AALBORG UNIVERSITET

CIVILINGENIØR, CAND.POLYT. I BIOPROCESTEKNOLOGI, 2020

CIVILINGENIØR
ESBJERG

MODULER SOM INDGÅR I STUDIEORDNINGEN

INDHOLDSFORTEGNELSE

ANALYSIS OF MACRO AND MOLECULAR BIOTECHNOLOGY SYSTEMS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who complete the module must be able to

- account for general microbial cultivation techniques
- account for perspectives in utilisation of biomass resources
- optimize production of target products through genetic engineering, microbial fermentation or extraction
- account for technologies for conversion of biomass to target products
- explain biomass chemistry
- account for microorganisms as biocatalysts in the biological processes and processing of biomass
- account for bottlenecks and inhibition effects
- account for bioenergy technologies: Biogas process, bioethanol production, biohydrogen, microbial fuel cells (MFC), biodiesel production, combustion, and gasification.
- explain process optimization and scaling up
- account for biorefinery concept and design

SKILLS

- transform microorganisms (bacteria and fungi) genetically
- identify microorganisms based on molecular techniques
- perform biomass and bioenergy mass balances
- draw flow sheets of biorefineries for selected biomasses (incl. unit operation choices and process mass balances)
- carry out biomass resource mapping
- write a project report following the standards of the field of study, include relevant original scientific literature, use the correct terminology, and communicate the research-based foundation, problem and results of the project coherently in writing, graphically and orally
- assess and select relevant original scientific literature and current scientific methods, models and other tools used in the project and asses the problem of the project and results in relevant scientific and social contexts

COMPETENCES

- handle the planning, implementation and management of complex research and/or developmental tasks and take professional responsibility for implementing academic assignments and interdisciplinary collaborations
- take responsibility for own professional development and specialization

TYPE OF INSTRUCTION

- Project work

EXTENT AND EXPECTED WORKLOAD

450 hours

EXAM

EXAMS

Name of exam	Analysis of Macro and Molecular Biotechnology Systems
Type of exam	Oral exam based on a project
ECTS	15
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Analyse af makro- og molekylære bioteknologiske systemer
Module code	K-KT-K1-30
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	Lars Porskjær Christensen

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science

MOLECULAR BIOTECHNOLOGY – RECOMBINANT DNA TECHNOLOGY

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who complete the module must be able to

- account for general technologies in molecular biology and genomic analyses
- account for basic methods in recombinant DNA technology (cloning, vectors, primer design and transformation)
- account for methods in genetics, epigenetics, transcriptomics and proteomics
- account for basic techniques in DNA sequencing (genomes and fragments)
- explain the basic methods for microbiome assessment and identification
- explain the methods used in protein engineering (tagging, isolation, prediction and analyses)
- explain the theoretical background of these methods, their advantages and limitations as well as possible applications

SKILLS

- use molecular tools for heterologous expression of genes and proteins
- perform DNA alignments of genes or fragments
- optimize and design primers for PCR amplification of target DNA
- determine variation in microbiome in environmental matrices
- detect and isolate heterologously produced proteins

TYPE OF INSTRUCTION

- Lectures
- Workshops
- Experimental exercises

EXTENT AND EXPECTED WORKLOAD

150 hours

EXAM

EXAMS

Name of exam	Molecular Biotechnology – Recombinant DNA Technology
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Molekylær bioteknologi - rekombinant DNA-teknologi
Module code	K-KT-K1-31
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	Jens Laurids Sørensen

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science

FERMENTATION TECHNOLOGY

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who complete the module must be able to

- describe microbial physiology
- account for optimal medium design
- explain reactor configuration (batch, fed batch, continuous processes) and control systems
- account for applications of bio- and fermentation processes and industrially important microorganisms
- describe microbial metabolic pathways from a systems biology perspective
- account for fundamental microbial growth kinetics and models
- explain process improvement through metabolic manipulation

SKILLS

- apply biological and bioengineering principles in microbial fermentation systems.
- carry out preservation of microorganisms, propagation, and inocula
- setting up bioreactors and cultivation in bioreactors
- describe growth kinetics and characteristics mathematically
- perform mass balance calculations based on experimental data

TYPE OF INSTRUCTION

- Lectures
- Workshops
- Exercises
- Mini-projects

EXTENT AND EXPECTED WORKLOAD

150 hours

EXAM

EXAMS

Name of exam	Fermentation Technology
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Fermenteringsteknologi
Module code	K-KT-K1-32
Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	Mette Hedegaard Thomsen

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science

RECOVERY AND PURIFICATION OF CHEMICAL AND BIOLOGICAL PRODUCTS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who complete the module must be able to

- account for industrial downstream processing methods for different types of products
- describe main principles of process design and development of downstream processing strategies
- explain effect of fermentation development on downstream processing (upstream versus downstream)
- account for separation principles and their effectiveness
- account for product release, secretion, cell disruption, flocculation processes, centrifugation, conventional filtration and membrane filtration, precipitation processes, process chromatography, product polishing, and distillation.

SKILLS

- calculate sizing and scale up of most frequently used unit operations
- develop complete processes

TYPE OF INSTRUCTION

- Lectures
- Workshops
- Exercises

EXTENT AND EXPECTED WORKLOAD

150 hours

EXAM

EXAMS

Name of exam	Recovery and Purification of Chemical and Biological Products
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Oprensning af kemiske og biologiske produkter
Module code	K-KT-K1-33

Module type	Course
Duration	1 semester
Semester	Autumn
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	Lars Porskjær Christensen

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science

APPLIED BIOPROCESS DESIGN AND ENGINEERING

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who complete the module must be able to

- identify the characteristics of biomass from different resources
- describe suitable microbial processes for processing different types of biomass to produce biofuels and biochemicals
- account for the metabolic interactions in microbial cells
- explain the principles for the concept of renewable bioenergy and sustainability
- explain the bottlenecks and/or inhibition effects of the different biomass conversion processes
- account for calculation and simulation tools to determine metabolic fluxes
- explain techniques to measure cellular metabolic fluxes

SKILLS

- select appropriate modelling strategies
- model carbon fluxes in microorganisms
- manipulate the direction of metabolite fluxes
- genetically optimize production strains
- use commercial software such as Super Pro Designer or Aspen plus for process design
- perform techno-economic analysis for designed biorefineries
- write a project report following the standards of the field of study, include relevant original scientific literature, use the correct terminology, and communicate the research-based foundation, problem and results of the project coherently in writing, graphically and orally
- assess and select relevant original scientific literature and current scientific methods, models and other tools used in the project and asses the problem of the project and results in relevant scientific and social contexts

COMPETENCES

- handle the planning, implementation and management of complex and unpredictable research and/or developmental tasks and take professional responsibility for implementing academic assignments and interdisciplinary collaborations
- take responsibility for own professional development and specialization

TYPE OF INSTRUCTION

Project work

EXTENT AND EXPECTED WORKLOAD

450 hours

EXAM

PREREQUISITE FOR ENROLLMENT FOR THE EXAM

- An approved PBL competency profile is a prerequisite for participation in the project exam

EXAMS

Name of exam	Applied Bioprocess Design and Engineering
Type of exam	Oral exam based on a project
ECTS	15
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Anvendt bioprocessdesign og -teknik
Module code	K-KT-K2-33
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	15
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	Sergey Kucheryavskiy
Time allocation for external examiners	B

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science

LIFE SCIENCE COMPANIES – FROM INNOVATION TO INDUSTRY

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who complete the module must be able to

- account for the concepts: life science, sustainability, bioeconomy, life cycle analysis, and circular economy
- describe the principles of the transfer from innovation to production of new bioproducts
- account for patent issues
- account for biological production companies within the following sectors: bioengineering and biotechnology, pharma, food, feed and bioenergy

SKILLS

- work out a life-cycle analysis and techno-economical assessments
- establish a plant description, process diagrams, mass balances and energy balance of a biological production
- calculate a budget for the establishment and operation of a biological production
- evaluate the sustainability of biological production and products by means of a life-cycle analysis
- set principles for the establishment of a business plan and a budget for expenditure, establishment and initial operation

TYPE OF INSTRUCTION

- Lectures
- Workshops
- Exercises
- Mini-projects

EXTENT AND EXPECTED WORKLOAD

150 hours

EXAM

EXAMS

Name of exam	Life Science Companies – from Innovation to Industry
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Life science virksomheder - fra innovation til industri
Module code	K-KT-K2-34
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	Peter Stephensen Lübeck

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science

MODELLING AND SIMULATION OF BIOLOGICAL PROCESSES

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who complete the module must be able to

- explain the effects of temperature, pressure, and initial concentrations on reaction equilibria
- quantitatively account for the reaction rates in commonly used expressions such as power law and rational expressions
- account for coupled mass and energy balances to derive design equations for ideal, isothermal, isobaric reactors (e.g. batch, CSTR, PFR)
- account for coupled mass and energy balances to design non-isothermal reactors and apply fluid mechanics principles to design non-isobaric reactors.
- account for the mechanism, rate expressions, and models for heterogeneous reactor systems incorporating heat and mass transfer effects.

SKILLS

- apply material balances to derive and use design equations for ideal, homogeneous, isothermal, non-isothermal, non-isobaric, and heterogeneous reactos.
- analyze and interpret rate data by determining rate expressions from laboratory experimental measurements.
- design and evaluate chemical reactor using computer-aided design and computational chemistry tools

TYPE OF INSTRUCTION

- Lectures
- Workshops
- Exercises
- Mini-projects

EXTENT AND EXPECTED WORKLOAD

150 hours

EXAM

EXAMS

Name of exam	Modelling and Simulation of Biological Processes
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Modellering og simulering af biologiske processer
Module code	K-KT-K2-35
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	Mette Hedegaard Thomsen

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science

CHEMOMETRICS AND PROCESS MONITORING

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who complete the module must be able to

- account for general methods for multivariate data analysis (principal component analysis, multiple linear regression, principal component regression, projection on latent structures, soft independent modelling of class analogy)
- account for methods for data preprocessing (centering, scaling, nonlinear and spectroscopic reprocessing, orthogonal signal correction).
- explain basic methods for variable selection (Selectivity ratio, VIP, interval PLS, jack-knife)
- explain the theoretical background of these methods, their advantages and limitations as well as possible applications
- explain how multivariate methods complement traditional statistical methods

SKILLS

- explore multivariate data, find groups and trends, detect and remove outliers
- calibrate and do proper validation of multivariate regression models, use these models for prediction
- evaluate if data need a preprocessing and which method to apply
- calibrate and evaluate models for data classification
- compare different regression and classification models and identify the best
- use multivariate methods for analysis of real data from different applications

TYPE OF INSTRUCTION

- Lectures
- Workshops
- Exercises
- Mini-projects

EXTENT AND EXPECTED WORKLOAD

150 hours

EXAM

EXAMS

Name of exam	Chemometrics and Process Monitoring
Type of exam	Written or oral exam
ECTS	5
Assessment	7-point grading scale
Type of grading	Internal examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kemometri og procesovervågning
Module code	K-KT-K2-36
Module type	Course
Duration	1 semester
Semester	Spring
ECTS	5
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	Sergey Kucheryavskiy

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
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SPECIALIZATION IN BIOENGINEERING

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who complete the module must be able to

- account for relevant aspects of modern biotechnology

SKILLS

- execute laboratory experiments
- apply physico-chemical models in bioengineering
- analyse experimental data
- write a project report following the standards of the field of study, include relevant original scientific literature, use the correct terminology, and communicate the research-based foundation, problem and results of the project coherently in writing, graphically and orally
- assess and select relevant original scientific literature and current scientific methods, models and other tools used in the project and asses the problem of the project and results in relevant scientific and social contexts

COMPETENCES

- select and combine experimental and theoretical methods, as appropriate, in order to solve complex problems in chemical engineering
- handle the planning, implementation and management of complex research and/or developmental tasks and take professional responsibility for implementing academic assignments and interdisciplinary collaborations
- take responsibility for own professional development and specialization

TYPE OF INSTRUCTION

- Project work

EXTENT AND EXPECTED WORKLOAD

900 hours

EXAM

EXAMS

Name of exam	Specialization in Bioengineering
Type of exam	Oral exam based on a project
ECTS	30
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Specialisering i Bioprocesteknologi
Module code	K-KT-K3-33
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	30
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	Jens Laurids Sørensen
Time allocation for external examiners	B

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science

SPECIALIZATION IN BIOENERGY

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who complete the module must be able to

- account for the development and production of biofuels

SKILLS

- execute laboratory experiments
- apply physico-chemical models to biochemical engineering and biofuel production
- analyse experimental data
- write a project report following the standards of the field of study, include relevant original scientific literature, use the correct terminology, and communicate the research-based foundation, problem and results of the project coherently in writing, graphically and orally
- assess and select relevant original scientific literature and current scientific methods, models and other tools used in the project and asses the problem of the project and results in relevant scientific and social contexts

COMPETENCES

- select and combine experimental and theoretical methods, as appropriate, in order to solve complex problems in biochemical engineering and bioenergy production
- handle the planning, implementation and management of complex research and/or developmental tasks and take professional responsibility for implementing academic assignments and interdisciplinary collaborations
- take responsibility for own professional development and specialization

TYPE OF INSTRUCTION

- Project work

EXTENT AND EXPECTED WORKLOAD

900 hours

EXAM

EXAMS

Name of exam	Specialization in Bioenergy
Type of exam	Oral exam based on a project
ECTS	30
Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Specialisering i Bioenergi
Module code	K-KT-K3-34
Module type	Project
Duration	1 semester
Semester	Autumn
ECTS	30
Language of instruction	English
Empty-place Scheme	Yes
Location of the lecture	Campus Esbjerg
Responsible for the module	Mette Hedegaard Thomsen
Time allocation for external examiners	B

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science

MASTER'S THESIS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who have passed the module should be able to

- explain the scientific basis and scientific issues in within the competence profile of the program
- explain the highest international research within the thesis subject area

SKILLS

- master the scientific methods and general skills related to the competence profile of the program
- write a project report following the standards of the field of study, use the correct terminology and document extensive use of relevant and original scientific literature, and communicate and discuss the
- project's research-based foundation and problem and results in writing, graphically and verbally in a professionally reasoned and coherent way
- Critically assess and select relevant original scientific literature and current scientific methods, models and other tools used in the project and asses and discuss the problem of the project and results in relevant scientific contexts and social conditions
- evaluate the potential of the project for further development, assessing and incorporating relevant economic, ethical, environmental and other societal relevant factors

COMPETENCES

- participate in and independently implement technological and scientific development and research, develop and implement experimental work and solve complex tasks using scientific methods
- handle the planning, implementation and management of complex and unpredictable research and/or developmental tasks and take professional responsibility to implement independent academic assignments and interdisciplinary collaborations
- independently take responsibility for own professional development and specialization

TYPE OF INSTRUCTION

Project work

EXTENT AND EXPECTED WORKLOAD

900 hours

EXAM

EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	30
Assessment	7-point grading scale
Type of grading	External examination

Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	K-KMB-K4-5
Module type	Project
Duration	1 semester
Semester	Spring
ECTS	30
Language of instruction	English
Responsible for the module	Lars Haastrup Pedersen
Time allocation for external examiners	D

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science

MASTER'S THESIS

2021/2022

CONTENT, PROGRESS AND PEDAGOGY OF THE MODULE

LEARNING OBJECTIVES

KNOWLEDGE

Students who have passed the module should be able to

- explain the scientific basis and scientific issues in within the competence profile of the program
- explain the highest international research within the thesis subject area

SKILLS

- master the scientific methods and general skills related to the competence profile of the program
- write a project report following the standards of the field of study, use the correct terminology and document extensive use of relevant and original scientific literature, and communicate and discuss the
- project's research-based foundation and problem and results in writing, graphically and verbally in a professionally reasoned and coherent way
- Critically assess and select relevant original scientific literature and current scientific methods, models and other tools used in the project and asses and discuss the problem of the project and results in relevant scientific contexts and social conditions
- evaluate the potential of the project for further development, assessing and incorporating relevant economic, ethical, environmental and other societal relevant factors

COMPETENCES

- participate in and independently implement technological and scientific development and research, develop and implement experimental work and solve complex tasks using scientific methods
- handle the planning, implementation and management of complex and unpredictable research and/or developmental tasks and take professional responsibility to implement independent academic assignments and interdisciplinary collaborations
- independently take responsibility for own professional development and specialization

TYPE OF INSTRUCTION

- Project work.

A long Master's thesis of more than 30 ECTS must include work of experimental nature and has to be approved by the Head of Studies. The amount of experimental work must reflect the allotted ECTS.

EXTENT AND EXPECTED WORKLOAD

1800 hours

EXAM

EXAMS

Name of exam	Master's Thesis
Type of exam	Master's thesis/final project
ECTS	60

Assessment	7-point grading scale
Type of grading	External examination
Criteria of assessment	The criteria of assessment are stated in the Examination Policies and Procedures

FACTS ABOUT THE MODULE

Danish title	Kandidatspeciale
Module code	K-KMB-K4-4
Module type	Project
Duration	2 semesters
Semester	Autumn
ECTS	60
Language of instruction	English
Responsible for the module	Lars Haastrup Pedersen
Time allocation for external examiners	D

ORGANISATION

Study Board	Study Board of Biotechnology, Chemistry and Environmental Engineering
Department	Department of Chemistry and Bioscience
Faculty	Faculty of Engineering and Science