Bioprocess engineering	
Code	(not yet made available)
Credits (as per ECTS)	7
Attendance time	7 SWS
Course language	English
Duration	1 semester
Rota	annually
Module coordinator	Prof. Dr. Ebert
Assistant professor(s)	Prof. Dr. Ebert
Incorporation in the degree programs	Industrial biotechnology BSc, mandatory module, 4th Semester
Required knowledge	• Content: Recommendation: Technical microbiology, biochemistry
Learning outcomes	Students that have successfully completed this module, • understand biological methods for materials production using microorganisms in bioreactors • are capable of conducting a fed-batch fermentation at a scale of 20 litres with preparation and analysis of the product, as well as of evaluating and balancing the process • master basic aspects of statistical experiment planning • understand biological methods for materials production using microorganisms in bioreactors
Content	The following technical contents are taught in this module: Lecture "Bioprocess engineering" • Profitability of bioprocesses under consideration of various aspects of a production • Media components and media composition, development of media • Growth kinetics and growth models (Monod model and logistic growth) • Balancing of bioprocesses • Derivation of bioprocess models (batch, fed-batch, continuous process with and without cell retention • Cleaning and sterilisation processes • Transport processes in biosuspensions • Introduction to design of experiments (DOE) (full-factorial and fractional factorial experiment designs, data evaluation, introduction to the "MODDE" software Practical course "Bioprocess engineering practical course" • Reactor preparation, sterilisation, manufacture of media and buffers • Process control in the fed-batch mode for cultivation of *Cupriavidus necator* and the manufacture of Polyhydroxybutyrate • Process monitoring and online and offline analysis (substrate and metabolic products) • Optimisation of the reconditioning process of biopolymers (here: polyhydroxybutyrate) using DOE as well as aspects of the scale-up to the production scale.

	• Gas-chromatography analysis of products including derivatisation • Evaluation with regards to the specific process parameters in the bioreactor • Determination of the yields of the complete process
Literature	Lecture "Bioprocess engineering" • Lecture notes • Chmiel, Horst; Bioprozesstechnik, Spektrum-Verlag, 3. Auflage • Storhas, Winfried; Bioverfahrensentwicklung; Wiley-VCH, 2. Auflage Practical course "Bioprocess engineering practical course" • Practical course handout • Chmiel, Horst; Bioprozesstechnik, Spektrum-Verlag, 3. Auflage • Steinbüchel, Oppermann-Sanio, Ewering, Pötter; Mikrobiologisches Praktikum, Springer Spektrum-Verlag, 2. Auflage
Forms of teaching and learning	• Bioprocess engineering (V), 2 SWS, 2 LP • Bioprocess engineering practical course (P), 5 SWS, 5 LP
Workload	**Lecture "Bioprocess engineering"** Attendance time: 30 h Individual study: 30 h **Practical course "Bioprocess engineering practical course"** Attendance time: 75 h Individual study: 75 h **Total** Attendance time: 105 h Individual study: 105 h Total: 210 h
Evaluation method	The evaluation is a written exam (60 minutes) covering the entire module. Participation in this written examination requires students to have successfully completed the prerequisite "Bioprocess technology practical course (P)" (written composition, presentation).
Grading	The module grade corresponds to the result of the examination.