Analysis of *Dictyostelium Discoideum* Motion

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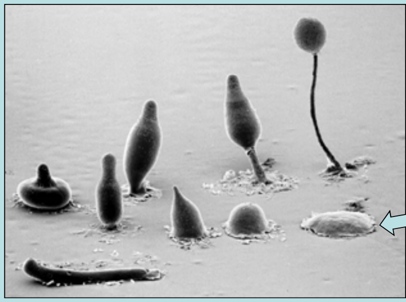
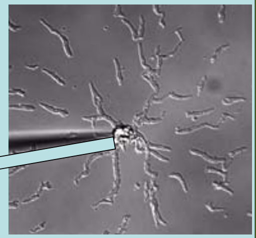
Social Amoebae as a Model of Cell Migration

• *Dictyostelium Discoideum* is used as a model system for interactions among cells in a group and migration of cells. Similar processes are important for human cells during, e.g., embryogenesis and cancer metastasis , but they are more easily studied in a simpler model organism.





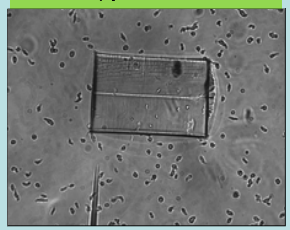
• In the graphic on the right, cells move toward a cyclic-AMP source in order to form an aggregate of cells, similar to the one seen in the bottom right of the graphic on the left.

• As the cycle continues, the *Dictyostelium* cells work together to form the spore pictured in the top right of this graphic.

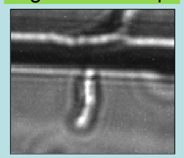
Tracking the Shape of a Cell

• Use an active snake algorithm to extract coordinates of a cell's shape in a given image sequence.

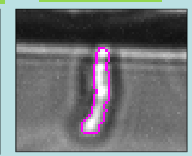
Original image of Dicty cells on and around ramp, obtained via phase-contrast microscopy



Zoomed in image of cell on the edge of the ramp

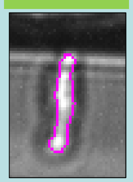


Snaked cell

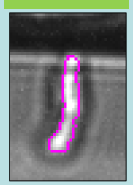


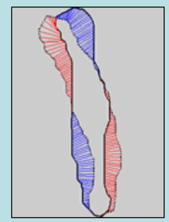
• Connect cell outline from each image to the next image of that cell in that sequence.

Frame 20



Frame 21

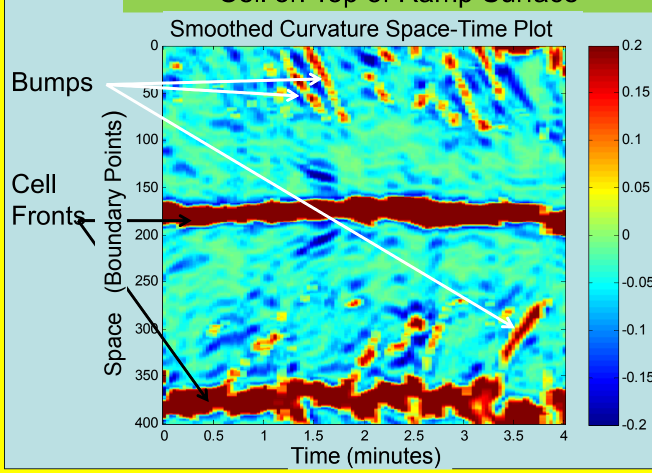




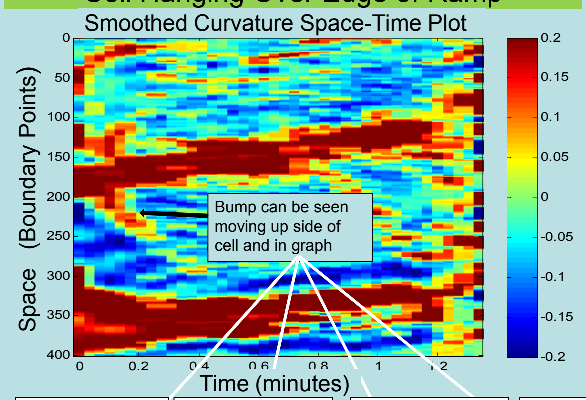
Analyzing a Cell on the Edge

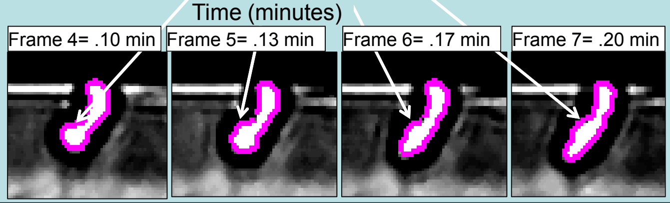
When the cell is moving, graphing its localized curvature reveals that the cell has bumps, or protrusions, that travel down the length of its cell membrane.

Cell on Top of Ramp Surface



Cell Hanging Over Edge of Ramp





Results and Discussion

• Local curvature measurements show that there are moving protrusions in all cells observed, both on the ramp, and hanging off of it.

• Based on other analysis of *D. Discoideum* performed in our lab, it appears that these cells put out filaments that adhere to surfaces and remain stationary. It has been theorized that the curvature waves are caused by the cell passing over these filaments.

• Some of these curvature waves were produced because a protrusion from the cell membrane remained stationary, while the cell fronts continued to translate, supporting this theory.

• However, the fact that these waves are also present when the cell is hanging off the edge of a ramp, when there is nothing for these 'feet' to cling onto, suggests that surface adhesions are not the cause of the waves. Even when the cell was on the ramp, a significant number of waves were seen to have resulted from a protrusion actually moving along the edge of a cell.

• Another hypothesis is that these waves result from internal actin polymerization that occurs in the cytoplasm of the cell.

•Interestingly, the speed of these bumps differs whether the cell is on the ramp, or hanging off its edge. For one cell, when on top of the ramp, the fastest protrusions along the cell membrane moved at a rate of 16.6 μm/min. When the same cell was on the edge of a ramp, these protrusions moved as fast as 29.0 μm/min.

• Other cells hanging over the edge of the ramp have also been seen with protrusions moving at approximately 30 μm/min., whereas the cells moving on top of the ramp have not exhibited such fast behavior.

•While It is possible that some waves result from actin polymerization and others from surface adhesions, neither theory explains the faster motion on the edge of a ramp.

Acknowledgements

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