2014 CSE SEMINAR

November 26, 4:00pm

Advanced science & technology Center # 608

Yangjin Kim

Department of Mathematics, Konkuk University

Mathematical modeling of tumor growth: an application to breast cancer and glioblastoma

Glioblastoma is the most aggressive brain cancer with the poor survival rate. A microRNA, miR-451, and its downstream molecules, CAB39/LKB1/STRAD/AMPK, are known to play a critical role in regulating a biochemical balance between rapid proliferation and invasion in the presence of metabolic stress in microenvironment. We develop a novel multi-scale mathematical model where cell migration and proliferation are controlled through a core intracellular control system (miR-451-AMPK complex-mTOR) in response to glucose availability and physical constraints in the microenvironment. Tumor cells are modeled individually and proliferation and migration of those cells are regulated by the intracellular dynamics and reaction-diffusion equations of concentrations of glucose, chemoattractant, extracellular matrix, and MMPs. The model predicts that invasion patterns and rapid growth of tumor cells after conventional surgery depend on biophysical properties of cells, dynamics of the core! control system, and microenvironment as well as glucose injection methods. We developed a new type of therapeutic approach.

Ductal carcinoma in situ (DCIS) is an early stage noninvasive breast cancer that originates in the epithelial lining of the milk ducts, but it can evolve into comedo DCIS and ultimately, into the most common type of breast cancer, invasive ductal carcinoma. Understanding the progression and how to effectively intervene in it presents a major scientific challenge. The extracellular matrix (ECM) surrounding a duct contains several types of cells and several types of growth factors that are known to individually affect tumor growth, but at present the complex biochemical and mechanical interactions of these stromal cells and growth factors with tumor cells is poorly understood. Here we develop a mathematical model that incorporates the cross-talk between stromal and tumor cells, which can predict how perturbations of the local biochemical and mechanical state influence tumor evolution. We focus on the EGF and TGF-β signaling pathways and show how up- or down-r! egulation of components in these pathways affects cell growth and proliferation. We then study a hybrid model for the interaction of cells with the tumor microenvironment (TME). Our results shed light on the interactions between growth factors, mechanical properties of the ECM, and feedback signaling loops between stromal and tumor cells, and suggest how epigenetic changes in transformed cells affect tumor progression.

Organizer	Eunjung Lee	eunjunglee@yonsei.ac.kr
Contact	Haeeun Han	csedept@yonsei.ac.kr
		cse.yonsei.ac.kr

Computational Science & Engineering

BK21+