Spread of infectious diseases

Introduction
This simple computer model allows students to visualise the spread of an infectious disease and to see how different parameters can affect the rate and extent of the spread. Students can quickly investigate different parameters. Discussion questions link the findings to the real world.

Resources
Computers, linked to internet to download the model.

The activity
Students should be encouraged to use the suggested settings before playing with other values. The whole activity takes about 20 minutes; although it could well lead on to discussion of a topical news story about the spread of an infectious disease and a comparison of the rate of spread of different diseases.

Suggested answers to questions on the model
1. What parameters are not included in this model?
   Travel of people into, out of and within the area.

2. What is the likely effect of introducing mobility of people?
   A second model where another area becomes infected in a similar way. Possibly producing an epidemic or pandemic infection.

3. Why does a simple model not introduce more parameters?
   Because it is a SIMPLE model to reflect how a disease spreads through a closed society. More complex models will require time consuming input AND will take a lot longer to run. Weather forecasting for example, uses simple programming and is fairly accurate in the short term. The same goes with disease modelling, it is fairly accurate in the short term, but as time increases inaccuracies produce a wider difference between the model and reality.

Science Explanations

Aa Many diseases (of humans, other animals, and plants) are caused by small organisms (microbes) such as bacteria, fungi and viruses which are present in the environment and can be passed on from already infected individuals.

Ac The body can defend itself against infections with its immune system. An individual who survives an infection by a particular microbe is then able to make those specific antibodies very quickly and is thus protected against future invasion by that organism.

Ae An individual can be infected by microbes in several ways which include: directly from an infected person, from a contaminated environment including air and water, or via an insect vector. The route of transmission depends on the microbes.

Questions using the model to predict how a disease might spread
4. If the probability of infecting a neighbour is changed what effect does this have on the spread of the disease. Your model population is 10 000 people. Note what percentage of them have been infected after 80 days.
   A high probability of infection means a rapid spread of disease. Diseases such as measles and SARS have a high probability of infection.

5. With a small reduction in the probability of infecting a neighbour you sometimes find that the infection dies out altogether. What does this tell you about the importance of preventive measures that reduce the chances of one person infecting another?

   Any preventive measure that reduces the chance of infection will make the disease less likely to spread.

6. Suggest some preventive measures that would have this effect in real life.

   Preventive measures include better overall health, nutrition, housing, immunisation, hygiene and, for very infectious diseases, isolation.

7. Try changing the number of days a person remains infected and therefore able to infect others. How does this affect the impact of the disease? If it doesn't seem to have much effect try reducing the probability of infecting a neighbour to 0.05. Suggest some diseases for which people remain infected for a long time.

   A long infection time has little effect if the probability of infection is high. With a low probability of infection a disease with a short infection time dies out whilst one with a long infection time continues to spread. HIV is an example of a disease with a low probability of infection but a long infection time.

This programme was devised by Bruce Halsey of East Norfolk 6th Form College. We are grateful for his permission to use it.

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Introduction

This activity allows you to use a computer model find out how different factors affect the number of people who become infected or die form an infectious disease.

The model

The model is very simplistic. Each cell represents one person.

Any cell can only infect its 8 immediate neighbours.

This may not be realistic as people can move in or out of the area and this is not taken into account.

The random number generator is used to decide whether a neighbour is infected or an infected cell dies.

You can change the model to see how different factors affect the spread of the disease.

To run the model

1. Left click ‘programme’ then ‘setup’

2. Left click ‘programme’ then ‘run’

The programme stops automatically when either it ‘runs out of time’ or the run time is completed.

You can continue by increasing the ‘days run’ and clicking ‘programme’ then ‘run’.

If you use ‘setup’ the programme re-starts from the beginning.

The model has been set up with the following parameters:-

- Number of days infected 3
- Probability of infecting a neighbour on any one day 0.2
- Probability of dying from the disease 0.1

You can change any of these to see what effect they have on the rate of infection and on the total number infected or dying.

Questions on the model

1. What parameters are not included in this model that would in real life influence the spread of disease?

2. What is the likely effect of introducing mobility of people?

3. Why does a simple model not introduce more parameters?

Questions using the model to predict how a disease might spread

You may find it easier to record your findings if you set the total days at 80 for most runs.

4. If the probability of infecting a neighbour is changed what effect does this have on the spread of the disease.

   Your model population is 10 000 people. Note what percentage of them have been infected after 80 days.

5. With a small reduction in the probability of infecting a neighbour you sometimes find that the infection dies out altogether. What does this tell you about the importance of preventive measures that reduce the chances of one person infecting another?

6. Suggest some preventive measures that would have this effect in real life.

7. Try changing the number of days a person remains infected and therefore able to infect others. How does this affect the impact of the disease? Suggest some diseases for which people remain infected for a long time.