

Conceptual Agent-Based Modeling: Vaccinations

Supplemental Lecture | GEOG 510
GIS & Spatial Analysis in Public Health

Varun Goel

Outline

- Vaccines
- Herd Immunity
- Agent-Based Modeling: Intuition

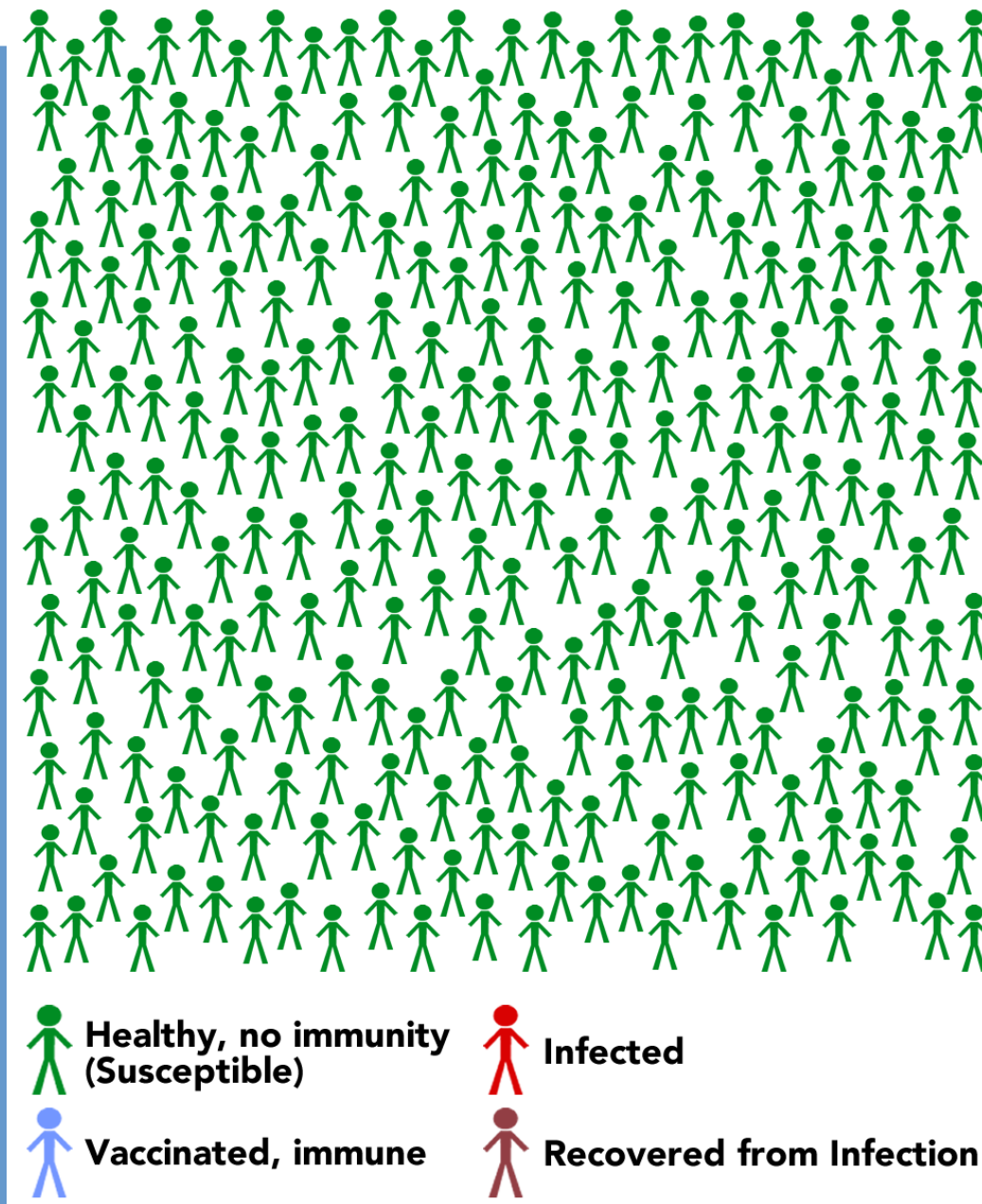
Vaccines

- Provide immunity
 - Triggers an immune response
 - Learned by the body
- Individual Immunity
 - Vaccines not 100% effective
 - Human bodies not 100% effective
 - Some cannot be vaccinated
 - Immunocompromised or allergic

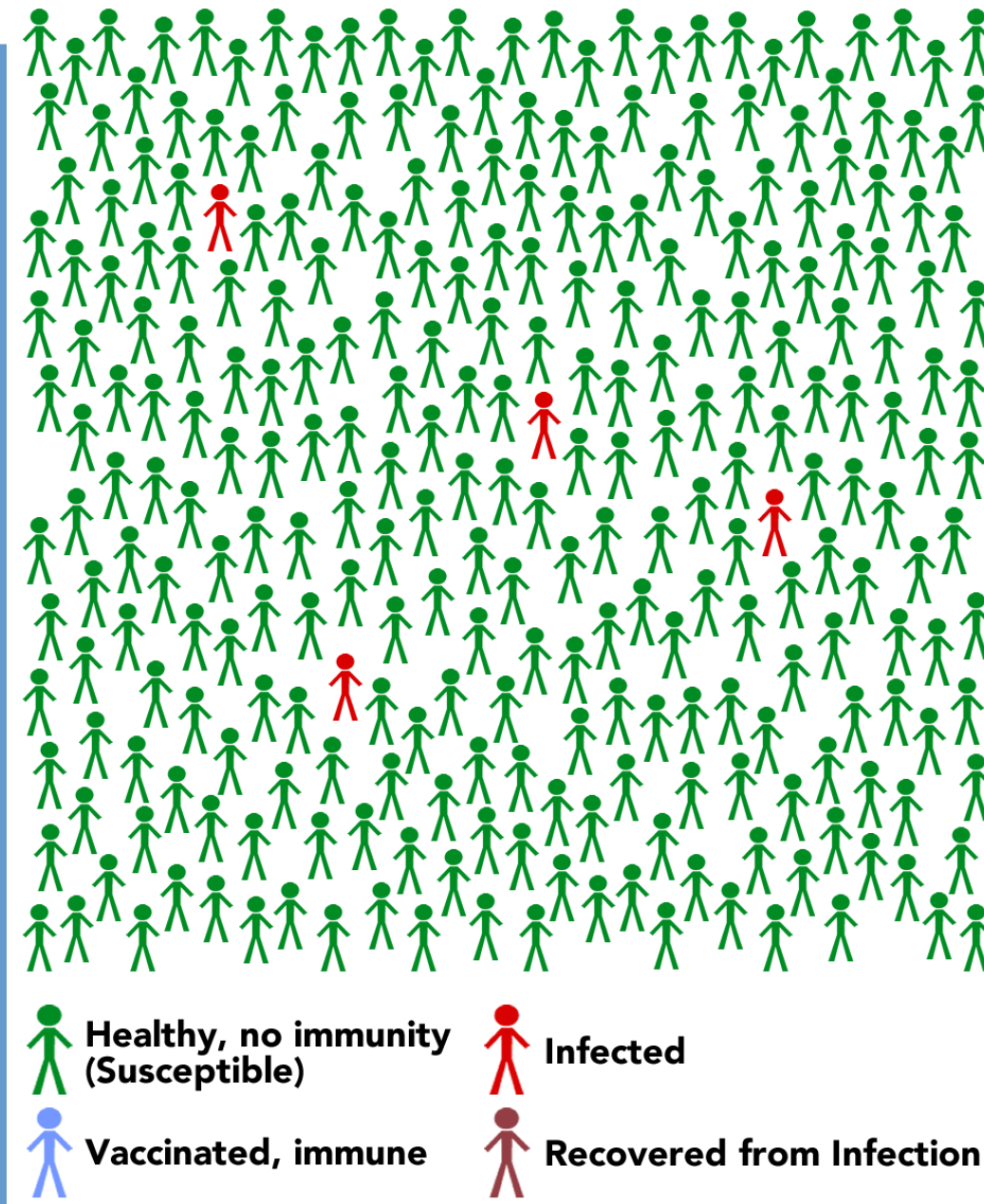
Herd Immunity

- Indirect protection of those without immunity
 - High vaccination coverage in a population
 - Interruption of disease transmission via reduced probability of susceptible person coming into contact with an infectious person

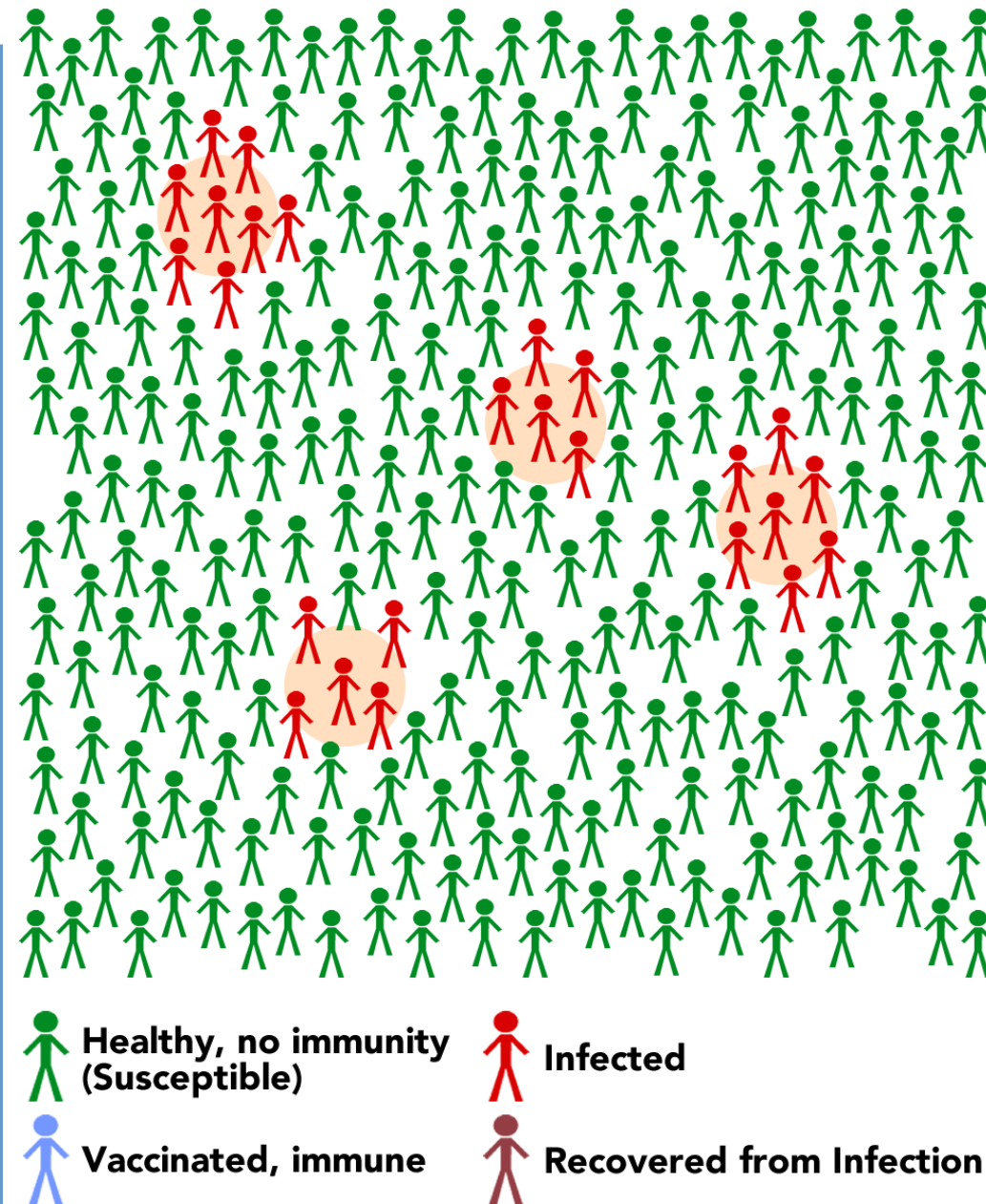
No immunity in population



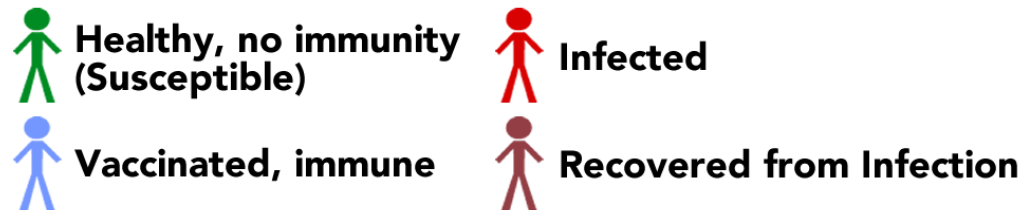
No immunity in population



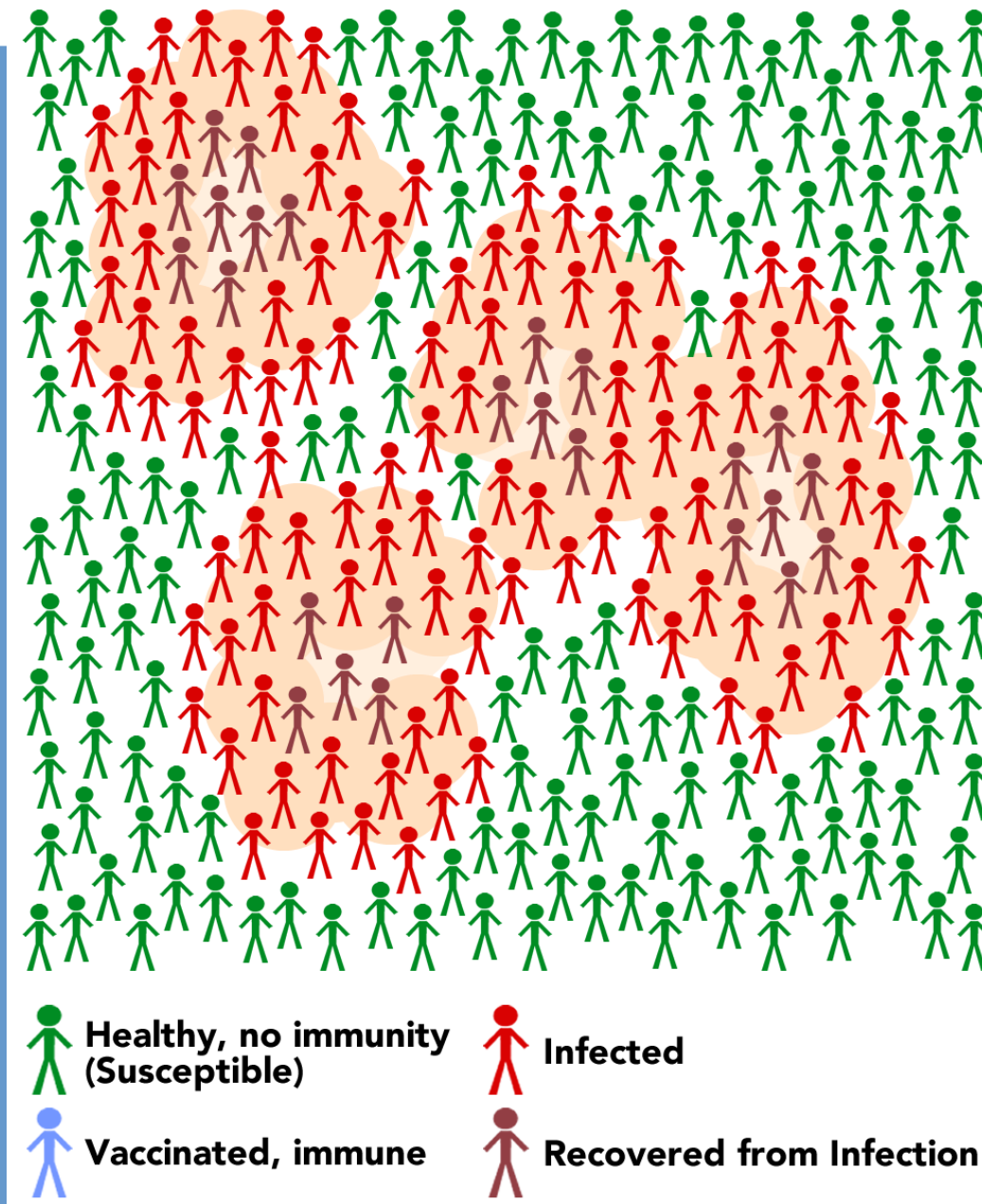
No immunity in population



No immunity in population



No immunity in population



No immunity in population

Infected
190

Vaccinated

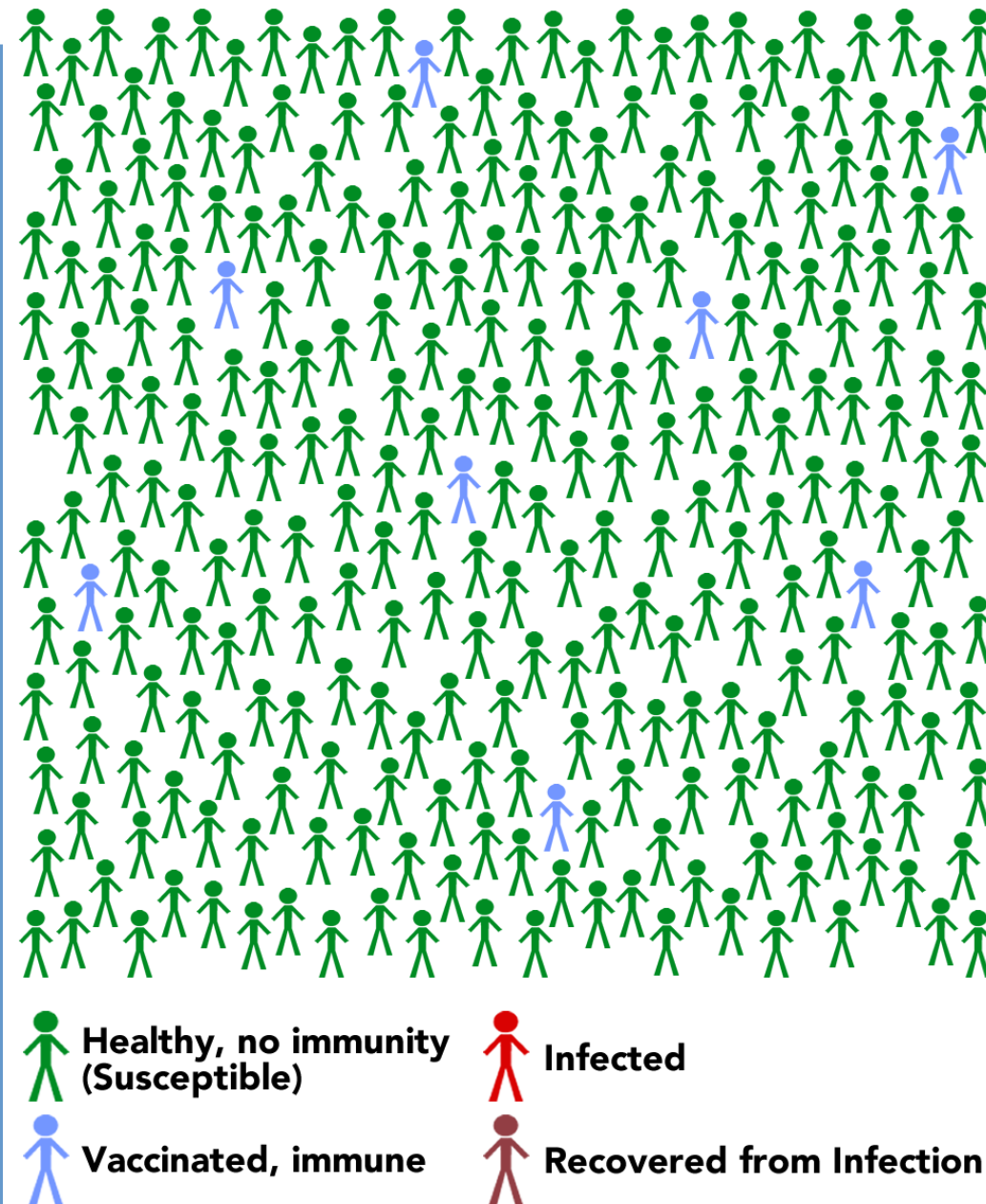
0

Indirectly
Protected

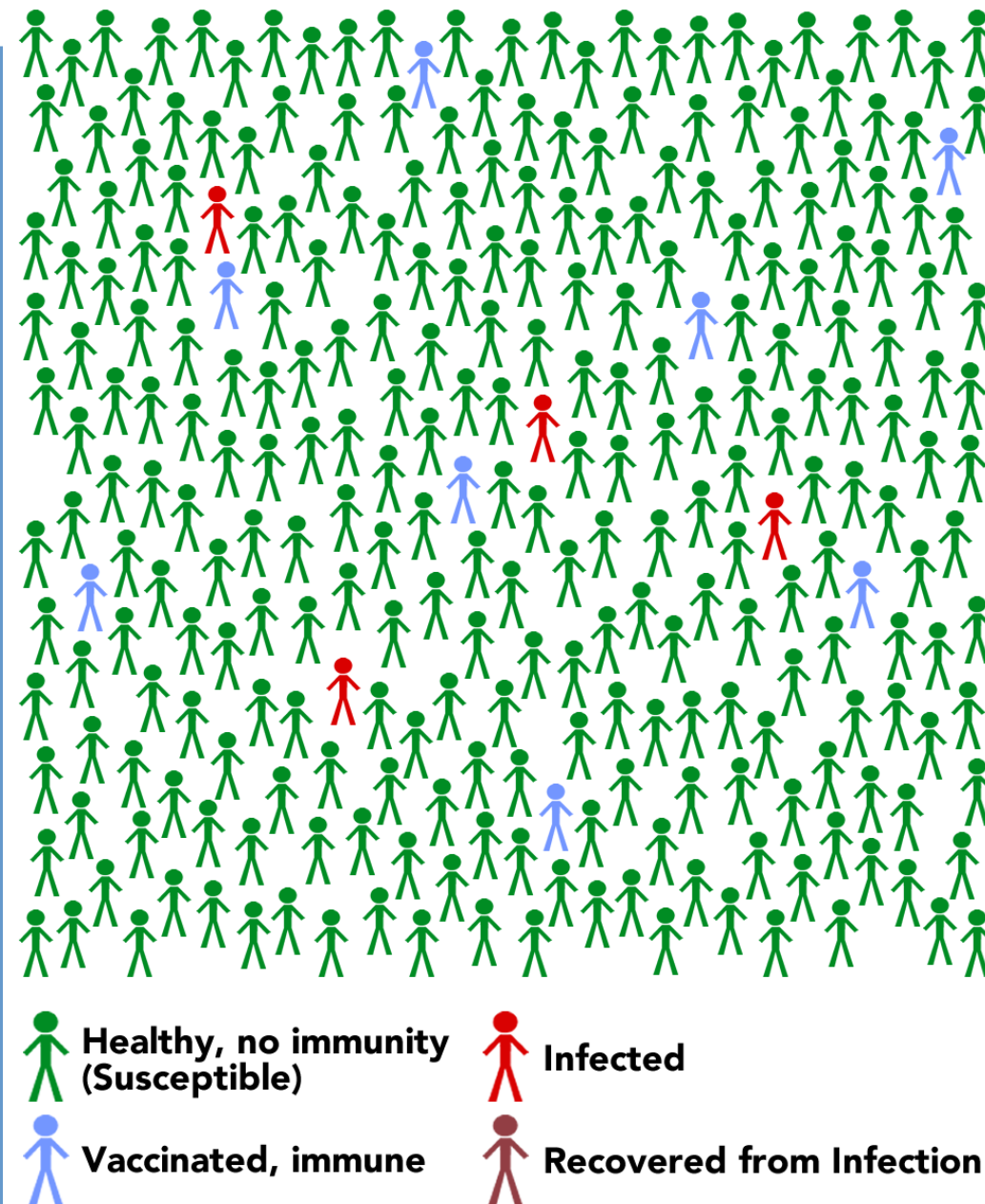
0%



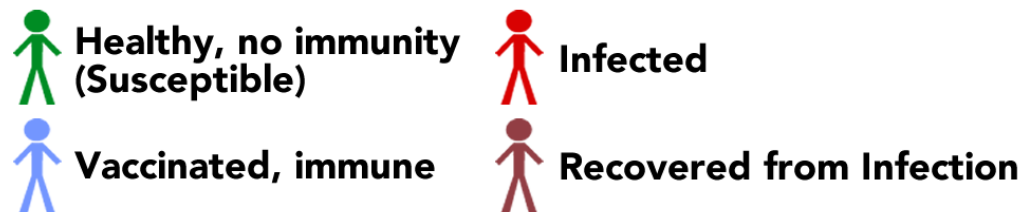
Few vaccinated (immune)



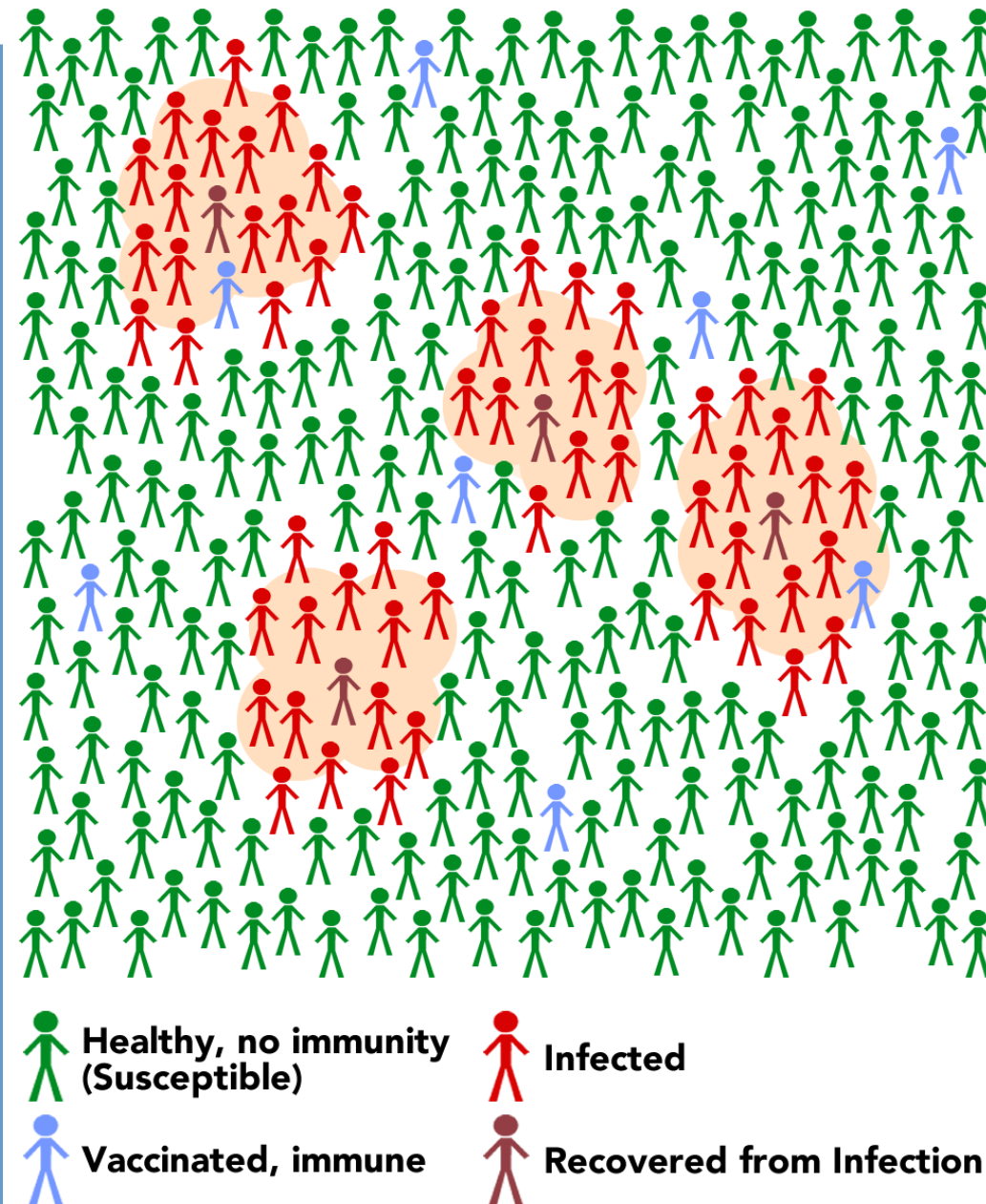
Few vaccinated (immune)



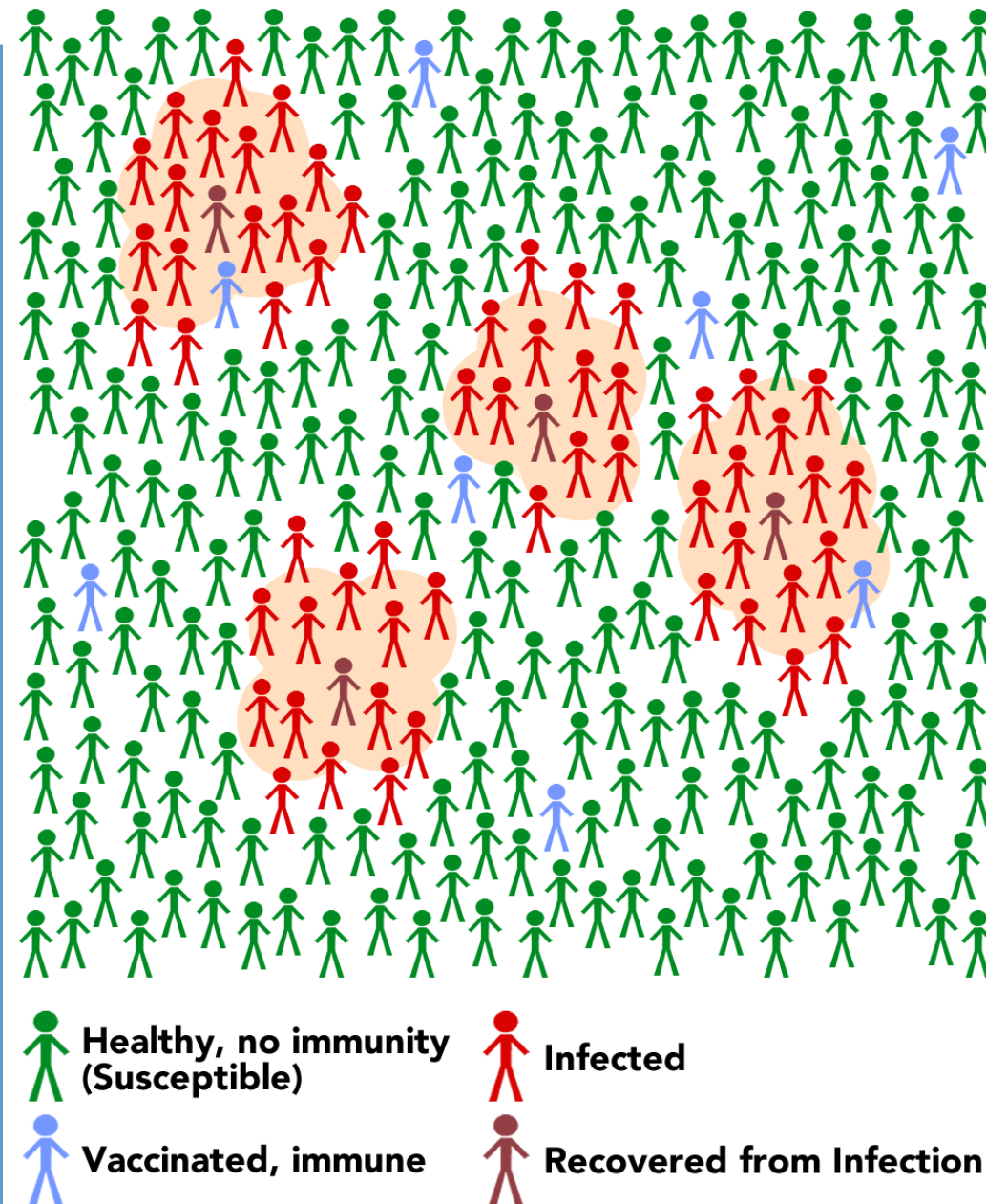
Few vaccinated (immune)



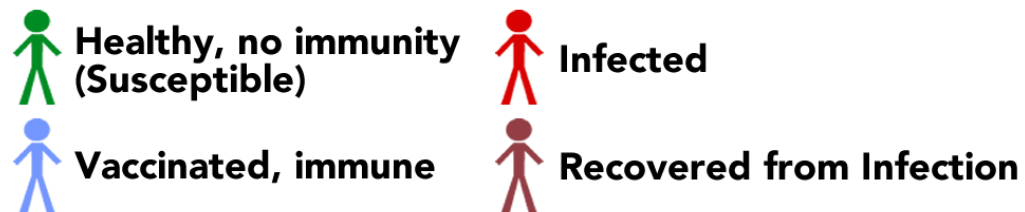
Few vaccinated (immune)



Few vaccinated (immune)



Few vaccinated (immune)



Few vaccinated (immune)

Infected
184

Vaccinated

4

Indirectly
Protected

1%



No immunity in population

Infected
190

Vaccinated

0

Indirectly
Protected

0%



Moderate vaccination (50%)



Moderate vaccination (50%)



Moderate vaccination (50%)



Moderate vaccination (50%)



Moderate vaccination (50%)



Moderate vaccination (50%)



Infected
33

Vaccinated

96

Indirectly
Protected

65%



Healthy, no immunity
(Susceptible)



Infected



Vaccinated, immune



Recovered from Infection

No immunity in population

Infected
190

Vaccinated

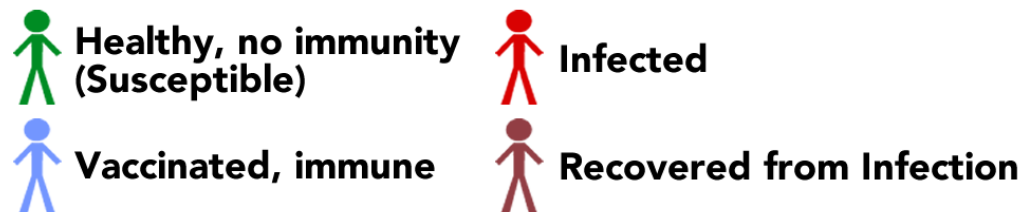
0

Indirectly
Protected

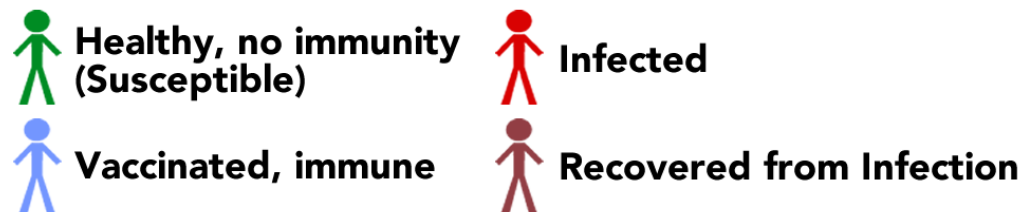
0%



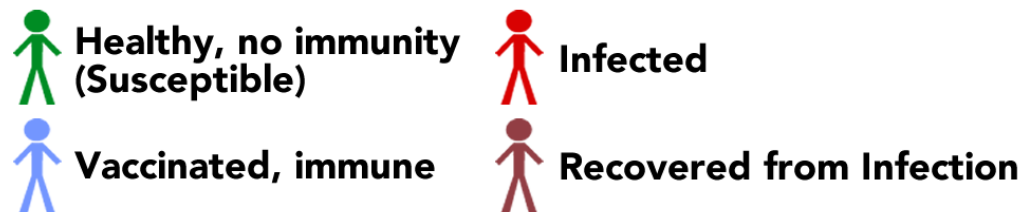
High vaccination (90%)



High vaccination (90%)



High vaccination (90%)



High vaccination (90%)

Infected
0

Vaccinated

176

Indirectly
Protected

100%



Healthy, no immunity
(Susceptible)



Infected



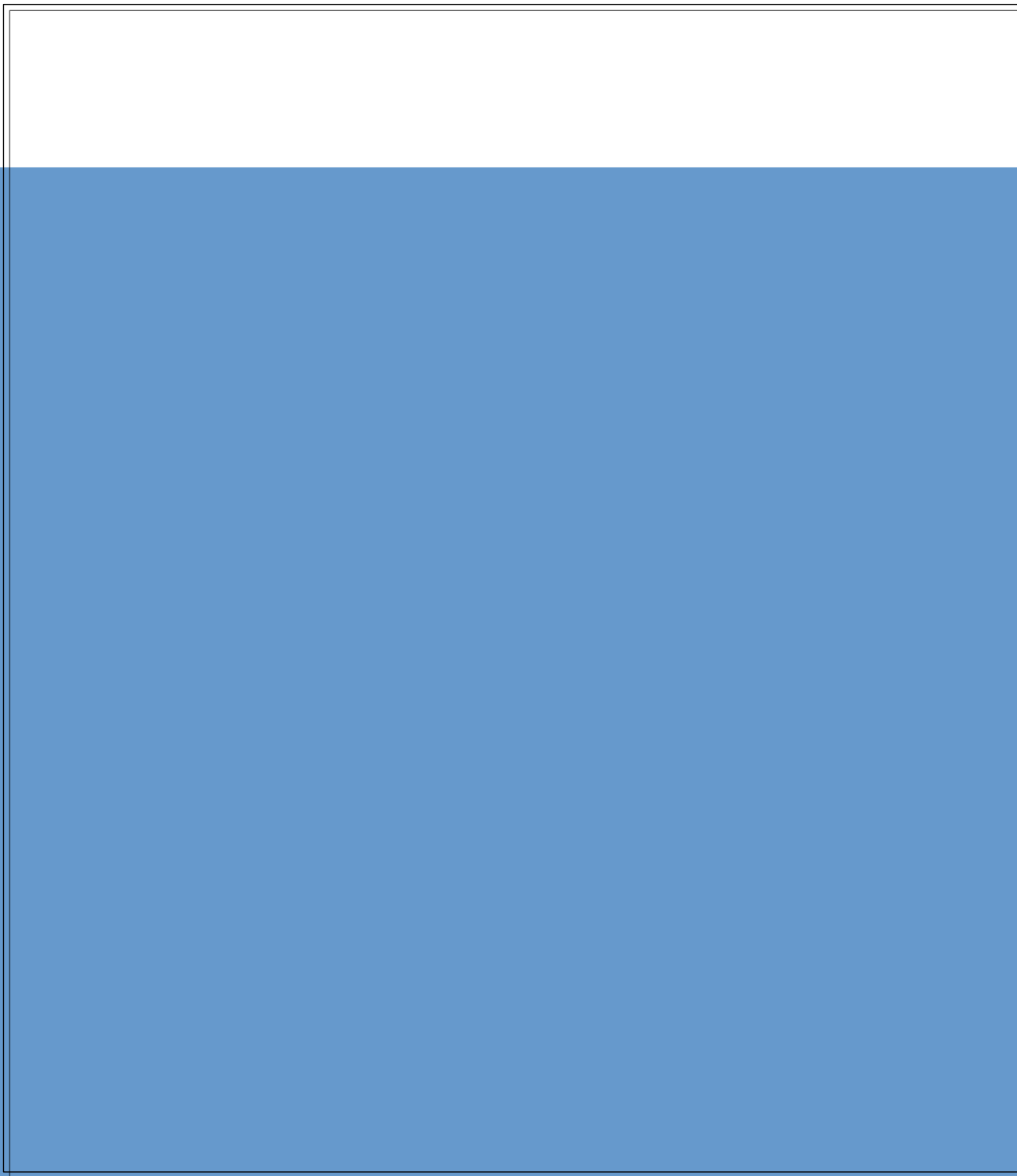
Vaccinated, immune



Recovered from Infection

Vaccination in the US

- Non-medical Exemptions from Vaccination
 - Increasing in many places
 - People that choose this option tend to cluster in space
 - Threat to people without immunity



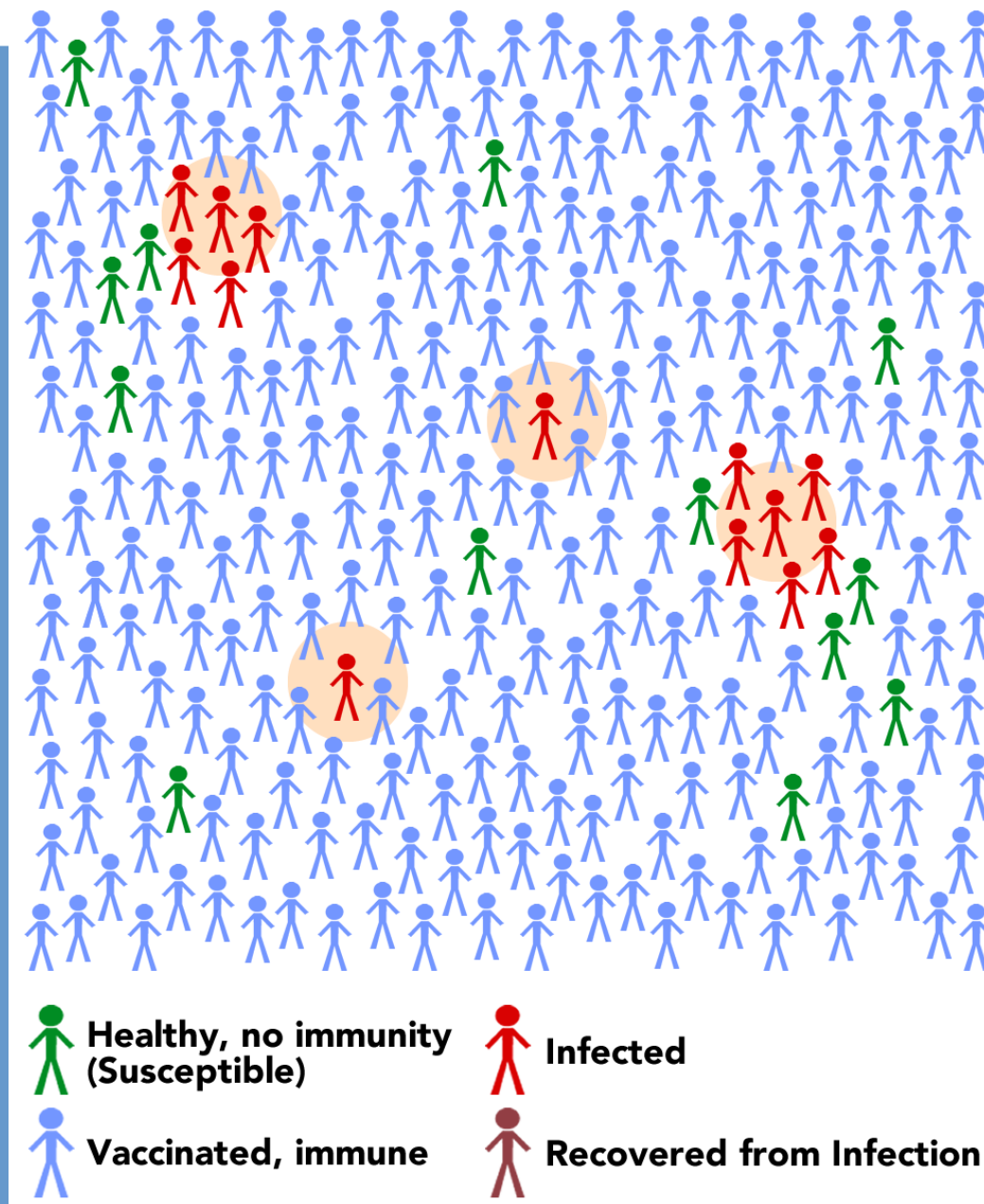
High vaccination (90%), clustered in space



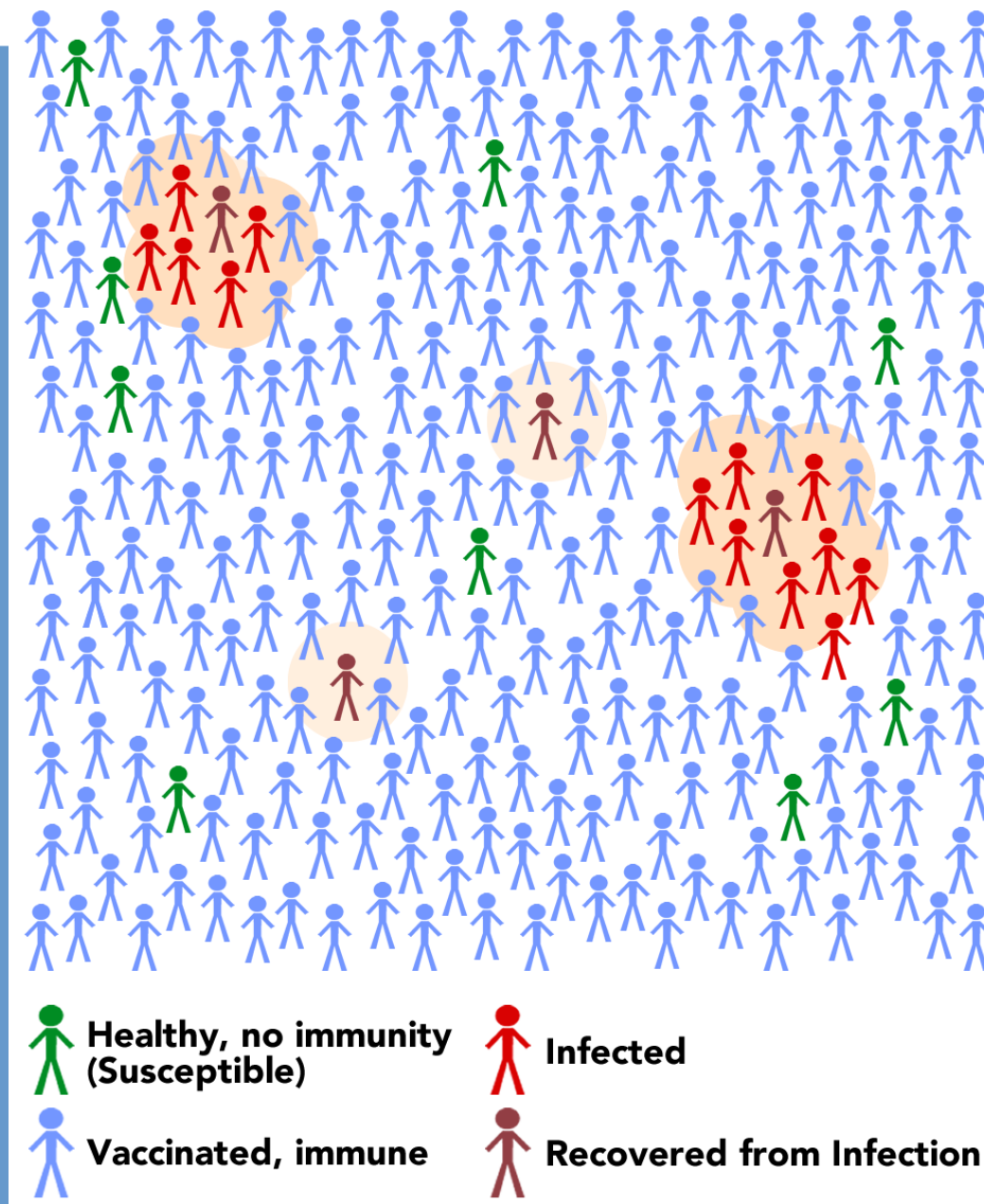
High vaccination (90%), clustered in space



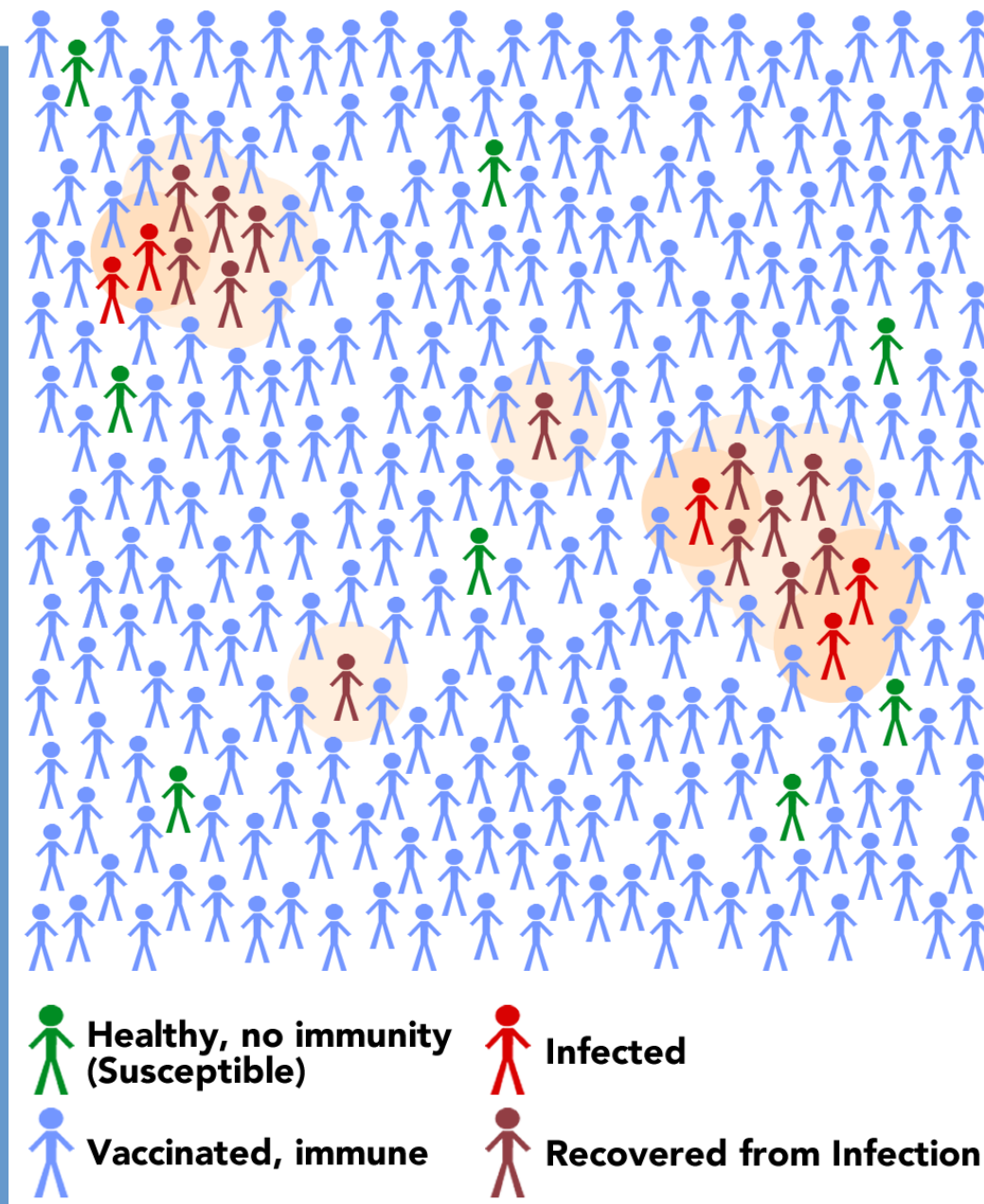
High vaccination (90%), clustered in space



High vaccination (90%), clustered in space

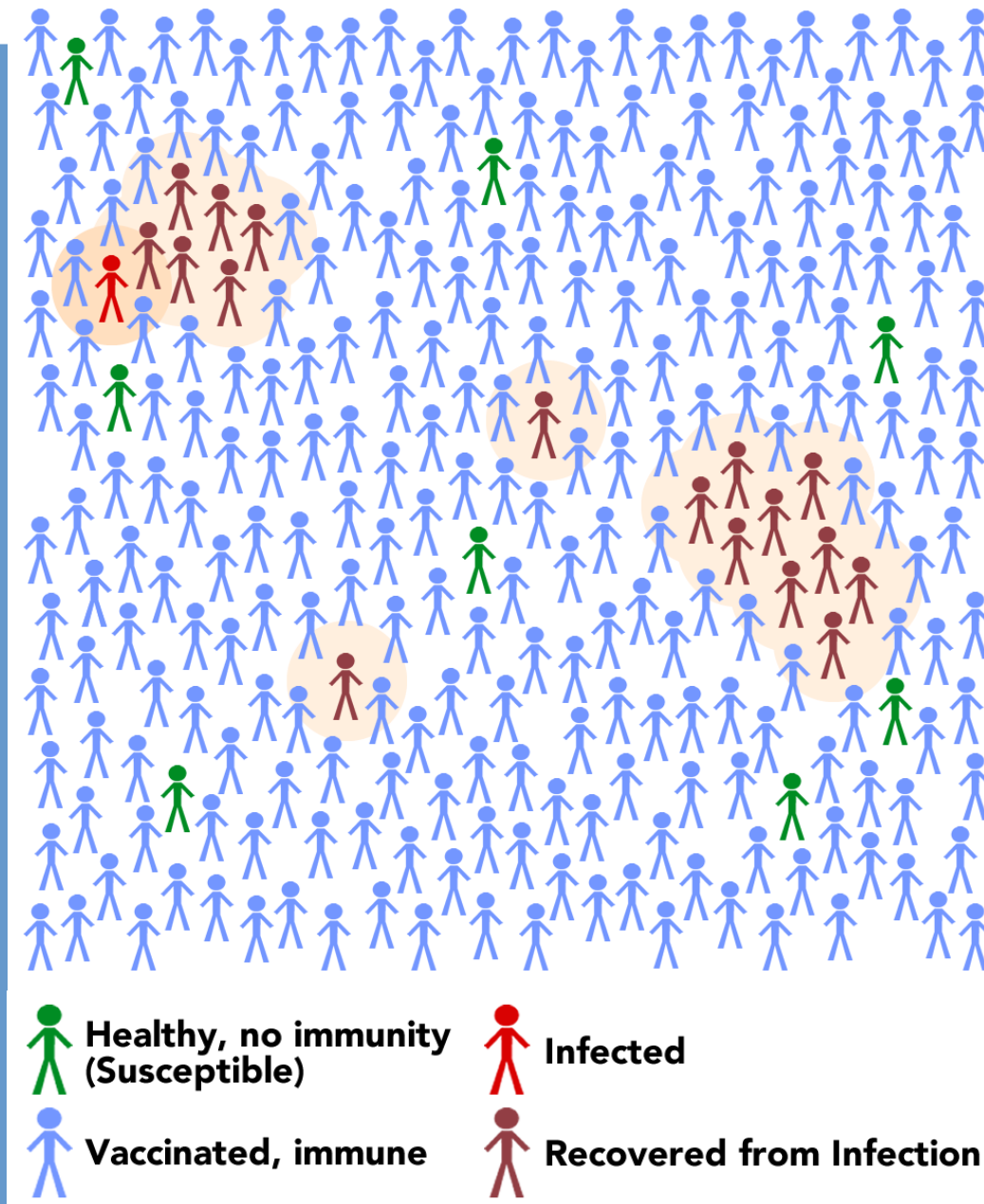


High vaccination (90%), clustered in space



High vaccination (90%), clustered in space

Infected
14



Vaccinated

168

Indirectly Protected

36%

Vaccination: It works



REDPEN/
BLACK PEN

Hey guys - I don't even feel any rain. Why are we doing this again? Just put down the stupid umbrellas - they're bad for your arms anyway.

Modeling Diffusion

- Simulation models
 - Agent-based, spatially aware models
 - Agents are independent actors
 - Generally, local in scale
 - Simulate individuals movement through space and time
 - Chance of interaction and disease transmission
 - Eg. <https://fred.publichealth.pitt.edu/measles>