MICHAELIS-MENTEN KINETICS

$$E + S \underset{k_{REV}}{\overset{k_{FWD}}{\rightleftharpoons}} E\cdot S \xrightarrow{k_{cat}} E + P$$

WHERE E = ENZYME S = SUBSTRATE P = PRODUCT

WE WANT TO FIND HOW PRODUCT VARIES IN TIME

$$\boxed{\frac{dP}{dt} = k_{cat}[E\cdot S]}$$

A. WE WILL CALCULATE $[E\cdot S]$ ASSUMING IT IS AT PSEUDO-STEADY STATE. IN OTHER WORDS $\frac{dES}{dt} \approx 0$

$$\frac{d[E\cdot S]}{dt} = k_{FWD}[E][S] - k_{REV}[E\cdot S] - k_{cat}[E\cdot S] = 0$$

SOLVE FOR $[ES]$

$$[ES](k_{rev} + k_{cat}) = k_{FWD}[E][S]$$

DEFINE K_m

$$K_m \equiv \frac{k_{rev} + k_{cat}}{k_{FWD}}$$

$$\boxed{[ES] = \frac{k_{WD}}{k_{rev} + k_{cat}}[E][S] = \frac{1}{K_M}[E][S]}$$

B. NOW WE NEED TO ACCOUNT FOR FREE AND UNBOUND ENZYME

$$[E_{TOTAL}] = [E] + [ES]$$

$$[E_{TOTAL}] = [E] + \frac{[S]}{K_M}[E]$$

SOLVE FOR E

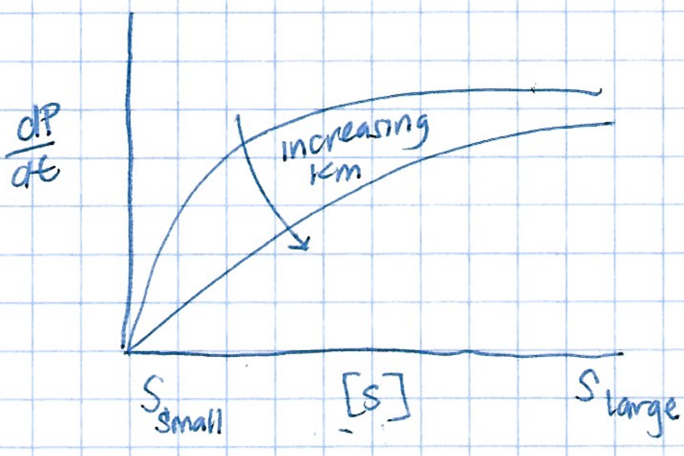
$$[E] = \frac{[E_{TOTAL}]}{1 + [S]/K_M}$$

C. SUBSTITUTE INTO DEFN OF $[ES]$

$$[ES] = \frac{1}{K_M}\frac{[E_T]}{(1 + [S]/K_M)}[S] = \frac{[E_T][S]}{K_M + [S]}$$

THEREFORE,

$$\frac{dP}{dt} = \frac{k_{cat}[E_T][S]}{K_M + [S]} = V_{max}\frac{[S]}{K_M + [S]} \qquad V_{max} \equiv k_{cat}[E_T]$$



$\frac{dP}{dt} \simeq \frac{V_{max}}{K_m}[S]$

⇒ like mass action

$\frac{dP}{dt} \simeq V_{max}$

⇒ saturated

WHEN $S = K_m$

$\frac{dP}{dt} = \frac{V_{max}}{2}$ ⇒ ½ maximal

$$\frac{dP}{dt} = k_{cat}[E_T]\frac{[S]}{K_m + [S]}$$