

Number of module: 5	Module: Bioenergy - Biogas
Coordinator of module	Prof. Dr. P. Scherer
Lecturer	Prof. Dr. P. Scherer
Period	The lecture takes place in one half of the semester, both in winter and summer (1,25 CP). Additionally a homework has to be prepared (1,25 CP). The practical course in the biotechnology-building is performed primarily in the winter (2,5 CP), but it is not performed during the holidays.
Credits	5 CP
Workload	On campus program: 64 h, self study: 86 h. From this 1/3 of time is devoted to the lecture, 1 third to the home work, a further third part is reserved to write the protocol of practical course
Status	optional
Prerequisites	Basic knowledge in biology, laboratory knowledge
Max. number of participants	Not limited number of participants in the lecture The practical course can host max. 12 participants in dual groups
Language	German/ Englisch
<p>Skills to be acquired / learning objectives In the lecture Biogas Engineering basic characteristics and also specialities of the biogas process are presented. Also the microbiological basics of the biogas process is explained.</p> <p>Subject based and methodical skills By lecture the students are able</p> <ul style="list-style-type: none"> -to assess the potentials of biogas production -to rate the bacterial conversion of biomass by different bacterial groups -to typecast important biogas processes for suspended biomass, e.g., mesophilic or thermophilic, 1-stage or 2-stage processes -to detect mismanagement of biogas plants -to make proposals for optimization a biogas plant, changing the key parameters <p>By homework the students are able</p> <ul style="list-style-type: none"> -to seek and find systematically specific literature and patents in a scientific data base -to get specific literature and patents -to deposit scientific literature by a professional software <p>That is the fundament to perform later a scientifically orientated master thesis.</p> <p>Personal and social skills By lecture the students are able</p> <ul style="list-style-type: none"> • to reach the educational objectives independently and in a confident manner • to experience time management and the ability to cope with pressure • to learn to divide the working load in small, rational portions • to learn team work in the practical course • to learn to document experimental results in a comprehensible way 	

Contents of the lecture “Biogas Engineering” (1,25 CP, presented in German if only German speaking students are present):

“Highlights”, energetical considerations, physicochemical factors influencing the methane content of a biogas reactor, “wet and dry” anaerobic digestion processes, online and offline parameters of laboratory reactors. The importance of the inoculum-sludge for the start-up period. Biology of the anaerobic digestion: The anaerobic food chain, anaerobic fatty acid oxidizers, interference with nitrate and sulphate, toxicity of ammonium and H₂S, influence of volatile fatty acids, substrate affinity, interspecies hydrogen transport, the „energetical window“ and the dependence on the right H₂-concentration of an anaerobic digestion process. Role of the process parameters HRT and OLR, factors forcing a two-step anaerobic digestion process, continuously driven reactors, schemes of different types of anaerobic digesters, diversifications and examples of biogas plants for renewable biomass.

Content of the homework „Data Bank Search (1,25 CP, explained individually in German if only German speaking students are present):

An elaborate information package belonging to the search is offered on an E-Learning-platform. Different and individual key words of the literature search are issued to the participants. These key words have to be linked to find a proper amount of literature to a special subject (e.g., find all literature and patents for micronutrients being necessary for the biogas process, but only the most important and new 100 literature citations). The data bank search is performed in Hamburg in 2-3 libraries to load the data direct in place. The extensive reworking and asserting is done at home.

Content of the practical course “Biogas Engineering” (1,25 CP, presented in German if only German speaking students are present):

The content of the lecture of the same name shall be demonstrated by some examples. For this aim quantitative anaerobic digestions of biomass are performed simultaneously in mini-fermenters. The mini-fermentations are recorded online and many of them are equipped with methane sensors. 6 working stations with up to 96 mini-fermenters in series are ready for use by max. 12 participants. The practical course is not restricted to a special time of presence, it is quite individually grouped. The presence time can be Monday **or** Tuesday **or** Thursday **or** Friday, but not Wednesday (every Wednesday a parallel basic practical course of microbiology is conducted in the laboratory for Applied Microbiology). Time for about two introductions and two discussions has to be reserved. The experiments can also be extended to a full-length project.

The instrumental equipment belongs to the research and transfer center for “regenerative energy and energy efficiency” (FTZ REEVE), research group Scherer

Teaching skills	Teaching in small groups of max. 15-20 participants. Presentations by beamers (standard of all teaching rooms, also an apparatus with overhead foils is available). A script for the lecture and practical course exists on a separate E-Learning - resp. “Moodle”-platform in the internet of the faculty of Life Sciences in Hamburg-Bergedorf, name: BGEBGTVORL09_LS The information package belonging to the professional data bank research is also on an own E-Learning platform available: BGEBGTDRL09_LS Practical course with students in dual groups. There exists an exact manual for doing the experiments. This is also on a separate E-Learning-platform available: BGEBGTPRL09_LS . To get access to the E-Learning platform of the campus you have to use your personal mail account name for the university and the name of the course without the ending _LS
Exam	Recording exam (on demand without a mark; also attainable for guest auditors !) Recorded protocol of the data bank search according to individually defined targets Protocol of the performed experiments and fermentations, generally without a mark.
Literature / Teaching aids	See the different E-Learning-platforms above