CTC-on-CAM: a platform for studying heterogeneity, epithelial-mesenchymal transition, and therapeutic sensitivity of circulating tumor cells in comparison to the primary tumor using advanced isolation and implantation techniques in the CAM model

Malignant tumors remain one of the leading causes of death worldwide, and one of their most dangerous and difficult-to-treat features is the ability to form metastases. This process is driven by circulating tumor cells (CTCs), which detach from the primary tumor and travel through the bloodstream to distant organs. These cells are often responsible for the development of secondary tumors, significantly worsening the patient's prognosis. Importantly, CTCs can differ substantially from the primary tumor cells in their biological characteristics, making them harder to detect and effectively target with treatment.

The goal of this project is to develop and implement an innovative research platform – CTC-on-CAM – aimed at better understanding the biology of CTCs. The model of the chicken chorioallantoic membrane (CAM) will be used, which represents an ethical and efficient in vivo system for studying tumor cell behavior in a living environment. The CAM model does not require complex infrastructure or ethical approval, while still providing reliable data for research on metastasis, tumor vascularization, and drug response.

In this project, CTCs will be isolated using advanced microfluidic techniques and implanted into the CAM model. The study will focus on analyzing the heterogeneity of CTCs, their potential for epithelial-mesenchymal transition (EMT) – a process facilitating migration and invasion – as well as their response to selected anticancer therapies, including drugs used in clinical practice. By comparing CTCs to their corresponding primary tumors, we aim to determine whether CTCs can serve as accurate indicators of tumor biology and provide useful information for guiding treatment decisions.

This research topic was chosen due to the growing importance of personalized medicine and the need for a deeper understanding of the mechanisms driving metastasis. CTCs are increasingly considered promising biomarkers for cancer diagnosis, disease monitoring, and therapy evaluation. However, their clinical application remains limited by challenges such as biological variability, rarity, and difficulty in culturing and characterization.

Expected outcomes of the project include the development of an effective method for CTC implantation in the CAM model, identification of key molecular and functional differences between CTCs and the primary tumor, and evaluation of treatment efficacy at the individual patient level. In the long term, these findings may contribute to the development of more effective, personalized therapeutic strategies and improve non-invasive methods for cancer monitoring.