Syllabus for

Downstream Processing in Biotechnology

KBTN05, 7.5 ECTS, A (Advanced level)
Applies to: Academic year 2024/2025
Faculty: LTH, Lunds Tekniska Högskola
Decided by: Program management Biotechnology/Chemical engineering
Decision date: 2024-10-15

General information

Main field: Biotechnology
Language of instruction: The course is given in English

Description of course goal

This course has the primary goal of introducing students to the essential engineering principles involved in purifying bioproducts. Biochemical engineers are tasked with developing efficient and environmentally sustainable techniques for separating small and large biomolecules from complex fermentation mixtures. The aim of this advanced course is to provide a comprehensive understanding of the systematic and quantitative design of integrated downstream processes. By the end of the course, participants will possess the tools and knowledge necessary to create a cohesive downstream process that effectively integrates multiple stages while achieving the required level of product purity.

Objectives and learning outcomes upon the completing the course

The students are expected to:

- Demonstrate knowledge and understanding of different techniques and processes used to separate and purify products in biotechnological applications.
- Apply the appropriate separation techniques based on the specific characteristics of the target product.
- Analyze and evaluate the yield and purity of the separated products.

Skills and abilities

The students are expected to:

- Evaluate the impact of various physico-chemical properties and operating parameters on the effectiveness of separation processes.
- Propose and discuss a purification plan for a product derived from a specific bio-based source material.
- Design and optimize downstream processes to achieve desired product purity, yield, and quality. This involves understanding the principles of process development, scalability, and cost-effectiveness.

- Be familiar with the equipment and instrumentation used in downstream processing, such as chromatography systems, filtration units, centrifuges, and analytical instruments.
- Enhance their problem-solving abilities, learn how to identify and address challenges that may arise during downstream processing, and develop skills in troubleshooting and finding solutions to optimize processes.
- Present a comprehensive written report and give an oral presentation, describing a downstream process.

Evaluation ability and approach

The students are expected to:

- Be capable of gathering information from diverse sources and evaluating it independently. This involves conducting research, analyzing data, and critically assessing the reliability and relevance of the information obtained.
- Be able to critically evaluate another project task, which requires them to analyze and assess the strengths, weaknesses, and effectiveness of a given project or task. This evaluation may involve identifying areas for improvement, suggesting alternative approaches, or providing constructive feedback.
- Possess the ability to select appropriate unit operations based on the information available. This involves considering factors such as the characteristics of the desired product, the properties of the raw material, and the desired separation or purification objectives.
- Be able to conduct risk assessments specifically related to bioseparation processes. This involves identifying potential risks and hazards associated with the process, evaluating their likelihood and severity, and implementing appropriate measures to mitigate or manage these risks effectively.

Course Content

1. Introduction to Bioproducts:
    - Overview of bioproducts and their significance in biotechnology
    - Classification and characteristics of bioproducts
    - Current trends and applications of bioproducts
2. Introduction to Bioseparation
    - Stages of downstream processing
    - Basic principles of engineering analysis
    - Process and product quality: Purity and Yield

3. Separation Processes Used in Downstream Processing:
    - Cell Lysis
    - Filtration and membrane filtration
    - Sedimentation
    - Extraction
    - Precipitation and crystallization

- Protein chromatography
- Purification of nucleic acids
- Evaporation and drying
- Process design and integration

4. Protein chromatography
    - Introduction to proteins as macromolecules
    - Principles of protein chromatography
    - Purification strategy selection for target protein
    - Adsorption chromatography techniques
    - Size exclusion chromatography technique
    - Fiber and multimodal chromatography techniques
    - Purification process validation, evaluation and development

5. Bioprocess Design and Economics:
    - Principles of bioprocess design and optimization
    - Engineering aspects of downstream processing, including scale-up considerations
    - Economic analysis and cost estimation in downstream processing
    - Resource efficiency and sustainability in bioprocess design

6. Group Projects and Hands-on Activities

7. Laboratory exercises addressing downstream processing techniques and characterization methods

Course examination

Grade scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)

Performance assessment: Examination takes place through written exam, written and oral presentation of project assignment and through mandatory participation in laboratories and laboratory report.

If it is necessary for a student with a permanent disability to be given an equivalent examination option compared to a student without a disability, the examiner can, after consultation with the university's department for pedagogic support, decide on an alternative form of examination for the student concerned.

Subtask

Code: 0117. Title: Written exam.
Number of higher education credits: 3.5. Grade scale: TH. Performance assessment: Written exam
Code: 0217. Title: Project assignment.

Number of higher education credits: 2.5. Grading scale: UG. Performance assessment: Written and oral presentation of project tasks
Code: 0317. Title: Labs.
Number of higher education credits: 1.5. Grading scale: UG. Performance assessment: Laboratory report.

Admission information (high recommendation):
KBTF15 Bioprocess technology, KETF10 Separation processes or KETF40 / KTE170 Mass transfer processes in environmental engineering, KLGN20 Food technology.
KBKF15 Biology, KBKA10/ KBKF15 Biochemistry, with the fundamental knowledge in mathematics.

Course literature
Roger G. Harrison, Paul W. Todd, Scott R. Rudge and Demetri P. Petrides: Bioseparations Science and Engineering Second Edition. Oxford University Press, 2015, ISBN: 978-0-19-539181-7.

Contact information and other information
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