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| **Title and Code** of the subject:  **Industrial microbiology,** **MTBE7019A** | **ECTS Credit Points: 3** |
| **Type** of the subject: compulsory / optional | |
| **Ratio of theory and practice: 67/33** (credit%) | |
| **Type and number of classes per semester**: 28 hour(s) lecture and 14 hour(s) practice per **semester**  Number of teaching hours / week : eg.:2+1 (lecture and practice) | |
| **Type of exam**: exam / practical course mark | |
| **Subject in the curriculum:** semester 4. | |
| Preliminary requirements:Basics of microbiology, Biochemistry | |

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| **Summary of content - theory**: |
| Course objectives:  Based on biochemical and microbiological studies, the general objective of the subject is to provide more detailed knowledge about the biochemical and physiological processes of "industrial" micro-organisms used in biotechnology. The course covers the technical and technological basics of industrial microbiology, the most important operations and processes, and the qualitative and quantitative relationships between them.  **Schedule:**   1. Basic principles of microbiology. Introduction - Microorganisms and microbiology. A short journey in the world of microbes. Cell structure of prokaryotes and eukaryotes. 2. Phylogenetics and characteristics of industrial microbes. 3. Protein synthesis: amino acids, DNA and RNA processes. 4. Molecular biology / bioinformatics in biotechnology: PCR, qPCR, sequencing. 5. Molecular biology / bioinformatics in biotechnology: microarrays, databases. 6. Industrial fermentation media. Qualitative and quantitative characteristics of the medium. Water, carbon source, nitrogen source, phosphorus, sulphur, potassium, sodium, other ions, trace elements, vitamins, supplements. 7. Isolation, maintenance and development of industrial microorganisms. 8. Basics of fermentation. History of fermentation. 9. Upstream Processing: Engineering basics, unit operation. 10. Fermentation analytics. Basic elements of the control systems. Fermentation parameters: temperature, pH, stirring rate, dissolved oxygen content and redox potential of the medium, air flow rate, gas balance of inlet and outlet air, reactor current consumption and weight, pressure inside the reactor, degree of foaming. 11. Downstream processing. Extraction of extracellular product. Removal of solids and microorganisms. Filtration, centrifugation, precipitation. Recovery of intracellular products. Cell disruption. 12. Industrial Microbiological Products I. Biology and technology of the production of amino acids (L-lysine, L-glutamic acid, L-threonine). 13. Industrial Microbiological Products II. Biology and technology of fermentation production of organic acids (citric acid, itaconic acid, gluconic acid, lactic acid, acetic acid). 14. Industrial Microbiological Products III. Fermentable antibiotics. |
| **Summary of content - practice**: |
| Skills to be learnt: the technical and technological basics of industrial microbiology, the most important operations and processes, and the qualitative and quantitative relationships between them.  Schedule:  1-4: Structure, assembly and sterilization of different types of fermenters  5-10: Monitoring and control of fermentation processes.  11-14: Addition of fermentation: harvesting fermentation, separation of cells and fermentation media, product extraction |
| **Literature, handbooks in English** |
| 1. Nduka Okafor, Benedict C. Okeke: Modern Industrial Microbiology and Biotechnology, CRC Press, 2nd edition, 2018. ISBN: 9781138550186. 2. Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark: Brock Biology of Microorganisms, Benjamin Cummings, 13th edition, 2012. 3. Pirt JS: Principles of Microbe and Cell Cultivation. Blackwell Scientific Publications, Oxford, UK, 1975 4. Stanbury PF, Whitaker A: Principles of Fermentation Technology, Pergamon Press, Oxford, UK, 1984 |
| **Competencies gained** *(acc. to the Regulation on training and outcome requirements)* |
| 1. **Knowledge:**  * Know the most important biological processes in food production and their basic laws * Know the factors that fundamentally determine the quality and safety of food in terms of health conscious nutrition * Know the basic principles of laboratory testing for identifying food technology and food safety issues  1. **Skills:**  * Capable of assessing the risks to food chain safety of food commodities, storing and preserving value-added preserving processes for the production and preservation of safe foods  1. **Attitude:**  * Attaches constructively to the professional issues, initiates and is receptive to the novelties.  1. **Autonomy and responsibility:**  * The students is sensitive and open to problems in the food industry, strives to analyse and solve them. |

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| **Responsible lecturer: Dr. Károly Pál, senior research fellow, PhD** |
| **Other lecturer(s): Dr. habil Fekete Erzsébet, associate professor, PhD** |

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| **Terms of course completion:** |
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| **Form of examination:** |
| written exam |
| **Requirement(s) to get signature:** |
| participation at the practice |

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| **Exam questions:** |
| 1. What is the difference between traditional biotechnology and nucleic acid biotechnology? 2. What is the difference between industrial biotechnology and medical biotechnology in terms of fermentation scale (volume)? 3. What does ‘fevere’ means in Latin? 4. What do we call ‘fermented food’? 5. List four common features of prokaryotic and eukaryotic cells! 6. List four different features of prokaryotes and eukaryotes! 7. Name the parts of the mitochondrion! 8. What is the nucleolus? 9. Why is the work of Carl R. Woese important? 10. What are the three main groups in the phylogenetic tree? 11. What is the difference between the homofermentative and heterofermentative lactic acid production? 12. Why is nitrogen important for the microbial cell? What is the role of it? 13. Name a nitrogen source that is used in biotechnology in culture media! 14. Name two major mineral elements! 15. Name two trace elements! 16. What is trophophase and idiophase? 17. Describe briefly what happens during the trophophase! 18. Describe briefly what happens during the idiophase! 19. Describe briefly: corn steep, proflo (pharmamedia), distillers solubles, sulphite liqur. 20. What are the growth factors? 21. Name two vitamins that are growth factors! 22. What are the three major types of bioreactors? 23. What is the chemical equation for cellular respiration? 24. What is the ‘propagator’? 25. What are the main parameters to be measured in liquid phase in a fermentor? 26. What are the main parameters to be measured in gas phase in a fermentor? 27. What are the two types of probes that are used for measurement of dissolved oxygen in a fermentor? 28. What are the main steps of downstream processing? 29. What is an antibiotic? 30. Who did discover the penicillin? 31. What are the three main 'groups' of antibiotics? 32. What are the two natural penicillins used as medicines? 33. What microorganisms are used for the production of penicillin and cephalosporin? 34. Types of bioreactors and their characterization. Parts of fermenters and their characterization. 35. Possibilities of temperature control and sterilization of the different fermenter types. 36. The importance of bioreactor oxygen supply. Possibilities for calculating and determining dissolved oxygen supply. 37. Controlled elements of bioreactors. Basic elements of the control system. List, characterize, and control possibilities of fermentation parameters. 38. Options for extracting extracellular fermentation products and their characterization. 39. Opportunities for recovering intracellular fermentation products and their characterization. 40. Biology and technology of amino acid production. 41. Biology and technology of fermentation production of organic acids. 42. Biology and technology for the production of the most important antibiotics produced by fermentation. |