Univerza v Mariboru

FRAMEWORK PROGRAMME OF EARLY STAGE RESEARCHER TRAINING[1]

1. BASIC DATA

Mentor's name and surname	**Mateja Primožič**	Mentor's register number at ARIS (SICRIS)**:**	**21460**
Mentor's e-mail:	mateja.primozic@um.si	Mentor's tel. no.:	+38622294462
Research programme (RP) leader's name and surname:	Željko Knez	RP leader's register number at ARIS (SICRIS):	02619
Title of research programme:	Separation processes and product design	RP's Register number at ARIS (SICRIS):	P2-0046
Research organisation (RO) of University of Maribor, where training shall be conducted:	Faculty of Chemistry and Chemical Engineering	RO Register number at ARIS (SICRIS):	0552-0794
Research field according to ARIS classification:	2.02 Chemical Engineering	Research field according to Ortelius classification (EURAXESS)	15.5 Chemical Engineering

2. DEFINITION OF RESEARCH PROBLEM AND GOALS OF DOCTORAL RESEARCH[2]

Starting point of research task of the early stage researcher and its position in the research programme, where the mentor is included, work hypothesis, research goals and foreseen result with emphasis on an original contribution to science:

Starting points and hypotheses

The use of microorganisms (MO) for the production of bioactive substances is an environmentally friendly and sustainable approach. However, finding optimal MO cultivation conditions for their

[1] *Term early stage researcher (ESR) is written in male form and used as neutral for women and men.*

[2] *Research and study programme of training have to harmonise with contents of the research programme, where the mentor is a member.*

production remains a challenge. The use of genetically modified microorganisms (GMOs) allows the modification of MO with the aim of obtaining a specific bioactive substance, but the directives on the use of GMOs are very restrictive. The production of desired bioactive substances can also be achieved by exposing MO to extreme conditions and their adaptation to a new environment. During the cultivation of MO, they use various enzymes for nutrient metabolism and intermediate conversion. By exposing MO to stress conditions (changes in pH, pressure, temperature, etc.), MO must adapt to new conditions for successful growth, as do enzymes related to cellular MO metabolism. In this way, enzymes that are adapted to function in extreme conditions can be obtained. Furthermore, they can be used in various fields of sustainable engineering, where the requirement for enzymes to function under extreme conditions arises (wastewater remediation, synthesis of active ingredients at high temperatures, etc.). To obtain bioactive substances, such as (intracellular) enzymes from MO, both conventional and unconventional methods will be used, such as supercritical fluids, which allow the opening of MO cells. The method of using supercritical fluids to isolate bioactive substances from MO is a more environmentally friendly method, without the use of organic solvents. Since free enzymes are quite unstable, their operational stability and activity can be improved by immobilization. In addition to activity, immobilization also increases the lifetime of the immobilized enzyme and ensures multiple uses. The advantage of immobilized enzymes is simple separation from the reaction medium, which can be introduced into various "real-life" technologies. The choice of support for immobilization is of key importance since only a properly selected support can ensure optimal enzyme function and stability. The main goal of the program is the preparation of nanostructured biomaterials of inorganic and organic origin, which represent advanced materials for the immobilization of enzymes and other active substances obtained from MO, adapted to extreme conditions. Such smart nanostructured hybrids (nanostructured biomaterials with immobilized bioactive substances such as enzymes) represent high-performance tools for various sustainable, biocatalytic, and biomedical applications.

Research goals

The goal of the proposed program is the design and construction of new smart nanostructured hybrids with obtained biologically active substances from MO, adapted to extreme conditions:

- adaptation of MO to extreme conditions in order to obtain the so-called. extremozymes,
- preparation of nanostructured biomaterials of inorganic (e.g. metal nano-frameworks (MOFs), nanowires (NFs), etc.) and organic origin (bacterial nanocellulose (BNC), plant nanocellulose (PNC)),
- modification/functionalization of nanostructured biomaterials for further immobilization of bioactive substances, e.g. extremozymes,
- preparation of smart nanostructured hybrids (e.g. MOFs with immobilized enzymes, NFs with immobilized enzymes, magnetic BNC with immobilized enzymes, magnetic PNC with immobilized enzymes, etc.),
- implementation of smart nanostructured hybrids for various sustainable applications (e.g. wastewater remediation (removal of pollutants (heavy metals, pharmaceutical active ingredients, etc.))).

Expected results

The proposed program is focused on the green transition and represents a relatively new approach using nanostructured biomaterials of inorganic and organic origin together with enzymes for various sustainable, biocatalytic and biomedical applications.

Thus, the development of new process technologies that produce products with high added value will be enabled. Developing new technological procedures for enzyme immobilization may also represent a possibility for the involvement of Slovenian companies and personnel in the European and global labor market.

The proposed program will also contribute new insights that will help in the development of biotechnological sustainable applications, such as the degradation of dyes, bioremediation of certain toxic chemical waste, and the treatment of wastewater and soil.

The results of research within the program will be published at domestic and foreign scientific conferences and in international scientific journals with an impact factor. Therefore, such knowledge will also have a wider impact on the scientific community.

The proposed research program will be part of the research program P2-0049 Separation processes and product design, where research on nanostructured biomaterials as carriers for immobilization of various bioactive substances is one of the important parts. The proposed research directly coincides with one of the current main European challenges (healthy and active life) and with part of the country's strategic direction for achieving quality of life (Strategy of Slovenia 2030 - preserved healthy natural environment) and is in line with the Slovenian smart specialization strategy S4 (materials, nanotechnology, health and medicine).

3. STUDY PROGRAMME

Foreseen study programme, to which early stage researcher shall be enrolled in academic year 2025/2026:

Third-cycle Doctoral study program in Chemistry and Chemical Engineering at FKKT UM

4. DESCRIPTION OF WORK AND TASKS

Implements scientific and research projects.
Professionally participates in research tasks.
Prepares reports and studies on research.
Monitors and coordinates research work in accordance with funding agreements.
Ensures safe and healthy work.
Performs other related tasks as instructed by a superior.
Replaces colleagues and superior in their absence (by authorization).
Performs other related work as instructed by superiors.

5. REQUESTED LEVEL OF EDUCATION

VII/2nd tariff group

6. REQUESTED FIELD OF EDUCATION

Technical, natural science

7. KLASIUS SRV

Seventh level: Second-cycle higher education and similar education/Second-cycle higher education and similar education

8. KLASIUS P

05 – Natural sciences, mathematics and statistics
07 – Engineering, manufacturing and construction

9. REQUESTED KNOWLEDGE

Computer skills: Word, Excel, Powerpoint, MS Teams, Internet, email.

10. REQUESTED SPECIAL REQUIREMENTS

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11. REQUESTED LANGUAGES

Active knowledge of one world language.

12. REQUESTED WORK EXPERIENCE

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13. FORESEEN POSTDOCTORAL TRAINING

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Mentor's signature:

Mateja Primožič Digitally signed by Mateja Primožič Date: 2025.02.02 11:53:37 +01'00'

Research programme leader's signature:

Željko Knez Digitally signed by Željko Knez Date: 2025.02.03 11:35:20 +01'00'

Name and surname of Dean or authorised person[3]:
Prof. Dr. Zoran Novak

Signature of dean or authorised person:

ZORAN NOVAK Digitally signed by ZORAN NOVAK Date: 2025.02.03 12:04:27 +01'00'

[3] The training program is signed by the dean of the member where the ESR's employment and training will take place.

Place and date:

Maribor, 2. 02. 2025

Stamp: