

PowerLecture:  
Chapter 6  
Ground Rules of Metabolism  
Section 6.0: Weblinks and InfoTrac

**See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)**

- Section 6.0: National Institute on Alcohol Abuse and Alcoholism
- Section 6.0: Alcohol, Chemistry, and You
- Section 6.0: How Antabuse Affects the Metabolism of Alcohol
- Section 6.0: BRENDA—The Comprehensive Enzyme Information System
- Section 6.0: Hangovers: Why Do They Happen and What Is the Best Cure? David Lucey Indulges, for Your Education, of Course. David Lucey. *Student BMJ*, June 2002.
- Section 6.0: Alcohol Hangover: Mechanisms and Mediators. Robert Swift et al. *Alcohol Health & Research World*, Winter 1998.
- Section 6.0: Exploring Alcohol's Effects on Liver Function. Jacquelyn Maher. *Alcohol Health & Research World*, Winter 1997.

How Would You Vote?

The following is the question for this chapter. See national results below.

Would you support restricting the priority for a liver transplant to patients who have maintained healthy lifestyles?

Impacts, Issues: Alcohol, Enzymes, and Your Liver

- Catalase is an enzyme that helps the body break down toxic substances in alcoholic drinks

Impacts, Issues: Alcohol, Enzymes, and Your Liver

- The liver plays a central role in alcohol metabolism
- Consumption of too much alcohol, as in binge drinking, can lead to *alcoholic hepatitis* or *alcoholic cirrhosis*

Section 6.1: Weblinks and InfoTrac

See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)

- Section 6.1: The Development of an Intuitive Understanding of Entropy. William Friedman. *Child Development*, Mar. 2001.

#### What Is Energy?

- Capacity to do work
- Forms of energy
  - Potential energy
  - Kinetic energy
  - Chemical energy

#### What Is Energy?

##### First Law of Thermodynamics

- The total amount of energy in the universe remains constant
- Energy can undergo conversions from one form to another, but it cannot be created or destroyed

#### What Can Cells Do with Energy?

- Energy inputs become coupled to energy-requiring processes
- Cells use energy for:
  - Chemical work
  - Mechanical work
  - Electrochemical work

#### One-Way Flow of Energy

- The sun is life's primary energy source
- Producers trap energy from the sun and convert it into chemical bond energy
- All organisms use the energy stored in the bonds of organic compounds to do work

#### Second Law of Thermodynamics

- No energy conversion is ever 100 percent efficient
- The total amount of energy is flowing from high-energy forms to forms lower in energy

#### Entropy

- Measure of degree of disorder in a system
- The world of life can resist the flow toward maximum entropy only because it is resupplied with energy from the sun

Entropy  
Entropy

Section 6.2  
Participants in  
Metabolic Reactions

- Energy carriers
- Enzymes
- Cofactors
- Transport proteins

Endergonic Reactions

- Energy input required
- Product has more energy than starting substances

Exergonic Reactions

- Energy is released
- Products have less energy than starting substance

The Role of ATP

- Cells “earn” ATP in exergonic reactions
- Cells “spend” ATP in endergonic reactions

The Role of ATP

ATP/ADP Cycle

- When adenosine triphosphate (ATP) gives up a phosphate group, adenosine diphosphate (ADP) forms
- ATP can re-form when ADP binds to inorganic phosphate or to a phosphate group that was split from a different molecule
- Regenerating ATP by this ATP/ADP cycle helps drive most metabolic reactions

Section 6.3: Weblinks and InfoTrac

**See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)**

- Section 6.3: What the Heck is an Enzyme?
- Section 6.3: Enzymes, Kinetics, and Diagnostic Use
- Section 6.3: Enzymes—The Movers and Shakers of Our Body Chemistry. Arthur Yellin. *FDA Consumer*, Apr. 1986.
- Section 6.3: Cages, Cavities, and Clefts: By Building and Setting Molecular Traps, Chemists Shed Light on How One Molecule Recognizes Another. Ivars Peterson. *Science News*, Aug. 8, 1987.

## Enzyme Structure and Function

- Enzymes are catalytic molecules
- They speed the rate at which reactions approach equilibrium

### Four Features of Enzymes

- 1) Enzymes do not make anything happen that could not happen on its own. They just make it happen much faster.
- 2) Reactions do not alter or use up enzyme molecules.

### Four Features of Enzymes

#### Activation Energy

- For a reaction to occur, an energy barrier must be surmounted
- Enzymes make the energy barrier smaller

### Induced-Fit Model

- Substrate molecules are brought together
- Substrates are oriented in ways that favor reaction
- Active sites may promote acid-base reactions
- Active sites may shut out water

#### Section 6.4: Weblinks and InfoTrac

**See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)**

- Section 6.4: [The Phytochemical Collection \(antioxidants\)](#)
- Section 6.4: [Hot-Blooded Proteins: Heat-Loving Enzymes Stay Cool under Stress.](#) Corinna Wu. *Science News*, May 9, 1998.

Allosteric Activation

Allosteric Inhibition

Feedback Inhibition  
Factors Influencing  
Enzyme Activity

Temperature

pH

Salt concentration

Allosteric regulators

Coenzymes and cofactors

Effect of Temperature

- Small increase in temperature increases molecular collisions, reaction rates
- High temperatures disrupt bonds and destroy the shape of active site

Effect of pH

Enzyme Helpers

- Cofactors
  - Coenzymes
    - NAD<sup>+</sup>, NADP<sup>+</sup>, FAD
    - Accept electrons and hydrogen ions; transfer them within cell
    - Derived from vitamins
  - Metal ions
    - Ferrous iron in cytochromes

Section 6.5: Weblinks and InfoTrac

**See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)**

- Section 6.5: [Integration and Compartmentation of Metabolism](#)
- Section 6.5: [Metabolic Pathways Wall Chart](#)
- Section 6.5: [Cooperation and Competition in the Evolution of ATP-Producing Pathways](#). Thomas Pfeiffer et al. *Science*, Apr. 20, 2001.

### Metabolic Pathways

- Defined as enzyme-mediated sequences of reactions in cells
  - Biosynthetic (anabolic) –  
ex: photosynthesis
  - Degradative (catabolic) –  
ex: aerobic respiration

### Chemical Equilibrium

- At equilibrium, the energy in the reactants equals that in the products
- Product and reactant molecules usually differ in energy content
- Therefore, at equilibrium, the amount of reactant almost never equals the amount of product

### Chemical Equilibrium

#### Redox Reactions

- Cells release energy efficiently by electron transfers, or oxidation-reduction reactions (“redox” reactions)
- One molecule gives up electrons (is oxidized) and another gains them (is reduced)
- Hydrogen atoms are commonly released at the same time, thus becoming  $H^+$

#### Electron Transfer Chains

- Arrangement of enzymes, coenzymes, at cell membrane
- As one molecule is oxidized, next is reduced
- Function in aerobic respiration and photosynthesis

### Uncontrolled vs. Controlled Energy Release

#### Section 6.6: Weblinks and InfoTrac

**See the latest Weblinks and InfoTrac articles for this chapter online or click highlighted articles below (articles subject to change)**

- Section 6.6: [The Bioluminescence Web Pages](#)
- Section 6.6: [What Makes a Firefly Glow?](#)
- Section 6.6: [The Firefly Files](#)
- Section 6.6: [Lighting Up Biological Clocks: Genes from Glowing Organisms Illuminate Circadian Rhythms. John Travis. \*Science News\*, Aug. 12, 1995.](#)
- Section 6.6: [Illuminating Drug Discovery. Christopher Contag et al. \*Chemistry and Industry\*, Sept. 6, 1999.](#)

#### Bioluminescence

- An outcome of enzyme-mediated reactions that release energy as fluorescent light
  - Bioluminescent Bacteria
  - Bioluminescent Bacteria

