Slide 1

CHAPTER 5
The Working Cell

Slide 2

BIOLOGY AND SOCIETY:
STONEWASHING WITHOUT THE STONES
• The sturdy cotton fabric denim has been worn because of its toughness and appeal
  • Stonewashing jeans with pumice stone can damage the fabric
  • Recently the enzyme cellulase has been used to achieve better results

Slide 3

SOME BASIC ENERGY CONCEPTS
• Energy makes the world go around
Slide 4

• Kinetic energy is the energy of motion
• Potential energy is stored energy

Slide 5

• Energy can be changed from one form to another

Slide 6

Entropy

• Heat is
Slide 7

- Scientists use the term *entropy* as a measure of disorder, or randomness.

Slide 8

**Chemical Energy**

- Chemical energy

Slide 9

- Living cells and automobile engines use the same basic process to make chemical energy do work.
Slide 10

Figure 5.3b

- Heat energy
- Food
- Oxygen
- Cellular respiration
- Energy for cellular work
- Carbon dioxide
- Water

Slide 11

- Cellular respiration

Slide 12

**Food Calories**

- A calorie is the amount of energy that raises the temperature of 1 gram of water by 1 degree Celsius
Slide 13

- The kilocalorie is
  - 1,000 calories
  - The unit used to measure the energy in food

<table>
<thead>
<tr>
<th>Food</th>
<th>Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken</td>
<td>540</td>
</tr>
<tr>
<td>Ham</td>
<td>239</td>
</tr>
<tr>
<td>Eggs (4 large)</td>
<td>238</td>
</tr>
<tr>
<td>Fish (4 oz)</td>
<td>108</td>
</tr>
<tr>
<td>Pasta (1 oz)</td>
<td>196</td>
</tr>
<tr>
<td>Vegetables</td>
<td>15-20</td>
</tr>
<tr>
<td>Grains</td>
<td>100-150</td>
</tr>
<tr>
<td>Baked Products</td>
<td>250-350</td>
</tr>
</tbody>
</table>

Slide 14

- The energy of calories in food is burned off by many activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Calories per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running 5 miles</td>
<td>600</td>
</tr>
<tr>
<td>Dancing</td>
<td>600</td>
</tr>
<tr>
<td>Swimming</td>
<td>500</td>
</tr>
<tr>
<td>Tennis</td>
<td>400</td>
</tr>
<tr>
<td>Yoga</td>
<td>200</td>
</tr>
<tr>
<td>Walking 3 miles</td>
<td>100</td>
</tr>
<tr>
<td>Biking</td>
<td>100</td>
</tr>
</tbody>
</table>

Slide 15

**ATP AND CELLULAR WORK**

- The chemical energy of organic molecules is released in cellular respiration to make ATP in the mitochondria
Slide 16

The Structure of ATP

- ATP (adenosine triphosphate)

Slide 17

Phosphate Transfer

- ATP can energize other molecules by transferring phosphate groups

Slide 18

Three Main Kinds of Cellular Work

- Mechanical work
- Transport work
- Chemical work
Slide 19

The ATP Cycle

• Cellular work spends ATP
• ATP is recycled from ADP and phosphate through cellular respiration

Slide 20

• ATP functions in what is called energy coupling, or the ATP cycle

Slide 21

ENZYMES

• Metabolism is defined as the many chemical reactions that occur in organisms
• Few metabolic reactions occur without the assistance of enzymes
**Activation Energy**

- Activation energy

---

**Enzymes**

- Each enzyme is very selective
Slide 25

- Each enzyme recognizes a specific substrate

Slide 26

- Enzymes can function over and over again

Slide 27

**Enzyme Inhibitors**

- Enzyme inhibitors
Other inhibitors

MEMBRANE TRANSPORT

• Working cells must control the flow of materials

Passive Transport: Diffusion Across Membranes

• Molecules contain heat energy
Slide 31

- Diffusion is one result of the movement of molecules.

Slide 32

Slide 33

- Another type of passive transport is facilitated diffusion, the transport of some substances by specific transport proteins that act as selective corridors.
Osmosis and Water Balance in Cells

- Osmosis is the passive transport of water across a selectively permeable membrane.

Slide 35

- A hypertonic solution
- A hypotonic solution
- An isotonic solution

Slide 36

Water Balance in Animal Cells

- The survival of a cell depends on its ability to balance water uptake and loss.
Slide 37

- Osmoregulation is the control of water balance in animals

---

Slide 38

**Water Balance in Plant Cells**

- Water balance in plant cells is different

---

Slide 39

**Active Transport: the Pumping of Molecules Across Membranes**

- Active transport requires energy to move molecules across a membrane
Exocytosis and Endocytosis: Traffic of Large Molecules

Slide 40

- **Exocytosis**

Slide 41

- **Endocytosis**

Slide 42

- In phagocytosis ("cellular eating") a cell engulfs a particle and packages it within a food vacuole
- In pinocytosis ("cellular drinking") a cell "gulps" droplets of fluid by forming tiny vesicles
Slide 43

- Receptor-mediated endocytosis

Slide 44

The Role of Membranes in Cell Signaling

Slide 45

- Cellular communication
- The signal transduction pathway
Slide 46

**Figure 5.19**

- Outside cell
- Inside cell
- Receptor protein
- Signal transduction pathway
- Hydrolysis of glycogen releases glucose for energy
- Epinephrine (adrenaline) from adrenal glands

---

**Slide 47**

**EVOLUTION CONNECTION:**
**EVOLVING ENZYMES**

- Organisms use many different enzymes

---

**Slide 48**

- The processes of natural selection and directed evolution
Chapter 5 Study Objectives

1. Explain how enzymes can be used to produce “stonewashed” jeans.
2. Define the terms: energy, kinetic energy, the principle of conservation of energy and potential energy.
3. Explain the relationship between heat and entropy.
4. Compare the processes by which a car and a human use “fuel” to perform work. Explain why the human process is more efficient.
5. Compare the amount of energy in a calorie to that found in a kilocalorie. Which is most commonly used on food labels?
6. Explain how ATP drives work in chemical reactions in cells.
7. Explain the process of energy coupling in cells.
8. Explain how enzymes are able to speed up chemical reactions.
9. Define the terms: metabolism, enzyme, activation energy, substrate, active site, induced fit, and feedback regulation.
10. Explain how enzymes can act as inhibitors and poisons.
11. Distinguish between the following pairs of terms: diffusion versus osmosis, passive transport versus active transport, hypertonic versus hypotonic, endocytosis versus exocytosis, and phagocytosis versus pinocytosis.
12. Explain how enzymes can be produced by directed evolution.
13. Explain how directed evolution and natural selection are similar and different.