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A 3-D Individual Cell Based Model (ICBM) for simulating cell mobility, cell-cell and cell-ECM interactions.

I present a 3-D Individual Cell Based Model (ICBM) for simulating and visualizing cell signaling, adhesion, motility, and stiffness and their affect on cell movements and growth in multicellular systems. The building blocks of the model are individual deformable ellipsoidal cells, with both mechanical and chemical response that depend on their internal parameter state (cell adhesion and stiffness) and on external cues from the neighboring cells, extracellular matrix, and chemical signals. Cell movement and deformation is calculated from the equations of motion using the total force acting on each cell. The model uses experimentally measured cellular characteristics, can simulate over 100,000 cells, and is adaptable to many different systems. I highlight the many new unique features of this model such as non-uniform cell surface receptor density and secretion, as well as desmosome like lateral adhesion. Finally I show the ramifications of these interactions for a number of different biological systems (cervical tissue, mammary tumors, $zebrafish$ and $dictyostelium$ development) and demonstrate that the emerging cell patterns in these multicellular systems are distinctively different from that of an individual cell. The simulated cells are visualized using an openGL code. The visualization enables us to see how cells deform when moving past other cells inside mutlicellular tissues, and watch how chemical concentrations change over time at different locations. All this helps us compare the results to experimental findings and gain insight into what processes are important as we adjust the model to match the experimental results.