BIOTECH-08: **BIOCHEMISTRY AND PHYSIOLOGY OF INDUSTRIAL MICROORGANISMS**	
GENERAL INFORMATION	
Course Coordinator(s)	Ivica Strelec, PhD, full prof.
Associate(s)	Natalija Velić, PhD, assoc. prof. Hrvoje Pavlović, PhD, full prof.
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	1st Year / 2nd Semester
Credits (ECTS)	**6.5**
Teaching Method (number of classes)	Lectures 30; Seminars 15; Exercises 30
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The aim of this course is to provide advanced knowledge on biochemistry, microbiology, genetics and molecular enzymology necessary in application, analysis and evaluation of methods and procedures used during preparation and performance of biotechnological processes for nutraceuticals and pharmaceuticals production.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme of Natural sciences (chemistry, biology), Biotechnical sciences, Biomedicine or Health.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-2; INDBIOT-1; INDBIOT-2; MEDBIOT-2

Learning Outcomes at the Course Level

After successful completion of this course students should be to:

1. Compare structure and morphology of most important industrial microorganisms
2. Select and explain adequate methods for studying physiology and biochemistry of industrial microorganisms
3. Explain in depth membrane transport of prokaryotes and eukaryotes
4. Compare mechanisms of communication between prokaryotic/eukaryotic cells and biofilm formation
5. Compare catabolic and anabolic pathways of various industrial microorganisms
6. Explain differences between primary and secondary metabolism of various industrial microorganisms, and differentiate key secondary metabolites
7. Explain in depth aerobic and anaerobic processes in biotechnological production

Course Content

Lectures. Introduction to biochemistry and physiology of industrial microorganisms. Structure of the most important industrial microorganisms: elemental composition of cells, structure and function of cells and organelles, morphology and classification of microorganisms. Microbial growth and development: cell cycle and cell division, physiology, monitoring and kinetics of microbial growth, batch and continuous cultivation, biomass yield. Biological membranes, membrane transport and bioenergetics: membrane structure, prokaryotes and eukaryotes membrane functions, passive and active membrane transport, endocytosis and exocytosis, membrane transport kinetics, bacterial transport systems, protein transport and secretion, chemiosmotic theory, electrochemical energy, ionophores, organization of the electron carries in mitochondria and bacteria. Bioenergetics in cytosol: high-energy molecules and group transfer potential, central role of group transfer potential reactions in biosynthesis, ATP synthesis by substrate level phosphorylation. Cell-cell communication mechanisms: bacterial signal molecules,

signalling by signal molecules, signalling that requires contact, microbial biofilms. Primary metabolism of industrial microorganisms: glycolysis, Entner–Doudoroff (ED) pathway, pentose phosphate pathway, tricarboxylic acid (TCA) cycle, glyoxylate cycle, fatty acid oxidation, transamination and oxidative deamination of amino acids, oxidation of hydrocarbons, nitrification and denitrification, gluconeogenesis, fatty acid biosynthesis, amino acid biosynthesis, nucleotide biosynthesis. Secondary metabolism of common industrial microorganisms: differences between primary and secondary metabolism, physiological and morphological aspects of secondary metabolism, secondary metabolites: classification, function and microbial sources, secondary metabolism of peptide antibiotics, ergot alkaloids, immunosuppressive drugs, insecticides, herbicides and enzyme inhibitors. Production of microbial biomass, alcohols, organic acids, organic solvents, vitamins, antibiotics, enzymes and others. **Seminars.** Structure and growth of selected industrial microorganisms, primary and secondary metabolisms, industrial production of microbial biomass, alcohols, organic acids, organic solvents, vitamins, antibiotics, enzymes and others.
Laboratory exercises. Submerged and solid state cultivation of filamentous fungi, aerobic and anaerobic cultivation of S. cerevisiae, microbial production of citric acid, actinomycete as antibiotic producer - isolation, selection and mutagenesis.

Teaching Methods

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up.

Monitoring the Activity of the Students (Connecting Learning Outcomes, Teaching Methods, and Grading)

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Max.
Classes	0.5	1-7	Attendance to classes	Keeping records	2	10
Seminars	1.5	1-7	Preparation of seminar presentation	Seminar presentation	12	25
Laboratory exercises	1.5	1-7	Work in laboratory	Written report	6	15
Partial exams or final exam	3.5	1-7	Studying for the partial exams or final exam	Written exam	30	50
Total	**6.5**				**50**	**100**

Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade points
99.00 – 100.00	50
97.00 – 98.99	49
95.00 – 96.99	48
93.00 – 94.99	47
91.00 – 92.99	46
89.00 – 90.99	45
87.00 – 88.99	44
85.00 – 86.99	43
83.00 – 84.99	42

81.00 – 82.99	41
79.00 – 80.99	40
77.00 – 78.99	39
75.00 – 76.99	38
73.00 – 74.99	37
71.00 – 72.99	36
69.00 – 70.99	35
67.00 – 68.99	34
65.00 – 66.99	33
63.00 – 64.99	32
61.00 – 62.99	31
60.00 – 60.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-69.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
White D, Drummond J, Fuqua C: The Physiology and Biochemistry of Prokaryotes, 4th Ed., Oxford University Press, Oxford, 2012	-	-
Waites MJ, Morgan NL, Rockey JS, Hightoon G: Industrial Microbiology: An Introduction, Blackwell Science Ltd, Oxford, 2001	-	-

Additional Literature

1. Okafor N, Okeke BC: Modern Industrial Microbiology and Biotechnology, 2nd Ed., CRC Press, Boca Raton, 2018
2. Kim BH, Daad GM: Bacterial Physiology and Metabolism, Cambridge University Press, Cambridge, 2008
3. Scientific and professional papers related to the specific areas of the course

Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.

Note

E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.