

**Doctoral School of Information and Biomedical Technologies Polish Academy of Sciences  
TIB-PAN**

**Discipline:** Biomedical engineering

**Thematic area:** Systems biology, innate immune response

**Subject:** Systems biology models of propagation and eradication viral infections

**Supervisor:** prof. Tomasz Lipniacki, **Adjunct supervisor** Dr Joanna Jaruszewicz-Błońska

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**Research laboratory:** Laboratory of Modeling in Biology and Medicine,  
Institute of Fundamental Technological Research, Polish Academy of Science

### **Research proposal**

The PhD student will be involved in conducting larger project (GRIEG):

Interaction of natural killer cells with an infected cancer cell population: microfluidics-based experiments and single-cell-level mathematical modeling

The aim of the project is to analyze interactions of natural killer (NK) cells with a virus infected cell population at the single-cell resolution. Specifically, we will investigate the interactions of NK cells, two respiratory epithelial cell lines: cancerous A549 and non-cancerous BEAS-2B, and two respiratory viruses: respiratory syncytial virus (RSV) and influenza A virus (IAV).

We will integrate the following techniques:

- Live confocal imaging using viruses encoding fluorescent proteins, cells expressing fluorescently tagged transcription factors and fluorescent markers of apoptosis.
- Immunostaining scanning. In this technique we simultaneously observe different triplets or quadruplets of proteins of a considered regulatory pathway in single cells. We will also use RNA FISH and the emerging technique of sequential immunostaining.
- Gene expression, protein analysis and cytokine production in infected cell populations through the use of RT-PCR, digital PCR, Western Blot, ELISA.
- Droplet-based microfluidic systems to culture adherent and suspended cells allowing for their confocal imaging and immunostaining.
- Mathematical modeling employing Markov processes to describe virus replication, intra- and intercellular signaling, NK cells activation, eradication of infected (and non-infected) cells in heterogeneous cell populations. We will account for spatial aspects of the cytokine diffusion and viral spread.

## **Requirements for the candidate**

We seek outstanding candidate at master degree level, who ideally should combine wet lab experience with mathematical/physical background. The candidate is expected to:

- conduct various type biological experiments and/or
- build mathematical models using ODE/PDE as well Markov processes formalism.

**Literature:** The candidate should familiarize with publications by members of Laboratory of Mathematical Modeling in Biology and Medicine, Institute of Fundamental Technological Research, Polish Academy of Science <http://pmbm.ippt.pan.pl/web/Publications> related to the project.