

Simulating the Immune System

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Hypothesis

A realistic immune system simulator can be built using Processing (a Java-based visualization language).

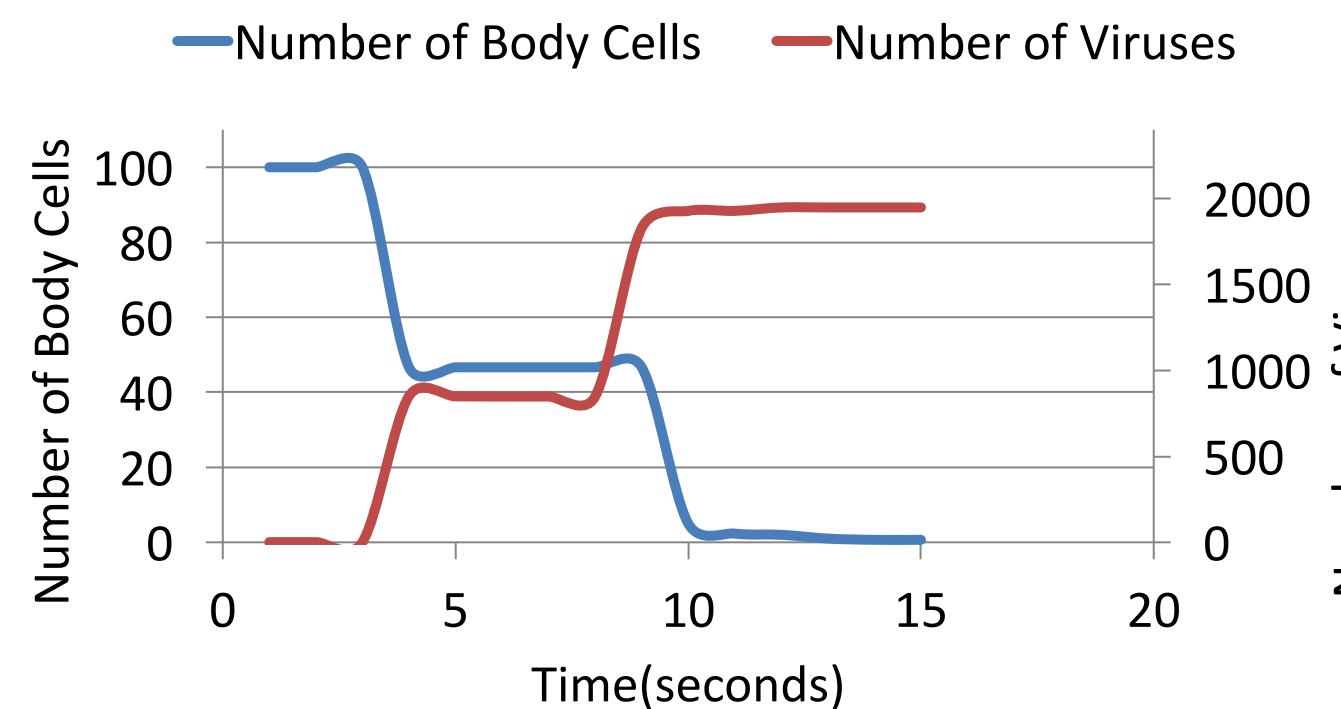
Materials and Methods

- Simulation of immune system using Processing 3. I simulated all white blood cell types and two pathogens: a cold virus and *Staphylococcus aureus* (Staph)
- I ran the code many times under many different settings to make sure all the components worked.
- The program recorded data (number of body cells, number of viruses, and number of bacteria during each infection)
- I analyzed the data using Microsoft Excel.

Viral Infections

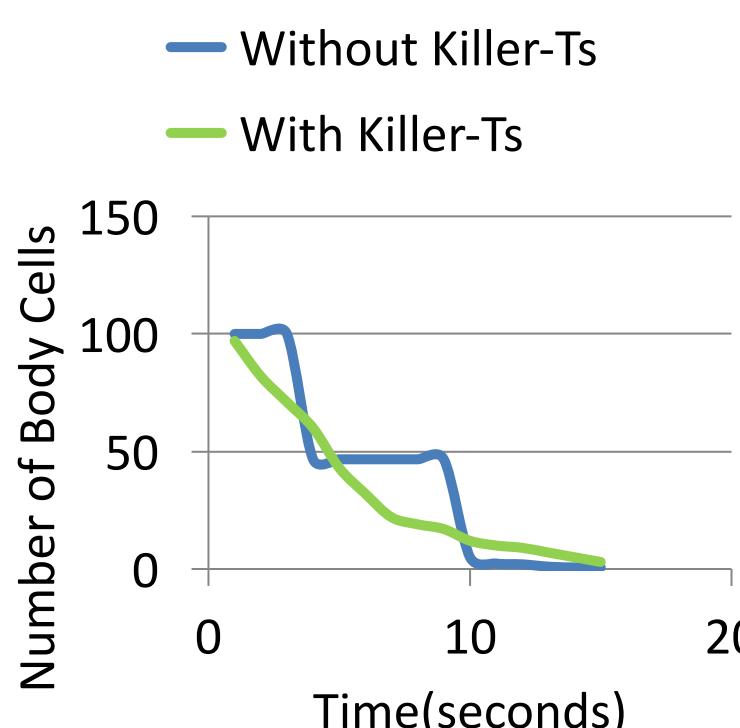
Experiment 1: Infecting 100 body cells with no immune system

Cell Death with Viruses

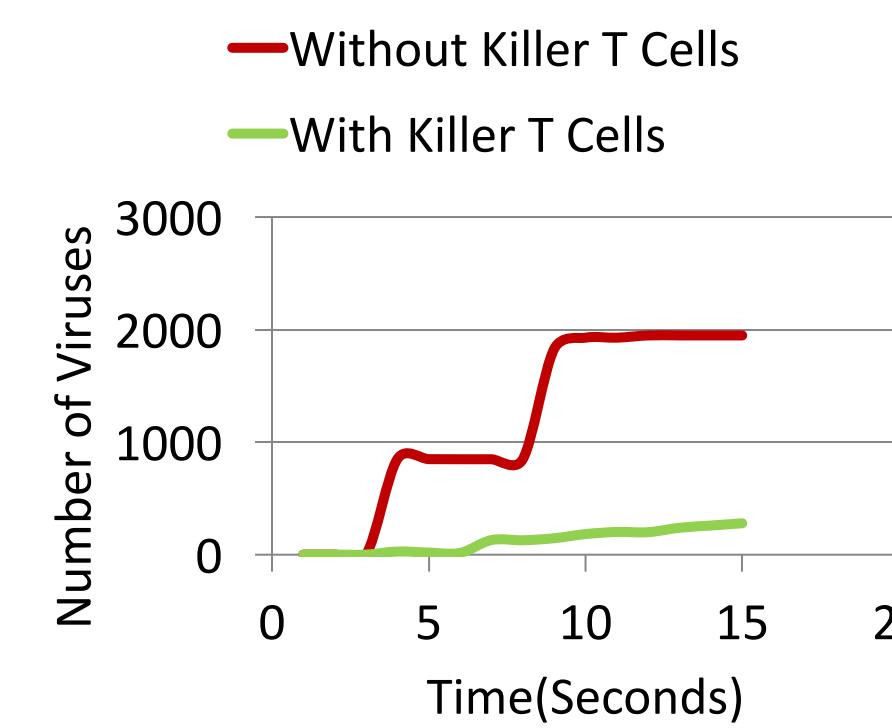


Experiment 2: Infecting 100 body cells with 10 Killer-T cells for protection

Cell Death With and Without Killer-T Cells



Virus Reproduction with and without Killer Ts



Introduction

We all get sick. What defends us from invading pathogens like bacteria and viruses? **Our immune system.**

Our immune system has many kinds of white blood cells. These cells each have an important role in killing pathogens.

- Dendritic cells** eat a pathogen and deliver digested parts of it to a helper-T cell. They do this so that the immune system can tell what to attack.
- Helper-T cells** deliver the parts to a b-cell, so the b-cell can target the invading pathogens.
- B-cells** use the parts to create proteins called antibodies which stick to the specific type of pathogen.
- Macrophages** migrate to the pathogens with antibodies and swallow them, killing them instantly. They can only kill viruses flagged with antibodies, but they can kill bacteria without needing an antibody.
- Finally, **killer-T cells** kill infected cells. Since viruses reproduce inside cells, they can also be killed inside them.

Objective

To simulate the immune system and different pathogenic infections so we can better understand how our immune system works.

Conclusion

The simulation reflected aspects of the immune system effectively, based on known behaviors of the immune system.

Sources

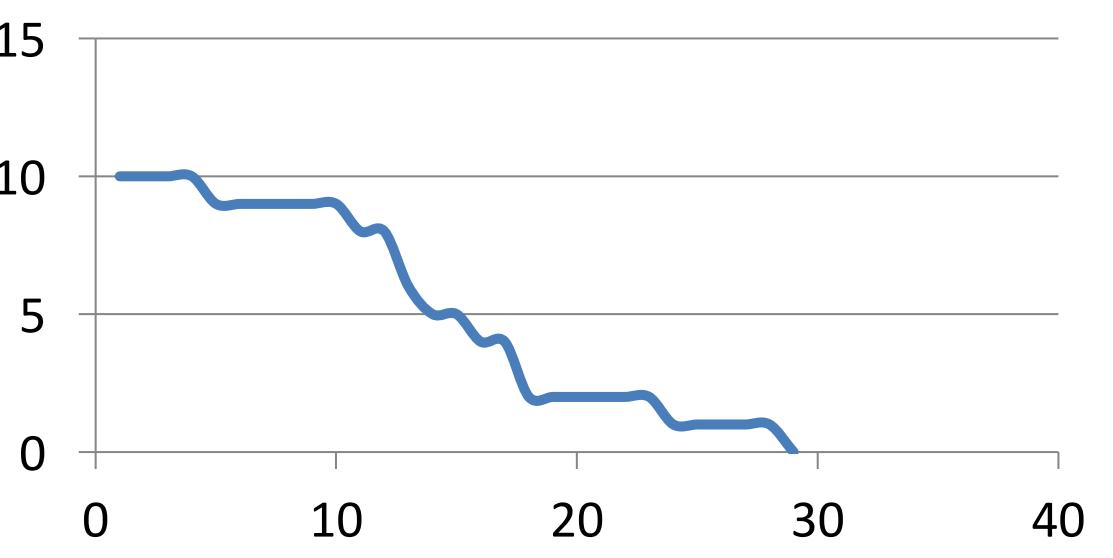
- <http://www.diabetes.co.uk/>
- Your Amazing Immune System: How it Protects Your Body, compiled by the Japanese Society for Immunology. Wiley-Blackwell 2009. pp. 1-71
- Burillo-Kirch, C, Microbes: Discover an Unseen World. Nomad Press 2015, pp 1-114

Special Thanks to Dr. Loida Viera-Hutchins, Pediatric Immunology, University of Utah

Bacterial Infections

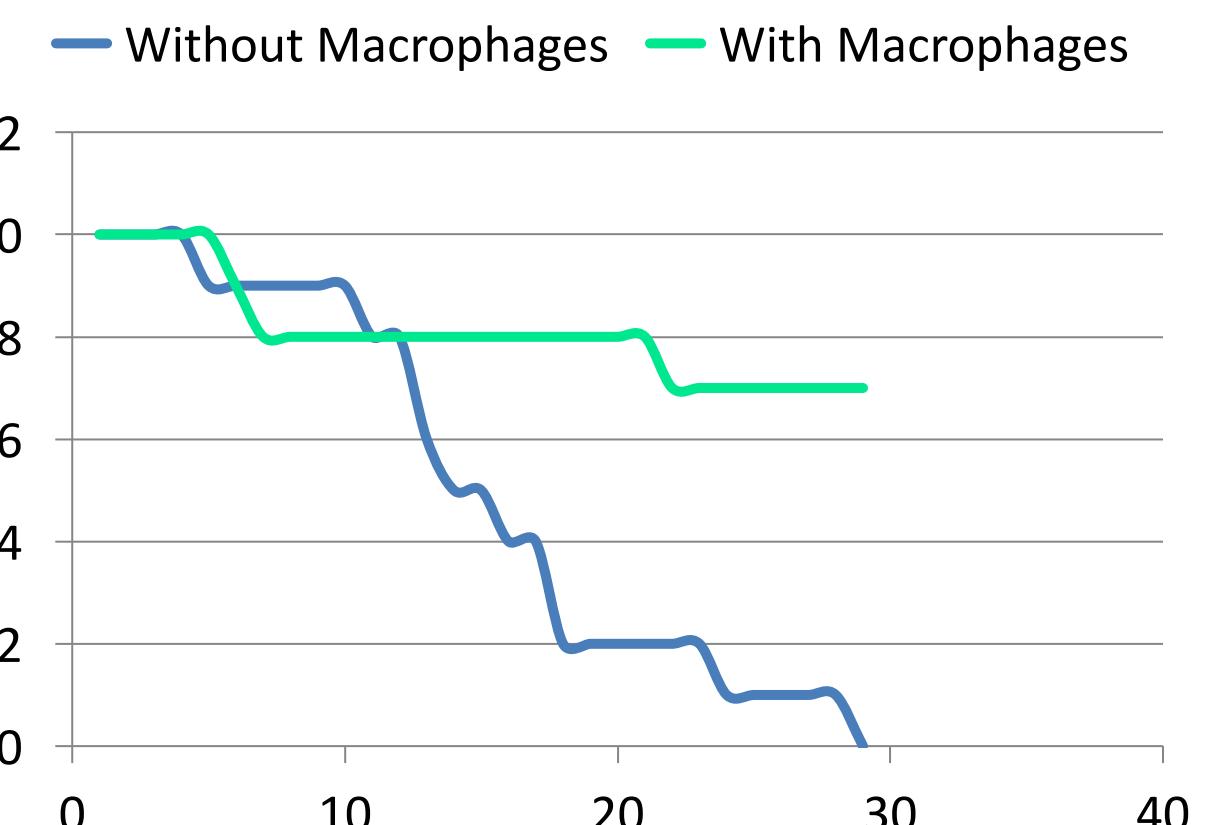
Experiment 4: Killing 10 body cells with bacteria

Number of Body Cells Dying With Bacteria



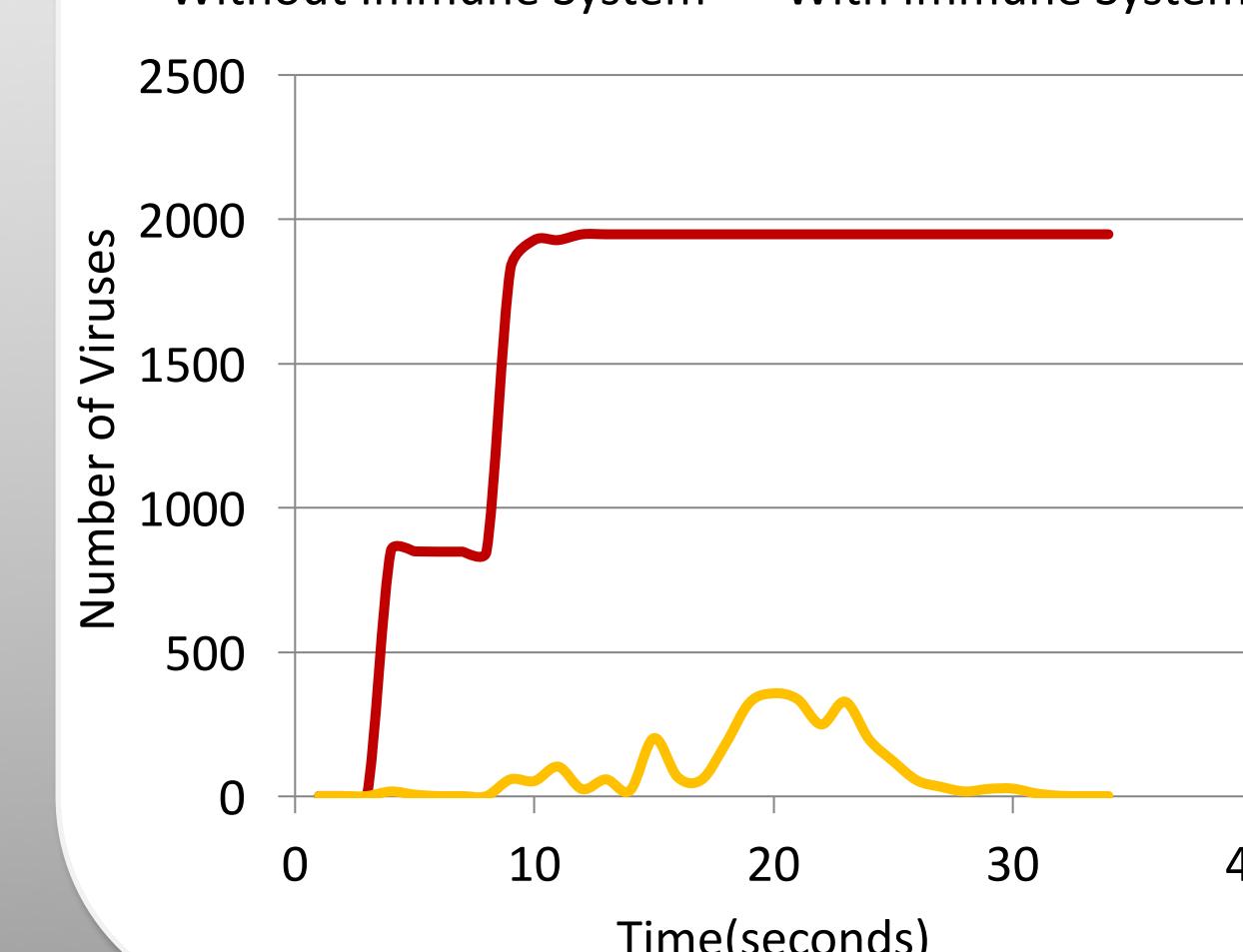
Experiment 5: Killing 10 body cells with 10 macrophages for protection

Body Cell Death with Bacteria and Macrophages



Virus Reproduction

— Without Immune System — With Immune System



Experiment 3: Infecting 100 body cells with the entire immune system for protection

Body Cell Death With and Without Immune System

