Q8. Enzyme kinetics

$$E + S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_3} E + P$$

8.1

$$\nu_E = -k_1 [E][S] + (k_2+k_3)[ES]$$

$$\nu_S = -k_1 [E][S] + k_2 [ES]$$

$$\nu_{ES} = k_1 [E][S] - (k_2+k_3)[ES]$$

$$\nu_P = k_3 [ES]$$

8.3

because the total amount of enzyme is fixed:

$$[E_{total}] = [E_{free}] + [ES]$$

at steady state $\nu_{ES} = 0 \Rightarrow k_1 [E][S] = (k_2+k_3)[ES]$

$$\Rightarrow k_1([E_{total}] - [ES])[S] = (k_2+k_3)[ES]$$

$$\Rightarrow \frac{k_1}{k_2+k_3} = \frac{[ES]}{([E_{total}]-[ES])[S]} \Rightarrow \frac{k_2+k_3}{k_1} = \frac{[E_{total}][S]}{[ES]} - [S]$$

$$\Rightarrow \frac{[E_{total}][S]}{\frac{k_2+k_3}{k_1} + [S]} = [ES]$$

$$V = \nu_P = k_3 [ES] = \frac{k_3 [E_{total}][S]}{\frac{k_2+k_3}{k_1} + [S]}$$

when $[S]$ is very high $1^\circ ([S] \gg [E_{total}]) \to [E_{total}] = [ES]$

$V_{max} = k_3 [E_{total}]$ $\quad 2^\circ ([S] \gg \frac{k_2+k_3}{k_1}) \to V_{max} \approx k_3 [E_{total}]$

when $k_1 = 100$ um/min $k_2 = 600$ /min $k_3 = 150$ /min $[E_{total}] = 1$ um

$$V_{max} = 150 \text{ um/min}$$

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