Virus Trends

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Viruses go from human to human infecting them, and possibly killing them. This can be expressed with possible equations. Even though a virus mutates randomly, their behavior is far from random and it is easier than it seems to model their behavior. Equations have already been derived, discussed, etc. for almost all viruses, but only a few have been actually focused on by so many people, usually only the very deadly viruses. I used these formulas and their results to find a way to make a universal formula for all viruses, or just a base for it. The basic structure for the formula is pretty easy to speculate since it models what every virus does: produce virus then subtract how much actually makes it through the immune system. Then you start adding to that formula other aspects since a virus needs more than its concentration to successfully reproduce. Afterwards, the formula needs to be tested with different circumstances not only to successfully model the virus (here would be HIV), but see if it can successfully model other viruses, and see how many changes needed to make it apply to other viruses. Here, the results were accurate enough for HIV, but the equation needs to be broader to apply to all viruses, just it won't be as accurate until that broad equation can get more variables of other characteristics of all viruses added.

What I was trying to find is a universal formula for the spread of viruses, etc. How I would do this would be to find/ask for the formulas then find the similarities with mathematics, graphs, etc. To begin, I will put down some of the most basic mathematical formula that was derived for the transmission rate for any virus

$$P = V - (c * V)$$

Where P is the production rate, V is the virus concentration, and c is the clearance rate constant. This formula is a good base for most of the virus equations, but lacks the factors that affect virus spread like strengthening immune system, etc. Another variable is added, t (time), in the equation for HIV production rate:

$P = V/t - (cV)$

I is still unknown whether the t can be added to this equation for viruses other than HIV.

The number of potential cells in the human body is also needed:

$\dot{T}=s-dT+aT(1-T/Tmax)$

Where d is the natural death rate of T-cells, s is the source term for uninfected T-cells, a is the growth rate of T-cell population, and Tmax is the maximum population level for the T-cells.

Another part to consider is also the infected cells' reproduction, death, etc.

$I = V/t - (cV)$

Where I is the infected cells, V is viral load of the virions, and c, again, is the clearance rate constant. A lot similar to the first equation, mostly because infected cells are made mathematically similar to the production rate: the number of cells it can infect/number of viruses it can produce minus the number that will die in the process. The latter equation seems to be the dependent equation since the production rate is entirely dependent on the number of infected cells. We can also expand the second and third equation:

$dT/dt=s-dT+aT(1-T/Tmax)-\beta TV+\rho I$

Where β is the rate that the T-cells become infected with the virus and p is the rate of cure. This now combines the number of cells that can be infected relative to the number of cells that are being born. The one last factor that must be considered is the incubation period that the cells go through before becoming infected, combined with the current equation:

$dT/dt=s-dT+aT(1-T/Tmax)-\beta T(t-\tau)V(t-\tau)+\rho I,$

Where τ is the period of time that the cell has been in incubation ($t - \tau$ shows the delay that occurs because of incubation).

Although this is still a relatively simple formula for the infection rate of HIV, it is still enough to put into programming. Not only did I use the latest formula, I also used the first formula discussed to compare the results. Relatively, the results were actually not that close. Meaning that the formula is a nice base, but the added formulas for accuracy is needed. Unfortunately, there are no formulas available for relatively safe viruses, so I cannot test the formula given for HIV. The universal formula should look very similar to (or look exactly like) the formula since all viruses infect cells, have an incubation period, and affected by the number of potentially infected cells. The only probable change is the values of the equation. Something that still needs to be added is the change of strength in the immune system, especially since HIV destroys the immune system, while other viruses are eventually eliminated by the adapted immune system. What this has provided us then is a nice base formula for all virus equations, but still needs to be edited since it needs to be more accurate with more characteristics of a virus.

Acknowledgements

http://www.sciencenetlinks.com/sci_update.cfm?DocID=117

http://www.hindawi.com/GetArticle.aspx?doi=10.1155/2008/903678&e=html