Math 481: Mathematical Modeling
Part 2:Introduction to Modeling Infectious Diseases

Spring Semester, 2006
Tuesday-Thursday 4:00-5:15pm M/P 008 (Mostly March, first week in April)

Instructor: Jonathan Bell M/P 405
Office hours: right after class, or by appointment (see me, or contact office staff, 410-455-2412, or drop by the office. If I have a few minutes I will try to help you.)
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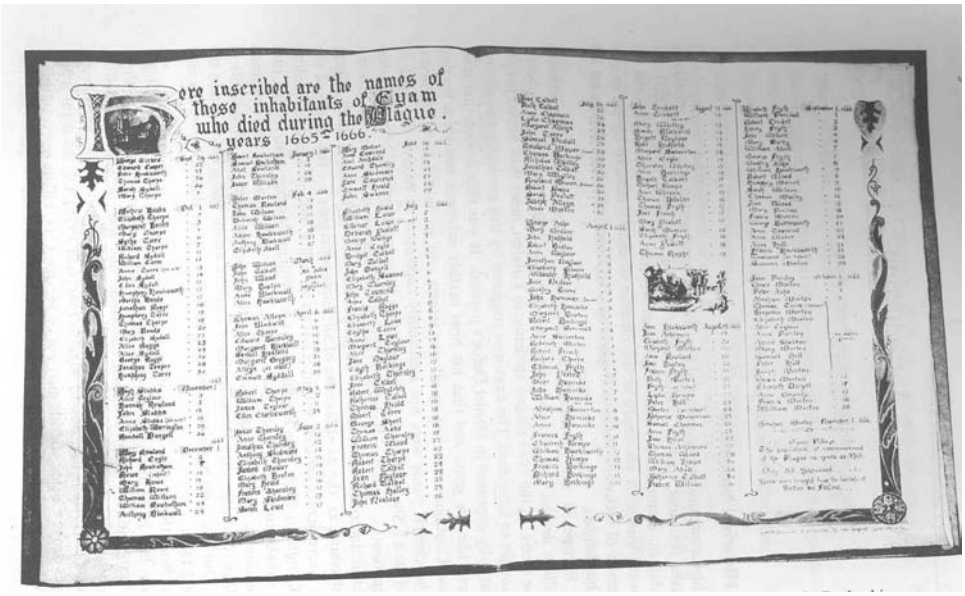

About the Module: The course can be considered consisting of three modules, this being the second one. With all the discussion in the media about avian flu and a possible pandemic, I thought it might be appropriate to introduce modeling of infectious diseases. To be consistent with the other modules we will investigate deterministic models involving differential equations for the most part, rather than stochastic models, which requires the technology of probability theory, Markov chains, difference equations, etc. Still, these models have proved valuable in focusing on what questions to address, and what to measure.

The basic outline of the module will be:

Week 1: definitions, historical comments, population modeling approach, first disease models

Week 2: SIR model, threshold phenomenon, model analysis and approximations, examples, SIRS models, vaccination policies

Week 3: general characteristics of sexually transmitted diseases, conditions for a sustained disease, cross-cross disease modeling, introducing AIDS and HIV-1 infection basics, the simplest HIV model

Week 4: full TT*V model of AIDS, drug regulation modeling, conclusions, missing factors, vaccination issues, introduction to spatial models, as time permits.

By the end of this part of the course, you should be able to understand a segment of the research literature that involves mathematical modeling of infectious diseases, and even have the methodology to write out some simple model situations on diseases not discussed in class. You should also be a little more comfortable with differential equations.

Projects: Here are a few suggestions for projects:

- Except for a couple of specific sexually transmitted diseases, the model ideas I discuss in class are for a generic infectious disease. For a project one can look at a particular disease with its specific characteristics (incubation period, infectious rate, recovery rate, etc) and analyze a particular model for that disease.
- One can develop a project of doing an analogue simple probabilistic model of a disease and compare results to an analogue deterministic model.
- One can develop a cost-benefit analysis of stockpiling drugs for a flu pandemic.
- From a bioterroristic standpoint, both smallpox and anthrax can be used as a weapon. There are significant differences of characteristics of these two diseases. One project, of many, would be take one of them and analyze in a model framework the pros and cons of a mass vaccination program vs. a selected vaccination program.
- Analyze HIV model with more factors included in the model, and compare to experiments
- Incubation of a disease is an issue that is modeled through SEIR type models, so analyze a model for a disease with a significant incubation period.
- Spatial spread of infectious diseases; epidemic waves; quarantine and vaccination issues.

Homework: Homework assignments will be given weekly.

About the above picture: This is the church register of deaths by the 1665 plague epidemic in Eyam in Derbyshire, England. At least 258 of the town's approximate 350 citizens died.