MODULE HANDBOOK

IIP@HBC

CLUSTER:
SUSTAINABLE BIOTECHNOLOGY

HBC.
HOCHSCHULE
BIBERACH
UNIVERSITY
OF APPLIED SCIENCES

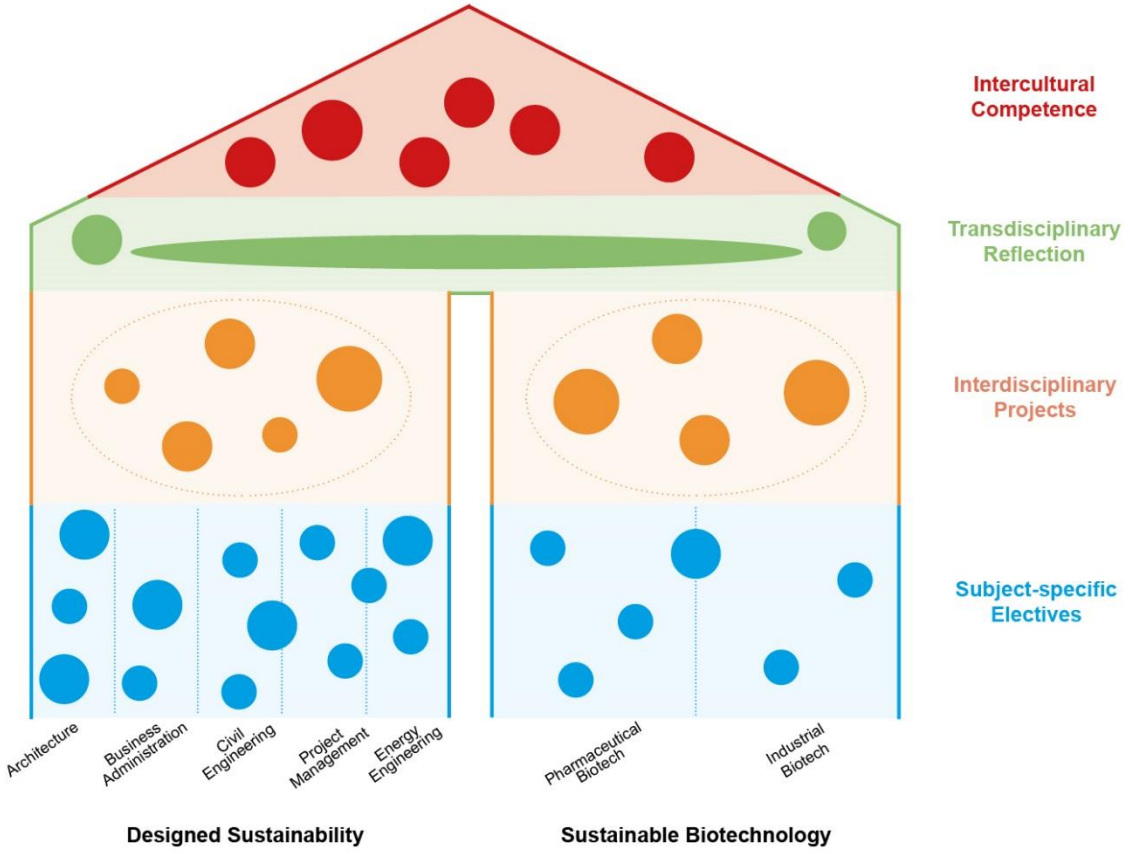
Alena Fritsch, Helena Huyer
fritsch@hochschule-bc.de, huyer@hochschule-bc.de

Version: SS 24

Table of Content

1. IIP@HBC general program information

Students can choose up to 30 ECTS with a combination of intercultural competence courses, transdisciplinary reflections topics, interdisciplinary projects and subject-specific electives. The courses are offered on Bachelor level.



Graphic 1: Program Structure overview

Depending on students' focus at their home university it is possible to choose subject-specific (disciplinary) electives and interdisciplinary projects from **one** field of studies. We call those study areas Clusters. As of now, it is not possible to choose courses from several clusters.

Designed Sustainability contains subjects, which might be of interest for future Architects, Civil Engineers, Energy Engineers, Project Managers and Business Administrators.

Whereas the Cluster Sustainable Biotechnology offers courses for students in the field of Pharmaceutical and Industrial Biotechnology.

2. Cluster: Sustainable Biotechnology

In the cluster sustainable biotechnology, the energy balance of processes classically associated with biotechnology (fermentations, heat sterilization, etc.) is addressed. In addition, courses in modern processes of biotechnological production (cultivation of animal cells, from the cell culture bottle to the fermenter), biochemical analysis and purification of proteins are offered.

2.1. Course Overview

Course title	PBT	IBT	Semester
Intercultural Competence	**min. 3 ECTS**	**min. 3 ECTS**	
German language course*	2	2	WS / SS
Intercultural Training with Incomings*	1	1	WS / SS
Mentoring Program for HBC students only	2	2	WS / SS
Negotiation Skills and Work Cultures	2	2	WS / SS
Intercultural Competence Training	1-2	1-2	WS / SS
Spanish A1	2	2	WS / SS
Spanish A2	2	2	WS / SS
Transdisciplinary Reflection	**min. 1 ECTS**	**min. 1 ECTS**	
Transdisciplinary Activities (IO_TA)	1	1	WS / SS
Interdisciplinary Projects	**min. 3 ECTS**	**min. 3 ECTS**	
Sustainable Development in Biopharmaceutical Industry	3	3	WS / SS
Advanced Therapeutic Medicinal Products (ATMP)	3	3	WS / SS
Disciplinary Electives			
Equipment and Plant Engineering IBT		**2 + 1**	SS
Process Development / Scale Up (Laboratory)*		**5**	SS
Organical Chemistry and Natural Products Lecture		**2**	SS
Organical Chemistry and Natural Products Laboratory*		**4**	SS
Information Retrieval /-management		**2**	SS
Product Isolation		**2**	SS
Bioprocessing Technology Lecture		**2**	SS
Protein Chemistry		**2**	SS
Cell culture technology Seminar	**2**		WS / SS
Cell culture technology Laboratory*	**6**		WS / SS
Biotechnology Lecture Series	**2**		WS / SS
Selected Topics of Modern Biotechnology	**3**		WS / SS
Downstream Processing*	**8**		WS / SS
Plant and Apparatus Engineering PBT	**3**		WS / SS
Biotechnological Processing	**3**		WS / SS
Protein Analytics Laboratory	**3**		WS / SS
Protein Analytics Seminar	**1**		WS / SS

2.2. Intercultural Competence

Various formats of activities are offered to develop students' intercultural competence, in which the students can deal with intercultural aspects, questions of global and peaceful coexistence and also with cultural, ethical and social topics.

2.2.1. German Language Course (IO_DK)

Credits (ECTS)	2 ECTS
Lecture hours (SWS)	2 SWS
Prerequisite	An entry test will be offered to assign participants to the appropriate course level.
Semester (Summer/Winter/Both)	Both
Lecturer	
Objectives (Learning Outcome)	Introduction and extension of vocabulary. Increase of understanding of German culture
Lecture topics (content)	Explanation and illustration of German grammar, everyday vocabulary, study specific situations and intercultural differences
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	It takes place in two groups: Beginners and Advanced (B1). In person lecture and online sessions After a one-week intensive course, the German course continues during the semester.
Examination	ECTS will be achieved with mandatory attendance.
Literature list	Depending on level

2.2.2. Intercultural Training (IO_ITI)

* This course is compulsory of international Incoming students

Credits (ECTS)	1 ECTS
Lecture hours (SWS)	1 SWS (2 days during the Orientation Week)
Prerequisite	No prerequisite
Semester (Summer/Winter/Both)	Both
Lecturer	Tanja Böttcher (Dipl Psych)
Objectives (Learning Outcome)	Increase Intercultural competence of participating Students
Lecture topics (content)	▪ Explain and illustrate the concept of „culture“ ▪ Find and compare strategies to improve intercultural competence ▪ Discuss the term „Typical German“ and its components
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Interactive seminar
Examination	ECTS will be achieved with mandatory attendance.
Literature list	worksheets

2.2.3. Mentoring program

* This course is for HBC students only

Credits (ECTS)	2 ECTS
Lecture hours (SWS)	Individual workload
Prerequisite	▪ Recommended: successfully absolved semester abroad at a partner university, ▪ curiosity, organization, efficiency, responsibility, and engagement; ▪ Presence in Biberach one week before the official start of the semester (Orientation week)
Semester (Summer/Winter/Both)	Both
Lecturer	N/A
Objectives (Learning Outcome)	▪ Creation of an international network by meeting students from all over the world: Europe, Asia, North and South America etc. ▪ Gain knowledge about foreign cultures and lifestyles ▪ Improvement of foreign language skills ▪ Increase intercultural experience and competence ▪ Help for Incoming students ease into their new study environment and make them feel welcome in Biberach ▪ Connection of HBC students (mentors) and incoming students (mentees) ▪ Assurance of integration of incoming students
Lecture topics (content)	▪ get in contact with the mentee via email before he/she arrives ▪ if necessary support the mentee in finding a suitable housing ▪ if necessary help the mentee to organise the journey from the airport to Biberach ▪ pick up the key from the students' dorm before the mentee's arrival in Biberach ▪ be on hand to pick up the mentee from the train station and bring her/him home ▪ join the welcoming activities as well as the semester program organized by HBC's international office ▪ provide general help with getting settled in Biberach an make her/him feel at home and familiarize her/him with: the public transport system, where to go out, where to meet the local students, where to go shopping (town, shops, farmer's markets, supermarkets …), where to find a doctor, where to get a SIM card, … and answer any questions that might pop up

	▪ help the mentee with the first orientation around HBC and its university life: where do you find important places like the library, cafeteria/canteen, university sports, the international office, class schedules, how to download scripts, how to charge a copy card … ▪ be on hand during semester activities: international regulars' table, excursions, BBQ's … ▪ keep in touch with your mentee throughout the whole semester not just via e-mail or facebook, but by meeting in the flesh
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Individual meetings and events
Examination	Not required
Literature list	N/A

2.2.4. Negotiation and Work Culture (SG.NWC)

Credits (ECTS)	2
Lecture hours (SWS)	2
Prerequisite	English skills at least B2
Semester (Summer/Winter/Both)	Both
Lecturer	Lyn Fish
Objectives (Learning Outcome)	
Lecture topics (content)	A negotiation is a strategic discussion that resolves an issue in a way that both parties find acceptable. In a negotiation, each party tries to persuade the other to agree with his or her point of view. How are negotiations conducted with Germans? What should be taken into consideration to prepare English-speakers for entering into negotiations with Germans. Doing business in Germany, as well as getting to grips with the business culture in Germany, can be a challenge for newcomers. This is especially true if your place of work isn't an international company or a tech start-up. Whilst the English-speaking world shares many social and cultural similarities, German work culture is definitely an area which is substantially different and we will examine these differences to prepare us for working in Germany.
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	In person lecture
Examination	tba
Literature list	N/A

2.2.5. Intercultural Competence Training (SG)

Credits (ECTS)	1 ECTS (2 ECTS for Bachelor International Students)
Lecture hours (SWS)	2 full-day appointments during the Semester
Prerequisite	
Semester (Summer/Winter/Both)	Winter
Lecturer	Mrs. Westenhoefer, Mr. Goth
Objectives (Learning Outcome)	The students can recognize their own world view and perceive and accept cultural differences and similarities. Cultural differences, cultural dimensions, cultures are recognized and understood (concepts based on Geert Hofstede and Erin Meyer/Harvard, among others). The students get an overview of the essential aspects of intercultural competence, they perceive, reflect and understand themselves in the intercultural space. Dealing with stereotypes is learned and intercultural sensitivity and competence are developed. Students can deal with their own culture shock and reflect on existing intercultural encounters
Lecture topics (content)	Constructivism Concepts for measuring & recognizing cultural characteristics and differences (culture onion and cultural dimensions according to Hofsteede, Sinus milieu) Culture shock Stereotypes & prejudices Characteristics of intercultural competence Preparation for one's own abroad
Teaching format(e.g. online / in person lecture / Seminar / Lab etc.)	Interactive Seminar
Examination	Active participation and at least 75% attendance (For Bachelor international students, the examination performance is determined by the lecturers at the beginning of the semester)
Literature list	N / A

2.2.6. Spanish A1 (Spanisch A1) (SG)

Credits (ECTS)	2 ECTS
Lecture hours (SWS)	2 SWS
Prerequisite	None
Semester (Summer/Winter/Both)	Both
Lecturer	Mrs. Vera Sproll
Objectives (Learning Outcome)	Teaching the Spanish language and culture in Spanish-speaking countries
Lecture topics (content)	Chapters 1 to 8 in textbook Perspectivas !Ya! A1 **Chapter 1** Greeting, name and origin, verb ser, negation, alphabet, pronunciation and intonation, numbers 0 to 10 **Chapter 2** Saying goodbye, asking how you are, introducing someone, ordering something in a restaurant / bar, verb estar, nouns in the singular and plural, the article, regular verbs on -ar and -er, numbers from 11 to 20 **Chapter 3** Giving your profession and place of work, asking what something is called in Spanish, giving your place of residence, street and telephone number, regular verbs ending in -ir, verb tener, numbers from 21 to 100 **Chapter 4** wishing someone a happy birthday, naming family members, giving a date, describing someone, possessive companions, adjectives, verb conocer **Chapter 5** talking about everyday life, days of the week and times of day, frequencies, verb creer, giving reasons for something, verbs with 1st person singular on -go, verb ir **Chapter 6** Describing a place or city, use of ser and estar, use of hay, cardinal points, indefinite adjectives, numbers from 100 upwards **Chapter 7** Talking about accommodation, expressing preferences, booking a hotel room, complaining about something, verbs with stem vowel changes, se + verb in the 3rd person **Chapter 8** talking about means of transport, giving places and directions, asking for directions, tener + que + infinitive, verbs with stem changes, subordinate clauses with para +, infinitive, subordinate clauses with ir a + infinitive, demonstrative pronouns and companions
Teaching format (e.g. online / in person	In person

lecture / Seminar / Lab etc.)	
Examination	Essay + oral examination
Literature list	Perspectivas !Ya! A1

2.2.7. Spanish A2 (Spanisch A2) (SG)

Credits (ECTS)	2 ECTS
Lecture hours (SWS)	2 SWS
Prerequisite	Spanish A1
Semester (Summer/Winter/Both)	Both
Lecturer	Mrs. Paloma Bernal Munoz
Objectives (Learning Outcome)	
Lecture topics (content)	Spanisch A2
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	In person
Examination	Written presentation
Literature list	N / A

2.3. Transdisciplinary Reflection

In addition to the disciplinary and interdisciplinary cluster elements, the transdisciplinary aspect is another component of the respective cluster. The aim of the reflection module is for the participants in the individual clusters to enter into a dialogue on current and not necessarily technical topics.

2.3.1. Transdisciplinary Activities (IO_TA)

Credits (ECTS)	1
Lecture hours (SWS)	Individual
Prerequisite	Participation in at least three events
Semester (Summer/Winter/Both)	Both
Lecturer	Organizer: International Office
Objectives (Learning Outcome)	▪ Strengthen the students' connection / network with the industrial partners in the region. ▪ Giving an insight into German companies and their international productions. ▪ Introducing the German culture to international students ▪ Visit and introduce regional sights and cities to international students ▪ Experience Biberach and its surrounding with all senses ▪ Improvement of intercultural and international competence
Lecture topics (content)	▪ **Company visits:** Participants will get the possibility to visit local companies, such as LIEBHERR GmbH, Boehringer Ingelheim or BAUFRITZ and get first-hand insight and information on their production plants. ▪ **Cultural Trips**: Both Incoming and regular HBC students visit cultural highlights in the South of Germany, for example a local Christmas Market in the winter semester or Schloss Neuschwanstein in the summer semester. ▪ **Social Activities:** Social Activities take place on HBC Campus and around Biberach City. They are mostly open for the whole HBC community and include activities such as international food-tasting on Campus, Clean-Up Walks around town, Debating Events on sustainability topics etc.

	A catalogue with an overview of Events, Trips and company visits planned for the current/upcoming semester will be created and provided by the International Office.
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Excursions to companies; Activities on Campus or in the surrounding area
Examination	1-2 pages report about the chosen fieldtrip / social activity needs to be handed in via email to the International Office
Literature list	

2.4. Interdisciplinary Projects

2.4.1. Sustainable Development in Biopharmaceutical Industry (PBT22_SDB)

Credits (ECTS)	3
Lecture hours (SWS)	2
Prerequisite	Basic kknowledge of biopharmaceutical manufacturing processes and process engineering
Semester (Summer/Winter/Both)	both
Lecturer	Dr. Jürgen Haas
Objectives (Learning Outcome)	▪ Students who have successfully completed this module ▪ can set biopharma industry sustainable goals in context with the Sustainable Development goals of the United Nations ▪ possess the theoretical knowledge in tools to calculate sustainable metrics, e.g. Process Mass Intensity ▪ understand how Life Cycle Assessments are performed, e.g. to calculate CO_2 emissions ▪ know the basics of circular economy and eco-design in context of biopharmaceuticals ▪ know the essential impact categories on environment and human health ▪ are able to compare sustainable development topics across industry sectors ▪ have a basic knowledge about the business drivers for sustainability in biopharmaceutical industry
Lecture topics (content)	▪ 17 global Sustainable Development (SD) goals of the United Nations ▪ derived SD goals for the biopharmaceutical industry, e.g. carbon footprint, resource depletion ▪ policies, programs and initiatives of biopharma companies and suppliers with respect to SD ▪ principles of sustainability, e.g. Circular Economy, Eco-design ▪ definition of the development and manufacturing process in terms of system boundaries like „cradle to gate“ and „cradle to grave“, “gate to gate” for mass and CO2 balancing ▪ metrics, methods, tools to measure “sustainability”, e.g. Process Mass Intensity Tool (PMI), Sustainability Assessment Tool (SAT), Life Cycle Inventory (LCI), Life Cycle Assessment (LCA) ▪ impact categories on environment and human health ▪ biopharma industry examples for PMI and LCA – comparison with other industries, e.g. automotive ▪ topics of sustainability, e.g. process technologies, comparison of stainless steel versus single use ▪ business drivers und business value for sustainable development

	▪ certification, ISO-norms, databases, biopharma industry consortia
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	▪ in person lecture with tasks to deepen topics ▪ discussion about topics in the lecture
Examination	written summary (about 20 pages) on an individual topic with a short oral presentation (about 10-15 minutes)
Literature list	Amasawa_2021_Cost Benefit Analysis MAB Life Cycle Ooerating Costs.pdf Barbaroux Pollard_2021_Creating-a-susatainability-alt-data.pdf Baron_2012_TowardsAGreenerPharmacyByMoreEcoDesign.pdf Becker_2022_Green chemistry sustainability metrics in pharmac manufact.pdf Belkhir_2019_Carbon footprint of global pharmaceutical industry.pdf Belkhir_2019_Carbon footprint of global pharmaceutical industry_JH.pdf Belkhir_2019a_Big Pharma emits more greenhouse gases than the automotive... Budzinski_2019_Introduction of a process mass intensity metric for biologics.pdf Budzinski_2019_Introduction of a process mass intensity metric for biologics_J... Bunnak_2016_Life-cycle and cost of goods assessment of fed-batch and perfu... Bunnak_2016_Life-cycle and cost of goods assessment of fed-batch and perfu... Cespi_2015_Life cycle inventory improvement in assessment of sustainability c... Chang_2019_Evaluation Alliance Partners in Green Biopharma Industry.pdf Cytiva_2013_An environmental life cycle assessment SU vs conventional.pdf Cytiva_2017_Single-use technology and sustainability.pdf Dong_2020_The+development+of+circular+economy+in+biopharmaceutical.... Dong_2020_The+development+of+circular+economy+in+biopharmaceutical_... ecovadis_2020_commitment-zahlt-sich-aus-der-roi-von-nachhaltigkeit.pdf ecovadis_2021_business-sustainability-risk-and-performance-index.pdf Erickson_2021_End-to-end collaboration transform biopharmaceutical dev ma... Erickson_2021_End-to-end collaboration transform biopharmaceutical dev ma... GaBi_Education_License_Application_Form.pdf GaBi_Life_Cycle_Engineering_Suite_24.pdf GaBi-ts_flyer_01.pdf GE Healthcare_2020_Single use and sustainability_LCA.pdf Geipel-Kern_2022_process_warum-sich-in-der-chemie-vieles-aendern-muss_1... ISO_2006_ISO14040_Life CycleAssessment.pdf

	Jeswiet_2004_Eco Design and future environmental impacts.pdf Jimenez-Gonzales_2022_Green metrics in pharmac development.pdf Lalor_2019_Sust in Biopharma-holistic approach.pdf Lokko_2018_Biotechnology bioeconomy.pdf Mueller_2022_Process intensification in biopharma industry.pdf Pietrzykowski_ 2013_LCA comparison single use and convent technology.pdf Process_2022_warum-der-modularen-anlage-die-zukunft-gehoert_2022_JH.pdf Ramasamy_2015_LCA as tool in biopharmaceutcial industry.pdf Ramasamy_2015_LCA as tool in biopharmaceutcial industry_JH.pdf RAMASAMY_2018_Thesis_Environm-Based Decision-Making Biopharma-Ind.pdf Sala-European Commission_2017_Global_normalisation_factors_for_LCA.pdf Sala-European Commission_2017_Global_normalisation_factors_for_LCA_JH.pdf Sala-European Commission_x_Life cycle assessment.pdf Sartorius_2017_sustainability-report-en-data.pdf Schmidt_2018_Process intensification in biomanufacturing driven by advances... Sheldon_2018_Metrics of Green Chemisitry and Sustainability.pdf Sheldon_2022_Metrics of Green Chemistry.pdf SimaPro9_Introduction to LCA.pdf Veleva_2017_Lessons from Biogen zero waste journey.pdf Whitford_2018_Single-use and sustainability_ Continued studies using LCA too... Whitford_2018_Single-use and sustainability_ Continued studies using LCA too... Zanni_2017_LCA in an eco design of environmental biotechnology for air treat...

2.4.2. Advanced Therapeutic Medicinal Products (ATMP)

Credits (ECTS)	3 Credits
Lecture hours (SWS)	2 SWS
Prerequisite	
Semester (Summer/Winter/Both)	Both
Lecturer	Dr. Johannes Solzin, Dr. Abhilash Chiramel, Dr. Friedrich Kaess and Dr. Thomas Kriehuber (from Boehringer Ingelheim).
Objectives (Learning Outcome)	Give an idea to students on how to improve patients life by using viruses
Lecture topics (content)	The following contents are taught in this elective compulsory (Wahlpflichtfach): ▪ What are ATMPs? Differences to “classical” biologics ▪ What is emerging on the market? An overview about new therapeutic modalities ▪ Viruses as therapies? How do they work in e.g. oncology or hereditary disease ▪ Understanding the virus replication cycle and the role of the immune system ▪ Development of manufacturing processes for therapeutic viruses ▪ How to analyze a whole virus? Methods to measure infectivity and safety of therapeutic viruses ▪ How to keep viruses “alive"? Formulation development of viruses for therapy
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Lecture and interactive seminar
Examination	Written examination
Literature list	

2.5. Disciplinary Electives

2.5.1. Equipment and Plant Engineering IBT Lecture (Part 1)

Topic: General Aspects and Material Science

Credits (ECTS)	2 Credits
Lecture hours (SWS)	2 SWS
Prerequisite	successful participation in the scale-up laboratory course (if places are available)
Semester (Summer/Winter/Both)	Summer
Lecturer	Dr. Britta Schwartze
Objectives (Learning Outcome)	Students who have successfully completed this module have basic skills in project management know the phases of plant engineering projects know in principal documentation requirements in the planning phase of plant construction can scale-up processes following different scale-up criteria can use basic economic equations for economic assessment have knowledge on legal and sustainability aspects for plant engineering know the basics on equipment design can calculate mechanical and thermal material properties can distinguish materials according to different material classes
Lecture topics (content)	▪ General aspects on plant engineering and construction ▪ Project management ▪ Basics of scale-up ▪ Economic feasibility study ▪ Contracting ▪ Sustainability aspects ▪ Overview on equipment design and manufacturing ▪ Material science: mechanical, physical, chemical and tribological properties of materials and classes of materials
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	In person lecture
Examination	Written examination
Literature list	Chemietechnik, E. Ignatowitz, Verlag Europa-Lehrmittel, 2015 Entwicklung und Planung verfahrenstechnischer Anlagen, S. Ripperger, K. Nikolaus, Springer Vieweg, 2020 Projektierungspraxis Verarbeitungsanlagen, P. Römisch, M. Weiß, Springer Vieweg, 2014 Project Management (IPMA), Karen Dittmann et al., Haufe Group, 1. Auflage, 2020 Projekte und Projektmanagement, S. von Känel, Springer Gabler 2020 Crashkurs Projektmanagement, Sabine Peipe, Haufe Group, 8. Auflage, 2020

	Nitsche-Planungs-Atlas, Planung und Berechnung verfahrenstechnischer Anlagen, M. Nitsche, Springer Vieweg, 2020 Mechanisches Verhalten der Werkstoffe, J. Rösler et al., , Springer Vieweg 2019, 6. Auflage Werkstoffe, E. Hornbogen et al., Springer Vieweg 2019, 12. Auflage

2.5.2. Equipment and Plant Engineering IBT Lecture (Part 2)

Topic: Technology, Function and Manufacture of Fittings and Appliances

Credits (ECTS)	1 Credit
Lecture hours (SWS)	1 SWS
Prerequisite	successful participation in the scale-up laboratory course (if places are available)
Semester (Summer/Winter/Both)	Summer
Lecturer	Dipl.-Ing. (FH) Klaus Mensch
Objectives (Learning Outcome)	▪ Students who have successfully completed this module ▪ know the function of fittings and their components (especially seals) ▪ have a basic knowledge of the manufacturing processes in general and especially in welding technology and machining production ▪ are able to read drawings
Lecture topics (content)	▪ Fittings & the influence of corrosion ▪ Seals and sealing systems ▪ Basics of production technology ▪ Special processes of production technology in valve construction ▪ Basics and exercises on design theory
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	In person lecture (teaching language is German, language on teaching material is English
Examination	Written examination
Literature list	

2.5.3. Process Development / Scale Up (Laboratory)

Credits (ECTS)	5 Credits
Lecture hours (SWS)	4 SWS
Prerequisite	Recommendation: Pre-knowledge in process engineering, technical microbiology, mathematics and statistics, practical course in process engineering, practical course in technical microbiology
Semester (Summer/Winter/Both)	Summer
Lecturer	Prof. Dr. Frühwirth, Britta Schwartze
Objectives (Learning Outcome)	Students participating in that course, ▪ are able to use measurement data obtained in the laboratory for the mathematical description of the processed basic operations ▪ have the ability to investigate complex biotechnological issues experimentally in small, project-oriented groups and to incorporate the knowledge gained into a system scale-up
Lecture topics (content)	▪ Process development: Independent pursuit of a task from the definition of the topic to the rough draft of an industrial plant ▪ Experimental development of biotechnological processes: project plan, laboratory protocol, results ▪ Creation of project documentation, block flow diagram, material flow table ▪ Technology mapping ▪ Outlook on industrial implementation
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Laboratory, practical training
Examination	Written paper and presentation
Literature list	Internship "Process Development/Scale up" • Erikson, Johansson, Design of Experiments, Umetrics 2008. Schwister, Lewen, Process Engineering for Engineers, Hanser, 2019

2.5.4. Organical Chemistry and Natural Products Lecture

Credits (ECTS)	2 Credits
Lecture hours (SWS)	2 SWS
Prerequisite	Basic knowledge in Organic chemistry and natural products
Semester (Summer/Winter/Both)	Summer
Lecturer	Prof. Dr. Schips
Objectives (Learning Outcome)	Students who have successfully completed this module ▪ have knowledge of the most important methods of organic-preparative chemistry in connection with the synthesis of natural substances ▪ can apply preparative unit operations of organic chemistry in the laboratory ▪ know the most important reaction mechanisms of organic chemistry ▪ are in the able to process and chemically modify natural substances ▪ know current trends in the biotechnological industry ▪ can explain the concept of the biorefinery ▪ can interpret current reports from industrial biotechnology
Lecture topics (content)	Basic concepts of organic reactions: reactivity of functional groups according to substance classes, reactions of alkanes, nucleophilic substitution, elimination, addition, electrophilic aromatic substitution, reactions of carbonyl compounds, enolates and enols, selected classes of natural substances (carbohydrates, fats and oils, terpenes, alkaloids)
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Lecture
Examination	Written examination
Literature list	•„Grundlagen der Organischen Chemie“ Joachim Buddrus, Walter de Gruyter GmbH (2015), ISBN 978-3-11-030559-3. •„Basisbuch Organische Chemie“ Carsten Schmuck, PearsonVerlag (2018), ISBN 978-3-8632-6821-3. •„Organische Reaktionen“ Ulrich Lünig, Spektrum (2010), ISBN: 978-8274-2478-5 •„Naturstoffchemie" Peter Nuhn, Hirlitz (2006), ISBN: 978-37-7761363-5

2.5.5. Organical Chemistry and Natural Products Laboratory

Credits (ECTS)	4 Credits
Lecture hours (SWS)	4 SWS
Prerequisite	Basic knowledge in Organic chemistry and natural products
Semester (Summer/Winter/Both)	Summer
Lecturer	Prof. Dr. Schips
Objectives (Learning Outcome)	Students who have successfully completed this module ▪ have knowledge of the most important methods of organic-preparative chemistry in connection with the synthesis of natural substances ▪ can apply preparative unit operations of organic chemistry in the laboratory ▪ know the most important reaction mechanisms of organic chemistry ▪ are in the able to process and chemically modify natural substances ▪ know current trends in the biotechnological industry ▪ can explain the concept of the biorefinery ▪ can interpret current reports from industrial biotechnology
Lecture topics (content)	▪ Teaching of classic separation methods in the laboratory (recrystallization, extraction, suction, distillation) ▪ Characterization of organic compounds via melting point, refractive index, IR spectra, HPLC and GC separation ▪ Preparative synthetic methods, basic reaction types: Substitution, addition, elimination, CH-acidic reactions on selected compound classes, creation of a literature preparation ▪ Organic reactions with renewable raw materials (vegetable oils, cellulose digestion)
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Laboratory
Examination	Written examination
Literature list	•„Organikum“ 24. Auflage (2015), WILEY-VCH Verlag, ISBN: 978-3-527-33968-6 •„Integriertes Organisch-Chemisches Praktikum (I.O.C.-Praktikum)“ Siegfried Hünig, Lehmanns (2012), ISBN: 978-3-86541-149-5 •„Praktikum Präparative Organische Chemie“ R. Brückner, Spektrum (2009), ISBN: 978-3-8274-1981-1

2.5.6. Information Retrieval /-management

Credits (ECTS)	2
Lecture hours (SWS)	2 SWS
Prerequisite	Basic knowledge of MS (Office Word/Powerpoint) and internet research
Semester (Summer/Winter/Both)	Summer
Lecturer	Prof. Dr. Grammel
Objectives (Learning Outcome)	Students who have successfully completed this module ▪ have acquired skills necessary for highly qualified activities in various areas of a modern information society ▪ master the use of various sources of information, mainly internet-based databases with a focus in life sciences/biotechnology ▪ Different sources of information can be critically ▪ evaluated ▪ know appropriate information resources in the field of biotechnology and can use them adequately
Lecture topics (content)	▪ Search engines, catalogues, databases on the Internet ▪ Original scientific literature ▪ scientific publication practice ▪ Patent Search ▪ Molecular biology databases and bioinformatics
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Lecture and Exercises
Examination	Written examination
Literature list	

2.5.7. Product Isolation

Credits (ECTS)	2 Credits
Lecture hours (SWS)	2 SWS
Prerequisite	
Semester (Summer/Winter/Both)	Summer
Lecturer	Prof. Dr. Ebert
Objectives (Learning Outcome)	▪ Master the important principles and methods of Protein purification on laboratory and process scale ▪ are able to practically process biomolecules and to characterize ▪ can precipitation processes, protein crystallization, Chromatography and tangential flow filtrations practical carry out ▪ can biomolecules on the measurement of Characterize enzyme activities ▪ can determine the purity of protein solutions
Lecture topics (content)	▪ Introduction to the processing of biomolecules ▪ Cell disruption methods ▪ Basics of chromatography ▪ Chromatographic separation methods for the separation of Biomolecules (ion exchanger, hydrophobic interaction, mixed mode, affinity, reversed phase and size exclusion) ▪ Process design for production scale ▪ Radial and continuous chromatography ▪ Precipitation and crystallization ▪ Filtration process ▪ Two-phase systems for the separation of biomolecules
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Lecture
Examination	Written Examination
Literature list	

2.5.8. Bioprocessing Technology Lecture

Credits (ECTS)	2 Credits
Lecture hours (SWS)	2 SWS
Prerequisite	
Semester (Summer/Winter/Both)	Summer
Lecturer	Prof. Dr. Ebert
Objectives (Learning Outcome)	Students who have successfully completed this module ▪ are familiar with biological processes for substance production Microorganisms in bioreactors ▪ are capable of practically im a fed-batch fermentation 20 L scale, product processing and analysis to carry out as well as to evaluate and to the process balance ▪ master basic aspects of statistical design of experiments
Lecture topics (content)	▪ Economic efficiency of bioprocesses under consideration different aspects of a production ▪ media components and media composition, media development ▪ Growth kinetics and growth models (Monod model and logistical growth) ▪ Balancing of bioprocesses ▪ Derivation of bioprocess models (batch, fed-batch, Continuous processes with and without cell retention) ▪ Cleaning and sterilization processes ▪ Transport processes in organic suspensions ▪ Introduction to statistical design of experiments (full factorial and partial factorial designs, Data evaluation, introduction to the "MODDE" software)
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Lecture
Examination	Written Examination
Literature list	▪ Chmiel, Horst; Bioprozesstechnik, Spektrum-Verlag, 3.Auflage ▪ Storhas, Winfried; Bioverfahrensentwicklung; Wiley-VCH, 2.Auflage ▪ Villadsen, John; Fundamental Bioengineering; Wiley-VCH,1. Auflage ▪ Hu, Wei-Shou; Engineering Principles in Biotechnology;Wiley, 1. Auflage

2.5.9. Protein Chemistry

Credits (ECTS)	2 Credits
Lecture hours (SWS)	30 SWS
Prerequisite	Basic knowledge in Biochemistry
Semester (Summer/Winter/Both)	Summer
Lecturer	Prof. Dr. Ebert
Objectives (Learning Outcome)	Students who have successfully completed this module ▪ know the structure of the proteins and the influence ▪ certain amino acids on the secondary structure ▪ know methods for engineering enzymes (e.g. ▪ Directed Evolution, CASTing) ▪ master the most important cofactors and ▪ Reaction types and mechanisms in which these are involved
Lecture topics (content)	Introduction to protein chemistry Structure and composition of proteins: Stereochemistry of the main chain, structure and mobility of the side chain, acid-base behavior of the side chains, Side chain polarity, chemical differentiation Structural systems in proteins (helix, sheet, turning point, domains), X-ray structure analysis, interaction between protein side chains Non-protein structural components (glycosylation, phosphate groups, N-terminal acyl residues) Enzyme screening and protein engineering (rational design, directed evolution, saturation mutagenesis (CAST, B-Fit) Coenzymes and reaction mechanisms
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Lecture
Examination	Written examination
Literature list	▪ Alfred Schellenberger (Hrsg.) Enzymkatalyse: Einführung in die Chemie, Biochemie und Technologie der Enzyme, Springer-Verlag, ISBN: 978-3642734366 ▪ Buchholz, Klaus, Kasche, Volker, Bornscheuer, Uwe Theo. Biocatalysts and Enzyme Technology, Wiley VCH-Verlag GmbH, ISBN: 9783527329892 ▪ Aehle, W. Enzymes in Industry, Production and Application, Wiley VCH Verlag GmbH, ISBN 9783527316892

2.5.10. Cell Culture Technology Seminar (PBT15-ZKS)

Credits (ECTS)	2 Credits
Lecture hours (SWS)	1 SWS
Prerequisite	Recommendation: Lecture Cell Biology, Practical Course Technical Microbiology
Semester (Summer/Winter/Both)	Both
Lecturer	Prof. Dr. Hannemann
Objectives (Learning Outcome)	Students who have successfully completed this module, ▪ know the principal function of the equipment used in cell biology laboratories (e.g. microscopes, sterile workbenches (laminar flow benches), CO2-Incubators, etc.). ▪ can name the advantages and disadvantages of the different transfection methods ▪ know the use of retroviral vectors for gene transfer and for use as gene therapy medicinal products (ATMP). ▪ know the basic methods for isolating transfected and selected cells (adherent cells and suspension cells). ▪ know the function of the serum frequently used in cell culture (as a media additive) and the basic functions of the growth factors used. ▪ have a good basic theoretical knowledge of standard methods in cell biology laboratories (e.g. trypsinization of adherent cells, cell counting using Neubauer cell counting chamber and automated systems (Cedex), transfection of adherent cells with different transfection reagents, upscaling of suspension cells (hybridoma cells) from T25 flask to shake flask, spinner to 2L benchtop fermenter, analysis of cellular GFP (Green Fluorescent Protein) expression using inverted fluorescence microscope and flow cytometry. ▪ know the differences when working with adherent cells and cells growing in suspension. ▪ know different cell lines (adherent and suspension cell lines).
Lecture topics (content)	▪ History of cell culture technology ▪ Theory of sterile working techniques ▪ Sources and types of contamination ▪ Media and media components ▪ Laboratory equipment and sterilization ▪ Cell staining and cell count ▪ Cultivation vessels and conditions ▪ Cell types (adherent cells and suspension cells) ▪ Different transfection and selection methods ▪ Gene transfer using retroviral vectors and quantification of these recombinant viruses
Teaching format	Seminar

(e.g. online / in person lecture / Seminar / Lab etc.)	
Examination	Written exam (90 mins) (for the module)
Literature list	▪ Zell- und Gewebekultur: Einführung in die Grundlagen sowie ausgewählte Methoden und Anwendungen, Toni Lindl, 2. Auflage, 2013, ISBN 978-3827411945 ▪ Culture of Animal Cells: A Manual of Basic Technique, R. Ian Freshney, 2. Auflage 2005, ISBN 978-0471453291

2.5.11. Cell Culture Technology Laboratory (PBT15-ZKT)

Credits (ECTS)	6 Credits
Lecture hours (SWS)	5 SWS
Prerequisite	Recommendation: Lecture Cell Biology, Practical Course Technical Microbiology
Semester (Summer/Winter/Both)	Both
Lecturer	Prof. Dr. Hannemann
Objectives (Learning Outcome)	Students who have successfully completed this module, ▪ know the principal function of the equipment used in cell biology laboratories (e.g. microscopes, sterile workbenches (laminar flow benches), CO2-Incubators, etc.). ▪ can carry out sterile processes under a sterile workbench as part of cell culture work. ▪ know the basic methods for isolating transfected and selected cells (adherent cells and suspension cells). ▪ know the function of the serum frequently used in cell culture (as a media additive) and the basic functions of the growth factors used. ▪ have a good basic practical knowledge of standard methods in cell biology laboratories (e.g. trypsinization of adherent cells, cell counting using Neubauer cell counting chamber and automated systems (Cedex), transfection of adherent cells with different transfection reagents, upscaling of suspension cells (hybridoma cells) from T25 flask to shaker flask and roller bottles, analysis of cellular GFP (Green Fluorescent Protein) expression using inverted fluorescence microscope and flow cytometry. ▪ know the differences when working with adherent cells and cells growing in suspension. ▪ know different cell lines (adherent and suspension cell lines).
Lecture topics (content)	▪ Sterile work under a sterile workbench ▪ Cultivation of cells that grow adherently or in suspension ▪ Expansion of suspension cells from the T-flask, shaking flask, spinner to roller bottles ▪ Trypan blue staining and cell counting using the Neubauer counting chamber and the automated cell counting device "Cedex” ▪ Calculate and set the required cell density for passaging cells ▪ Different transfection methods ▪ Analysis of fibroblast cells transfected with the GFP (Green Fluorescent Protein) gene by fluorescence microscope and flow cytometer ▪ Analysis of in-process controls such as glucose content, pO2, pH, ammonium, lactate.
Teaching format	Laboratory

(e.g. online / in person lecture / Seminar / Lab etc.)	
Examination	Written exam (90 mins) for the module
Literature list	▪ Zell- und Gewebekultur: Einführung in die Grundlagen sowie ausgewählte Methoden und Anwendungen, Toni Lindl, 2. Auflage, 2013, ISBN 978-3827411945 ▪ Culture of Animal Cells: A Manual of Basic Technique, R. Ian Freshney, 2. Auflage 2005, ISBN 978-0471453291

2.5.12. Biotechnology Lecture Series (PBT18-BÖR)

Credits (ECTS)	2 Credits
Lecture hours (SWS)	1 SWS
Prerequisite	Recommendation: Microbiology, Cell and Molecular Biology, Technical Microbiology, Pharmaceutical Biotechnology, Protein Biochemistry, Genetic Engineering. Contents connection with “Selected topics of modern Biotechnology”.
Semester (Summer/Winter/Both)	Both
Lecturer	Prof. Dr. Gaisser
Objectives (Learning Outcome)	Successful participants will improve their English language skills and further expand their academic knowledge based on contents of recently published papers. ▪ Further improvement of self-directed learning skills and self-competence, promoted by reading recently published articles and preparation of slides required for their respective presentations. ▪ Presentations are given in English, students deliver their presentations in front of an audience (course participants). ▪ Participants gain an overview of different aspects of current biotechnological methods and developments in industry and research preparing their presentation and during lectures presented in the accompanying lecture series. The lecture series provides the opportunity to invite researchers working in different industrial areas or laboratory teams presenting overviews over recent developments as experts in their respective fields.
Lecture topics (content)	The content changes depending on the selected topics and lecturers
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Lectures, Presentations
Examination	Written exam (60mins)
Literature list	Is specified in the individual courses and changes every semester

2.5.13. Selected Topics of Modern Biotechnology (PBT18-ATB)

Credits (ECTS)	3 Credits
Lecture hours (SWS)	2 SWS
Prerequisite	Recommendation: Contents of biotechnologically relevant modules of semesters 1-3. Contents connection with "Biotechnology Lecture Series"
Semester (Summer/Winter/Both)	Both
Lecturer	Prof. Dr. Gaisser
Objectives (Learning Outcome)	Successful participants will improve their English language skills and further expand their academic knowledge based on contents of recently published papers. ▪ Further improvement of self-directed learning skills and self-competence, promoted by reading recently published articles and preparation of slides required for their respective presentations. ▪ Presentations are given in English, students deliver their presentations in front of an audience (course participants). ▪ Participants gain an overview of different aspects of current biotechnological methods and developments in industry and research preparing their presentation and during lectures presented in the accompanying lecture series. The lecture series provides the opportunity to invite researchers working in different industrial areas or laboratory teams presenting overviews over recent developments as experts in their respective fields.
Lecture topics (content)	▪ Introduction, Drug Discovery: An Overview ▪ Natural Products, Marine-derived Drugs ▪ Antibiotics ▪ Problems and Pathogens: Coronavirus Outbreak ▪ Problems and Pathogens: Vector-borne Diseases ▪ Biofilm ▪ Microbiota and Disease ▪ Plant-based Production of Pharmaceuticals ▪ Malaria and Artemisinin, Avermectin ▪ Biopharmaceutical Benchmarks
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Seminar
Examination	Written exam (60mins)
Literature list	Recent publications

2.5.14. Downstream Processing (PBT14_BAV/BAP)

Credits (ECTS)	8 Credits
Lecture hours (SWS)	8 SWS
Prerequisite	Lecture "Downstream Processing (Recommended)
Semester (Summer/Winter/Both)	Both
Lecturer	Prof. Dr. Kiefer
Objectives (Learning Outcome)	Students who have successfully completed this module ▪ know the processing of proteins and other biopharmaceutical active substances from different sources ▪ can describe how their degree of purity is determined, how critical contaminants are detected and removed ▪ can select which methods are suitable for different tasks in each case. ▪ have been given an overview of methods used in the processing of biopharmaceuticals, especially proteins, on a laboratory and industrial scale and can select the appropriate methods themselves in specific cases. ▪ Use chromatography and filtration techniques in the laboratory to purify and analyze recombinant proteins from different sources. ▪ have learned how to use the chromatography system (ÄKTA pure) independently. They can pack columns and check their packing quality.
Lecture topics (content)	▪ Overview of multi-stage purification processes ▪ Cell harvesting, preparation of a lysate; centrifugation and microfiltration techniques. ▪ Chromatography: IEX, SEC, HIC, RPC, AC ▪ Ultrafiltration, diafiltration, adsorber membranes ▪ Separation of DNA, viruses, endotoxin, host cell proteins (HCPs) and product-related contaminants ▪ Special purification techniques: extraction from aqueous multiphase systems, radial flow chromatography, continuous chromatography, precipitation and crystallization ▪ Design and implementation of PAT (Process Analytical Technologies) and QbD (Quality by Design) ▪ Set-up and operation of the ÄKTA-pure chromatography systems
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Lecture / Lab
Examination	Written examination
Literature list	▪ Lecture presentations

	▪ Desai, Mohamed A. [Hrsg.]: Downstream processing of proteins: methods and protocols, Humana Press, 2000; ISBN 0-89603-564-6 ▪ Protein purification manuals from GE Healthcare (available via ILIAS as pdf) ▪ Special issue BioProcess International March 2008 (available via ILIAS as pdf)

2.5.15. Plant and Apparatus Engineering in PBT (PBT13-AAB)

Credits (ECTS)	3 Credits
Lecture hours (SWS)	2 SWS
Prerequisite	Recommendation: Fundamentals of Process Engineering, Thermal and Mechanical Process Engineering
Semester (Summer/Winter/Both)	Both
Lecturer	Prof. Dr. Hesse
Objectives (Learning Outcome)	Students who have successfully completed this module, ▪ can apply the relevant design criteria in biopharmaceutical manufacturing processes (technologies in measurement and control technology, clean room design, sterile technology and in the planning of biopharmaceutical production facilities). ▪ know the process variables, the laboratory and application-oriented process measurement and control technology as well as the reference to operational practice. ▪ know the functional principles and the mode of operation of measuring, actuating and control elements as well as the possible sources of error. ▪ know the planning phases of a pharmaceutical plant from pre-project planning to commissioning and are familiar with the design aspects of fittings as well as the possibilities and limits of different membrane filter tests. ▪ know planning contents, planning tools, required qualification documents, qualification and validation processes as well as risk analyses. ▪ know the basics of sterile and cleanroom technology (terminology, history and structural conditions, cleanroom classes). ▪ know the relationship between particles, germs and cleanroom class, the difference between turbulent mixed flow and low-turbulence displacement flow. ▪ can plan premises for the production of active pharmaceutical ingredients with the aid of the relevant regulations.
Lecture topics (content)	Plant design in the pharmaceutical industry: documentation and information (databases, flow diagrams: Block flow diagram, process flow diagram, P&I flow diagram), equipment, pipe classes, layout planning, pipe routing, support areas for production, feasibility studies, contracts and risks, approval procedures, official requirements, plant planning with phase model, project planning (concept, basic and detail engineering, safety analyses, operating manual), planning tools, qualification

	documentation, qualification and validation, risk analysis (FMEA). ▪ Technical basics in plant engineering for hygienic and sterile applications: Selection criteria for plant and equipment components (materials, sealing technology), surface finishes and connection types, valve function principles, diaphragm valves for sterile processes, poppet valves for steam, valves in control applications. ▪ Integrity test on membrane filters: physical basics of the test procedures, bubble point test, forward flow test, water intrusion test, integrity test equipment.
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Lecture
Examination	Written exam (60mins)
Literature list	G. Bernecker: Planung und Bau verfahrenstechnischer Anlagen: Projektmanagement und Fachplanungsfunktionen, Springer Verlag Berlin, 2001 ▪ R. Herz: Grundlagen der Rohrleitungs- undApparatetechnik, Vulkan-Verlag Essen, 2009 ▪ L. Gail, H.-P. Hortig (Hrsg.): Reinraumtechnik, Springer-Verlag Berlin, 2001 ▪ Chmiel, H.: Bioprozesstechnik, Spektrum Akademischer Verlag, 2011 ▪ FMEA- Fehlermöglichkeits- und Einflussanalyse,Deutsche Gesellschaft für Qualität, DGQ-Band 13-11,2008 ▪ Paul Präve: „Standardisierungs- und Ausrüstungs-empfehlungen für Bioreaktoren und periphereEinrichtungen“, Frankfurt am Main, DECHEMA, 1991

2.5.16. Biotechnological Processing (PBT12-BVT)

Credits (ECTS)	3 Credits
Lecture hours (SWS)	3 SWS
Prerequisite	Recommendation: Lecture Protein Biochemistry
Semester (Summer/Winter/Both)	both
Lecturer	Prof. Dr. Kiefer
Objectives (Learning Outcome)	students who have successfully completed this module, ▪ know the processing of proteins and other biopharmaceutical active substances from different sources, ▪ can describe how their degree of purity is determined, how critical contaminants are detected and removed ▪ can select which methods are suitable for different tasks in each case. ▪ have been given an overview of methods used in the processing of biopharmaceuticals, especially proteins, on a laboratory and industrial scale and can select the appropriate methods themselves in specific cases. ▪ Use chromatography and filtration techniques in the laboratory to purify and analyze recombinant proteins from different sources. ▪ have learned how to use the chromatography system (ÄKTA pure) independently. They can pack columns and check their packing quality. ▪ have learned protein analytical methods theoretically and practically, which can be carried out in biochemical laboratories without expensive technical equipment. ▪ can independently compile original English-language publications from topics of protein analytics and present them in English. Based on these publications, they have obtained an overview of protein analytical techniques
Lecture topics (content)	▪ Overview of multi-stage purification processes ▪ Cell harvesting, preparation of a lysate; centrifugation and microfiltration techniques. ▪ Chromatography: IEX, SEC, HIC, RPC, AC ▪ Ultrafiltration, diafiltration, adsorber membranes ▪ Separation of DNA, viruses, endotoxin, host cell proteins (HCPs) and product-related contaminants ▪ Special purification techniques: extraction from aqueous multiphase systems, radial flow chromatography, continuous chromatography, precipitation and crystallization ▪ Design and implementation of PAT (Process Analytical Technologies) and QbD (Quality by Design)

	▪ Set-up and operation of the ÄKTA-pure chromatography system
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	In person lecture
Examination	Written Examination (90mins)
Literature list	▪ Lecture presentations ▪ Desai, Mohamed A. [Hrsg.]: Downstream processing of proteins: methods and protocols, Humana Press, 2000; ISBN 0-89603-564-6 ▪ Protein purification manuals from GE Healthcare (available via ILIAS as pdf) ▪ Special issue BioProcess International March 2008 (available via ILIAS as pdf

2.5.17. Protein Analytics Laboratory (PBT14-PAN)

Credits (ECTS)	3 Credits
Lecture hours (SWS)	3 SWS
Prerequisite	Recommendation: Lecture protein biochemistry, Seminar Protein Analytics (accompanying practical course)
Semester (Summer/Winter/Both)	Both
Lecturer	Prof. Dr. Kiefer
Objectives (Learning Outcome)	students who have successfully completed this module, ▪ know the processing of proteins and other biopharmaceutical active substances from different sources ▪ can describe how their degree of purity is determined, how critical contaminants are detected and removed ▪ can select which methods are suitable for different tasks in each case. ▪ have been given an overview of methods used in the processing of biopharmaceuticals, especially proteins, on a laboratory and industrial scale and can select the appropriate methods themselves in specific cases. ▪ Use chromatography and filtration techniques in the laboratory to purify and analyze recombinant proteins from different sources. ▪ have learned how to use the chromatography system (ÄKTA pure) independently. They can pack columns and check their packing quality. ▪ have learned protein analytical methods theoretically and practically, which can be carried out in biochemical laboratories without expensive technical equipment. ▪ can independently compile original English-language publications from topics of protein analytics and present them in English. Based on these publications, they have obtained an overview of protein analytical techniques.
Lecture topics (content)	▪ Purification of lysozyme from chicken egg white by ion exchange chromatography, protein determination by BCA assay, SDS gel electrophoresis, activity determination ▪ Measurement and optimization of protein stability ▪ Removal and detection of critical contaminants (endotoxin, DNA, HCPs) from a protein solution ▪ Measurement of protein-ligand binding, determination of KD and Bmax
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Laboratory
Examination	Written exam (60mins)
Literature list	▪ Experiment instructions

	▪ Literature of the seminar Protein Analysis

2.5.18. Protein Analytics Seminar (PBT14-SPA)

Credits (ECTS)	1 Credit
Lecture hours (SWS)	1 SWS
Prerequisite	Recommendation: Lecture Protein Biochemistry
Semester (Summer/Winter/Both)	Both
Lecturer	Prof. Dr. Kiefer
Objectives (Learning Outcome)	students who have successfully completed this module, ▪ know the processing of proteins and other biopharmaceutical active substances from different sources, ▪ can describe how their degree of purity is determined, how critical contaminants are detected and removed ▪ can select which methods are suitable for different tasks in each case. ▪ have been given an overview of methods used in the processing of biopharmaceuticals, especially proteins, on a laboratory and industrial scale and can select the appropriate methods themselves in specific cases. ▪ Use chromatography and filtration techniques in the laboratory to purify and analyze recombinant proteins from different sources. ▪ have learned how to use the chromatography system (ÄKTA pure) independently. They can pack columns and check their packing quality. ▪ have learned protein analytical methods theoretically and practically, which can be carried out in biochemical laboratories without expensive technical equipment. ▪ can independently compile original English-language publications from topics of protein analytics and present them in English. Based on these publications, they have obtained an overview of protein analytical techniques.
Lecture topics (content)	▪ Protein identification and quantification ▪ Protein Immunological detection methods ▪ Analysis of post-translational modifications ▪ Measurement of protein activity ▪ Micromethods/Mass spectrometry ▪ structure analysis
Teaching format (e.g. online / in person lecture / Seminar / Lab etc.)	Seminar
Examination	Written exam (60mins)
Literature list	▪ Issued original publications (changing) ▪ Introductions (presentations)