

**COURSE SYLLABUS – DOCTORAL SCHOOL
EDUCATION CYCLE FROM 2025/2026 TO 2028/2029**

| GENERAL INFORMATION ABOUT THE SUBJECT | | | | |
|--|---|--|--|--|
| Subject title | DOCTORAL SEMINAR | | | |
| Name of the unit offering the subject | Doctoral School of the University of Rzeszów | | | |
| Type of subject (<i>compulsory, optional</i>) | compulsory | | | |
| Year/semester | Years I–IV, semesters I–VII | | | |
| Discipline | Biotechnology | | | |
| Language | Polish/English | | | |
| Name and surname of the course coordinator | Prof. Maciej Wnuk | | | |
| Name and surname of the person(s) teaching the subject | Prof. Maciej Wnuk | | | |
| Prerequisites | <p>The candidate must have extensive knowledge in the field of biotechnology, including in particular RNA molecular biology and epitranscriptomic mechanisms. Knowledge of contemporary paradigms in research on RNA-modifying enzymes (with particular emphasis on the NSUN and TRDMT1 families) is required. It is essential to have a theoretical foundation in the following areas:</p> <ul style="list-style-type: none"> • Computational chemistry and bioinformatics: Understanding of the principles governing homologous protein modelling and ligand-receptor interaction stability. • Scientific research methodology: Knowledge of the principles of experiment planning, research hypothesis verification and critical analysis of statistical data. | | | |
| COURSE SUMMARY | | | | |
| <i>(synthetic description of the content and objectives of the course; 100-200 words)</i> | | | | |
| <p>The doctoral seminar serves as a platform for the systematic presentation and critical discussion of research progress in the preparation of a doctoral dissertation in the field of biotechnology, focusing in this case on the innovative design of m⁵C RNA methyltransferase inhibitors (NSUN_{1–7} and TRDMT1 isoforms). The course includes an in-depth review of the literature, clarification of the research problem in the field of epitranscriptomics, precise formulation of hypotheses and objectives, as well as the development of theoretical formalism based on advanced <i>in silico</i> methods. A key element is the implementation and verification of research results, including homologous modelling, analysis of active enzyme pockets, and multi-stage pharmacophore optimisation using molecular dynamics (MD). The seminar provides a forum for knowledge exchange, supporting doctoral students in the preparation of conference presentations, scientific publications and subsequent chapters of their dissertations, with particular emphasis on <i>drug repositioning</i> strategies and the translation of basic research into therapeutic solutions. In addition, the classes develop communication skills in English, promote the ethos of independent research, and develop the ability to manage intellectual property in a national and international environment, preparing participants to conduct reliable and innovative scientific work at an expert level.</p> | | | | |
| LEARNING OUTCOMES FOR THE COURSE AND VERIFICATION METHODS | | | | |
| Learning outcome symbol | Expected learning outcomes | Reference to learning outcomes for qualifications at level 8 of the Polish | Form of teaching (lectures, practical classes, etc.) | Assessment methods (e.g. test, oral examination, written examination, project, etc.) |

| | | Qualifications Framework (symbol) | | |
|-----------------------|---|-----------------------------------|---------|---|
| Knowledge: No. | <i>knows and understands, has knowledge</i> | | | |
| P8S_WG1 | The doctoral student has extensive theoretical knowledge and rich research experience, grounded in the current global scientific achievements in the field of epitranscriptomics and molecular engineering. Understands the mechanisms of RNA modification, with particular emphasis on the activity of m5C methyltransferases (NSUN1–7, TRDMT1). | P8S_WG | seminar | oral presentation, discussion |
| P8S_WG2 | Knows the directions of development of scientific research in the field of drug positioning in the scientific discipline of biotechnology and knows the related global discoveries. | P8S_WG | seminar | oral presentation, discussion |
| P8S_WG3 | Knows, understands and is able to use specialist terms used by scientists and specialists in the discipline of biotechnology and related disciplines in their native and foreign languages, which are leading in the discipline and relate to their research interests. | P8S_WG | seminar | oral presentation, discussion |
| Skills: No. | <i>is able to</i> | | | |
| P8S_UW1 | Based on their interdisciplinary knowledge in various fields of science, they are able to identify and solve scientific research problems, define objectives, formulate hypotheses and research topics, select and refine research techniques, methods and tools, and draw conclusions based on scientific research results. | P8S_UW | seminar | oral presentation, discussion, written work |
| P8S_UW2 | Is able to select and use available scientific literature to diagnose and solve research problems and innovative activities in scientific work, and is able to apply the appropriate tools to create new elements of scientific achievements. | P8S_UW | seminar | oral presentation, discussion, written work |
| P8S_UW3 | Using their knowledge from various fields to analyse and evaluate the results of scientific research, expert works and other scientific studies, they are able to formulate opinions, including critical judgements. | P8S_UW | seminar | oral presentation, discussion, written work |
| P8S_UK6 | They are able to speak in public to present the results of their own scientific research and participate in discussions on scientific, social and professional topics in an international environment, using a foreign language at level B2 of the Common | P8S_UK | seminar | oral presentation, discussion, written work |

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|--------------------------------|---|--------|---------|--|
| | European Framework of Reference for Languages. | | | |
| Social competences: No. | <i>is ready</i> | | | |
| P8S_KK1 | Is prepared to conduct an objective assessment of achievements in the scientific discipline of biotechnology and to critically evaluate the contribution of the results of their own research activities to the scientific development of the discipline in which they conduct research and pursue education. | P8S_KK | seminar | oral presentation, discussion, written work |
| P8S_KK3 | Thanks to his/her extensive knowledge, he/she solves various theoretical and practical problems. | P8S_KK | seminar | oral presentation, discussion, written assignments |

FORMS OF TEACHING ACTIVITIES, NUMBER OF HOURS AND CREDITS

| Semester (no.) | Lecture | Practical/Conv. | Lab | Practical | Other | Number of ECTS points |
|----------------|---------|-----------------|-----|-----------|---------------------------------|-----------------------------|
| I - VII | - | - | - | - | 7 x 15 hours - 105 hours | 7 x 2 ECTS – 14 ECTS |

TEACHING METHODS

- *academic discussion,*
- *study of scientific literature,*
- *multimedia presentation,*
- *preparation and presentation of research objectives, research methods, research results,*
- *final projects,*
- *progress in the preparation of a doctoral dissertation*

PROGRAMME CONTENT

Semester I: Theoretical foundations and overview of the state of knowledge

- **Topic 1:** Analysis of global scientific achievements in the field of RNA epitranscriptomics.
- **Topic 2:** Critical assessment of paradigms concerning the druggability of RNA-modifying machinery.
- **Topic 3:** Formulation of a research problem and preliminary hypotheses for a doctoral dissertation.

Semester II: *In silico* methodology and structural modelling

- **Topic 1:** Homological and *ab initio* modelling techniques for NSUN1–7 isoforms.
- **Topic 2:** Analysis of TRDMT1 crystallographic structures: verification and validation of PDB structure quality.
- **Topic 3:** Mapping of active sites and identification of catalytic centres using bioinformatic tools.

Semester III: Virtual Screening and Inhibitor Design

- **Topic 1:** Preparation of targeted libraries (antibiotics, antiviral drugs, phytochemicals).
- **Topic 2:** Implementation of molecular docking algorithms for m^5C methyltransferases.
- **Topic 3:** Preliminary selection of "hit" compounds based on energy and physicochemical parameters.

Semester IV: Molecular dynamics and pharmacophore optimisation

- **Topic 1:** Molecular dynamics (MD) simulations of protein-ligand complexes: stability analysis.
- **Topic 2:** Investigation of the plasticity of active sites under the influence of ligands (isoform selectivity).
- **Topic 3:** Pharmacophore optimisation: designing structural modifications to increase activity.

Semester V: Analysis of the translational pathway and technology transfer

- **Topic 1:** Assessment of drug *repositioning* potential in a clinical context.

- **Topic 2:** Intellectual property aspects: patent protection of molecular research results.
- **Topic 3:** Analysis of the implementation possibilities of research results in the medical biotechnology sector.

Semester VI: Scientific verification and discussion of paradigms

- **Topic 1:** Comparison of own research results with existing paradigms (confirmation/refutation).
- **Topic 2:** Preparation of a scientific publication in a renowned JCR-listed journal.
- **Topic 3:** Critical expert debate on the limitations of *in silico* methodology.

Semester VII: Summary and preparation of the dissertation

- **Topic 1:** Synthesis of research results in the form of a doctoral dissertation.
- **Topic 2:** Preparation of conference presentations and dissemination of research results.
- **Topic 3:** Defence of the research concept and finalisation of documentation of scientific achievements.

COURSE COMPLETION REQUIREMENTS (ASSESSMENT CRITERIA)

The doctoral student's continuous work in each semester and academic year is assessed in terms of: research implementation, knowledge expansion, literature study, commitment and progress in the preparation of the doctoral dissertation.

The course ends after each semester of implementation:

**pass – pass,
fail – fail.**

Requirements

The assessment of the course is based on the percentage of points obtained:

*- **up to 60% - fail** - the doctoral student does not make progress in scientific research, does not expand their knowledge, does not study the reading list, does not participate in substantive discussions, does not fulfil their scientific obligations;*

*- **61% - 100% - passed** - the doctoral student makes progress in scientific research, expands their knowledge, studies basic and supplementary literature, participates substantively in discussions, fulfils all scientific duties*

TOTAL WORKLOAD OF THE DOCTORAL STUDENT REQUIRED TO ACHIEVE THE DESIRED RESULTS IN HOURS AND ECTS POINTS

| Form of activity | Average number of hours to complete the activity |
|---|--|
| Hours spent in direct contact resulting from the study programme | 7 x 15 hours – 105 hours |
| Other with teacher participation (participation in consultations, examinations) | 10 |
| Hours completed independently by the doctoral student (preparation for classes, examination, writing a paper, etc.) | 305 |
| TOTAL HOURS | 420 |
| TOTAL NUMBER OF ECTS POINTS* | 7 x 2 ECTS – 14 ECTS |

LITERATURE

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|---------------------------|--|
| Basic literature: | <ul style="list-style-type: none"> • Jain, S. et al. (2020). Structure-Based Drug Discovery: An Overview. In: "Methods in Molecular Biology". • Schlick, T. (2010). Molecular Modelling and Simulation: An Interdisciplinary Guide. Springer. • Leach, A. R. (2001). Molecular Modelling: Principles and Applications. Pearson. |
| Supplementary literature: | <ul style="list-style-type: none"> • Sliwoski, G., Kothiwale, S., Meiler, J., & Lowe, E. W. (2014). <i>Computational Methods in Drug Discovery</i>. Pharmacological Reviews. |

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| | <ul style="list-style-type: none">• Jumper, J. et al. (2021). <i>Highly accurate protein structure prediction with AlphaFold.</i> Nature.• Wang, J. et al. (2019), Drug Repositioning: A. Promising and Powerful Strategy for Rare Disease Treatment. "Expert Opinion on Orphan Drugs", |
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*(1 ECTS POINT CORRESPONDS TO 25-30 HOURS OF TOTAL WORK REQUIRED BY A DOCTORAL STUDENT TO ACHIEVE THE INTENDED LEARNING OUTCOMES)

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Date and signature of the course lecturer

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Approval of the Head of the Unit or authorised person