

Course:

OPTIONAL COURSE III

THE BASICS OF INDUSTRIAL ENZYMOLOGY

ECTS	3
Module status	optional
Module final assessment	examination
Preliminary requirements	no prerequisites

Field of study:

FOOD TECHNOLOGY AND HUMAN NUTRITION

Educational profile	academic
Code of studies and education level	SM
Semester of studies	1
Language	English

Teaching module offered by:

Name of faculty offering the module	Faculty of Food Technology
Name of department offering the module	Department of Food Biotechnology
Coordinator	Professor Krzysztof Żyła

Learning outcomes:

Symbol of outcome	Description of the learning outcome	Reference to main field of study outcomes	Area symbol*
KNOWLEDGE – the graduate knows and understands			
BIE 1_W01	Defines and understands chemical and thermodynamic basics of catalysis. Understands differences between a mineral catalyst and a biocatalyst and is able to list and characterize physical, chemical, thermodynamic kinetic and molecular factors that determine the efficacy of a biocatalyst	TŻ2_W01 TŻ2_W12	R/P7S_WG/1 R/P7S_WG/4
BIE 1_W02	Student knows the basic processes and operations that are characteristic for the bio-industry. Recognizes the machinery and equipment that is needed for the microbial synthesis of bioactive proteins. Recognizes the pros and cons of surface fermentation and submerged fermentation and understands the solutions necessary for elimination of these problems.	TŻ2_W04 TŻ2_W12	R/P7S_WG/1 R/P7S_WG/4

BIE 1_W03	Understands the types and generations of soluble and immobilized biocatalysts. Student also knows the most important parameters that determine selection of a proper immobilized biocatalyst and recognizes basic differences in operation of the stirred tank (STR) and packed bed (PBR) bioreactor.	TŻ2_W01 TŻ2_W04 TŻ2_W12	R/P7S_WG/1 R/P7S_WG/4
BIE 1_W04	Students characterize the basic technical and technological solutions used now and in the past to produce enzyme preparations for the food industry and for non-food applications.	TŻ2_W01 TŻ2_W04 TŻ2_W12	R/P7S_WG/1 R/P7S_WG/4
BIE 1_W05	Recognizes different methods of catalytic activity utilization (activation or inactivation of endogenous activity, enzyme preparation, overproduction of the activity in plant and animals tissues) to solve a technical or technological problem.	TŻ2_W01 TŻ2_W04 TŻ2_W12	R/P7S_WG/1 R/P7S_WG/4
BIE 1_W06	Students understand and characterize different non-technological factors and different segments of the market for enzyme preparations.	TŻ2_W01 TŻ2_W04 TŻ2_W12	R/P7S_WG/1 R/P7S_WG/4
BIE 1_W07	Knows the factors that determine economic effectiveness of enzyme production and understands the impact of technological solutions on the production costs.	TŻ2_W01 TŻ2_W04 TŻ2_W12	R/P7S_WG/1 R/P7S_WG/4
SKILLS – the graduate is able to			
BIE 1_U01	Student is able to study and characterize the type of kinetic of an enzyme biosynthesis by the shaking-flasks culture method	TŻ2_U01 TŻ2_U07	R/P7S_UW/1 R/P7S_UW/2
BIE 1_U02	Can design an experiment necessary for the laboratory enzyme immobilization by the adsorption method	TŻ2_U02 TŻ2_U07	R/P7S_UW/1 R/P7S_UW/2 R/P7S_UW/3
BIE 1_U03	Is able to analyze and interpret experimental data and draw proper conclusions from the data obtained.	TŻ2_U01 TŻ2_U02	R/P7S_UW/1 R/P7S_UW/2 R/P7S_UW/3
SOCIAL COMPETENCIES – the graduate is ready to:			
BIE 1_K01	Knows the hazards of chemicals utilization in research and is responsible for personal safety and safety of the group.	TZ2_K04	P7S_KR/1
BIE 1_K02	Demonstrates the ability of individual work as well as to be an effective member of a team, to be a leader of a team, making decisions, plan and organize own and the team work.	TZ2_K03 TZ2_K05	P7S_KO/1 P7S_KO/2 P7S_KK/1
BIE 1_K03	Is conscious about the environmental hazards of modern biotechnology	TZ2_K04	P7S_KR/1

Course contents

Lectures: hrs 30

Topics	Commercial enzyme preparations used in the industry. Enzymes from plant and animal tissues. Microbial enzymes The GRAS list (generally recognized as safe). Units of enzymatic activity. Activity standardization. Commercial forms of preparations.
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	<p>The basics of enzyme biosynthesis „in vitro”. Molecular basics of protein overproduction and secretion. Regulation of gene expression in an induced operon.</p> <p>Expression of genes that encode enzymes in microbial cells, in plant and animal tissues. Multiple copies of a gene. Phytase expression in soybean, rapeseed and in salivary gland of a pig. – Natuphos, Phytaseed, Enviropig.</p> <p>Enzyme manufacturing by microbial fermentation (I). Isolation, selection and improvement of a production microbial strain. Optimization of the fermentation medium composition</p> <p>Enzyme manufacturing by microbial fermentation (II) – surface fermentation. Solid substrate and liquid substrate surface fermentations. The flow chart for enzyme biosynthesis plant by the surface methods. Modifications of the classical SSF technology.</p> <p>Enzyme manufacturing by microbial fermentation (III). Submerged fermentation method. Bioreactors, their construction and in-line controls apparatus</p> <p>Secretion and purification of intra- and extracellular enzymes. Extraction of enzymes in the surface fermentation method. Cell wall disintegration methods. Concentration by ultrafiltration, Salting –out, sorption and drying.</p> <p>Examples of hydrolases and oxidoreductases biosynthesis and manufacturing. Manufacturing of glucose oxidase, lipase, amylase, protease and phytase.</p> <p>The economics of enzyme production and utilization. The analysis of the economics of phytase addition to animal feeds.</p> <p>Immobilized enzyme kinetics. Diffusion barriers for the enzyme and substrate. Determination of kinetic parameters for the immobilized biocatalyst. Damköler’s constant. Processing with the aid of the STR and PBR-type bioreactors. Basic engineering calculations.</p>
Implemented learning outcomes	TŻ2_W01, TŻ2_W04, TŻ2_W12
Verification methods and evaluation rules	Written exam test – single choice questions (positive result-pass-with the score of more than 51% points. Proportions in the final course assessment: 50% in the term 1, 90% in the term 2, 90% in the term 3.
Laboratory trainings:	15 hrs
Topics	<p>Determination of the kinetics in enzyme biosynthesis by the shaking-flasks culture method. Analyses of the biomass, enzyme activity and metabolite concentration changes.</p> <p>Immobilization of an enzyme by the adsorption on an anion-exchange resin. Determination of the yield of immobilization and stability of the catalyst.</p> <p>Determination of basic characteristics the experimental enzymatically modified starch products: glucose syrup, maltose syrup and high conversion syrup.</p>
Implemented learning outcomes	TŻ2_U02, TŻ2_U07, TŻ2_K03, TŻ2_K04, TŻ2_K05
Verification methods and evaluation rules	<i>Lab trainings are evaluated on the basis of students activity and lab protocols – for the passed (3.0) mark. Written test will be used for a mark higher than 3.0. Proportions in the final course assessment: 50% in the term 1, 10% in the term 2, 10% in the term 3.</i>

References:

Basic	<ol style="list-style-type: none"> 1. Buchholtz K., Kaszhe V., Bornscheuer U.T. <i>Biocatalysts and Enzyme Technology, C.H.I.P.S.</i>, 2005. 2. Kennedy, J.F., <i>Enzyme Technology, Biotechnology Vol. 7a (Rehm & Reed, Eds), Weinheim, Verlag Chemie, 1987</i>
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	3. <i>Wingrad, L.B., Katchalski-Kastzir, E., Goldstein L. 1979. Enzyme Technology. In: Applied Biochemistry and Bioengineering, Academic Press, New York.</i>
Supplementary	1. <i>Chandrasekaran, M., 2016. Enzymes in Food and Beverage Processing, CRC Press, Boca Raton, Florida</i> 2. <i>Whitaker, J.R., Voragen, A.G.J., Wong, D.W.S. 2003. Handbook of Food Enzymology. Marcel Dekker, Inc., New York, Basel</i> 3. <i>Fogarty W. M. Microbial Enzymes and Biotechnology, Applied Science Publishers, Belfast, 1983</i>

Structure of learning outcomes

Area of academic study: R – Agricultural, forestry and veterinary sciences	3.0 ECTS **
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Structure of student activity

Contact hours	47 hrs.	1.9 ECTS**
Including:	lectures	30 hrs.
	classes and seminars	15 hrs.
	consultations	1 hr
	participation in research	0 hrs.
	obligatory traineeships	0 hrs.
	participation in examination and other form of completing	1 hr
Student own work	28 hrs	1.1 ECTS**

*Areas of academic study in the fields of: H- humanities; S - social studies; P – biological sciences; T – technological sciences; M- medical, sport and health sciences; R – Agricultural, forestry and veterinary sciences; A – the arts

** stated with an accuracy to 0.1ECTS, where 1 ECTS = 25 - 30 hours of classes