

<b>Title</b>	<b>Biomarkers of water pollution</b>						
<b>Code</b>	ZDIB17						
<b>Study Program</b>	Postgraduate Interdisciplinary University Study Programme <i>Environment Protection and Nature Conservation</i>						
<b>Semester</b>	3						
<b>ECTS</b>	5						
<b>Status</b>	elective						
<b>Lecturer</b>	Doc.dr. sc. Tvrtko Smital, assistant professor, doc dr.sc. Marijana Erk, assistant professor						
<b>Co-Lecturers</b>							
<b>Requirements for Enrolment</b>	University degree in Natural or Biotechnical Sciences						
<b>Objectives</b>	<p>The objectives are:</p> <ul style="list-style-type: none"> <li>to teach the students new scientific findings about measurable biological indicators (biomarkers) of subtoxic changes on the cellular level of organization caused by organic and/or inorganic contaminants that are taken from the aquatic environment;</li> <li>to explain to the students the application of a set of biomarkers in the assessment of the ecological status of water.</li> </ul>						
<b>Learning Outcomes</b>	<ol style="list-style-type: none"> <li>Getting knowledge about the characteristics and the role of biomarkers in aquatic organisms</li> <li>Getting knowledge about the function and features of metallothioneins, acetylcholinesterase, detoxification system of mixed function oxidases and multixenobiotic resistance (MXR) system; induction and inhibition of particular systems</li> <li>Getting knowledge about the procedures of determination of selected biomarkers in aquatic organisms</li> <li>Getting knowledge about the application of biomarkers in the biomonitoring programmes of aquatic environment.</li> </ol>						
<b>Connection between Learning Outcomes, Curricular and Student Activities</b>	<b>Student Activities</b>	<b>ECTS</b>	<b>Learning Outcomes</b>	<b>Curricular Activities</b>	<b>Methods of Assessment</b>	<b>Credits*</b>	
						<b>min</b>	<b>max</b>
	Activity during lectures	0.5	1-5	Lectures			
	Preparation of seminar	3.5	1-5	Seminar presentation	Evaluation of presentation		
	Preparation for oral exam	1.0	1-5	Final exam	Oral exam		
<b>Total</b>	<b>5</b>						
<b>Consultations</b>	If necessary; in accordance with lecturer						
<b>Learning Activities</b>	<b>Lectures</b>		<b>Seminars</b>		<b>Practice</b>		
<b>Hours</b>	15		0		0		
<b>Contents / Teaching Units</b>	<ol style="list-style-type: none"> <li>Definition and classification of biomarkers</li> <li>The examples of selected biomarkers (metallothionein induction, acetylcholinesterase inhibition, induction of mixed function oxidases system and MXR system, DNA damage)</li> <li>Determination of selected biomarkers in aquatic organisms – methodologies and procedures</li> <li>Statistical data analysis and interpretation of the results</li> <li>Application of biomarkers in the biomonitoring programmes</li> </ol>						
<b>Obligatory Literature</b>	1. C.H. Walker, S.P. Hopkin, R.M. Sibly, D.B. Peakall, Principles of Ecotoxicology, Second edition, Taylor and Francis, London, 2001.						

	<p>2. J.F. McCarthy, L.R. Shugart, Biological Markers of Environmental Contamination. Lewis Publishers, 1990, Boca Raton, Florida.</p> <p>3. J. Lopez-Barea, Biomarkers in Ecotoxicology: an Overview, Archives of Toxicology, Suppl. 17(1994)57-79; Springer. Proceedings of the 1994 EUROTOX Congress meeting, August 21-24, 1994, Basel, Switzerland.</p> <p>4. U. Varanasi, Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press Inc., 1989, Boca Raton, Florida</p> <p>5. W.J.Langston, M.J.Bebianno (editors), Metal Metabolism in Aquatic Environments, Chapman&amp;Hall Ltd, London, 1998.</p>
<b>Recommended literature</b>	<p>1. Proceedings of the Bivalve Biomarker Workshop, A.H. Ringwood (guest editor), Biomarkers, 4 (1999) 391-553.</p> <p>2. Kurelec, B. and Krča, S. (1987) Metabolic activation of 2-aminofluorene, 2-acetylaminofluorene and N-hydroxy-acetylaminofluorene to bacterial mutagens with mussel (<i>Mytilus galloprovincialis</i>) and carp (<i>Cyprinus carpio</i>) subcellular preparations. Comp. Biochem. Physiol. 88C, 171-177.</p> <p>3. Kurelec, B., Garg, A., Krča, S., and Gupta, R. C. (1990) DNA adducts as biomarkers in genotoxic risk assessment in the aquatic environment. Mar. Environ. Res. 28, 317-321.</p> <p>4. Raspor, B., 2004; Elements and Elemental Compounds in Waters and the Aquatic Food Chain. In: Elements and their Compounds in the Environment, Merian, E.; Anke, M.; Ihnat, M.; Stoepler, M. (ur.). Weinheim : Wiley-VCH, 127-147.</p> <p>5. J.-C. Amiard, C. Amiard-Triquet, S. Barka, J. Pellerin, P.S. Rainbow, Metallothionein in aquatic invertebrates: their role in metal detoxification and their use as biomarkers, Aquatic Toxicology, 76 (2006) 160-202.</p>
<b>Requirements for Aquiring Signature</b>	Attendance at lectures or consultations
<b>Type of Exam</b>	Oral exam with the possibility of presenting a seminar
<b>Lectures Language</b>	Croatian; English
<b>Quality Monitoring</b>	Survey after classes