The biology of metastasis-competent circulating tumor cells in colon and breast cancer

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Circulating tumor cells (CTCs) represent the invasive fraction of malignant cells that escape the primary tumor and seed distant metastases. In colon and breast cancer, a minority of CTCs possess metastasis-competent traits, driven by dynamic phenotypic plasticity and microenvironmental cues. These cells frequently exhibit hybrid epithelial–mesenchymal states, stem-like features, altered metabolic programs, and immune-escaping capabilities that enable survival in the bloodstream and colonization of secondary niches. Interactions with platelets, neutrophils, and extracellular vesicles further enhance their invasive potential by shielding them from immune surveillance and promoting intravascular arrest and extravasation. Recent genomic and transcriptomic profiling reveals distinct mutational landscapes and signaling dependencies, suggesting tissue-specific molecular routes to dissemination. Understanding the biology of metastasis-competent CTCs and their adaptive traits provides a crucial foundation for the development of precision liquid biopsy strategies and anti-metastatic therapeutics across solid tumors.