

Supporting Text S1 - PfEMP1 model with 26 variants ($n = 26$) and initial

seroconversion step of 6 variants ($n_0 = 6$)

$$\frac{\partial P_0}{\partial t} + \frac{\partial P_0}{\partial a} = -(\lambda(t) + \mu)P_0 + \rho P_1$$

$$\frac{\partial P_1}{\partial t} + \frac{\partial P_1}{\partial a} = -(\lambda(t) + \rho + \mu)P_1 + \rho P_2$$

$$\frac{\partial P_2}{\partial t} + \frac{\partial P_2}{\partial a} = -(\lambda(t) + \rho + \mu)P_2 + \rho P_3$$

$$\frac{\partial P_3}{\partial t} + \frac{\partial P_3}{\partial a} = -(\lambda(t) + \rho + \mu)P_3 + \rho P_4$$

$$\frac{\partial P_4}{\partial t} + \frac{\partial P_4}{\partial a} = -(\lambda(t) + \rho + \mu)P_4 + \rho P_5$$

$$\frac{\partial P_5}{\partial t} + \frac{\partial P_5}{\partial a} = -(\lambda(t) + \rho + \mu)P_5 + \rho P_6$$

$$\frac{\partial P_6}{\partial t} + \frac{\partial P_6}{\partial a} = \lambda(t)P_0 - (\lambda(t) + \rho + \mu)P_6 + \rho P_7$$

$$\frac{\partial P_7}{\partial t} + \frac{\partial P_7}{\partial a} = \lambda(t)P_1 - (\lambda(t) + \rho + \mu)P_7 + \rho P_8$$

$$\frac{\partial P_8}{\partial t} + \frac{\partial P_8}{\partial a} = \lambda(t)P_2 - (\lambda(t) + \rho + \mu)P_8 + \rho P_9$$

$$\frac{\partial P_9}{\partial t} + \frac{\partial P_9}{\partial a} = \lambda(t)P_3 - (\lambda(t) + \rho + \mu)P_9 + \rho P_{10}$$

$$\frac{\partial P_{10}}{\partial t} + \frac{\partial P_{10}}{\partial a} = \lambda(t)(P_4 + P_5) - (\lambda(t) + \rho + \mu)P_{10} + \rho P_{11}$$

$$\frac{\partial P_{11}}{\partial t} + \frac{\partial P_{11}}{\partial a} = \lambda(t)P_6 - (\lambda(t) + \rho + \mu)P_{11} + \rho P_{12}$$

$$\frac{\partial P_{12}}{\partial t} + \frac{\partial P_{12}}{\partial a} = \lambda(t)P_7 - (\lambda(t) + \rho + \mu)P_{12} + \rho P_{13}$$

$$\frac{\partial P_{13}}{\partial t} + \frac{\partial P_{13}}{\partial a} = \lambda(t)(P_8 + P_9) - (\lambda(t) + \rho + \mu)P_{13} + \rho P_{14}$$

$$\frac{\partial P_{14}}{\partial t} + \frac{\partial P_{14}}{\partial a} = \lambda(t)P_{10} - (\lambda(t) + \rho + \mu)P_{14} + \rho P_{15}$$

$$\frac{\partial P_{15}}{\partial t} + \frac{\partial P_{15}}{\partial a} = \lambda(t)P_{11} - (\lambda(t) + \rho + \mu)P_{15} + \rho P_{16}$$

$$\frac{\partial P_{16}}{\partial t} + \frac{\partial P_{16}}{\partial a} = \lambda(t)(P_{12} + P_{13}) - (\lambda(t) + \rho + \mu)P_{16} + \rho P_{17}$$

$$\frac{\partial P_{17}}{\partial t} + \frac{\partial P_{17}}{\partial a} = \lambda(t)P_{14} - (\lambda(t) + \rho + \mu)P_{17} + \rho P_{18}$$

$$\frac{\partial P_{18}}{\partial t} + \frac{\partial P_{18}}{\partial a} = \lambda(t)P_{15} - (\lambda(t) + \rho + \mu)P_{18} + \rho P_{19}$$

$$\frac{\partial P_{19}}{\partial t} + \frac{\partial P_{19}}{\partial a} = \lambda(t)P_{16} - (\lambda(t) + \rho + \mu)P_{19} + \rho P_{20}$$

$$\frac{\partial P_{20}}{\partial t} + \frac{\partial P_{20}}{\partial a} = \lambda(t)(P_{17} + P_{18}) - (\lambda(t) + \rho + \mu)P_{20} + \rho P_{21}$$

$$\frac{\partial P_{21}}{\partial t} + \frac{\partial P_{21}}{\partial a} = \lambda(t)P_{19} - (\lambda(t) + \rho + \mu)P_{21} + \rho P_{22}$$

$$\frac{\partial P_{22}}{\partial t} + \frac{\partial P_{22}}{\partial a} = \lambda(t)P_{20} - (\lambda(t) + \rho + \mu)P_{22} + \rho P_{23}$$

$$\frac{\partial P_{23}}{\partial t} + \frac{\partial P_{23}}{\partial a} = \lambda(t)(P_{21} + P_{22}) - (\lambda(t) + \rho + \mu)P_{23} + \rho P_{24}$$

$$\frac{\partial P_{24}}{\partial t} + \frac{\partial P_{24}}{\partial a} = \lambda(t)P_{23} - (\lambda(t) + \rho + \mu)P_{24} + \rho P_{25}$$

$$\frac{\partial P_{25}}{\partial t} + \frac{\partial P_{25}}{\partial a} = \lambda(t)P_{24} - (\lambda(t) + \rho + \mu)P_{25} + \rho P_{26}$$

$$\frac{\partial P_{26}}{\partial t} + \frac{\partial P_{26}}{\partial a} = \lambda(t)P_{25} - (\rho + \mu)P_{26}$$

where P_i represents the proportion of individuals seropositive to i variants, $\lambda(t)$ is the time-dependent seroconversion rate, ρ is the constant seroreversion rate, and μ is mortality rate. The boundary conditions for the system at age $a = 0$ are $P_0(t,0) = \mu$ and $P_i(t,0) = 0$, for $i \in \{1, \dots, n\}$.