Energy Usage During Exercise: How It Affects *Your* Workout

Introduction

While most people know that aerobic exercise is good for the heart and that resistance training helps build lean body mass, most people don't fully understand how these different types of exercise elicit very different responses within our bodies. A basic understanding of how our body uses energy during different forms of exercise is critical for designing an effective exercise program. We will focus on energy systems—i.e., how the body utilizes fat, carbohydrate, and protein to produce energy—and how these energy systems are relied upon during different forms of exercise.

This article will give you a better understanding of how your body converts the food you eat into usable energy and how targeting specific energy systems will help you achieve your personal health and fitness goals.

Energy Systems Review

In general, there are three basic energy systems: (1) the phosphagen system (also referred to as the immediate energy system), (2) the glycolytic energy system (also referred to as the nonoxidative or anaerobic system), and (3) mitochondrial respiration (also referred to as the oxidative or aerobic system).

Regardless of what energy system is used, the end result is the production of adenosine triphosphate (or ATP). ATP is extracted from the food we eat (fat, carbohydrate, and protein) and is required for the biochemical reactions involved in any muscle contraction. The intensity and duration of the activity dictates which foodstuffs are broken down as well as which energy system predominates. It is important to keep in mind, however, that no energy system acts alone. The relative contribution from each system depends on the intensity and duration of the activity.

The Phosphagen or Immediate Energy System

The phosphagen system is active during all-out exercise that lasts about 5 to 10 seconds such as a 100-meter dash, diving, jumping, lifting a heavy weight, dashing up a flight of stairs, or any other activity that involves a maximal, short burst of power. This system relies on stored ATP and to a larger extent, creatine phosphate to provide immediate energy. For any maximal intensity exercise lasting longer than 10 seconds, assistance from other sources of energy is required.

Glycolytic Energy or Anaerobic System

The glycolytic energy system (also called glycolysis) involves the partial break down of glucose to a molecule called pyruvate. During this process, a relatively small amount of energy is produced. When oxygen demands exceed the oxygen supply, pyruvate is converted to lactate. Under these circumstances, glycolysis is often referred to as "fast" or "anaerobic" glycolysis. Anaerobic glycolysis is a key contributor to the total energy requirements for moderate to high intensity exercise lasting about one to two minutes. Although this system can provide a rapid source of energy, it is only about half as fast as the phosphagen system.

When there is enough oxygen to meet the oxygen demands of the activity, such as during prolonged light to moderate intensity exercise, glycolysis proceeds much slower and the pyruvate that is formed participates in the formation of additional energy via aerobic processes (see Aerobic System discussion below). In this case, glycolysis is sometimes referred to as "aerobic" or "slow" glycolysis.

We often think of low to moderate intensity aerobic exercise as a good way to burn a significant amount of fat. While this is true, aerobic energy can be derived from carbohydrates and to a much smaller extent, protein. In fact, most people don't realize that even during light to moderate exercise, carbohydrates can provide up to 40 to 60 percent of the total energy requirements. (See Table 1.) In contrast, protein is not a preferred source of energy during any form of exercise (assuming an adequate diet) and generally contributes less than 10 percent of the total energy requirements.

Monitoring Your Energy Usage

One of the most effective methods of determining the predominant energy system during a specific form of exercise is by monitoring your heart rate. Heart rate monitoring can help you determine the intensity of your workout as well as estimate the heart rate at which you transition from aerobic to anaerobic exercise (i.e., from carbohydrate and fat usage to predominantly carbohydrate). While the transition point differs from person to person, you can get a general idea of where you transition from aerobic to anaerobic exercise by watching for substantial increases in heart rate, muscle fatigue, or in breathing depth and frequency. If you are truly engaging in anaerobic exercise, you will not be able to sustain the intensity of the exercise for longer than about one to two minutes. If you notice your intensity dropping off, you were probably performing anaerobic exercise. In contrast, if you are able to sustain your exercise intensity longer than about two minutes, you are probably exercising aerobically. As your fitness improves, you will be able to perform higher intensity exercise for longer periods of time.

Exercise Mode and Energy Usage

Keep in mind that although resistance training doesn't necessarily burn a significant number of calories, it can provide significant health and fitness benefits. Not only does resistance training increase lean body mass (i.e., muscle), which burns more calories than fat even while at rest, engaging in a regular resistance training can have positive effects on elements such as cholesterol, glucose metabolism, and bone density, to name a few.

Circuit Training

Circuit training is sometimes considered a type of resistance training, but it is actually a compromise between resistance training and cardiovascular training. Essentially, circuit training can improve muscle endurance as well as provide modest gains in aerobic capacity. Because it is generally a low to moderate intensity workout that is sustained for an hour or more, circuit training is primarily an aerobic activity.

Aerobic Exercise: Walking, Jogging, Traditional Hi-Lo Aerobics, and Step Aerobics

"Aerobic" exercise is typically touted as a great way to burn a lot of fat. While this is not necessarily incorrect, it can be misleading. For example, at about 25 percent of aerobic capacity (i.e., low intensity exercise), fat is the primary source of fuel, but you are not burning a significant number of calories. If your goal is to lose weight, the key consideration is the net deficit in calories, not where the calories come from. As exercise intensity increases, the number of calories burned also increases. Therefore, while it is true that fat contributes a greater percentage of the total energy during lower intensity exercise, at higher intensity exercise, the total quantity of fat utilized may be greater for exercise performed for an equivalent period of time.

So How Does Energy Usage Affect *Your* Workout?

If you don't have a specific goal in mind, but simply want to improve your overall health, the American College of Sports Medicine recommends moderate intensity physical activity performed for at least 20 to 30 minutes, excluding time spent warming up and cooling down, 3 to 5 times a week. If, on the other hand, you are training for some type of competitive event, make sure that your training program emphasizes the type of activity involved in that event. For example, if you are training for a triathlon, engaging in a power lifting training program three days a week will not make the best use of your time. You need to actively engage in running, biking, and swimming. Finally, if your goal is to lose weight, caloric deficit is key. You should aim for a caloric deficit of about 500 calories a day through decreased energy intake, increased energy expenditure, or a combination of the two. Although there are numerous types of exercise that are effective for weight loss, a combination of regular aerobic exercise and resistance training is a good place to start.

Bio

Jessica Smith, ME, is an independent scientific and medical consultant specializing in the areas of health and fitness, exercise physiology, biomechanics, ergonomics/human factors, and pharmaceuticals. She has authored several articles for fitness magazines in the areas of biomechanics, exercise physiology, resistance training, safety during various forms of exercise, and group exercise class formats. Jessica has a master's degree in bioengineering with an emphasis in biomechanics. In addition to her academic background, she has been a certified fitness instructor for the past 10 years and was a gymnast for 17 years, for which she was an All-American and a member of the University of Utah's 1990 NCAA championship gymnastics team. As a result of her experience as a high-level athlete, as well as her professional and academic background, Jessica brings a unique perspective to the health and fitness arena. She is currently developing content for health and fitness seminars directed toward fitness professionals that will focus on functional anatomy, exercise physiology, biomechanics, and group exercise safety. For more information on holding a seminar at your facility, or if you have comments or questions, Jessica can be reached via e-mail at **jws@xmission.com**, or by phone at (801) 487-9349.

Table 1. [a]Nutrient usage at different exercise intensities

Nutrient	At Rest	Light to moderate intensity exercise	High-intensity endurance exercise	High-intensity sprint-type exercise
Protein	2-5%	2-5%	5-8%	2%
Carbohydrate	35%	40%	70%	95%
Fat	60%	55%	15%	3%

Adapted from: McArdle, W.D., Katch, F.I., & Katch, V.L. 1999. *Sports & Exercise Nutrition*. New York: Lippincott Williams & Williams.
[a]The values included in the table are approximate and may vary depending on many factors.