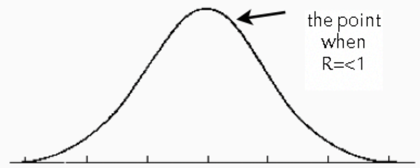
EPIDEMICS and EPIDEMIOLOGICAL MODELS

Epidemics: agents, hosts, vectors & rates of infection

Epidemiology is the study of infections and disease in populations.

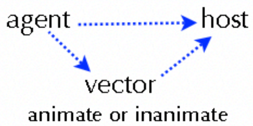
All epidemics at the population level have this same bell-curve pattern.

What we don't know is the scaling.

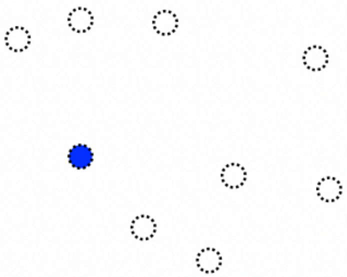


Scenario 1: no epidemic

In this scenario, an agent infects a host who then recovers or dies.
If R is the rate of infection, and R=<1, there is no chance of an epidemic.



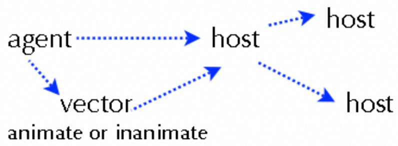
An agent can infect a host directly or, sometimes, via a vector.



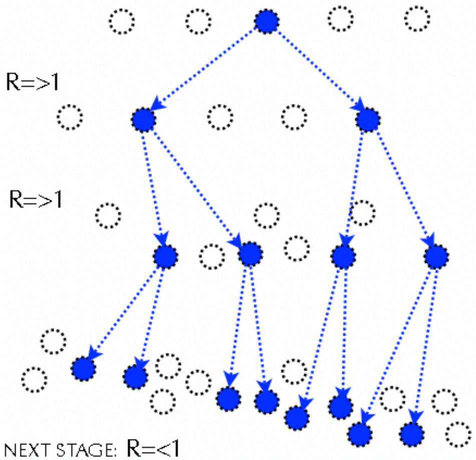
R=<1
because no other agent is infected before the host recovers or dies

Scenario 2: chance of epidemic

In this scenario, an agent infects ***and*** before recovery of death, it infects one or more other hosts. If R=>1, there is a chance of an epidemic.



Host carriers can be *true* (i.e. infected, but not diseased), *incubatory* or *convalescent*.



NEXT STAGE: R=<1
providing no new susceptibles arrive before all hosts recover or die

The four factors for disease epidemics: i.e. when R=>1

The factors for Scenario 2 are fourfold and a change in any one of them changes the outcome:

1 **Probability of transmission:** dependent upon infectivity, virulence and pathogenicity

2 **Duration of infectivity:** e.g. 2-3 days for Ebola, 10+ years for HIV because of treatment regimes

3 **Contact rates:** who comes into contact with the agent

4 **Susceptibility:** determinants can be changed through the *physical environment* (e.g temperature, nutrients, toxins), *interventions* (e.g. vaccines, animal dips, movement controls, quarantines) or other *biological* conditions (e.g being in utero, immunosuppression)

Susceptibility is the fuel by which epidemics run . . . but it gets even more complicated than this.

A host's susceptibility depends on all the factors above *and* upon whether the agent is, itself, changing. If it stays the same, the epidemic follows what's known as the SIR-model; if the agent changes, it follows the SIS-model.

The SIR-model

e.g. measles, mumps, rubella

S **I** **R**

Susceptible **I**nfective **R**emoval

Removal is through death, natural immunity, cross-immunity effects, or vaccination.

The SIS-model

e.g. influenza, HIV

S **I** **S**

Susceptible **I**nfective **S**usceptible

Hosts become re-susceptible after recovery from the initial infection because of antigenetic change in the agent, either *drift* (to which the host has partial immunity), or *shift* (so the host has no immunity).

In both the SIR and SIS-models
new susceptibles arrive through births, loss of immunity or immigration.