CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

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Project Number

J0809

Project Title

Cellular Factors Involved in the Progression of DCIS to Invasive Breast Cancer Using Computer Based Simulation

Abstract

Objectives/Goals

Breast cancer is the second leading cause of cancer death in women. A deeper understanding of how breast cancer grows and spreads can help in the development of life saving treatment. Ductal Carcinoma In Situ (DCIS) is a non-invasive breast cancer, where abnormal cells are contained in the breast ducts. The progression of DCIS to invasive breast cancer is still not well understood. Many cellular factors seem to play a role like Mitosis, Apoptosis and Adhesion between cells(Myoepithelial and Luminal). This project proposes a novel computational approach to investigate which important cellular factors play a dominant role in the evolution of DCIS to invasive breast cancer.

Methods/Materials

I used the computer based simulation CompuCell3D to create a 2D cross section of a breast duct, which contained a Luminal Epithelial Layer (LEP) and a Myoepithelial Layer (MEP). Modifying plugins using Python and XML scripting and based on the Cellular Potts Model, various factors including mitosis, apoptosis, and cellular adhesion were set to mimic the growth of luminal epithelial cells in DCIS. I modified each factor independently of each other, at rates of 12.5%, 25%, 50%, 100%, 200% 400%, and 800% of their baseline rate (the control rate). Each trial was run until invasion occurred, and the time until invasion was recorded on a spreadsheet. I compared each modified rate to its baseline rate, and used standard statistical analysis to determine trends within the data.

Results

The results showed a strong correlation between mitosis and likelihood to invasion. A weaker but still strong correlation was seen in the adhesion between LEP and MEP cells. A weak correlation was seen in adhesion between LEP and LEP cells and in adhesion between MEP and MEP cells. No correlation was seen for apoptotic rate.

Conclusions/Discussion

Of the factors tested in my project, mitosis was shown to play the key role in the progression of DCIS and invasive breast cancer. This corresponds to clinical data which shows a relationship between a higher grade of DCIS and progression to breast cancer. The moderate correlation between LEP cells suggest that luminal epithelial factors such as E-cadherin levels relate to tumor progression.

Summary Statement

I used a computational approach to study the factors involved in the progression of DCIS to invasive breast cancer, and this suggests that mitosis rate and luminal epithelial cellular adhesion in DCIS have significant roles in how invasive breast cancer progresses.

Help Received

I would like to thank Dr. James Li for introducing me to CompuCell and helping me narrow down my research topic.