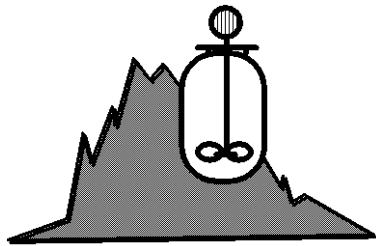


# BIOSYSTEMS ENGINEERING

## Bioreactors and Cell Factories

MODELLING AND SIMULATION  
EXPERIMENTAL METHODS  
INDUSTRIAL APPLICATIONS



22 – 27 September, 2019

BRAUNWALD, SWITZERLAND

[www.braunwald-bioengineering.de](http://www.braunwald-bioengineering.de)

### Bioreactor Modelling and Simulation

- Mass & energy balances
- Kinetics & stoichiometry
- Batch, fed-batch & continuous operation
- Heat & mass transfer
- Scale-up & scale-down

### Cell Modelling & Simulation

- Metabolic network reconstruction
- <sup>13</sup>C metabolic flux analysis
- Stoichiometric & constraint-based modelling
- Elementary flux mode analysis
- Flux balance analysis
- Dynamic network models
- Prokaryotic & eukaryotic systems

### Model-Based Design of Cells & Bioreactors

- Prediction of optimum yields & pathways
- Multi-omics data integration
- Model guided strain engineering
- Design principles of metabolic networks
- Techniques of computational strain design
- Cell & bioreactor models
- Experimental design strategies
- Bioprocess design

### Industrial Case Studies

- Mammalian cells for high-value therapeutics
- Microbial recombinant protein production
- Bio-based chemicals and materials
- Processing renewable raw materials
- Whole cell biocatalysis

### Exercises and Workshops

- Computer aided exercises -
- Berkeley Madonna & MATLAB software
- CellNetAnalyzer
- Supporting computational tools
- Workshops on selected topics

REGISTRATION FORM  
Biosystems Engineering  
Braunwald, Switzerland  
22 – 27 September, 2019

First Name .....  
Last Name .....  
Firm / Organization .....  
Address .....  
Phone, Fax .....  
Email .....

- I register for the course.
- Biotechnologist       Biologist  
 Engineer                 Chemist  
 (Bio)Informatician  
 Other, Specify .....

I bring my personal computer:     YES     NO

Send or fax this form to:

**Prof. E. Heinzle**  
**Biochemical Engineering**  
**Saarland University**  
**D-66123 Germany**

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Email: [e.heinzle@mx.uni-saarland.de](mailto:e.heinzle@mx.uni-saarland.de)

The all-inclusive fee of Euro 3300.- includes manual, book, software, single room with bath and all meals. Reduced fee of Euro 3000.- for payment before July 30, 2019.

A fee of Euro 100.- is charged for the supply of a computer. Payments should be made by bank transfer after billing. Cancellations after September 1, 2019 are subject to a fee of Euro 500.-.

The course “Biosystems Engineering” is **uniquely combining modelling and simulation of bioreactors and biological systems**. With continuous updates reflecting the newest trends and developments in biotechnology research, it has successfully conveyed expert knowledge to participants from academia and industry since 1981. Enabled by the interdisciplinary expertise of the lecturers, it integrates the quantitative description and engineering of metabolic systems with their reactor environment and thereby provides the full picture for successful strain and bioprocess development at the frontier of current research.

A speciality of the course is the **hands-on use of simulation software and relevant exercises**. Starting with examples from our book "Biological Reaction Engineering" and the easy-to-use simulation program Berkeley Madonna, the participants gain solid understanding of systems in biotechnology and their models and they can directly interact by changing process parameters and interpreting the graphical output. This greatly enhances the learning of mathematical modelling. Advanced exercises on metabolic networks use different software packages integrated in MATLAB, e.g. CellNetAnalyzer, which will also be available during the course.

The intentionally kept **small group size provides a great learning atmosphere and close personal interactions with the lecturers**. This gives rich opportunities to react to particular interests of the participants for special topics, workshops, and individual simulation problems. The teaching material outlines state-of-the-art methods as they are applied today in academic and industrial research and development.

**The participants and instructors live together in one of the most excellent Swiss mountain hotels**. The course is scheduled for the morning and late afternoon hours. The afternoons are usually reserved for a range of other activities, the most important of which is mountain walking and climbing. Often assisted with lifts to the top, we are able to enjoy the alpine world at 2000 m, from where the neighbouring peaks look very majestic. The special atmosphere of the course greatly enhances the learning experience. More details are given on our website.

**Credit points for advanced students**. Credit points equivalent to the course workload can be certified additionally with optional pre- and post-course work and documentation (4.5 credit points).

### Teaching Methods

Small group size	Informal lectures
Book with software	PC simulation exercises
Instructor interaction	Research discussions

### Time and Location

22 – 27 September, 2019 (17.00 Sunday - 14.00 Friday)  
Hotel Bellevue, Braunwald, Switzerland  
Morning and evening instructions  
Afternoons free for mountain walking, tennis or leisure.

Reached by cable railway, the auto-free village of Braunwald is situated at 1300 m, far above the Linth Valley and close to high mountains (3600 m). In 1.5 hours it is connected by train to Zurich main station and airport.

The Hotel Bellevue is an ideal, quiet location, and it is well equipped, comfortable, offers free WLAN and serves excellent meals.

### Registration and Information

Apply to  
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Email: [e.heinzle@mx.uni-saarland.de](mailto:e.heinzle@mx.uni-saarland.de)

### All-Inclusive Course Fee

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### The Instructors

Prof. Elmar Heinzle, Biochemical Engineering, Saarland University, Saarbrücken, Germany

Dr. Steffen Klamt, Max Planck Institute for Dynamics of Complex Technical Systems, Magdeburg, Germany

Prof. Christoph Wittmann, Institute of Systems Biotechnology, Saarland University, Saarbrücken, Germany

### Guest Lecturer

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