

MMBB 300/380 - Lecture #11
Enzyme Kinetics - Part I (Reading: Lehninger 4th Ed: pp 202-213)

Note:

(1) >99% of carbon in living organisms is in the form of:

(2) <1% of the C is in the form of:

hence, _____ are typically present in low conc.

(3) Enzymes enhance chemical rxns to:

by affecting kinetics, not thermodynamics.

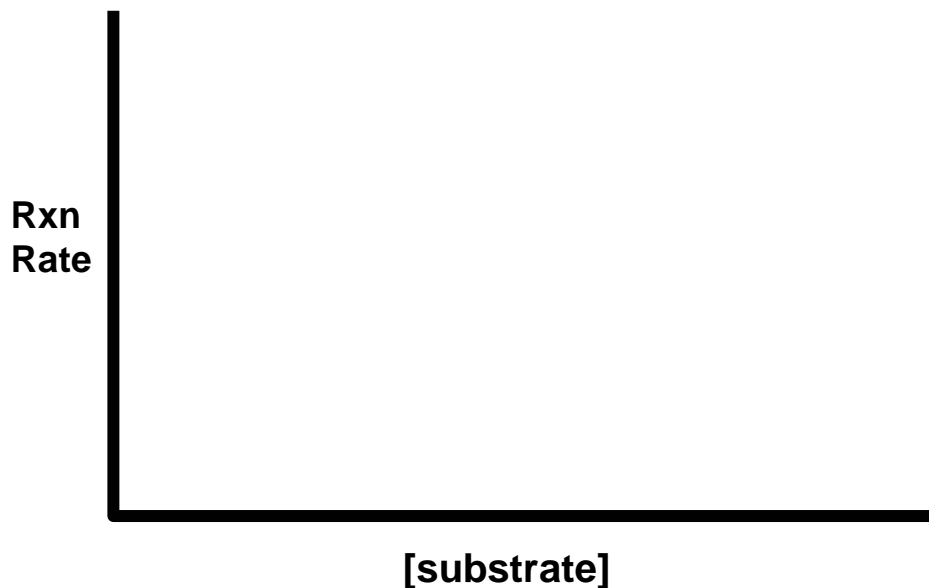
(a) Kinetics =

(b) Thermodynamics =

Michaelis/Menten: Maud Menten & Leonor Michaelis rediscovered:

In 1913, M&M described enzyme kinetics in a useful way.

Demonstration: A volunteer (the “enzyme”) will be required to demonstrate the M&M principle.



When substrate is scarce (dilute) enzyme activity is limited by availability of substrate.

When substrate is plentiful (concentrated) the enzyme activity reaches:

The Math: Michaelis & Menten described the kinetics of a simple enzyme-catalyzed reaction.



ES =

P =

Rate of formation of ES = $k_1[E][S]$ k_1 = rate constant for:

Rate of ES breakdown = $k_{-1}[ES] + k_2[ES]$

k_{-1} = rate constant for:

k_2 = rate constant for:

Two Assumptions:

1. The "initial rate assumption" assumes that little or no P has formed yet. Thus, the rate of E + P going to ES is:
2. The "steady state assumption" is that:

$$\therefore k_1[E][S] = k_{-1}[ES] + k_2[ES] = (k_{-1} + k_2)[ES] = k_1[E][S]$$

rearrange $[ES] =$

Since k_1 , k_{-1} & k_2 are all rate **constants**, its ok to do this: $\frac{k_1}{k_{-1} + k_2} =$

$K_M =$

$$[ES] = \frac{1}{K_M} [E][S] \qquad K_M = \frac{[E][S]}{[ES]}$$

Also, total enzyme concentration, $[E_T] = [E] + [ES]$ Or $[E] = [E_T] - [ES]$

$K_M =$ or $\frac{K_M}{[S]} =$

$$\frac{K_M}{[S]} + 1 = \frac{[E_T]}{[ES]} \qquad K_M + [S] =$$

Solve for [ES]: $[ES] =$

From last page: $[ES] = \frac{[E_T][S]}{K_M + [S]}$

Rate of product formation: $V =$

Maximum rate of product formation, V_{max}

If total enzyme (E_T) was in the form of ES and was going only toward the production of product ($E + P$), then: $V_{max} = k_2 [E_T]$

$$V = k_2[E_T] \frac{[S]}{K_M + [S]} \quad \text{Or} \quad V = \text{Michaelis-Menten Eqn}$$

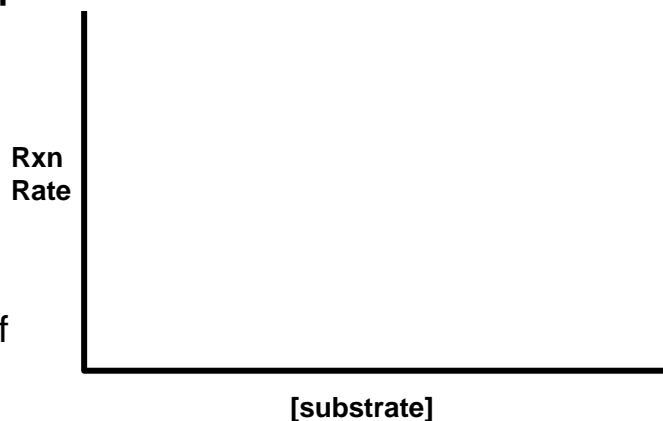
Let's consider what happens under three specific conditions:

1) Substrate is scarce; $[S] \ll K_M$

$$V = V_{max} \frac{[S]}{K_M + [S]} =$$

What does this mean?

Since V_{max} & K_M are both constants, the rate of the rxn, V , will be linearly dependent on the concentration of substrate, $[S]$,

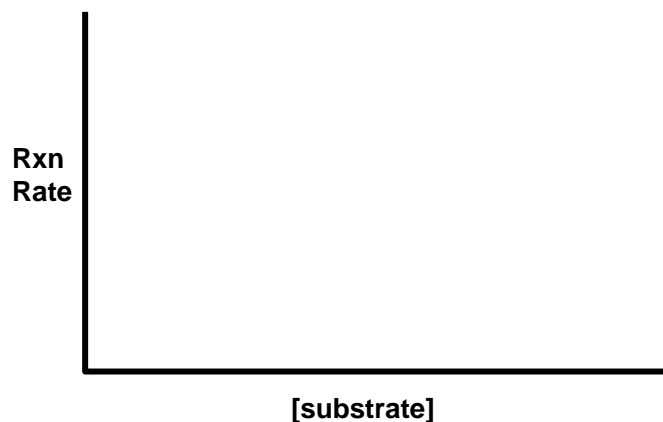


Under these conditions, for example, doubling the concentration of substrate would:

2) Substrate is plentiful; $[S] \gg K_M$

$$V = V_{max} \frac{[S]}{K_M + [S]} \quad \text{OR}$$

$V =$

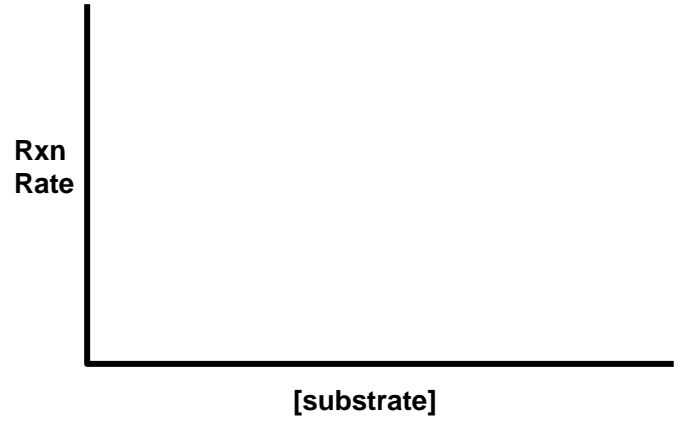


What does this mean?

When substrate, S , is plentiful, the enzyme will turnover as fast as possible & the rate of the reaction is at:

3) $[S] = K_M$

then $V = V_{\max} \frac{[S]}{[S] + [S]}$ OR $V =$



What does this mean? You can identify the K_M by identifying:

