

## ***Chapter 6: An Introduction to Metabolism***

### ***Outline***

- I. The chemistry of life is organized into metabolic pathways.
- II. Organisms transform energy
- III. The energy transformations of life are subject to two laws of thermodynamics
- IV. Organisms live at the expense of free energy
  - A. Free Energy: A Criterion for Spontaneous Change
  - B. Free Energy and Metabolism
  - C. Free Energy and Equilibrium
- V. ATP powers cellular work by coupling exergonic to endergonic reactions
  - A. The Structure and Hydrolysis of ATP
  - B. How ATP Performs Work
  - C. The Regeneration of ATP
- VI. Enzymes speed up metabolic reactions by lowering energy barriers
- VII. Enzymes are substrate-specific
- VIII. The active site is an enzyme's catalytic center
- IX. A cell's chemical and physical environment affects enzyme activity
  - A. Effects of Temperature and pH
  - B. Cofactors
  - C. Enzymes Inhibitors
  - D. Allosteric Regulation
  - E. Cooperativity
- X. Metabolic order emerges from the cell's regulatory systems and structural organization
  - A. Feedback Inhibition
  - B. Structural Order and Metabolism

### ***Key Terms***

Metabolism	bond energy	equilibrium	cofactors
Catabolic pathways	heat of reaction ( $\Delta H$ )	catalyst	coenzymes
Anabolic pathways	enthalpy	enzyme	competitive inhibitors
Kinetic energy	exothermic	activation energy	noncompetitive inhibitors
Potential energy	endothermic	transition state	cooperativity
Thermodynamics	spontaneous reaction	substrate	feedback inhibition
Closed system	free energy	active site	induced fit
Open system	exergonic	endergonic	saturation
Entropy			

### ***Objectives***

After reading this chapter, the student should be able to:

- 1 Explain the role of catabolic and anabolic pathways in the energy exchanges of cellular metabolism.
  - 2 Distinguish between open and closed systems.
  - 3 Explain, in your own words, the First and Second Laws of Thermodynamics.
  - 4 Distinguish between entropy and enthalpy.
  - 5 Write the Gibbs equation for free energy change.
  - 6 Explain how changes in enthalpy, entropy and temperature influence the maximum amount of useable energy that can be harvested from a reaction.
  - 7 Distinguish between exergonic and endergonic reactions.
  - 8 Describe the function of ATP in the cell, the three components of ATP, the major class of macromolecules to which it belongs, and explain how ATP performs cellular work.
  - 9 Describe the energy profile of a chemical reaction including activation energy ( $E_A$ ), free energy change ( $\Delta G$ ) and transition state.
  - 10 Describe the function of enzymes in biological systems.
  - 11 Explain the relationship between enzyme structure and enzyme specificity.
  - 12 Explain the induced fit model of enzyme function and describe the catalytic cycle of an enzyme.
  - 13 Describe several mechanisms by which enzymes lower activation energy.
  - 14 Explain how substrate concentration affects the rate of an enzyme-controlled reaction.
  - 15 Explain how enzyme activity can be regulated or controlled by environmental conditions, cofactors, enzyme inhibitors and allosteric regulators.
  - 16 Explain how metabolic pathways are regulated.
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