

## CHAPTER 8 BERG/STRYER *8e* STUDY GUIDE

1. Homework: 1-4, 29, 35, 37, 38. Understand the general statements about enzymes on 215- 225: they are very **specific**; they can be **regulated** several ways (feedback/allosteric inhibition, regulatory proteins, covalent modification, and zymogen cleavage, as examples); they can **transform energy**; they **can't** move the **equilibrium point**; they stabilize the **transition state**; they have an **active site cleft**, and they often **change shape** in response to the "correct" substrate (Koshland's Induced Fit, Fig. 8.9). Note – 6 Enzyme classes "OTHLIL" Table 8.8 p. 245.

2. An important point in the chapter is the discussion of **Gibbs' Free Energy**, or  $\Delta G$ . At equilibrium, the **enthalpy** change for a reaction will equal the **entropy** change times the absolute temperature, that is:  $\Delta H = T\Delta S$ . For reactions **not** at equilibrium, these two quantities differ, and the difference shows the available reaction energy, thus:  $\Delta G = \Delta H - T\Delta S$ . Defined this way – reactions at equilibrium have  $\Delta G = 0$ . Reactions which will move forward spontaneously have  $\Delta G < 0$ , i.e. negative. Reactions which will back up have  $\Delta G > 0$ . When standard conditions are applied, that is, all concentrations are set to [1 M], then the value of the free energy change will be  $\Delta G^\circ$ , the **Standard Free Energy Change**. Know the 5 statements listed on p. 218, and Equations (1) and (5) on 219. Be sure you understand Table 8.3. A difference in  $\Delta G^\circ$  of roughly 1.4 kcal/mol corresponds to a tenfold difference in the equilibrium constant. Thus, linking ATP hydrolysis to some reaction, which brings in  $-7.3$  kcal/mol, ought to make something like a million-fold difference in the combined  $K_{eq}$ .

3. The single most important concept in this chapter is the **Michaelis Menten Equation**, p. 228 (eq. 26). You should memorize the equation in this form and be able to use it. You should also *understand* the derivation on 226-8. **Rate constants** (lowercase **k**) only "look" at a reaction in a single direction, whereas equilibrium constants (capital **K**) "look" at both directions. Rate constants fall out simply from the *Principle of Mass Action*. You should be able to figure out the dimensions (units) of the various rate constants in the M-M derivation. You should also know the underlying assumptions – mainly, "**Initial Rate**" (i.e.  $[P] = \sim 0$ ) and "**Steady State**" ( $[ES]$  is constant, so  $V_{\text{fwd}} = V_{\text{back}}$ ). You should also understand that the Michaelis Menten Equation assumes a single active site and a single substrate, so that many enzymes fit *other* kinetic patterns. The Michaelis-Menten equation graphs as a *rectangular hyperbola* (like Myoglobin's oxygen binding curve). **Allosteric** enzymes, usually with multiple interacting active sites, graph as *sigmoidal* plots (Fig 8.13 p. 233, see also Ch. 10 Fig 10.14). Understand the **double reciprocal plot** shown in Fig. 8.12 (p. 229) but don't use equation (eq. 27) please.

4. Understand the significance of  **$K_M$** ,  **$V_{\text{max}}$**  and turnover number  **$k_2$**  (p. 229 ff). Notice that the  $K_M$  varies in Table 8.4 from 0.4 to 8000  $\mu\text{M}$ . A "typical"  $K_M$  might be about 1 mM or 1000  $\mu\text{M}$ . Discussing a "typical"  $V_{\text{max}}$  is rather meaningless since  $V_{\text{max}} = k_2 [E_t]$ , and the enzyme concentration can be nearly anything. Instead, the "**turnover number**" or  **$k_2$**  is often discussed – in Table 8.5, it varies from 0.5 to 600,000 per second. Once again, a "typical" number might be about 300/sec. A high turnover number means a "fast" enzyme. A low  $K_M$  means an enzyme binds tightly and specifically to its substrate. The term " **$k_{\text{cat}}$** " (same as  $k_2$ , turnover number) is defined on 230, and mainly is used to discuss the maximum rates of more complicated, non-M- M enzymes. Be able to distinguish between **competitive**, **uncompetitive**, and **non-competitive** inhibition (p. 234 ff).

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## **Table of Contents Berg Stryer 7e Study Guide Rutgers University**

1. Understanding the eBook Berg Stryer 7e Study Guide Rutgers University
  - The Rise of Digital Reading Berg Stryer 7e Study Guide Rutgers University
  - Advantages of eBooks Over Traditional Books
2. Identifying Berg Stryer 7e Study Guide Rutgers University
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Berg Stryer 7e Study Guide Rutgers University
  - User-Friendly Interface
4. Exploring eBook Recommendations from Berg Stryer 7e Study Guide Rutgers University
  - Personalized Recommendations
  - Berg Stryer 7e Study Guide Rutgers University User Reviews and Ratings
  - Berg Stryer 7e Study Guide Rutgers University and Bestseller Lists
5. Accessing Berg Stryer 7e Study Guide Rutgers University Free and Paid eBooks
  - Berg Stryer 7e Study Guide Rutgers University Public Domain eBooks
  - Berg Stryer 7e Study Guide Rutgers University eBook Subscription Services

- Berg Stryer 7e Study Guide Rutgers University Budget-Friendly Options
- 6. Navigating Berg Stryer 7e Study Guide Rutgers University eBook Formats
  - ePub, PDF, MOBI, and More
  - Berg Stryer 7e Study Guide Rutgers University Compatibility with Devices
  - Berg Stryer 7e Study Guide Rutgers University Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Berg Stryer 7e Study Guide Rutgers University
  - Highlighting and Note-Taking Berg Stryer 7e Study Guide Rutgers University
  - Interactive Elements Berg Stryer 7e Study Guide Rutgers University
- 8. Staying Engaged with Berg Stryer 7e Study Guide Rutgers University
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Berg Stryer 7e Study Guide Rutgers University
- 9. Balancing eBooks and Physical Books Berg Stryer 7e Study Guide Rutgers University
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Berg Stryer 7e Study Guide Rutgers University
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Berg Stryer 7e Study Guide Rutgers University
  - Setting Reading Goals Berg Stryer 7e Study Guide Rutgers University
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Berg Stryer 7e Study Guide Rutgers University
  - Fact-Checking eBook Content of Berg Stryer 7e Study Guide Rutgers University
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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