Ewa Korzeniewska, PhD **Appendix 3**

SUMMARY

of Scientific, Research, Organizational and Academic Accomplishments

Olsztyn, 2013

1. Name and Family name

Ewa Korzeniewska

2. Held diplomas, degrees / art - with the name, location and the year of their acquisition

1990 Msc – at Faculty of Food Technology, Academy of Agriculture and Technology, Olsztyn, Poland, title: „ *The study of technological wheat value varieties Gama and Panda*", promoter: Professor. Assoc. Łucja Fornal

2000 Ph.D. in agriculture science – at the Faculty of Environmental Sciences and Fisheries, University of Warmia and Mazury, Olsztyn, Poland, title: „ *Sanitary-bacteriological aspect of Wigry lake contamination*", promotor: promoter: Professor. Assoc. Stanisław Niewolak

3. Information on previous employment in scientific/artistic

1990 – 1992 Interdisciplinary Ph.D. Study at Academy of Agriculture and Technology, Olsztyn, Poland – Ph.D. student

1991 – 2000 Department of Environmental Microbiology, Academy of Agriculture and Technology, Olsztyn, Poland – Assistant,

since 2000 Department of Environmental Microbiology University of Warmia and Mazury – Assistant Professor

4. Indication of achievement* according art. 16, paragraph 2 of the Act from 14 March 2003 on academic degrees and academic titles and degrees and titles in the arts (Journal of Laws No. 65, item. 595, as amended.)

a) the title of the scientific achievement:

***Enterobacteriaceae* as bioindicators of air pollution at the area and in the vicinity of wastewater treatment plants**

b) publications included in the scientific achievements: (authors*, publication titles, year of publication, name of publisher)

1) **Korzeniewska, E.**, Harnisz M. Beta-lactamase producing *Enterobacteriaceae* in hospital effluents. Journal of Environmental Management, 123: 1-7, 2013. DOI:10.1016/ j.jenvman. 2013.03.024 **IF_{2011}=3,245; MNiSW=35.**

   I contributed to this paper by developing the concept of the research, conducting the experiment as well as performing the analysis and presentation of the results. I estimate my contribution at 95%.

2) **Korzeniewska, E.**, Korzeniewska A., Harnisz M. Antibiotic resistant *Escherichia coli* in hospital and municipal sewage and their emission to the environment. Ecotoxicology and Environmental Safety, 91:96-102, 2013. DOI: 10.1016/j.ecoenv.2013.01.014 **IF_{2011}=2,294; MNiSW=30.**

   I contributed to this paper by developing the concept of the research, conducting the experiment as well as performing the analysis and presentation of the results. I estimate my contribution at 95%.

3) **Korzeniewska, E.**, Harnisz M. Culture-dependent and culture-independent methods in evaluation of emission of *Enterobacteriaceae* from sewage to the air and surface water. Water, Air and Soil Pollution, (7) 223:4039–4046, 2012. DOI: 10.1007/s11270-012-1171-z **IF_{2011}=1,625; MNiSW=30.**

   I contributed to this paper by developing the concept of the research, conducting the experiment as well as performing the analysis and presentation of the results. I estimate my contribution at 95%.

4) **Korzeniewska E.** Emission of bacteria and fungi in the air from wastewater treatment plants – a review. Frontiers in Bioscience, S3, Issue 2, 393-407, 2011. DOI:10.2741/S159] **IF_{2011}=3,520; MNiSW=30.**

   I contributed to this paper by developing the concept of the research and the presentation of results of my own studies during many years. I estimate my contribution at 100%.

5) **Korzeniewska E.**, Filipkowska Z., Gotkowska-Płachta A., Janczukowicz W., Dixon B., Czułowska M. Determination of emitted airborne microorganisms from a BIO – PAK Wastewater Treatment Plant. Water Research, 43, 2841-2851, 2009. DOI:10.1016/j.watres.2009.03.050 **IF_{2011}=4,865; MNiSW=45.**

   I contributed to this paper by developing the concept of the research, conducting the experiment as well as performing the analysis and presentation of the results. I estimate my contribution at 85%.

6) **Korzeniewska E.**, Filipkowska Z., Gotkowska-Płachta A., Janczukowicz W., Rutkowski B. Bacteriological pollution of the atmospheric air at the municipal and dairy waste water treatment plant area and in the surroundings. Archives of Environmental Protection, 34, 4, 13-23, 2008. **IF_{2011}=0,444; MNiSW=15.**

   I contributed to this paper by developing the concept of the research, conducting the experiment as well as performing the analysis and presentation of the results. I estimate my contribution at 85%.

7) **Korzeniewska E.,** Filipkowska Z., Gotkowska-Płachta A, Janczukowicz W. Bacteriological pollution of atmospheric air In the constructed wetland (with reed bed system) area and in the surrounding. Woda Środowisko-Obszary Wiejskie, Wyd.: Instytut Melioracji i Użytków Zielonych w Falentach, t. 8, z. 1, 22, 161-173, 2008. **MNiSW=5.**

   I contributed to this paper by developing the concept of the research, conducting the experiment as well as performing the analysis and presentation of the results. I estimate my contribution at 85%.

8) **Korzeniewska E.**, Filipkowska Z., Gotkowska-Płachta A. Municipal wastewater treatment plant with activated sludge tanks aerated by CELPOX devices as a source of *Enterobacteriaceae* bacteria in the air. Ochrona Środowiska i Zasobów Naturalnych, 32. 184-189, IOŚ, 2007. **MNiSW=5.**

   I contributed to this paper by developing the concept of the research, conducting the experiment as well as performing the analysis and presentation of the results. I estimate my contribution at 90%.

9) **Korzeniewska E.**, Filipkowska Z., Gotkowska-Płachta A. Municipal wastewater treatment plant as a source of *Enterobacteriaceae* bacteria in the air. Ochrona Środowiska i Zasobów Naturalnych, 32. 178-183, IOŚ, 2007. **MNiSW=5.**

   I contributed to this paper by developing the concept of the research, conducting the experiment as well as performing the analysis and presentation of the results. I estimate my contribution at 90%.

** Statements contributors work together with determination of the individual contribution of each of them in the creation of individual manuscript can be found in Appendix 7*

c) description of research objective and results of the above study/studies with an indication of practical applications

The objective of the present study was to determine the usefulness of bacteria of the family *Enterobacteriaceae,* in particular antibiotic-resistant bacteria, as biological indicators of air pollution at the area and in the vicinity of wastewater treatment plants. In the first stage of the study, the percentage share of *Enterobacteriaceae*, including antibiotic-resistant beta-lactams and bacteria that produce extended-spectrum beta-lactamases (ESBL), was determined in the total population of bacteria colonizing hospital and municipal effluents. Comparative analyses were carried out to evaluate culture-dependent and molecular methods used in the isolation and identification of microbes which colonize effluent samples from different stages of the treatment process and ambient air in the vicinity of selected treatment devices which are the leading producers of bioaerosols as well bacteria colonizing water samples from a river which is a receiver of treated sewage. Genes responsible for multiple drug resistance of bacteria isolated from effluent and environmental samples were identified based on their nucleotide sequences to determine the percentage share of strains containing drug-resistant genes and their resistance profiles in different environments. The results of the study supported an evaluation of the actual contribution of hospitals and wastewater treatment plants to microbiological contamination of the local environment.

Key findings

- Third-generation cephalosporins are mainly used to treat in hospitals. Based on my studies conducted both hospital sewage and municipal sewage, to which hospital sewage inflows, I found that the presence of intestinal ESBL-positive *Enterobacteriaceae* in environmental samples may indicate the hospital sewage as the main source of pollution.
- Although wastewater treatment significantly reduces bacterial counts in effluents, antibiotic-resistant bacteria may still be present in sewage discharged from treatment plants. Even if treatment processes reduce bacterial counts by 3-4 orders of magnitude, treated effluents may still contain large populations of microorganisms, in particular antibiotic-resistant bacteria. The widespread presence of ESBL-producing strains could be attributed to the transfer of those microorganisms from hospital and municipal sewage to the environment.

- The results of the discussed study indicate that even wastewater treatment plants capable of removing 99.99% of indicator bacteria can contribute to the spread of multidrug-resistant organisms to the environment. The sources of bacteria include bioaerosols emitted from sewage to ambient air in treatment plants as well as antibiotic-resistant drugs which are discharged with treated wastewater to rivers and lakes.
- Comparative analyses were carried out to evaluate culture-dependent and molecular methods used in the isolation and identification of microbes which colonize sewage, water and air in the vicinity of leading bioaerosol producers (sand separators and aeration chambers). The results of those analyses supported an evaluation of the contribution of wastewater treatment plants to microbiological contamination of the local environment. The study addresses a crucial problem because emissions of intestinal microorganisms, including bacteria of the family *Enterobacteriaceae*, from effluents to ambient air are not controlled by legal acts which establish air quality monitoring standards.
- Innovative use of the FISH method in evaluation of microbial pollution of air, allows for precise quantitative and qualitative bacteriological assessment of the air around individual technology facilities at the wastewater treatment plant.
- In the final, results of my study at the wastewater treatment plants (with different technological solutions) area and in their vicinity guarantee, that *Enterobacteriaceae* can be considered as bioindicators of air pollution around this kind of municipal facilities. They also confirmed my hypothesis assumed that their presence in the air reflects the actual air pollution by bioaerosols originating from wastewater.
- *Enterobacteriaceae* bacteria can therefore be used to supplement the existing regulations for monitoring the microbiological quality of ambient air in the vicinity of wastewater treatment plants, to place hospitals and other health care facilities under the obligation to disinfect evacuated wastewater and to introduce new standards for evaluating the microbiological quality of wastewater discharged to surface water bodies.

Overview of research studies

(Information given in square brackets relates to publications listed in the specification of research accomplishments)

Policies aiming to reduce drug resistance and encourage rational use of antibiotics in various areas of medicine and the economy had not been introduced in Poland until the end of

the 20th century. The use of antibiotics without explicit medical justification generates economic costs through increased spending on more effective drugs, and it has detrimental consequences for the environment where antibiotic residues and selected strains of antibiotic-resistant bacteria are deposited. In most countries, beta-lactam antibiotics account for 50-70% of all antibiotics used in outpatient clinics, veterinary clinics and agriculture. For this reason, the most common bacterial resistance mechanism is the production of beta-lactamase enzymes which break the beta-lactam ring in antibiotics such as penicillin, cephalosporin, carbapenems, monobactam and beta-lactamase inhibitors. Some antibiotics are metabolized by humans in more than 90%, whereas others – in 10% or less. Antibiotics and their metabolites excreted to sewer systems with urine and feces can increase the resistance of environmental bacteria. The inactivation of beta-lactams in the environment minimizes the risk of spreading, but multidrug resistant bacteria also directly reach sewer systems, mainly with hospital effluents [1]. The low effectiveness or absence of hospital effluent treatment can promote the spread of antibiotic-resistant microorganisms from hospitals to municipal wastewater. Bacteria which are discharged from wastewater treatment plants can reach the environment and pollute rivers and lakes receiving treated effluents. Bioaerosols produced in wastewater treatment plants are also a source of bacteria which contaminate ambient air in the vicinity of treatment facilities [2-9].

Many bacterial species proliferate rapidly by doubling their population every 20-30 minutes. Their ability to adapt to changing conditions and survive in an unsupportive environment contributes to the development of mutations. In the process of environmental adaptation, bacterial cells do not rely solely on own genetic resources. Effluents, in particular untreated wastewater and activated sludge, are densely populated by bacteria which have access to a large pool of genes that can be transferred vertically and horizontally between bacterial cells. In dense microbial populations, genes are transferred by plasmids and mobile genetic elements such as transposons and integrons that can carry genes coding for antibiotic resistance [1-2].

Antibiotic resistance in microorganisms is conditioned by various mechanisms. Bacterial strains which synthesize extended-spectrum beta-lactamases (ESBL) are alert pathogens which pose a serious threat. Beta-lactamases are one of the key mechanisms responsible for bacterial resistance to antibiotics. There are more than 300 subtypes of beta-lactamases, the most popular being TEM- and CTX-encoding genes, whereas OXA and SHV-type ESBLs are less frequently encountered [1-2]. Gram-negative bacteria of the family

Enterobacteriaceae are one of the leading producers of beta-lactamases. Some of them have beta-lactamase encoding genes on the chromosome, but in most members of *Enterobacteriaceae,* genes encoding resistance to beta-lactams are localized on plasmids [1-2]. The above contributes to rapid and uncontrolled spread of genes among various species of Gram-negative bacteria in a given environment. ESBL-positive bacteria are characterized by multidrug resistance, and they are also resistant to aminoglycosides, trimethoprim, sulfonamides, chloramphenicol and, less frequently, carbapenems [2]. They were initially identified in *E. coli* and *K. pneumoniae* strains, and they are presently observed in most bacterial species of the family *Enterobacteriaceae* [1].

Enterobacteriaceae, a family of bacteria with genes that encode multidrug resistance, are found in large intestinal microbiota, and they naturally colonize the digestive system of healthy and diseased humans and animals. The above can be attributed to higher consumption of antibiotics, in particular extended-spectrum drugs. Excessive antibiotic consumption has catastrophic implications for the environment because it builds resistance in strains that were previously susceptible to those pharmaceuticals. Most analyses aiming to detect genes encoding antibiotic resistance are limited to bacterial strains cultured in hospital laboratories, and they do not monitor the occurrence of resistance genes in microorganisms that are evacuated to surface water bodies and other ecosystems with treated sewage. The list of microbiological criteria for wastewater evacuated to water and soil, introduced by the Regulation of the Minister of the Environment (Journal of Laws No. 137, item 984) on the requirements imposed on wastewater evacuated to water or soil (enforced in July 2006), contains only bacteria of the genus *Salmonella* and parasite eggs (*Ascaris, Trichuris, Toxocara*) in wastewater used for agricultural purposes. The above legal act fails to address even a fraction of the threats created by microbiological contaminants that reach ecosystems with treated sewage [3]. In most cases, only selected physicochemical parameters of wastewater are analyzed. Non-disinfected effluents from hospitals, sanatoriums and veterinary plants may not be evacuated to sewer systems pursuant to the provisions of the Act of 7 June 2001 on municipal water supply and municipal wastewater disposal (Journal of Laws No. 72, item 747), but the amendment to the above act of 22 April 2005 (Journal of Laws No. 85, item 729) limited the scope of the above ban to effluents disposed by infectious disease hospitals, blood donation stations, veterinary clinics treating infectious diseases and laboratories handling infectious materials of animal origin. In my research, out of 310 *Enterobacteriaceae* bacterial strains isolated from hospital wastewater, 295 (95.2%) were resistant to cefotaxime

(CTX), 253 (81.6%) were resistant to ceftazidime (CAZ) and 192 (61.9%) to cefpodoxime (CPD). A total of 150 (48.4%) beta-lactamase producing strains were isolated from hospital effluents. ESBL-producing *Enterobacteriaceae* were detected in all analyzed samples of hospital wastewater. Significant correlations were observed between the populations of bacteria resistant to beta-lactam antibiotics and ESBL-producing bacteria isolated from hospital effluent and the quantity of beta-lactam antibiotics administered in hospitals. The predominant species in the group of multidrug resistant bacteria of the family *Enterobacteriaceae* were *Escherichia coli, Citrobacter freundii, Kluyvera cryocrescens* and bacteria of the genus *Klebsiella* [1]. The highest frequency of ESBL-encoding genes which condition resistance to third-generation cephalosporins was noted in the genomes of the above bacteria. Multidrug resistance was conditioned by the presence of group 1 $bla_{\text{CTX-M}}$ genes, group 9 $bla_{\text{CTX-M}}$ genes, bla_{SHV} and bla_{TEM} genes on plasmids. Nearly 40% of those isolates had multiple *bla* genes. In the analyzed isolates, MIC values for cefotaxime and ceftazidime were generally high in the range of 128 to ≥512 μg/mL. Disposal of non-disinfected hospital sewage can lead to uncontrolled spreading of multidrug resistant bacteria [1-2]. In Poland, municipal wastewater is not disinfected in mechanical and biological treatment plants on a regular basis. The experiences of other countries, in particular the United States, suggest that continuous disinfection regimes should be introduced, at least at certain times of the year.

Pathogenic and potentially pathogenic bacteria of the genera *Enterobacter, Escherichia, Klebsiella, Salmonella, Citrobacter, Staphylococcus, Pseudomonas,* as well as pathogenic and potentially pathogenic yeasts and molds are identified in sewage and air samples collected from wastewater treatment plants [4-7]. *Enterobacteriaceae*, naturally occurring microbiota of the human digestive tract, have a high share of bacterial populations that colonize sewage [3]. Those microorganisms are transferred to air during mechanical (effluent flow through sand separators) and biological (effluent aeration in biological reactors) treatment processes [2-9]. In addition to chemical compounds, wastewater treatment plants also emit bioaerosols which can contribute to the spread of human and animal pathogens to air. Plant employees and local residents can be exposed to the harmful effects of those microorganisms. The potential threats of bioaerosols are determined by the degree of microbial virulence, environmental factors and the bacterial gene pool, including genes encoding resistance to antibiotics [2]. In my study, I analyzed the sensitivity of 395 *E. coli* isolates to the most popular antibiotics in human medicine: piperacillin/tazobactam, gentamicin, amikacin, imipenem, chloramphenicol, trimethoprim/sulfametoxazole and three

beta-lactam antibiotics: cefotaxime, ceftazidime and cefpodoxime. The highest indicators of multiple antibiotic resistance (MAR) were determined for *E. coli* isolates from hospital sewage and ambient air in the range of 0.44 to 0.63 and 0.44 to 0.50, respectively. Significantly higher MAR values were reported for ESBL-producing bacteria. ESBL-positive *E. coli* were isolated from 76.5% samples of hospital effluents, 57.1% samples of untreated effluents, 85.7% samples of effluents from aeration chambers, 44.2% water samples from a river supplied with treated wastewater and 28.6% air samples [2].

The type and extensiveness of environmental effects produced by wastewater treatment plants is determined by the applied treatment technology, the plant's processing capacity, weather conditions and environmental factors. Wastewater aeration and hermetization of treatment facilities significantly limit atmospheric pollution [4-9]. Some microorganisms are eliminated in ambient air, others reach soil, plants and other elements of the local environment through sedimentation. Microbes emitted to the air with bioaerosols may reach the human respiratory system by droplet inhalation. Infections of the lower respiratory tract are caused by bacteria of the family *Enterobacteriaceae*, including *K. pneumoniae, E. coli, S. marcescens* and *Enterobacter* spp. Bioaerosols emitted by process devices in wastewater treatment plants can contribute to the spread of allergies and infectious diseases. Air contamination analyses based on total microbial counts do not always precisely identify the source of air-borne bacteria in the vicinity of the treatment plant. The presence of fecal bacteria, including bacteria of the family *Enterobacteriaceae* which massively colonize effluents (10^6 – 10^7 CFU per cm^3), in particular antibiotic resistant bacteria [2], is a reliable metric for determining the level of contamination in wastewater and ambient air [3-9]. Evaluations of treatment plants' environmental impacts should account for the prevalence of fecal bacteria. The presence of *bla* genes encoding beta-lactamase in plasmid DNA could lead to the horizontal transfer of resistance genes on the premises of the treatment plant due to subinhibitory concentrations of antibiotics. Resistance genes can also be transferred to the environment with treated effluents and bioaerosols. Those mechanisms pose serious threats for public health.

5. Other scientific accomplishments

In 1990, I graduated from the Faculty of Food Technology of the University of Agriculture and Technology in Olsztyn with a Master's degree in food technology. I wrote my

Master's thesis in the Department of Plant Processing Technology under the supervision of Professor Łucja Fornal. I completed the Master's degree course as one of ten alumni who were awarded distinctions by the Board of the Faculty of Food Technology of the University of Agriculture and Technology in Olsztyn.

In 1990, I started a doctoral program in ecology at the Interdepartmental Doctoral Center of the University of Agriculture and Technology in Olsztyn. One of my advisors was Dr Irena Wojnowska-Baryła. My initial research interests focused on the use of biological membranes for removing cadmium from industrial wastewater. The Doctoral Center was transformed into a center for extramural studies, and in 1991, I took the position of assistant lecturer at the Department of Environmental Microbiology of the University of Agriculture and Technology in Olsztyn. In my work, I focused on microbiological pollution of the natural environment resulting anthropogenic pressure. I investigated the presence of pathogenic and potentially pathogenic Gram-negative (*Enterobacteriaceae*: *Salmonella* sp., *Escherichia coli*, *Klebsiella pneumoniae*, *Citrobacter* sp., *Enterobacter* sp.) and Gram-positive bacteria (*Staphylococcus* sp.) in water and bottom sediments of lakes and rivers in the Wigry National Park. I reported on the results of my research in a doctoral thesis entitled "Sanitary and Bacteriological Aspects of Pollution in Lake Wigry". I defended my doctoral thesis in 2000 at the Faculty of Environmental Sciences and Fisheries of the University of Warmia and Mazury in Olsztyn. My thesis received the Award of the Rector of the University of Warmia and Mazury in Olsztyn. The results of my research revealed that the main sources of microbiological contamination and biogenic substance accumulation in Lake Wigry were effluents discharged from a wastewater treatment plant in Suwałki to the Czarna Hańcza River, effluents from a fish farm in Gawre Ruda and leaking sewage wells in summer cottages in the lake's vicinity. My findings were published in a series of articles (II.A.5, II.A.7, II.A.9, II.A.11, II.A.12, II.A.13, II.E.16, II.E.23, II.E.27, II.E.28, II.E.29). Based on the above observations, in 2005-2007 and 2009-2012, I completed two research projects investigating the use of bacteria of the family *Enterobacteriaceae* as bioindicators of environmental pollution in the vicinity of municipal facilities (projects II.J.1 and II.J.4). I continued to pursue this line of research in successive years. My efforts gave rise to many scientific papers (II.A.1, II.E.5, II.E.6, II.E.11, II.E.12), lectures (III.L.1, III.L.2, III.L.3), reports and short communications published in domestic and international conference proceedings (III.B.7, III.B.8, III.B.12, III.B.13, III.B.14, III.B.15, III.B.20, III.B.22, III.B.25, III.B.27, III.B.28, III.B.31, III.B.32, III.B.34).

In cooperation with the Department of Environmental Engineering at the Faculty of Environmental Sciences (the former Faculty of Environmental Sciences and Fisheries) of the University of Warmia and Mazury in Olsztyn, I investigated the effect of magnetic field-assisted Fenton reactions on the quality and biosafety of wastewater sediments (project II.J.5). I participated in a European research project into distributed cogeneration systems fired by local and renewable sources of energy (project II.J.3). I continued to pursue my research interests in biofuels by preparing (2008) and carrying out (2009-2012) a project in collaboration with the Department of Environmental Engineering into the use of psychrophilic microorganisms to intensify the production of high-energy biogas from organic waste (project II.J.2). The results of the above project were presented as reports and communications in domestic and international conference proceedings (III.B.5, III.B.10, III.B.11, III.B.17), and they will be discussed in scientific papers which are currently under development.

I have published 19 papers which are listed in the Journal Citation Reports database. I have co-authored 29 papers published in other peer-reviewed journals, most of which (25) are listed in section B of the ranking of scientific journals kept by the Ministry of Science and Higher Education. I have written five chapters of a course lecture book for students which is regularly updated in accordance with Polish and EU laws. I have authored and co-authored 57 lectures delivered at scientific conferences and conventions, including 15 international events. I have completed six research projects, including one project financed by the Ministry of Science and Higher Education where I acted as manager and two projects where I was the principal investigator. I have developed 24 reports for business clients. I have reviewed 13 papers for academic journals, including *Journal of Environmental Management*, *Science of the Total Environment, African Journal of Microbiology Research, Atmospheric Environment, Oceanological and Hydrobiological Studies, BMC Microbiology, Woda Środowisko-Obszary Wiejskie* and *International Journal of Food Microbiology*.

Citation analysis performed according Web of Science database - 6.05.2013

http://apps.isiknowledge.com
Prepared: Katarzyna Maćkiewicz, PhD
Scientific Information and Periodicals Reading Room
The University Library
University of Warmia and Mazury in Olsztyn
Tel. 89 524 63 08

Summary of quantitative and points of the most important achievements of scientific research

Specification				**Before PhD**	**After PhD**	**Total**
Originally published scientific creative work available in the social circuit, monographs and book publications (with an ISBN and EAN); A-publications included to scientific achievement, B-other publications						
Type of publication		**Score points of MNiSW**	**IF_{2011}** *			
Journals from JCR list	A	185	15,993	-	6	6
	B	215	8,952		16	16
Journals from Philadelphia list	A	15	-	-	3	3
	B	103	-		19	19
Other journals		-		1	3	4
Conference materials		-		4	53	57
Monographs and scripts		-		-	3	3
TOTAL		**518**	**24,945** *	**5**	**103**	**107**
Participation in projects						
Projects		KBN/MNiSW		-	4	4
		funded by the EU		-	3	3
TOTAL					7	7
Other achievements of scientific research						
Reviews of articles published in journals JCR				-	13	13

Indicators of scientific achievements			
Source of data	Web of Science	Scopus (Elsevier)	Google Scholar
The Hirsch index *h*	3	3	5
The number of citations	50	36	76
The number of publication in database	25	13	48

* ***Total impact factor*** *according to the Journal Citation Reports (JCR) –* ***IF_{2011}=24,945****, by the year of publication –* ***IF=18,759***

6. Accomplishments in science promotion

I am actively involved in various science promotion projects. Since 2007, I have been developing and delivering lectures for school students as part of Olsztyn Science and Art Days. I developed a series of lectures for secondary school students in Olsztyn during a campaign promoting research achievements of the Faculty of Environmental Sciences and Fisheries.

In 2011, I participated in a program entitled "Commercialization of research findings and enterprise promotion at the University of Warmia and Mazury in Olsztyn through internships, training and academic enterprise initiatives" in PWiK Ostróda, a water supply and sewerage company in Tyrowo near Ostróda, as part of project No. POKL-08.02.01-28-001/08-00 co-financed by the European Social Fund.

7. Organizational accomplishments

I have managed various organizational projects on behalf of the University of Warmia and Mazury in Olsztyn, local authorities and local communities. Since 2005, I have been a member of the Faculty Council at the Faculty of Environmental Sciences (the former Faculty of Environmental Sciences and Fisheries) as a representative of lecturers. I am a member of the Evaluation Committee of the University of Warmia and Mazury in Olsztyn.

In 2009-2011, I participated in the development of tender procedures at the Faculty of Environmental Sciences and Fisheries as part of project No. POPW.01.01.00-28-008/08-00, entitled "Developing, upgrading and equipping scientific laboratories conducting research in the field of food technology, food quality and safety", Component V: "Equipping a laboratory for evaluating fish quality, waste and monitoring environmental pollution", financed under the National Cohesion Strategy and by the European Regional Development Fund.

My greatest organizational accomplishment at the University of Warmia and Mazury in Olsztyn was the development of the program, budget and schedule for project No. UDA-POKL.04.01.01-00-095/10-00, entitled "Strengthening the Academic Potential of the University of Warmia and Mazury in Olsztyn", implemented as part of Priority IV, Measure 4.1 of the Human Resources Development Operational Program. The project, worth more than PLN 20.2 million, was initiated in 2011 and is scheduled for completion in 2015. It is co-financed by the European Social Fund. In recognition of the project's success, I received a

diploma of merit from the Rector of the University of Warmia and Mazury in Olsztyn (III.D.1).

I participated in various projects initiated by the local authorities, local communities and water supply and sewerage companies. I developed expert opinions concerning the microbiological quality of mains water, river and lake water, process water, processed water, sewage and processed sewage deposits for Dywity Municipal Office, Grunwald Municipal Office, Stawiguda Municipal Office, Strzelce Krajeńskie Municipal Office, Olsztyn II Fish Farm in Ruś, water supply company in Iława, Michelin Polska in Olsztyn, PWiK water supply and sewerage company in Biskupiec, ZGK municipal services company in Olsztynek, Regional Prosecutor's Office in Ostrołęka, Tuberculosis and Lung Disease Hospital in Olsztyn, Wild Polska Ltd. in Warsaw and Szczytno Municipal Office (III.M.1-14).

I have been an active member of the Polish Society of Microbiologists since 1997. In 2004-2008, I held the post of Board Member of the Society's Branch in Olsztyn, and I have chaired the Society's Audit Committee since 2008.

8. Discussion of educational achievements

I have developed the following academic curricula for the University of Warmia and Mazury in Olsztyn:

- HEALTH FOOD SAFETY IN TOURISM, the direction of Tourism and Recreation, Department of Environmental Sciences, UWM, 2013 – the preparation of the program and conduct lectures and classes on the subject
- MICROBIOLOGICAL CONTAMINATION IN THE MUNICIPAL FACILITIES direction of Environmental Engineering, Faculty of Environmental Sciences, UWM, 2013 – the preparation of the program and conducting exercises with subject
- SANITARY MICROBIOLOGY direction of Environmental Engineering, Faculty of Environmental Sciences, UWM, 2013 – the preparation of the program and conducting exercises with subject:
- MICROBIAL ECOLOGY, the direction of Environmental Protection, Department of Environmental Sciences, UWM, 2013 – prepare a program of lectures and exercises of the course

- BIOTECHNOLOGICAL WASTE DISPOSAL, the direction of Microbiology, Faculty of Biology and Biotechnology, Warmia and Mazury in Olsztyn, 2013 – prepare a program of lectures and exercises of the course
- BIOTECHNOLOGY IN ENVIRONMENTAL PROTECTION, the direction of Microbiology, Faculty of Biology and Biotechnology, Warmia and Mazury in Olsztyn, 2013 – prepare a program of lectures and exercises of the course
- MICROORGANISMS IN THE AIR POLLUTION, the direction of Microbiology, Faculty of Biology and Biotechnology, Warmia and Mazury in Olsztyn, 2013 – prepare a program of lectures and exercises of the course
- MICROORGANISMS IN BIOTECHNOLOGY, the direction of Environmental Protection, specializing in Biotechnology, Faculty of Environmental Sciences, UWM, 2006 – 2013 – the preparation of the program and conducting exercises with subject
- PRACTICAL APPLICATION AND METHODS OF ANAEROBIC FLUORESCENCE MICROSCOPY IN THE DIAGNOSIS ANAEROBES, the direction of Environmental Protection, Department of Environmental Sciences, UWM, 2011 - 2015 – preparation and implementation of educational activities in this field

I teach microbiological laboratory workshops, Engineer's degree and Master's degree seminars at the Faculty of Environmental Sciences and veterinary microbiology classes at the Faculty of Animal Bioengineering of the University of Warmia and Mazury in Olsztyn.

To date, I have supervised 17 Engineer's degree theses and 24 Master's degree theses in the field of environmental sciences. I am currently supervising four Master's degree theses and four Engineer's degree theses.