

Lecture 13: Kinetics II

Michaelis-Menten Kinetics

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Enzyme Reactions



E = enzyme
 ES = enzyme-substrate complex
 ES* = enzyme/transition state complex
 EP = enzyme product complex
 P = product

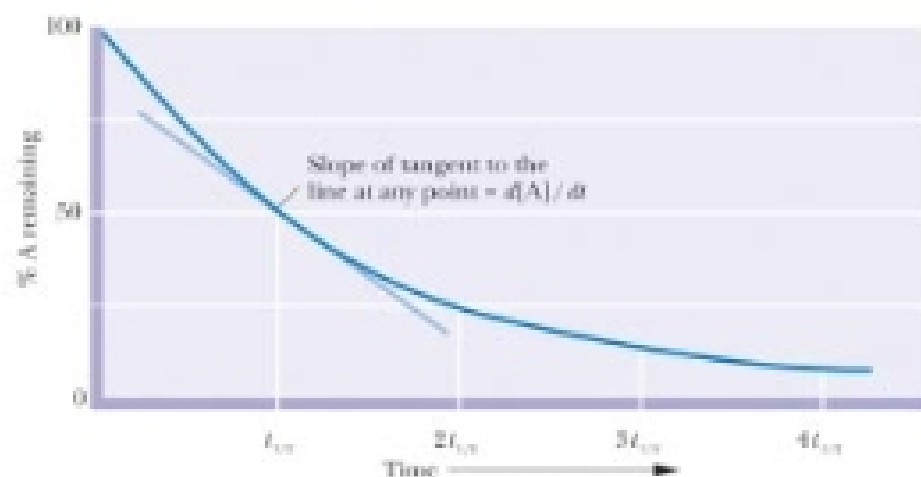
- Physically interact with their substrates to effect catalysis;
- Substrates bind to the enzyme's **active site**

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Return to a simple case: single-order kinetics



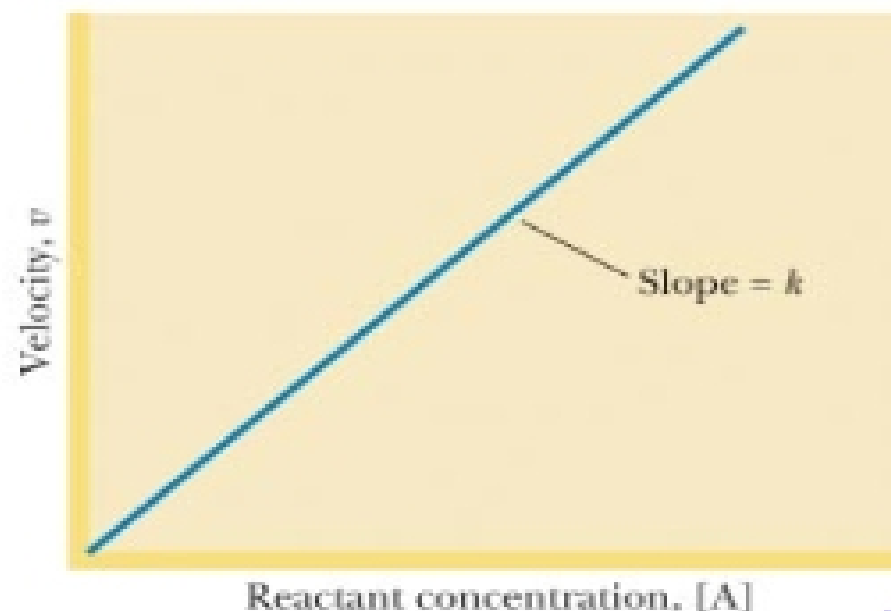
rate of disappearance of A: $v = -d[A]/dt = k[A]$



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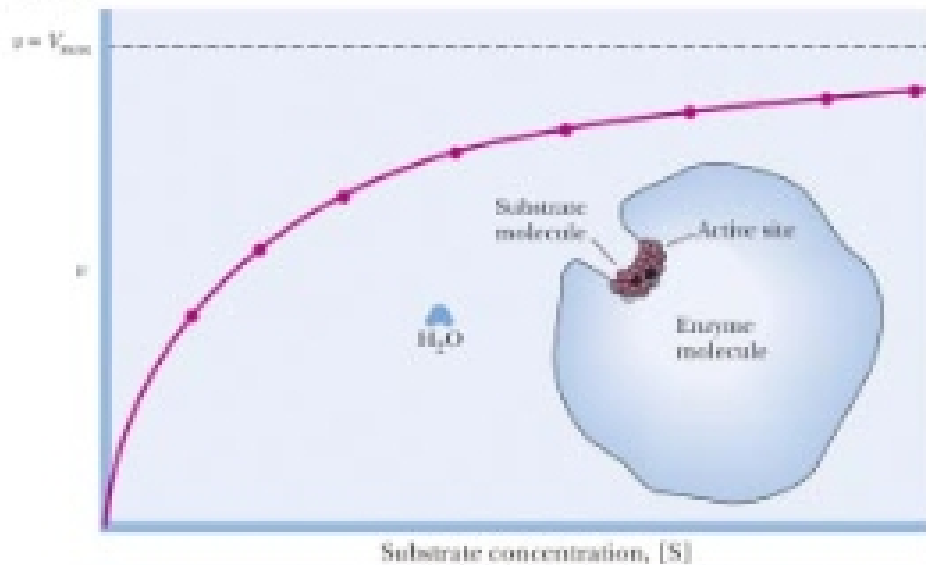
$$v = k_1[A]$$



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Enzyme kinetics: substrate saturation! (substrate saturation curves)

Garrett/Grisham, Biochemistry with a Human Focus
Figure 18.7



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Enzyme kinetics: what do we want to know?

How well does an enzyme bind a substrate?

$$K_m$$

How fast does an enzyme do its chemistry?

$$V_{max}$$

What is its maximal catalytic activity?

$$k_{cat}$$

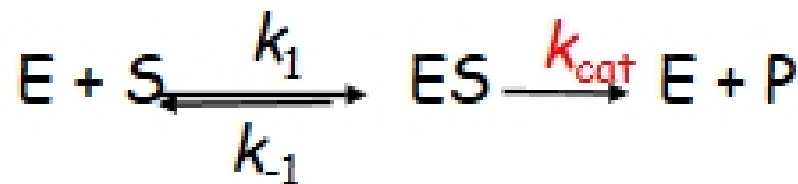
How efficient is the enzyme?

$$k_{cat}/K_m$$

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Michaelis-Menton Kinetics: I

ONE SUBSTRATE -----> ONE PRODUCT



REVERSIBLE

IRREVERSIBLE
(minimally reversible)



Leonor Michaelis
1874-1949



Maud Menten
1877-1961

Michaelis-Menton Kinetics: I



Inclusive in the k_{cat} step:



Enzyme creates strain on substrate so that chemistry can occur



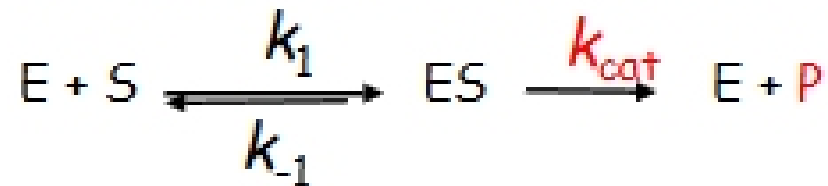
Enzyme performs chemistry on substrate



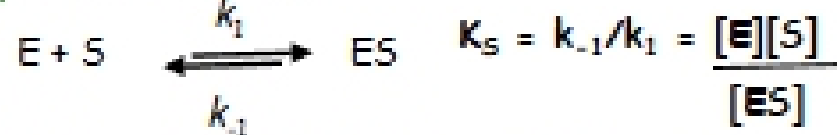
Product dissociates from enzyme; enzyme free to go another round

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Michaelis-Menton Kinetics: II



1) Equilibrium is fast.



2). Steady-state: When $[S] \gg [E]$

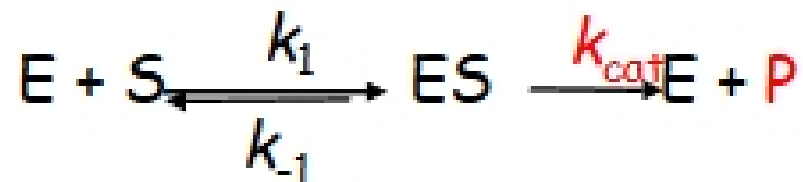
$$\frac{d[ES]}{dt} = 0$$

3). Initial velocity measurements:



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Michaelis-Menton Kinetics: III



RATE OF FORMATION OF "P"

$$V = k_{cat}[ES] \star$$

Need to measure both k_{cat} and $[ES]$

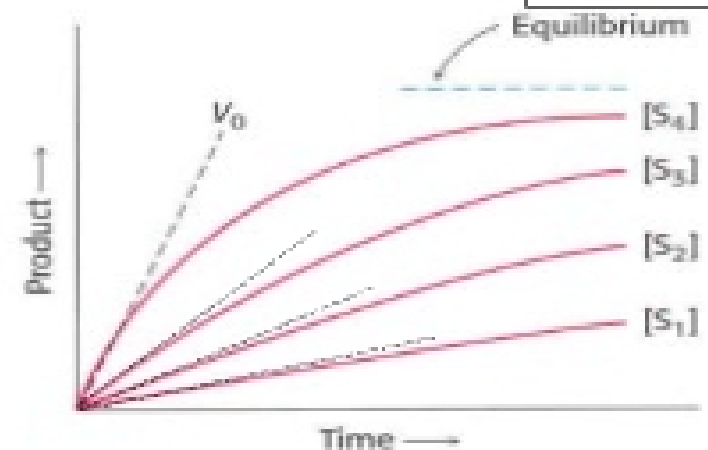
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Initial velocity (v_0) measurements

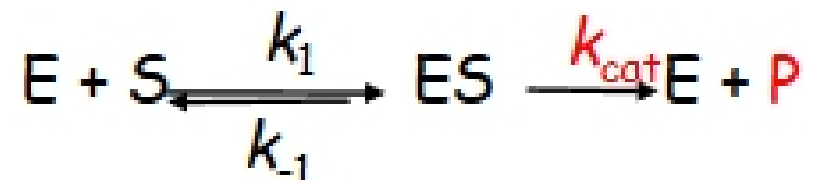
Determine v_0 by analyzing early time points

Measure absorbance
fluorescence vs. time

$$v_0 = \text{rate of product formation} = d[P]/dt$$



Michaelis-Menton Kinetics: IV



TOTAL CONCENTRATION OF ENZYME

$$[E]_t = [E] + [ES]$$

Express the rate in terms of $[S]$ and $[E]_t$

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