# Binding Model Equations

α is a unit conversion parameter, used in Equations S2, S5, S8 to convert the rate terms from (# receptors per cell)$^{-1}$ s$^{-1}$ to nM$^{-1}$ s$^{-1}$. It is defined in Equation S1 where $n_{cell}$ is the number of cells in the experiment or simulation, V is the volume containing the cells and the antibodies, and $N_A$ is Avogadro's number, $6.022 \times 10^{23}$ molecules per mole. For the conditions used in the flow cytometry binding assays and in the model simulations, $n_{cell} = 10^5$ cells and V = 200 μL, making $\alpha = 8.3 \times 10^{-7}$ nM/(# / cell).

$$\alpha = \frac{n_{cell}}{V * N_A} \qquad (S1)$$

$$\frac{d[Toci]}{dt} = \alpha * k_{off,Toci-6R}[Toci \cdot 6R] - 2 * \alpha * k_{on,Toci-6R}[Toci][6R] \qquad (S2)$$

$$\frac{d[Toci \cdot 6R]}{dt} = 2 * k_{on,Toci-6R}[Toci][6R] + 2 * k_{off,Toci-6R^*}[6R \cdot Toci \cdot 6R] - k_{on,Toci-6R^*}[6R][Toci \cdot 6R] - k_{off,Toci-6R}[Toci \cdot 6R] \qquad (S3)$$

$$\frac{d[6R \cdot Toci \cdot 6R]}{dt} = k_{on,Toci-6R^*}[6R][Toci \cdot 6R] - 2 * k_{off,Toci-6R^*}[6R \cdot Toci \cdot 6R] \qquad (S4)$$

$$\frac{d[H2]}{dt} = \alpha * k_{off,H2-8R}[H2 \cdot 8R] - 2 * \alpha * k_{on,H2-8R}[H2][8R] \qquad (S5)$$

$$\frac{d[H2 \cdot 8R]}{dt} = 2 * k_{on,H2-8R}[H2][8R] + 2 * k_{off,H2-8R^*}[8R \cdot H2 \cdot 8R] - k_{on,H2-8R^*}[8R][H2 \cdot 8R] - k_{off,H2-8R}[H2 \cdot 8R] \qquad (S6)$$

$$\frac{d[8R \cdot H2 \cdot 8R]}{dt} = k_{on,H2-8R^*}[8R][H2 \cdot 8R] - 2 * k_{off,H2-8R^*}[8R \cdot H2 \cdot 8R] \qquad (S7)$$

$$\frac{d[BS1]}{dt} = \alpha * k_{off,BS1-6R}[BS1 \cdot 6R] + \alpha * k_{off,BS1-8R}[BS1 \cdot 8R] - \alpha * k_{on,BS1-6R}[BS1][6R] - \alpha * k_{on,BS1-8R}[BS1][8R] \qquad (S8)$$

$$\frac{d[BS1 \cdot 6R]}{dt} = k_{on,BS1-6R}[BS1][6R] + k_{off,BS1-8R^*}[6R \cdot BS1 \cdot 8R] - k_{on,BS1-8R^*}[8R][BS1 \cdot 6R] - k_{off,BS1-6R}[BS1 \cdot 6R] \qquad (S9)$$

$$\frac{d[BS1 \cdot 8R]}{dt} = k_{on,BS1-8R}[BS1][8R] + k_{off,BS1-6R^*}[6R \cdot BS1 \cdot 8R] - k_{on,BS1-6R^*}[6R][BS1 \cdot 8R] - k_{off,BS1-8R}[BS1 \cdot 8R] \qquad (S10)$$

$$\frac{d[6R \cdot BS1 \cdot 8R]}{dt} = k_{on,BS1-6R^*}[6R][BS1 \cdot 8R] + k_{on,BS1-8R^*}[8R][BS1 \cdot 6R] - k_{off,BS1-6R^*}[6R \cdot BS1 \cdot 8R] - k_{off,BS1-8R^*}[6R \cdot BS1 \cdot 8R] \qquad (S11)$$

$$\frac{d[6R]}{dt} = k_{off,Toci-6R}[Toci \cdot 6R] + 2 * k_{off,Toci-6R^*}[6R \cdot Toci \cdot 6R] + k_{off,BS1-6R}[BS1 \cdot 6R] + k_{off,BS1-6R^*}[6R \cdot BS1 \cdot 8R] - 2 * k_{on,Toci-6R}[Toci][6R] - k_{on,Toci-6R^*}[6R][Toci \cdot 6R] - k_{on,BS1-6R}[BS1][6R] - k_{on,BS1-6R^*}[6R][BS1 \cdot 8R] \qquad (S12)$$

$$\frac{d[8R]}{dt} = k_{off,H2-8R}[H2 \cdot 8R] + 2 * k_{off,H2-8R^*}[8R \cdot H2 \cdot 8R] + k_{off,BS1-8R}[BS1 \cdot 8R] + k_{off,BS1-8R^*}[6R \cdot BS1 \cdot 8R] - 2 * k_{on,H2-8R}[H2][8R] - k_{on,H2-8R^*}[8R][H2 \cdot 8R] - k_{on,BS1-8R}[BS1][8R] - k_{on,BS1-8R^*}[8R][BS1 \cdot 6R] \qquad (S13)$$