# The Effect of Cell Regeneration on Viral Infections

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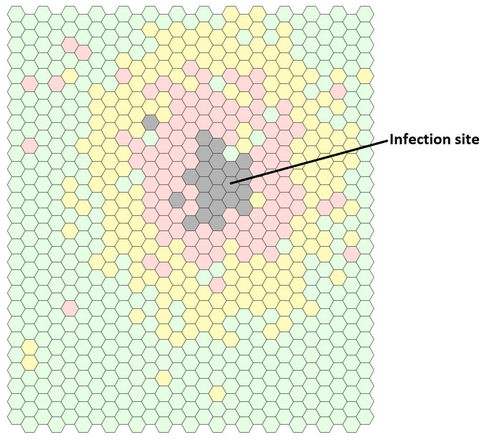
## BACKGROUND

Everyone gets sick and illness negatively affects all aspects of life. One major cause of illness is viral infections. Some viral infections can last for weeks; others, like influenza (the flu), can resolve quickly. During infections, healthy cells can grow in order to replenish the cells that have died from the virus. Past viral models, especially those for short-lived infections like influenza, tend to ignore cellular regeneration – since many think that uncomplicated influenza resolves much faster than cells regenerate. This research accounts for cellular regeneration, using an agent-based framework, and varies the regeneration rate in order to understand how cell regeneration affects viral infections. The model used represents virus infections and spread in a two-dimensional layer of cells in order to generate graphs of virus over time for corresponding regeneration rates.

## OUR APPROACH

- We constructed a hybrid agent based model and partial differential equation (PDE) model to simulate the spread of virus.
- An agent based model represents each cell independently and allows us to examine the collective behavior.




## MODELING CELL STATES

The cells can be in one of four phases:

| Healthy | Eclipse | Infected | Dead |
|---|---|---|---|

- Eclipse cells are infected, but not producing virus.
- Cells transition from eclipse to infected, and infected to dead according to a gamma distribution.
- Dead cells regenerate after a time pulled from an exponential distribution.
- One-million cells in a 2D hexagonal grid were simulated.

## VIRUS SPREAD

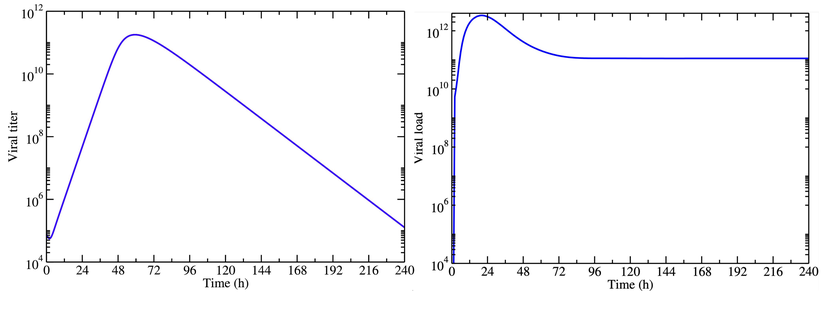
The virus spreads according to the following partial differential equation:

$$\frac{\partial V}{\partial t} = D\nabla^2 V + p - cV$$

*V = Number of virions*
*D = Diffusion coefficient:* $6\times10^{-8}$ $m^2/h$
*p = Virus production rate:* 562,800 virions/cells · h
*c = Clearance rate (viral rate of decay):* 0.105 /h

## AMOUNT OF VIRUS/TIME

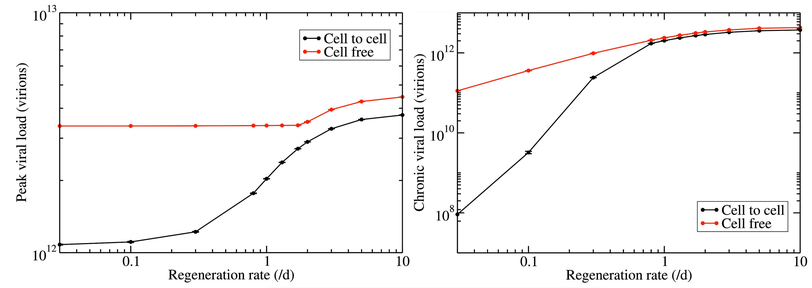
- We used parameters to simulate influenza infections and varied the regeneration rate.
- 100 simulations were run for each regeneration rate.
- A Multiplicity of Infection (MOI) of $10^{-2}$ was used.
- We compared infections with and without cellular regeneration.

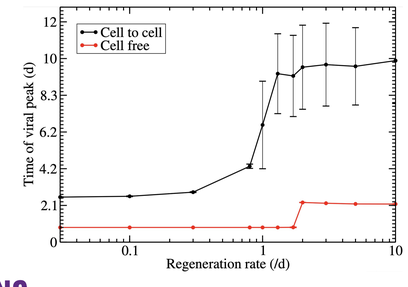



*Viral load (Y) vs time in hours (X): left no cell regeneration, right, cell regeneration.*

## EFFECT OF CELL REGENERATION

To better quantify the effect of cell regeneration on viral curves, we measured the peak viral load and chronic viral load.




## CONCLUSIONS

- The data we gathered shows that cellular regeneration is an important part of viral models, because it alters the time course of the viral load, and therefore, the length of the infection.
- The chronic viral load level increases with faster cell regeneration.

## FUTURE WORK

- Looking at the effect of cell regeneration and treatment.