Using ImageJ as a Method to Track and Analyze Population Dynamics of Gentamicin Treated *E. Coli* at the Single-Cell Scale

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***Short Abstract* —** Using the program ImageJ, I analyze the recorded microscopy videos of *E. coli* colonies treated with the antibiotic Gentamicin to create a lineage tree that visualizes the patterns of growth and death among related cells as they divide. With the trees, further mathematical studies can be applied to assess either a deterministic or stochastic death pattern for the ongoing project and direct other projects further. Studying how *E. coli* respond to the antibiotics they are treated with through their genes and relationships to other related cells will illuminate how antibiotics physically interfere with the life and duplication of bacteria.

***Keywords* — Antibiotic resistance, Gentamicin, Escherichia coli, growth and death kinetics, single-cell tracking, ImageJ**

I. Purpose

Antibiotic resistance is a persistent problem in health care, and it must be understood in detail to combat it effectively. Studying how antibiotics can more efficiently be administered and created is just as essential as focusing on the receivers of them on the other end; studying how the bacteria themselves adapt genetically or phenotypically to become resistant is equally crucial.

Analyzing Gentamicin treated *E. Coli* utilizing ImageJ as an optical tracking method allows the growth and death kinetics of a population to be approached from a biological and physical perspective. Automated microscopy videos of the expanding colonies over time allow visualization of the growth of the entire colony from the single parent cell to the final division. These videos enable the ability to track the antibiotic-treated *E. coli* at the single-cell scale utilizing the Trackmate feature of the program ImageJ to generate colony trees. While it is known that Gentamicin causes abrupt growth arrest in the cells without altering the growth rate, this finding may be disputed based on some of the recent colonies tracked under the same experimental conditions. In some of the colonies, only one of the two original sister cells proliferates and expands as a colony before abruptly ceasing in growth. In other colonies, both original sister cells proliferate, but stop elongating and reproducing at a different time stamp than the other colonies, reflecting differently timed lag and log phases. Due to Gentamicin's known deterministic death pathway, these differentiating findings, illuminated through the visual growth-and-death tracking method and data provided from ImageJ, allow for further projects to be directed to assess the nature of these population dynamics and allow Gentamicin to be administered most efficiently by truly understanding how the bacteria adapt to it.

II. Conclusion

While this is an ongoing project that focuses more on the data analysis technique rather than concrete findings, current projects are underway to determine if the growth and death kinetics of *E. Coli* treated with Gentamicin are truly deterministic, and what causes the discrepancies in the lifecycle between homogenous colonies. Phenotypic resistance currently appears to be the main reason for such growth time variations, however further tracking and mathematical models will be able to create a more cohesive answer to such a question. In conclusion, the Trackmate feature of ImageJ is an extremely useful program to visualize the dynamics in which these *E. Coli* cells interact as a colony population, and how antibiotics affect the population dynamics from a single-cell level.

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