The virus escapes through fusion of its membrane envelope with the endosome membrane. The fusion process is pH dependent. For SFV the threshold pH for fusion is 6.2. This threshold is reached in early endosomes. The fusion process is quite rapid. However, not all virus undergoes fusion. The virus balance in the endosome is:

$$dV_{ene}/dt = k_e V_s - k_{fus}\eta V_{ene} - k_{tran}V_{ene} \tag{15.5}$$

where V_{ene} is the number of virus in the early endosomes, k_{fus} is the observed fusion-rate constant, η is the fraction of virus that can successfully fuse with endosomal membrane, and k_{tran} is the rate constant for movement of inactive virus to the lysosome and degradation. The main cause of inactive virus is the fusion of virus with membrane fragments within the endosome instead of the endosomal membrane.

Virus that successfully fuses with the endosomal membrane is released into the cytosol. The protein coat is removed rapidly, and for this analysis we assume that effectively all cytoplasmic virus is uncoated, so that the RNA is released and can be replicated.

The rate equation for uncoating is

$$dV_{cyt}/dt = k_{fus}\eta V_{ene} \tag{15.6}$$

where V_{cyt} is the cytoplasmic virus.

The amount of RNA synthesized per cell follows a saturation type response, so that:

$$[RNA]_{cell} = \frac{k_m V_{cyt}}{K_{sv} + V_{cyt}} \tag{15.7}$$

where k_m and K_{sv} are parameters dependent on the host cell. Equation 15.7 applies only to the early parts of the infection cycle. Virus that enters after RNA replication has been completed for early entry virus probably no longer contributes to RNA synthesis, as host cell function begins to be lost.

Equations 15.1 to 15.6 allow for an analytical solution. If we assume that only free virus is present initially ($t = 0$), then the initial conditions are: $V_{ex} = V_{exo}$; $V_s = 0$; $V_i = 0$; $V_{ene} = 0$; $V_{cyt} = 0$. The solutions in this case are:

$$V_{\text{ex}} = V_{exo}e^{-k_a Ct} \tag{15.8}$$

$$V_s = \frac{k_a C V_{exo}}{k_e - k_a C}(e^{-k_a Ct} - e^{-k_e t}) \tag{15.9}$$

$$V_i = \frac{V_{exo}}{k_e - k_a C}[k_a C(e^{-k_e t} - 1) - k_e(e^{-k_a Ct} - 1)] \tag{15.10}$$

$$V_{ene} = \frac{k_e k_a C V_{exo}}{k_e - k_a C}\left[\frac{1}{k_{fus}\eta + k_{tran} - k_a C}(e^{-k_a Ct} - e^{-(k_{fus}\eta + k_{tran})t}) - \frac{1}{k_{fus}\eta + k_{tran} - k_e}(e^{-k_e t} - e^{-(k_{fus}\eta + k_{tran})t})\right] \tag{15.11}$$