Condensed Abstract (English)

This thesis explores the complex nature of causality in cancer biology, particularly within the tumor microenvironment (TME), integrating philosophical perspectives, mathematical modeling, and experimental data. It traces the evolution of cancer theories from cell-based to microenvironment-focused models, highlighting increased complexity in causal interpretation due to tumor heterogeneity. The "Hallmarks of Cancer" framework is discussed as a descriptive tool that lacks causal clarity, prompting the use of multi-scale and formal causal models.

Two main theoretical approaches—Somatic Mutation Theory and Tissue Organization Field Theory—are compared and integrated, with probabilistic models illustrating the variable influence of genetics, cellular environment, and microenvironmental factors. Case studies on diffuse gliomas and clear cell renal carcinoma demonstrate how advanced causal modeling (using DAGs, SEM, and Bayesian approaches) can clarify the interplay among invasion, immunity, metabolism, and genetic mutations. The research also identifies key molecular pathways and therapeutic targets, such as IL34 in renal carcinoma.

Methodologically, the work highlights the challenges of validating complex causal networks and advocates for systematically integrating causal analysis in biomedical research. The thesis concludes that a holistic, interdisciplinary approach is essential for advancing both fundamental understanding and clinical applications in oncology. Additionally, it is shown how biomedical research can enhance philosophical conceptual analysis and philosophical concepts biomedical research.

Key words: Tumor microenvironment, philosophical theories of causality, causal modeling, holistic approach to causality in oncology