

## ENERGY PRODUCTION AND AEROBIC RUNNING

To live, the human body needs energy. The more active a person is, the more energy required. Energy fuels the body and allows you to perform the wide range of your daily activities.

All human energy is produced through the breakdown of a chemical compound called **ATP**, *adenosine triphosphate*. Like gasoline, it's broken apart, or burned, to produce energy. At any given time, you have about 3 ounces of ATP spread throughout your body. That amount lets you engage in vigorous activity for only a very short time. For example, existing ATP is exhausted after roughly 6 seconds of an all-out sprint.

Physical activity that lasts longer than 6 seconds requires the body to produce additional energy by converting the raw fuel of carbohydrates, proteins and fats from food into ATP. This energy production is characterized by whether or not oxygen is used to make ATP. Energy can be produced through **aerobic** processes, that is, with oxygen. Or, it can be produced through **anaerobic** processes, meaning without oxygen.

Whether energy is produced aerobically or anaerobically depends mostly on the nature of the physical activity involved. As already mentioned, intense energy needed for a very short period of time is supplied from the breakdown of stored ATP. It is an immediate energy source.

Once ATP stores are exhausted, though, energy must come from another source. If the activity is intense and of short duration, energy is produced anaerobically. But while anaerobic processes supply energy quickly, they can only do so for a short while. You see, anaerobic processes create **lactate**, or **lactic acid**, that causes muscles to burn, cramp, or seize if the activity is carried on long enough. It's the body's way of signaling that it cannot create energy at the rate at which it's being used. The muscle burn at the end of a 400-meter sprint is an example. When lactate starts to accumulate, your muscles soon stop working.

To sustain activity over a long period of time, your body must be able produce ATP through aerobic means. A balance between the demands of the activity and aerobic energy production is called a steady state. In this steady state, lactic acid does not accumulate in the muscles, and you are able to continue activity for a long time. Since Soccer requires running for extended periods of time, you must be able to produce energy aerobically.

Aerobic fitness is important for three reasons. First, aerobic fitness creates generally good cardio-vascular capacity and strengthens muscles and tendons. Second, good aerobic fitness allows your players to run at a steady state without incurring oxygen debt and exhausting important ATP stores. Third, good aerobic fitness allows your athletes to recover quickly from short ATP-depleting sprints, making them able to be more effective throughout the game.

### **AEROBIC FITNESS FOR SOCCER PLAYERS**

Although Soccer players do need to be aerobically fit, they do not need to be distance runners. You should, however, establish standards of fitness for your athletes. Many Soccer coaches have used the Cooper 12-minute run as a standard measure of aerobic fitness. In this test, players cover as much distance as possible in 12 minutes. Although a hard 12-minute run also relies on anaerobic energy, the test is generally considered a good measure of fitness for Soccer. Athletes who can run a mile and a half in 12 minutes probably have sufficient fitness for competitive Soccer, though you need to determine how fit your team should be.

Aerobic fitness should be developed during pre-season training. Of course, you should encourage your athletes to begin fitness training before the practice season begins. Many high school Soccer players in California run Cross-Country in the fall. If you have the benefit of a pre-season sixth period Soccer P.E. class, devote at least one-half hour, three days per week to running fitness training. These running sessions should be relatively easy steady-state runs. For variety, you can intersperse steady-state running with ball-skills drills or fitness circuits. The goal of the training, however, is to raise the aerobic fitness of the athletes. You don't need to run athletes into the ground to make them fit. Harder mixed-pace anaerobic running should start once the athletes have developed basic aerobic fitness.

### **Steady-Pace Training (Continuous Slow Distance)**

Steady-pace training is relatively slow, continuous long-distance running, where the aerobic system remains in a steady state with energy demands. Long steady runs should be done at a pace that can be maintained comfortably for 40–60 minutes.

Exercise scientists estimate that the ideal intensity of a steady-pace run is 5–10 percent below the anaerobic threshold. A very good approximation of this intensity is the talk test. Athletes should run at a pace that lets them hold a conversation. Unstable breath-

ing (ventilation) indicates that the pace is too fast, approaching the anaerobic threshold.

Steady-pace training develops aerobic and cardiovascular capacity (VO<sub>2</sub> max), improves muscle capillarity, and enhances the efficiency of energy production. Coaches often refer to long steady runs as the base or foundation training that precedes more intense threshold training.

### **ANAEROBIC FITNESS**

The unique nature of the game of Soccer, however, demands both aerobic *and* anaerobic energy production. Within a relatively steady state of activity, an athlete must be able to sprint hard, recover quickly, and then sprint again. As a consequence, you must train your athletes to meet both aerobic and anaerobic requirements.

The varied-pace running that characterizes Soccer demands anaerobic fitness. Short bursts of speed within a general steady state create energy demands that cannot be met solely by ATP supply and aerobic metabolism. Soccer players need to develop a special kind of stamina that lets them engage in repeat bouts of anaerobic sprinting followed by periods of slow running or walking. This stamina is a unique form of what is called **speed endurance**. Normally *speed endurance* refers to the ability to perform anaerobically over time. In Soccer, however, the length of anaerobic activity is relatively short. What becomes important is the ability of the athlete to recover quickly from multiple speed bursts. This type of endurance can be referred to as **anaerobic recovery capacity**.

Anaerobic recovery capacity is developed by increasing aerobic fitness, by raising the lactate threshold, and by developing lactate tolerance. Since we have already discussed the basic principles of aerobic fitness training, we'll address what is called **threshold** and **high lactate training**.

### **Lactate Threshold Training**

The primary form of running designed to raise the lactate threshold is called **tempo-pace** running. Basically, tempo runs should be 8–15 minutes long at a pace that puts the athlete slightly out of breath. In other words, the athlete should have a difficult time having a conversation while running.

Threshold training also can be divided into segments, or tempo reps. Tempo reps are shorter runs lasting from 90 seconds to 4 minutes with short rest intervals of 1 minute

or less. The entire workout should last 15–20 minutes.

### **Repetition Training**

Repetition training helps athletes use oxygen more efficiently. In repetition training, athletes train above the threshold level for longer periods than can be sustained during a game.

Repetitions should be from 30 seconds to 3 minutes long or distances of 220–880 yards. Pace will vary according to distance. The rest period should provide slightly less than complete recovery. A 1:2 run-to-recovery ratio is a common rest parameter. The workout should total 20–25 minutes of running, sans recovery.

### **Intervals (High Lactate Training)**

Interval training is a frequently misunderstood concept. Most coaches use the terms interval and repetition interchangeably, but, in fact, they are very different types of training. A repetition is a single unit of running. An interval is the recovery period that follows individual bouts of running. In repetition training, the objective is to run specific distances with a relatively complete recovery. With interval training, the goal is to run specific distances with incomplete recovery so that the athlete trains with elevated blood lactate.

Interval training enhances a player's ability to tolerate and produce lactic acid. While interval training does help raise the lactate threshold somewhat, it is primarily anaerobic. Soccer games require a lot of anaerobic energy, so interval training develops specific fitness.

The duration of each run in an interval session is typically 10–90 seconds or 110–440 yards. The run-to-recovery ratio should be between 1:1 and 2:1, run to recovery. Interval training should be done at a pace fast enough to create oxygen deficit. The intention of these workouts is to produce lactic acid by forcing your athletes to run the last portion of each repetition anaerobically.

Interval training is intense, demanding and painful. Do not schedule more than one such session during any single week of training. Some athletes might require 2–3 days of easy workouts to recover fully from a hard interval session.

### **Shuttle Runs**

**Shuttle runs** have been a staple of Soccer training for a long time. Essentially, shuttle runs are repetition or interval runs that involve numerous changes of direction. Here is an example of a typical shuttle run workout:

Player runs 5 yards and back, 10 yards and back, 15 yards and back, 20 yards and back, 25 yards and back. The player is allowed to rest a specified time. Repeat three or four times.

### **Speed Play (Fartlek Training)**

**Speed play** is the literal translation of the Swedish word *fartlek*. It is varied pace running that combines fast and slow running within a continuous run. Bouts of fast running are followed by easy recovery running. Ideally, speed play is done over varied terrain, including hills. The length of speed bursts and recovery is unstructured so that the athlete gains a genuine feeling of playing with speed.

Since the aim of *fartlek* training is to develop speed in the context of continuous running, the overall pace should be relatively easy. Only the speed bursts should be done with any intensity. However, speed play is not easy training. Speed bouts should be 40–220 yards long (or 5–40 seconds). The number of speed bouts depends on their length and the total length of the run. Remember, athletes should always recover between sprints; it's not intended to be high-lactate training.

High school athletes tend to need some structure to reap the benefits of *fartlek* and surging workouts. You might use predetermined markers or time intervals to indicate speed units.

Speed play is especially effective training for Soccer because it closely resembles the type of segmented and varied-pace running that occurs in a game. Speed play also is easy to do on or around the field. The following is an example of a varied-pace workout:

Players jog one side of the field, sprint one side, jog two sides, sprint two sides, jog three sides, sprint three sides, jog the field, then sprint the field, then jog three sides, sprint three sides, jog two sides, sprint two sides, jog one side, sprint one side and then jog slowly. The total distance covered is approximately two miles.