

Calculating Biological Quantities

CSCI 2897

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How should we model vaccination in the SEIR model?

$$\dot{S} = -\beta SI$$

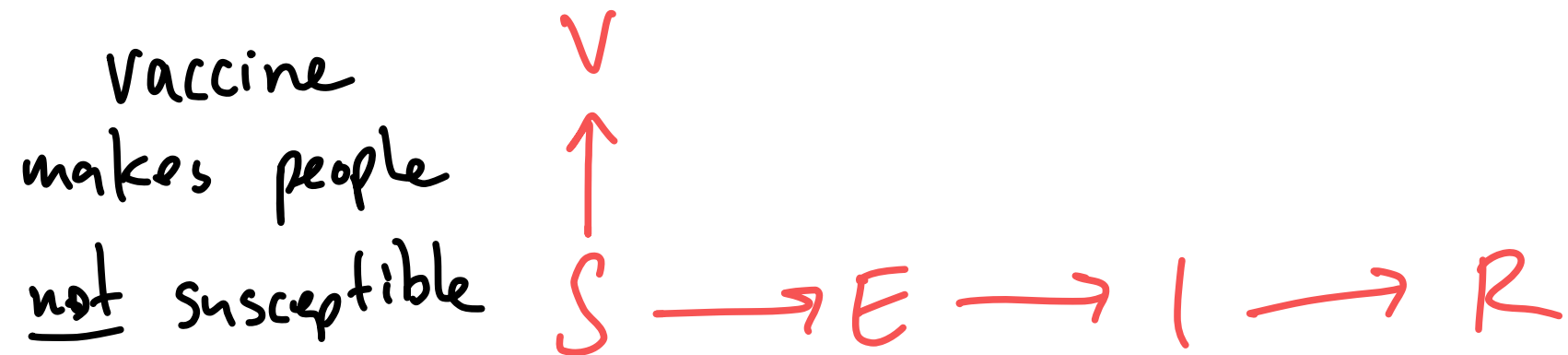
$$\dot{E} = \beta SI - \alpha E$$

$$\dot{I} = \alpha E - \gamma I$$

$$\dot{R} = \gamma I$$

where $S + E + I + R = 1$

Q: what does a vaccine DO?



• personal health
• group dynamics

• group dynamics

• personal health

[1) prevent infection.

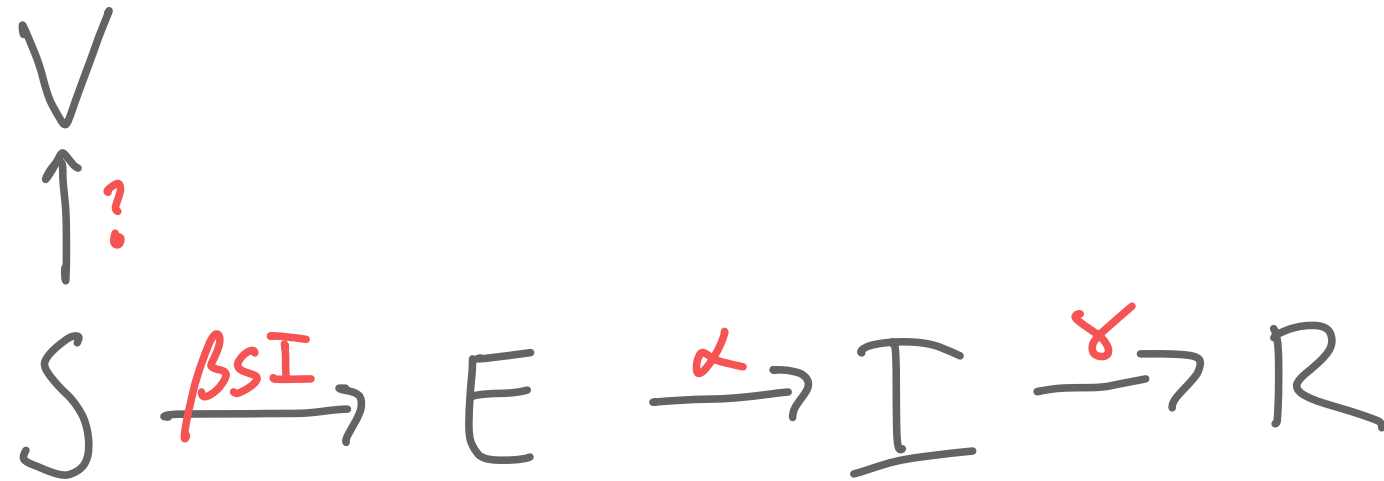
[2) prevent you from spreading virus.

[3) prevent you from getting really sick /dying.

Model 1: The Perfect Vaccine model

A **perfect vaccine** provides complete protection against infection.

same



- vax decreases fraction of pop that can become infected.

$$\begin{cases} \dot{S} = -\beta SI \\ \dot{E} = \beta SI - \alpha E \\ \dot{I} = \alpha E - \gamma I \\ \dot{R} = \gamma I \end{cases}$$

$$S + E + I + R + V = 1$$

different

What about vaccines with imperfect protection?

Vaccine efficacy (ve) is the reduction in disease outcomes in a vaccinated group compared to an unvaccinated group **under trial conditions**.

Vaccine effectiveness is the ability of the vaccine to prevent those disease outcomes **in the real world**.

What are some of the determinants of ve ?

- strength of immune response (measure antibody titers, neutralization)
- specificity of immune response (vax is for W.T., but circulating variant is diff.)
(influenza virus)
- individual determinants — age, for example "immunosenesence"
immune ↓ sleepiness ↓