4.4 Exercise Physiology Study Guide by Hisrich

4.4.a  What is the connection between power and movement in the body?

Movement requires power (fueled by energy). The energy comes from **cellular respiration**. Respiration can be **aerobic** ("with oxygen"—the source of long term energy) or **anaerobic** ("without oxygen"—the source of short term energy).

4.4.b  How does the body maintain a supply of ATP during exercise?

**Phosphagen System**
- Muscles use **creatine phosphate** to make energy for 8–10 seconds. An enzyme (creatine kinase) breaks the ATP into ADP, releasing energy & the ADP is quickly recharged back into ATP.

**Glycogen-Lactic Acid System**
- Muscles store carbs as **glycogen** (chains of glucose) and can use anaerobic respiration to turn glycogen into glucose and then convert the glucose into ATP and **lactic acid**. The process is slower, but longer lasting than the Phosphagen system. The lactic acid builds up and makes muscles sore (causing **muscle fatigue**).

**Aerobic Respiration**
- After about 2 minutes of exercise, the body is able to get oxygen to the muscles so that glucose can be fully broken down **aerobically**. The glucose can come from these places: 1) **glycogen** in muscles 2) **glycogen** in the liver 3) absorption of glucose from food in the intestine. After “hitting the wall” (depleting all glucose reserves), the body switches to burning fat reserves. When all fat is exhausted, the body can break proteins into amino acids & convert them into ATP. It works slower than the other processes, but is extremely long-lasting.

4.4.c  What body systems are involved with powering an athlete through a running race?

<table>
<thead>
<tr>
<th>System</th>
<th>Function</th>
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<tbody>
<tr>
<td>Digestive</td>
<td>Absorbs glucose through intestines and releases stored glucose from liver</td>
</tr>
<tr>
<td>Respiratory</td>
<td>Brings in steady supply of oxygen needed to combust glucose</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>Carries O₂ &amp; glucose to the cells to be converted into energy within the mitochondria</td>
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4.4.f  What are performance-enhancing drugs?

Performance enhancing drugs are artificial ways of making the body function better during competition.

**Anabolic Steroids**
- Promote tissue growth (esp. muscle) & improve endurance. **Blood doping** is loading an athlete’s blood with his/her own RBCs so blood carries more oxygen. **Erythropoietin** can be injected into the athlete to promote RBC production & increase O₂ carrying capacity.

4.4.g  How do specific performance-enhancing drugs affect the human body?

These drugs can make for an “unleveled playing field” & some can harm health (steroids). Not everyone agrees that they should be banned however. Is there any such thing as “a level field”?

4.4.h  Why should certain performance-enhancing drugs be banned from athletic competition?
Muscle cells rely upon a flow of electricity from the brain. It tells them to contract by signaling the sarcoplasmic reticulum to release calcium. Muscle fatigue is when the muscles can’t generate force.

Nerves are typically able to provide the necessary signals, but after a time of maximum contraction (such as strength training), the nerve’s signal reduces in frequency and contraction is reduced. There’s no pain, but the muscle seems to no longer listen to the brain & sometimes moves backwards. Continued strength training can increase the nerve’s ability to sustain high frequency signals for longer time periods, helping a person overcome muscle fatigue.

A new explanation is shown to the right→

Muscles can also fatigue when there’s a lack of oxygen, water, vitamins or nutrients or when there’s a build-up of lactic acid.

1. **Lack of oxygen**—During hard/fast exercise (like sprinting) the body may not be able to provide enough oxygen to the muscles to break down glucose and produce energy. That results in a build-up of **lactic acid**, causing fatigue.

2. **Lack of fluid & electrolytes**—If a person doesn’t drink enough fluids & taking in enough electrolytes during exercise, the muscles will cramp and fatigue. The blood won’t be able to carry oxygen/nutrients to muscles & won’t be able to carry away the waste products (CO$_2$ and lactic acid).

3. **Lack of sleep**—Without adequate sleep, the muscles won’t be able to recover from the day before and will fatigue more quickly.

4. **Poor nutrition**—A lack of calcium, or an imbalance of carbs, proteins and fats can lead to muscle fatigue.

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**4.4.i  What are areas to consider when designing a training plan for an athlete?**

The trainer should first consider the background and current condition of the athlete. She should then help the athlete set a goal. The trainer and athlete can develop plans for the following areas in order to help meet the goals.

**Diet**

**Exercise**

**Hydration**

**Injury Prevention**

**Tracking Progress**

**Medications, Vitamins or Supplements**