	Microbial selection in engineered microbiomes <i>David Weissbrodt</i>
12:30	Lunch
14:00	Exercises: thermodynamics, competition and growth of mixed cultures <i>Mark van Loosdrecht/Robbert Kleerebezem</i>
17:00	Aerobic granular sludge: scaling-up a new technology <i>Mark van Loosdrecht</i>
18:00	End of the day

### Thursday 15 June 2017

Theme: Fundamentals of environmental biotechnology: (bio)process engineering principles

09:00	Basic principles of transport processes in bioreactors <i>Cristian Picioreanu</i>
10:00	Gas-liquid interphase transport <i>Cristian Picioreanu</i>
11:00	Biofilms and flocs: diffusive transport and modelling of the structures <i>Cristian Picioreanu</i>
12:30	Lunch
13:30	Exercises on the integration of microbial conversions (zero and first order kinetics) and transport <i>Cristian Picioreanu</i>
17:00	Visit to research projects at the Department of Biotechnology
19:00	End of the day

### Friday 16 June 2017

Theme: Scale-up

09:00	Scale-up of environmental processes using regime analysis <i>Cristian Picioreanu</i>
12:30	Lunch
13:30	Case studie Scale-up: Aerobic granular sludge <i>Cristian Picioreanu</i>
17:00	Integrative approaches to remove of compounds of emerging concern from municipal wastewater <i>Thomas Ternes</i>
18:00	End of the day

### **Monday 19 June 2017**

Theme: Modelling microbial population dynamics: an engineering approach

- 9:00 Workshop BioWin: Modelling and simulation of activated sludge systems  
*Bas Meijer*
- 12.15 Lunch
- 13:30 Continuation of workshop
- 16:30 Anammox technology  
*Mark van Loosdrecht*
- 17:30 Social drink

### **Tuesday 20 June 2017**

Theme: Microbial conversion in environmental biotechnology

- 9:00 Microbial S-conversions  
*Gerard Muyzer*
- 10:00 Microbial P-conversions  
*Mark van Loosdrecht*
- 11:00 Microbial N-conversions  
*Maaïke Hoekstra*
- 11:45 Microbiology of methanogenic processes  
*Robbert Kleerebezem*
- 12:30 Lunch in bus to Utrecht
- 13:30 Excursion to the full-scale Nereda® WWTP Utrecht
- 17:00 End of the day

### **Wednesday 21 June 2017**

Theme: Case study

- 09:00 Case study: process and reactor design by integration of microbiology and chemical engineering  
(C-, S- and N-containing industrial waste stream)  
*Mark van Loosdrecht, Robbert Kleerebezem*
- 12:30 Lunch
- 13:30 Continuation case study
- 16:00 How to discover "impossible" organisms  
*Mike Jetten*
- 17:30 End of the day

### **Thursday 22 June 2017**

Theme: Continuation of the case study

- 09:00 Recent developments in anaerobic wastewater treatment  
*Robbert Kleerebezem*
- 10:00 Continuation of the case study  
*Mark van Loosdrecht, Robbert Kleerebezem*
- 12:30 Lunch
- 13:30 PHA Production  
*Robbert Kleerebezem*
- 14:30 Continuation of the Case study  
*Mark van Loosdrecht, Robbert Kleerebezem*
- 17:00 End of the day
- 19:00 Course dinner

### **Friday 23 June 2017**

Theme: Continuation of the case study

- 09:00 Continuation of the case study  
*Mark van Loosdrecht, Robbert Kleerebezem*
- 12:30 Lunch
- 13:30 Reporting of results
- 15:15 Environmental biotechnology moving towards product formation  
*Lars Angenent*
- 16:00 Course evaluation
- 16:15 Farewell drink

## **Course Board**

### **Mark van Loosdrecht**

Environmental Engineering  
Delft University of Technology Department of Biotechnology  
Delft, the Netherlands

### **Robbert Kleerebezem**

Environmental Engineering  
Delft University of Technology Department of Biotechnology  
Delft, the Netherlands

### **Cristian Picioreanu**

Environmental Engineering  
Delft University of Technology Department of Biotechnology  
Delft, the Netherlands

### **David Weissbrodt**

Environmental Engineering  
Delft University of Technology Department of Biotechnology  
Delft, the Netherlands

## **Course coordination**

### **Vincent Renken**

### **Claudia Westhoff**

BioTech Delft, Delft University of Technology  
Department of Biotechnology  
Delft, the Netherlands

## **Guest Lecturers**

### **Lars Angenent**

Universität Tübingen - Environmental Biotechnology &  
Planck Institute - Developmental Biology  
Tübingen, Germany

### **Maaïke Hoekstra**

Delft University of Technology  
Environmental Engineering  
Delft, the Netherlands

### **Mike Jetten**

Radbout Universiteit  
Department of Microbiology  
Nijmegen, the Netherlands

### **Bas Meijer**

ASM Design  
Utrecht, the Netherlands

### **Gerard Muyzer**

University of Amsterdam  
Faculty of Science  
Amsterdam, the Netherlands

### **Thomas Ternes**

Bundesanstalt für Gewässerkunde  
Koblenz, Germany

## Location

The course will be held at:  
Department of Biotechnology  
Delft University of Technology  
Van der Maasweg 9  
2629 HZ Delft, the Netherlands  
<http://bt.tudelft.nl>

## Accommodation

Hotel accommodation can be arranged at your request addressed to [biotechdelft@tudelft.nl](mailto:biotechdelft@tudelft.nl).

## Course registration

Please register via the website to attend the course. Deadline for application is 29 May 2017. Applicants will be handled in order of the date of receipt.

## Course fee

€ 3000.- in case of payment received before **1 May 2017** or  
€ 3250.- in case of payment received after this date.

In the event of cancellation before **1 May 2017**, a full refund will be granted, after this date, a 25% fee charge can be made.

To facilitate enrolment of employees from non-profit organisations and universities, a limited number of fellowships is available with a reduced fee of € 2400.- for employees of non-profit organisations and € 1500.- for PhD-students. To apply, please include a copy of your enrolment as a PhD-student from your university.

The fee includes course materials, lunches, the buffet on Tuesday, June 13th and the course dinner on Thursday, June 22th. 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 given each year various Advanced Courses 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)
- Environmental Biotechnology (1993)
- Genomics in Industrial Biotechnology (2005)
- Metabolomics for Microbial Systems Biology (2010)
- Bioprocess Design (2014)

### **Further information**

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Vincent Renken, MSc, MSc(Ed)

Course coordination

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