

Discussion Exercise 5: Analyzing Graphical Data

Skill 1: Use axis labels to describe a phenomenon as a function of a variable

- Some value “y” may be described as a function of some variable “x” and used to describe how a phenomena relates to a variable factor
- Linear functions may be not proportional, directly proportional, or inversely proportional
- Some graphs have linear and non-linear portions
- A bell-shaped curve centers around a maximum surrounded by minima
- Some graphs have more than one region, or phase, suggesting a change in mechanism or event

Problem 1: Use the graphs below to describe relationships between phenomena and a variable or answer questions concerning the relationships.

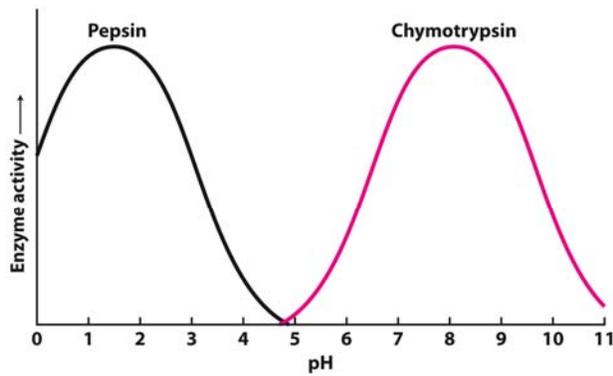


Figure 8.4
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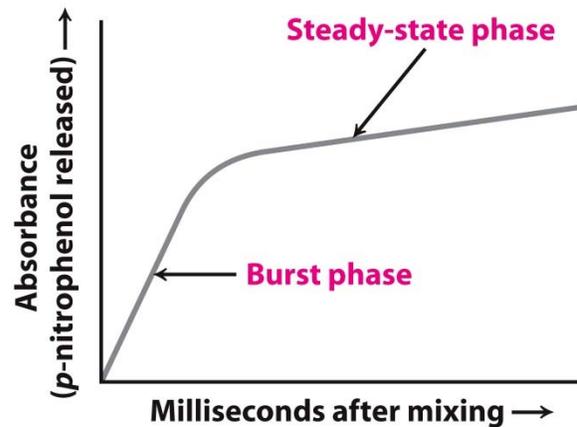


Figure 8.22
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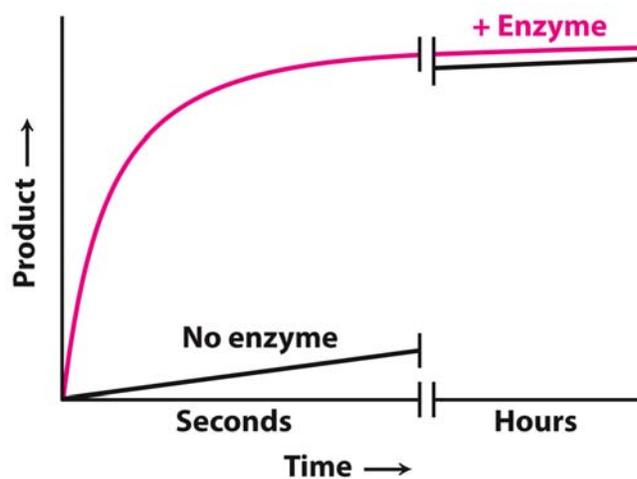
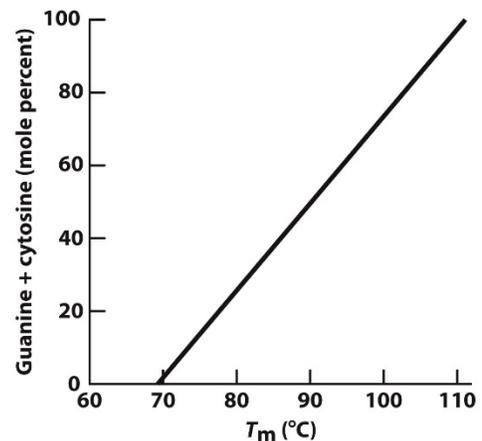


Figure 6.2
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Problem 33.20
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- A. What is the relationship between the pH of a solution and the catalytic activity of pepsin?
- B. How does doubling the mole % of G-C base pairs affect the melting point of the DNA double helix?
- C. For an enzyme catalyzed reaction, when is the concentration of product formation approximately linear as a function of time?
- D. What is the relationship of absorbance of product released to time during the burst phase of kinetics? How does the relationship change in the steady-state phase?

Problem 2: Draw a graph showing each of these relationships.

- A. During the initial part of a reaction reaction, the concentration of substrate is inversely proportional to the time of the reaction, then slowly approaches zero after a long time.
- B. At low concentrations of a hormone, receptor/hormone binding increases linearly with concentration of hormone present, but at high concentrations of hormone, binding of receptor and hormone is unaffected by hormone concentration. (Plot % bound verses [hormone]).
- C. An enzyme catalyzed reaction rate increases with an increase in temperature until it reaches 41 °C, at which point, the reaction abruptly stops.

Skill 2: Hyperbolic curves

- **In a rectangular hyperbola, x is a function of y with two constants, a and b according to this equation**

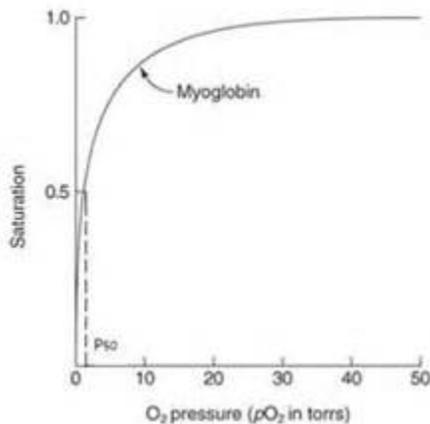
$$y = \frac{a[x]}{b+[x]}$$

- The constant “a” is the maximum value that y can attain.
- The constant “b” is equal to the value of x when y is at half of its maximum
- **This shape is seen in binding curves, where the fraction of bound protein is a function of the concentration of available ligand.**
 - “a” is equal to 1, meaning that the protein is fully bound
 - “b” is K_D , the dissociation constant. The physical meaning of K_D is the concentration of ligand necessary to ensure that the protein is half-saturated with ligand.
 - Low values of K_D suggest high binding affinity
- **This shape is seen in Michaelis-Menton kinetics, where the rate of the enzyme catalyzed reaction is a function of the concentration of substrate available.**

- “a” is equal to V_{\max} , meaning that the protein is catalyzing the reaction at the maximum possible rate, which will not be increased even if more substrate is available
- “b” is K_M , the Michaelis constant. The physical meaning of K_M is the concentration of substrate necessary to ensure that the enzyme is working at half its maximum rate.
- For simple enzymes, $K_M \sim K_D$, so K_M says something about the affinity of the enzyme for its substrate. Low values of K_M suggest high binding affinity

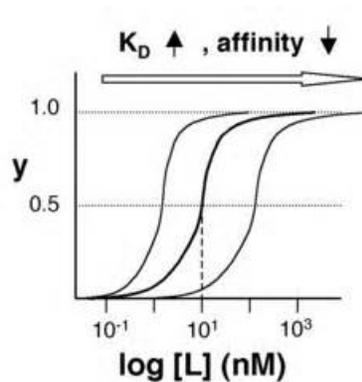
Problem 3: A mutation in Enzyme A has no effect on V_{\max} , but raises K_M from 1×10^{-5} to 1×10^{-4} . Draw a Michaelis Menton curve for Enzyme A and its mutant. Did the mutation cause the enzyme to become a better or worse catalyst?

Problem 4: Myoglobin is an oxygen binding protein. Its binding curve is shown below. Using this curve, what is the value of “a” in the graph? What is its physical meaning? What is the value of “b”? What is its physical meaning?



Skill 3: Interpreting Sigmoidal Curves

- Always check out the scale of the x-axis.
 - If the x-axis of a sigmoidal curve is linear, then we can often draw the conclusion that it is due to cooperativity
 - If the x-axis of a sigmoidal curve is logarithmic, then it is not due to cooperativity. It is actually a rectangular hyperbola where the small values of x have been stretched out. This is a helpful way to redraw a series of binding curves so that their affinities for substrate can be compared.

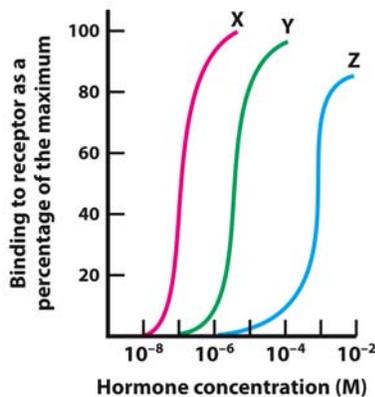


Problem 5: Answer the questions below based on the graphs.

A. Which of the graphs suggests cooperative binding?

B. Which hormone, X, Y, or Z, binds tightest to its receptor?

C. Both hemoglobin and myoglobin bind oxygen well at high concentrations of oxygen, but which binds oxygen better at low concentrations of oxygen? Most tissues in the body have a pressure of oxygen in the 20-40 torr region. Which protein, hemoglobin or myoglobin, will have greater effects to its oxygen binding when a tissue oxygen level drops from 30 torr to 25 torr?



Problem 13.27a
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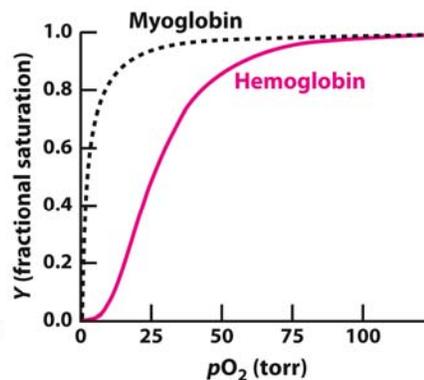
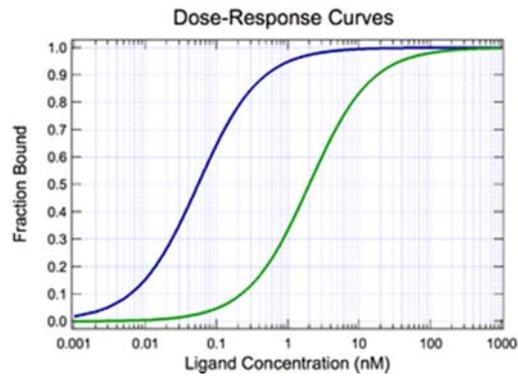


Figure 9.1
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Problem 6: A dose-response curve is drawn to show the relationship between the amount of a drug administered and its effect. In the chart below, two different drugs are tested and placed on the same graph. Drug A gives the left curve and drug B gives the right curve.



- A. Do these data suggest that drugs A and B exhibit cooperative binding?
- B. What is the dose of drug B that gives half maximal response?
- C. Which drug is most effective at lower doses? About how many times more effective is it?