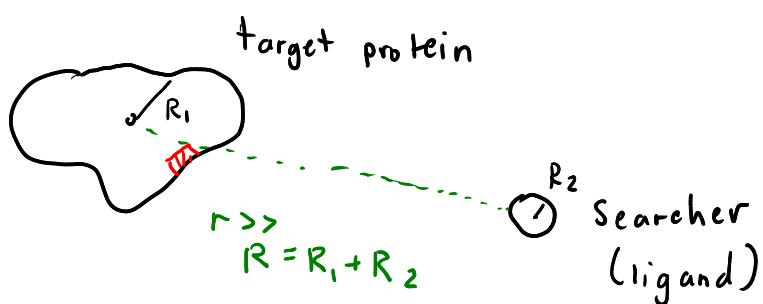


What happens after diffusion?

⇒ "sticking" or binding

3 state picture:

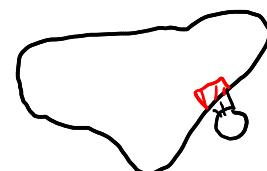
1) "FAR"



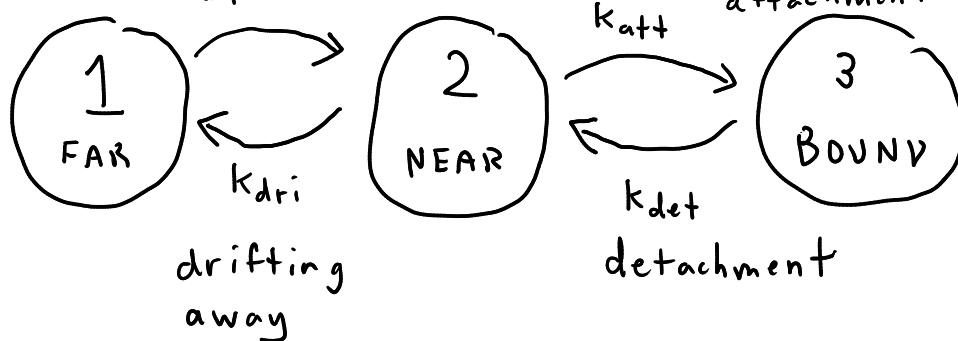
2) "NEAR"



3) "BOUNDED"



$$k_{\text{dif}} = 4\pi DR C \xrightarrow{\text{Smoluch.}} \text{conc. of searcher}$$



estimates: $k_{\text{dif}} = K_s C$ $K_s = 4\pi DR \approx 10^8 \text{ M}^{-1}\text{s}^{-1}$

$$C \sim 10 \text{ nM} - 0.1 \text{ mM}$$

$$\Rightarrow k_{\text{dif}} \sim 1 \text{ s}^{-1} - 10^4 \text{ s}^{-1}$$

k_{dri} : consider a molecule diffusing 1 nm away from target

$$\text{time} \sim \frac{R^2}{6D}$$

$$\sim 8 \text{ ns}$$

$$R = 1 \text{ nm}$$

$$D = 20 \mu\text{m}^2/\text{s}$$

$$k_{\text{dri}} \sim \frac{1}{\text{time}} \sim 10^8 \text{ s}^{-1}$$

Use mean first passage time eqn (earlier lect.) to find avg. time from 1 to 3:

$$\tau_{1 \rightarrow 3} = \frac{k_{\text{dif}} + k_{\text{dr}} + k_{\text{att}}}{k_{\text{att}} + k_{\text{dif}}}$$

effective rate to go from 1 \rightarrow 3
from binding rate

$$k_b = \frac{1}{\tau_{1 \rightarrow 3}} = k_{\text{dif}} \left[\frac{k_{\text{att}}}{k_{\text{dif}} + k_{\text{dr}} + k_{\text{att}}} \right] = \alpha_b K_s C$$

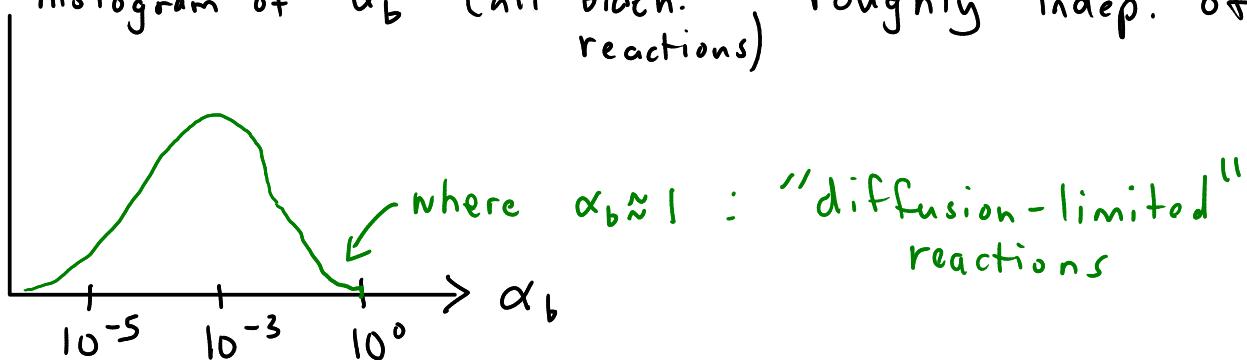
$$\equiv \alpha_b$$

$$0 \leq \alpha_b \leq 1$$

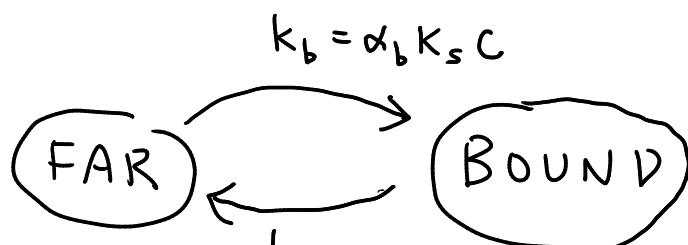
"Speed limit": $k_b \leq k_{\text{dif}} = K_s C$

Since $k_{\text{dif}} \ll k_{\text{dri}} \Rightarrow \alpha_b \approx \frac{k_{\text{att}}}{k_{\text{dri}} + k_{\text{att}}}$

histogram of α_b (all biach. reactions) roughly indep. of C



effective 2-state approx.



\hookrightarrow rate of unbinding = $\frac{1}{\tau_{3 \rightarrow 1}}$

$$k_u = \frac{k_{det} k_{dri}}{k_{det} + k_{dri} + k_{att}} = \text{const. indep. of } C$$

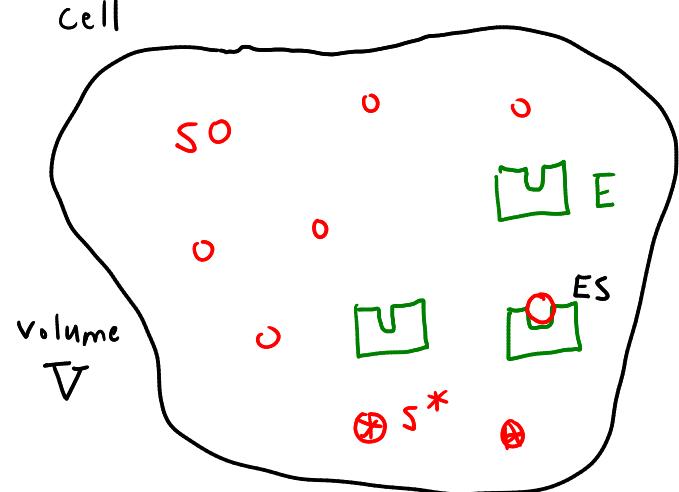
focus on a full chemical reaction:

enzyme E (one type of protein)

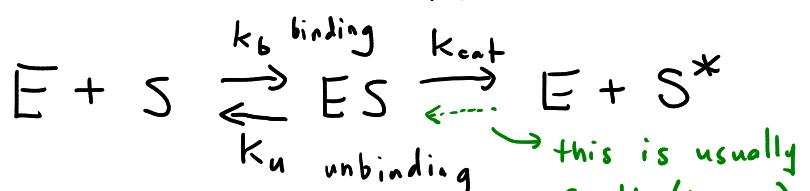
substrate S (another protein or small molecule)

reaction $S \rightarrow S^*$ (modified version of substrate)

ES : enzyme bound to substrate



reaction scheme:



k_{cat} = rate at which enzyme catalyzes reaction