

## Secret Code 20

$$8.2A) \langle f_b \rangle = \frac{[MA]}{[M] + [MA]} = \frac{1}{\frac{[M]}{[MA]} + 1} = \frac{1}{\frac{1}{[A]K_A} + 1} = \boxed{\frac{[A]K_A}{1 + [A]K_A}}$$

$$K_A = \frac{[MA]}{[M][A]} \quad [A]K_A = \frac{[MA]}{[M]} \quad \frac{1}{[A]K_A} = \frac{[M]}{[MA]}$$

$$8.2B) P = 1 + K_A [A] \quad S = 1 \quad \frac{\partial P}{\partial [A]} = K_A$$

$$\langle f_b \rangle = \frac{[A]}{SP} \frac{\partial P}{\partial [A]} = \frac{[A]}{S(1 + K_A [A])} \cdot K_A = \boxed{\frac{K_A [A]}{1 + K_A [A]}}$$

8.2C) Python.

$$8.2D) \left. \begin{array}{l} M_0 \xrightleftharpoons{K_A} MA_1 \\ K_A \downarrow \uparrow K_B \\ MB_1 \xrightleftharpoons{K_A} MA_1 B_1 \end{array} \right\} \Rightarrow P(A,B) = \frac{[M_0]}{[M_0]} + \frac{[MA_1]}{[M_0]} + \frac{[MB_1]}{[M_0]} + \frac{[MA_1 B_1]}{[M_0]} = 1 + \frac{[MA_1]}{[M_0]} + \frac{[MB_1]}{[M_0]} + \frac{[MA_1 B_1]}{[M_0]}$$

$$= 1 + [A]K_A + [B]K_B + [A][B]K_A K_B$$

$$\langle f_A \rangle = \frac{[A]}{SP} \left( \frac{\partial P(A,B)}{\partial [A]} \right)_B = \frac{[A]}{S \cdot P(A,B)} (K_A + [B]K_A K_B)$$

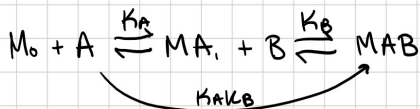
$$= \frac{[A]K_A + [A][B]K_A K_B}{1 + [A]K_A + [B]K_B + [A][B]K_A K_B}$$

$$S = 1$$

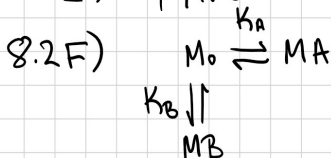
$$M_0 + A \xrightleftharpoons{\beta_{1,0} = K_A} MA \quad K_A = \frac{[MA]}{[M_0][A]}$$

$$M_0 + B \xrightleftharpoons{\beta_{0,1} = K_B} MB \quad K_B = \frac{[MB]}{[M_0][B]}$$

$$K_{AB} = K_A K_B = \frac{[MAB]}{[M_0][A][B]}$$



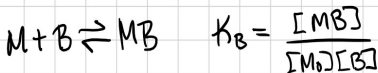
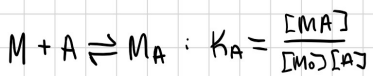
8.2E) Python



$$S = U = 1$$

$$P(A,B) = \frac{[M_0]}{[M_0]} + \frac{[MA]}{[M_0]} + \frac{[MB]}{[M_0]} = 1 + K_A [A] + K_B [B]$$

$$\frac{\partial P(A,B)}{\partial [A]} = 0 + K_A + 0 = K_A$$



$$\langle f_A \rangle = \frac{[A]}{SP} \frac{\partial P(A,B)}{\partial [A]} = \frac{[A]}{1(1 + [A]K_A + [B]K_B)} \cdot K_A = \boxed{\frac{K_A [A]}{1 + [A]K_A + [B]K_B}}$$

$$8.3A) \beta_i = \prod_{j=1}^i K_j$$

$$\beta_1 = K_1 = 10^2 M^{-1} \quad \beta_3 = K_1 K_2 K_3 = 10^6 M^{-3}$$

$$\beta_2 = K_1 K_2 = 10^4 M^{-2} \quad \beta_4 = K_1 K_2 K_3 K_4 = 10^8 M^{-4}$$

$$8.3B) \left. \begin{array}{l} \beta_1 = K_1 = 10^4 M^{-1} \\ \beta_2 = \beta_1 K_2 = 10^6 M^{-2} \\ \beta_3 = \beta_2 K_3 = 10^7 M^{-3} \end{array} \right\} \begin{array}{l} K_1 = 10^4 M^{-1} \\ K_2 = \frac{\beta_2}{\beta_1} = 10^2 M^{-1} \\ K_3 = \frac{\beta_3}{\beta_2} = 10 M^{-1} \end{array}$$

8.3C) The system in part A has no cooperativity. The second binding step does not have a significantly larger stepwise constant than the first step.  
The system in part B has negative cooperativity because second binding step is 100 fold less favorable than the first.