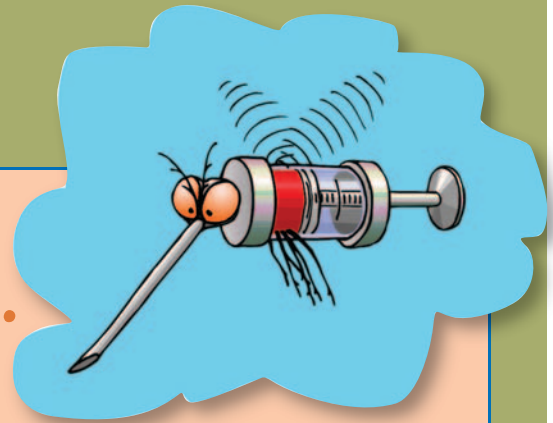


Apply It.



The math behind... VACCINATION

Some technical terms used :

Differential equations, basic reproduction number, herd-immunity

Uses and applications:

Mass vaccination projects of the World Health Organization (WHO) and public health departments.

How it works:

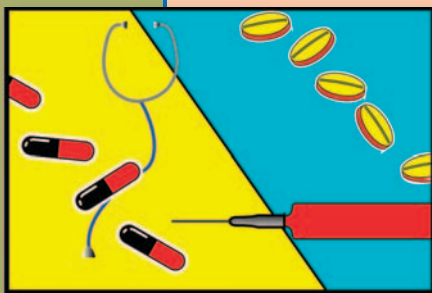
An important feature of an infectious disease is the basic reproduction factor R_0 , which gives the number of secondary infections that one infective individual will produce during the time being infectious. For almost any infectious disease, differential equation models can lead to the calculation of the basic R_0 using specific information such as transmission rate of the pathogen, duration of infectiousness, and average death rate in the population. R_0 provides an estimate of how 'infectious' the disease is, i.e., how well it can spread in an uninfected population. If $R_0 < 1$, the disease will not persist in the population. If $R_0 > 1$ the disease holds potential to spread as an epidemic or to become endemic.

Interesting Fact:

Smallpox, which has been successfully eradicated from around the world, had an R_0 of 3–5 and required about 70–80% of the population to be vaccinated. The last case of smallpox was observed in 1977. WHO is currently aiming to overcome polio worldwide. Polio has an R_0 of 5–7 which means that approximately 80–86% of the population would have to be immunized for it to be eradicated. For more information see: <http://www.polioeradication.org/>.

References

- [1] *Infectious Diseases of Humans*, Roy M. Anderson and Robert M. May (Oxford University Press, 1991)
- [2] *Essentials of Mathematical Biology*, N. F. Britton, Springer 2003. (See p. 102)



Submitted by Swati DebRoy, SIAM Gators Student Chapter, University of Florida, third place, Math Matters, Apply It! contest, January 2008

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