Mathematical Model of HIV: Immune System Dynamics and Treatments

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Human immunodeficiency virus (HIV) destroys a person's immune system by attacking the T-cells of the immune system and using them as viral replicating hosts. As a result, a person infected with HIV is more likely to get other infections that the immune system can't fight efficiently. Currently, there is no medication that cures a person of HIV, but HIV can be controlled through antiretroviral therapy (ART). A new treatment strategy for HIV has been suggested that blocks reactivation of the viral genome in the cells and locks the HIV virus into a state of latency. This strategy depends on a novel drug didehydro-Cortistain A (dCA), which targets the HIV protein Tat. The purpose of this project was to study the complex interactions between T-cells and HIV infected cells by the means of a mathematical model. A system of differential equations was created and used to test the effect of the novel dCA medication on the HIV infected immune system. The model showed that with the novel medication, the virus rebounds at a much slower rate compared to traditional ART and to a concentration that can be managed by the immune system. The outcomes of this project could be used by medical practitioners to understand the dynamics of the suggested HIV treatment before testing it on humans and in choosing a patient's treatment strategy at different stages of chemotherapy. The results of this study suggest that the novel block-and-lock therapy is the first step on the road to a functional cure of AIDS.

Awards Won:

Mu Alpha Theta, National High School and Two-Year College Mathematics Honor Society: Second Award of $1,000

Fondazione Bruno Kessler: Award to Travel to Trento, Italy to participate in summer school "Web Valley"