

(1.) Course Title: INFPHD102 Bio-inspired Computation: Membrane Systems	Credits: 6
Course Classification: Optional	
Theoretical or Practical Nature of the Course, 'training character'¹³: 90% theory (credit%)	
Type of Class: lecture and number of hours: 22 in the given semester, <i>(If the course is not (only) taught in Hungarian, then the language: English)</i> Additional (specific) methods and characteristics² used in delivering the knowledge <i>(if any)</i> : -	
Assessment Method (Exam / Midterm Grade / Other³): - Additional (specific) methods⁴ applied in knowledge assessment <i>(if any)</i> : -	
Course Placement in Curriculum (Semester Number): 2-3	
Prerequisites (if any): Knowledge in computer science (MSc level)	
Course Description: A concise yet informative description of the knowledge to be acquired.	
Bio-inspired computing is a new and perspective discipline at the interface of theoretical computing, molecular biology, chemistry and physics. An important subfield is the theory of membrane systems or P systems. Membrane systems or P systems are distributed constructs that mimic the functioning of a living cell and consist of regions bounded by so-called membranes, which contain objects. The objects correspond to molecules, chemical constituents. During the operation of the system, objects can change (evolve) and move between adjacent regions according to certain rules. P systems identify the contents of regions, i.e. the set of objects in them, by multisets of symbols or words, and specify the evolution and communication rules by formal language rewriting rules. The theory of membrane systems provides us with a number of computational models that are as powerful as Turing machines, but based on non-traditional principles, and allows us to describe natural processes in living cells or in biological or social organisms like them. The aim of this course is to introduce the basic properties and the main variants of membrane systems. The course will include computational power and size complexity characterization of object-based membrane systems, including systems with dynamically varying structures and constructs based solely on communication. The lectures will also analyze the properties of membrane automata, tissue-like membrane systems, and neural-network-like membrane systems, spiking neural P systems and will demonstrate the potential applications of membrane systems in other disciplines.	
2-5 Most Important Required and Recommended Literature List of required and recommended literature (notes, textbooks) with bibliographic data (author, title, publication details, (possibly pages), ISBN).	
• G. Zhang, M. J. Pérez-Jiménez et al. <i>Membrane Computing Models: Implementations</i>. Springer, 2021.	

- G. Zhang, M. J. Pérez-Jiménez, M. Gheorghe. *Real-life applications with membrane computing*, Springer, 2017.
- P. Frisco, M. Gheorghe, M. J. Pérez-Jiménez (eds.), *Applications of Membrane Computing in Systems and Synthetic Biology*, Springer-Verlag, Berlin Heidelberg, Germany, 2014
- Gh. Păun, G. Rozenberg, A. Salomaa (eds.), *The Oxford Handbook of Membrane Computing*, Oxford University Press, London, 2009
- G. Ciobanu, M. J. Pérez-Jiménez, Gh. Păun, (Eds.), *Applications of Membrane Computing*, Springer-Verlag, Berlin Heidelberg, Germany, 2006
- Gh. Păun, *Membrane Computing. An Introduction*, Springer-Verlag, Berlin, Germany, 2002

List of Prescribed Professional Competencies and Competency Elements

(knowledge, skills, etc., KKK Section 8) that the course significantly contributes to developing (highlight the most important ones).

a) Knowledge

- Has a research-level understanding of the general and specific characteristics, major directions, and precisely developed boundaries of the subject area within the discipline, as well as the agreed and debated interrelations.
- Creatively comprehends the interrelations, theories, and conceptual frameworks and terminologies of the given field of study.¹
- Possesses research methodology knowledge necessary for independent research in the given discipline/field.

b) Skills

- Capable of creative analysis of the field, synthesizing comprehensive and specific interrelations with a new perspective, and conducting appropriate evaluative and critical activities.
- Able to apply and further develop the specialized learning and problem-solving methods of the field.
- Can creatively elaborate on the novel, previously unknown practical implications of theoretical issues.
- Capable of planning and executing new projects, conducting research in the field, and developing new techniques and approaches.
- Able to identify unforeseen professional problems and uncover the detailed theoretical and practical background necessary for their resolution at a research level.
- Can construct and communicate new relations relevant to the field, as well as comprehensive interrelations significant for personal and communal existence.

c) Attitudes

- Represents and further develops the relations that contribute to the process of human self-creation based on the field's characteristics.

¹**Section 108**, Article 37 of the National Curriculum Act (Nftv.) 37. lesson: a session (lecture, seminar, exercise, consultation) requiring the personal involvement of the instructor to fulfil the academic requirements specified in the curriculum, the duration of which is at least forty-five minutes and not more than sixty minutes.

² e.g. case studies, role play, thematic presentations, etc.

³ e.g. continuous debriefing, mid-year report

⁴ e.g. request for case studies, thematic papers, essays, business, organisational plans, etc.

- Possesses an interest and learning ability that enable identifying and solving currently unpredictable research problems in the field.
- Demonstrates a firm professional commitment, a continuous dedication to exploring new approaches, and an acceptance of the necessity for persistent effort.

d) Autonomy and Responsibility

- Builds and initiates new knowledge areas with creative independence and proposes new practical solutions.
- Participates in formulating theoretical and practical questions with a leadership role and high-level cooperation.
- Engages as an equal discussion partner with professionals in the field.
- Takes responsibility for raising and addressing new ethical questions concerning theoretical and practical aspects of the profession.

Course responsible (name, position, academic degree): **Erzsébet Csuha-Jarj, prof. emerita, DSc**

Instructor(s) involved in teaching the course (if any) (name, position, academic degree):
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