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국문 강연제목: 3 차원 세포군집의 집단침윤에서 나타나는 규칙성

영문 강연제목: Collective Transitions from Orbiting to Matrix Invasion in 3D Multicellular Spheroids

Abstract(영문): Three-dimensional epithelial cell collectives often exhibit coordinated orbiting along curved cell-matrix interfaces before transitioning into collective matrix invasion. These symmetry-breaking transitions underlie morphogenesis and cancer invasion, yet the spatial cues that dictate where invasive branches arise remain elusive. Here, we show that the transition from orbiting to invasion is governed by bidirectional coupling between cell traction and local matrix curvature. We used slightly elongated multicellular spheroids that initially possessed both sharper and flatter regions. During the early orbiting phase, they round up while exerting stronger contractile forces preferentially near the initial sharper curvatures. This process locally aligns collagen fibers radially, priming the matrix for subsequent invading branches that emerge roughly along the initial major axis of the spheroid. Notably, applying osmotic pressure arrested or even reversed these invading branches. “Mosaic” spheroids containing small fractions of “leader” cells disrupted coherent orbiting yet retained invasiveness. Finally, we establish a minimal self-propelled particle model to elucidate how the crosstalk of cell-cell and cell-matrix adhesion mediates collective orbiting. Altogether, this work elucidates how local curvature guides symmetry-breaking collective, with relevance for embryonic development and tumor progression.

Brief Biosketch (간단한 이력, 연구/대외활동 소개,국문/영문)

2023 년 박사학위 취득(지도: KAIST 신현정 교수님) 후 박사후연구원으로 재직중(지도: 브라운 대학교 Ian Y. Wong 교수님) 입니다. 3 차원 세포모델을 대상으로 이미징 기반 형태분석과 기계적 자극제어를 통해 세포의 기계적 기억력과 침윤 거동을 규명하였습니다. 기계적 미세환경 조절을 통한 질병의 정량적 이해와 치료기작 개발에 기여하고자 합니다. Hibbitt Postdoctoral Fellow 로 선정되어 BME Design and Innovation II 과목을 공동지도 하였습니다. Rising Stars in Mechanical Engineering (female)로 선정되었습니다. Jiwon Kim received her Ph.D. from KAIST and is currently a Postdoc at Brown

University. Her research focuses on 3D cell mechanics/mechanobiology. She was selected as a Hibbitt Postdoctoral Fellow (2023-2025) and as a Rising Star in Mechanical Engineering (2025).