ex rx | By Jason R. Karp, PhD

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The Right Way to Train for a Marathon

Improving the body's natural ability to adapt is the key to crossing the finish line after 26.2 miles.

To paraphrase an ancient Chinese philosopher, "A journey of 26.2 miles begins with a single step." From the time the Greek runner Pheidippides ran from Marathon to Athens in 490 BC to announce the Greeks' victory in the Battle of Marathon, humans have had a compelling interest in taking that single step—and many more after it.

Whether your clients want to run a marathon for the thrill of it, to cross it off their bucket list or to qualify for the prestigious Boston Marathon, it all starts with a single step, which leads to another step, and then another, and then another. When a client puts together enough steps to cover 26.2 miles, he or she becomes a marathoner.

Marathon Physiology

Running a marathon involves a beautiful integration of cardiovascular, muscular and metabolic factors that influence the body's transportation and use of oxygen and the use of carbohydrate and fat as fuel.

CARDIOVASCULAR FACTORS

As the cardiovascular system sends blood and oxygen to working muscles, each heartbeat generates a **stroke volume,** which depends on

- the heart's ability to contract forcefully to squeeze blood out of its left ventricle,
- the return of deoxygenated blood from the muscles back to the heart so that oxygenated blood can be pumped out again, and
- the size of the left ventricle.

One of the body's most elegant adaptations to endurance training is an increase in the size of the left ventricle. The larger the left ventricle, the more blood it can hold; the more blood it can hold, the more it can pump. Multiply your stroke volume by your heart rate and you get cardiac output—the volume of blood your heart pumps per minute.

The flow of blood from the heart to the muscles depends on the blood's oxygen transport capacity, which is determined by three forces: the total volume of red blood cells, the amount of hemoglobin transporting oxygen in those blood cells, and the volume of capillaries that perfuse the muscle fibers. The larger the network of capillaries surrounding the muscle fibers, the shorter the diffusion distance for oxygen from the capillaries to **the mitochondria,** the important microscopic factories responsible for aerobic metabolism.

MUSCULAR FACTORS

Once muscles receive oxygen, they must use it to regenerate adenosine triphosphate, or ATP, for muscle contraction. The amount of oxygen your muscles use depends primarily on how many mitochondria they have.

Together, cardiac output and the amount of oxygen your muscles use determine the volume of oxygen your muscles consume (VO_2). As you quicken your running pace from easy jogging to running as fast as you can, VO_2 increases to keep up with the demand of the run until you reach VO_2max, the peak volume of oxygen you can consume per minute. Although a marathon pace should not push you to VO_2max, building up to a higher VO_2max allows you to run faster at a fraction of your VO_2max.

VO_2 represents the specific volume of oxygen you consume every minute to maintain a submaximal pace (VO_2 rises as your pace quickens). The less oxygen you consume to maintain a given pace, the more economical you are. **Running economy** is likely the most important

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indicator of marathon performance. For example, if two clients have the same VO_2max, but Jason uses 70% of VO_2max and Jack 80% when they both run at a 9-minute-per-mile pace, the pace feels easier for Jason because his body is more economical. Therefore, Jason can run at a faster pace before feeling the same amount of fatigue as Jack. With the same VO_2max and superior running economy, Jason would whoop Jack's butt in the marathon.

METABOLIC FACTORS

Faster running speeds require a greater reliance on anaerobic metabolism to produce energy because aerobic metabolism can't keep up with the demand. When this happens, hydrogen ions accumulate in the muscles and blood, decreasing the pH and causing metabolic acidosis and fatigue. The speed at which acidosis occurs is called the **acidosis (lactate) threshold** and is an important determinant of marathon performance because it represents the fastest speed you can sustain aerobically without a significant anaerobic contribution (and thus the development of metabolic acidosis).

The ability to metabolize fat also influences marathon performance, since the muscles' preferred fuel—carbohydrate—is limited. When you run for long enough, you severely lower your muscle glycogen levels, which threatens the muscles and causes a greater synthesis and storage of glycogen than was previously present, thereby increasing your endurance. The more glycogen there is in your muscles, the greater your ability to hold your pace to the finish line.

When muscles run out of carbohydrate, they're forced to rely on fat and so become more effective at using fat for energy. A marathon will use up the carbohydrate in your muscles long before you go 26.2 miles; this forces muscles to "learn" how to use fat more effectively and helps you maintain your marathon pace. >>

When muscle glycogen and blood glucose get low, the liver senses your low fuel tank and converts amino acids and lactate into glucose so you have more quick fuel to sustain your marathon pace.

The marathon thus requires the largest glycogen storage capacity possible, a very effective use of fat and a very efficient capacity to make new glucose. How do you get all that? Let's find out.

Marathon Training

MILEAGE

Despite the focus of most marathon training groups, training for a marathon isn't just about one long run each week—it's about the total amount of running you do. To finish a marathon, your clients need to become as aerobically developed as possible.

Running lots of miles

- improves blood vessels' oxygen-carrying capability by increasing the number of red blood cells and hemoglobin,
- stimulates the storage of more glycogen in the muscles,
- increases the use of intramuscular fat to spare glycogen,
- creates a greater capillary network for a more rapid diffusion of oxygen into the muscles, and
- increases mitochondrial density and aerobic enzyme activity, thereby increasing aerobic metabolic capacity.

Many novice runners don't run enough miles during the week to support a long run on the weekend. You don't want to run 4 or 5 miles on 2 or 3 weekdays and then shock your legs with a 15-miler on Sunday. Your clients may be able to get away with that once or twice, but if they do that week after week after week, they're setting themselves up to get injured.

LONG RUNS

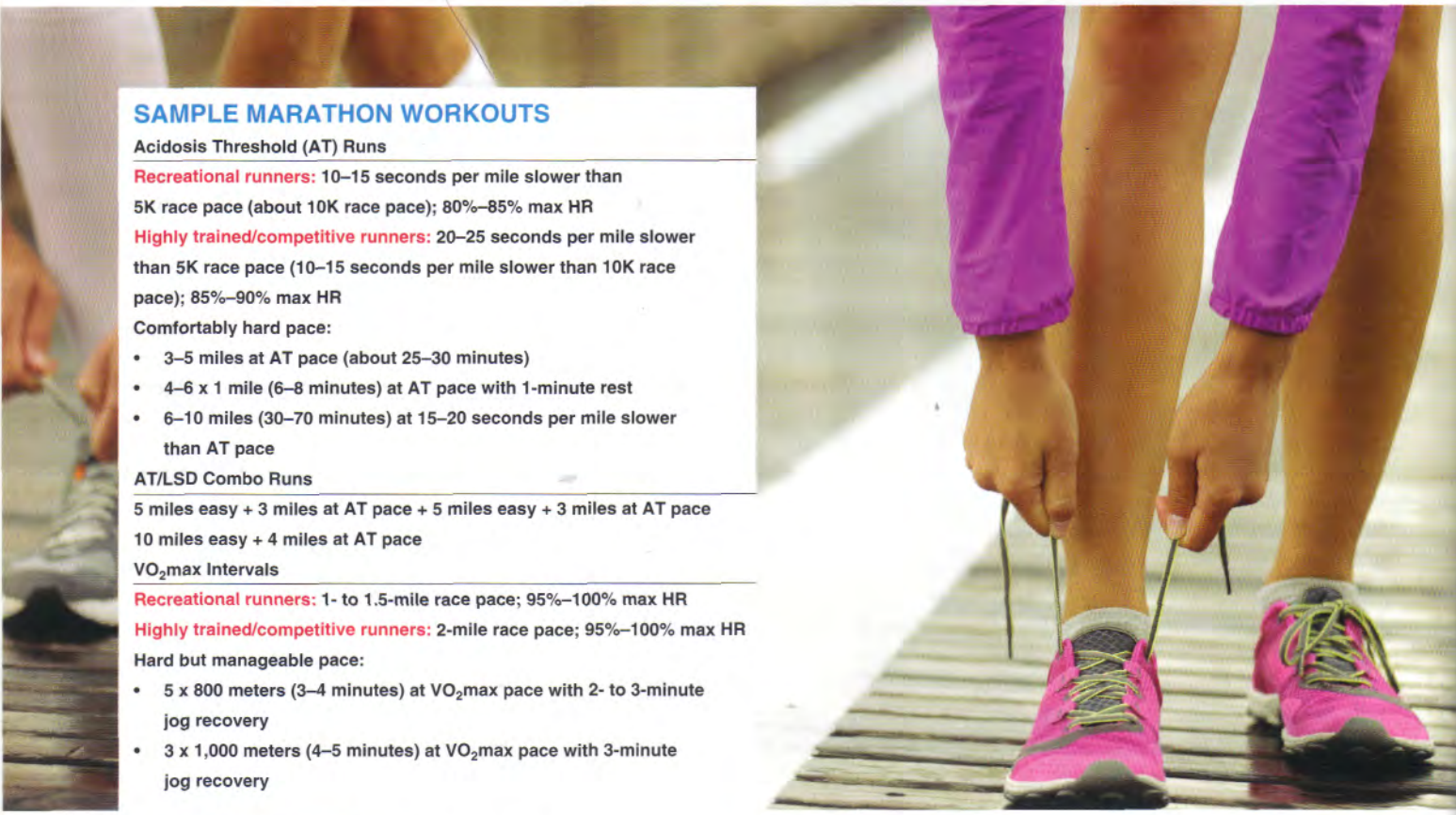
To avoid injury, the long run shouldn't be more than about a third of the total weekly mileage. So, a client planning a 20-mile long run should be running at least 60 miles per week. Most runners don't run that much, so you need to be creative to ensure people don't accumulate too much stress in one run. While the long run should be stressful enough to induce adaptations, it shouldn't be far more stressful than any other run during the week. To circumvent the problem of making the long run a large percentage of the weekly total, have your clients do a midweek, medium-long run that is about 65%–75% of the length of their long run.

Systematically lengthen the long run a mile at a time (even running the same distance a few times to habituate to it) for 3 or 4 weeks before backing off for a recovery week. Keep adding miles until clients reach 20–22 (or 3½ hours, whichever comes first), and have them do their longest run 2–3 weeks before the marathon. The amount of time they spend on their feet is more important than the number of miles they run.

You need a different strategy for clients who have run a marathon before and are training to improve their finish times: Alternate the long runs with a medium-long run (12–16 miles) that combines long-slow-distance (LSD) running with segments at acidosis threshold (AT) pace (Karp 2012). These LSD/AT combo runs simulate the physiological and psychological fatigue of the marathon. Like regular long runs, they severely lower muscle glycogen, stimulating its synthesis and storage.

ACIDOSIS (LACTATE) THRESHOLD RUNS

Running at AT pace increases a runner's AT speed, making what was an anaerobic



SAMPLE MARATHON WORKOUTS

Acidosis Threshold (AT) Runs

Recreational runners: 10–15 seconds per mile slower than 5K race pace (about 10K race pace); 80%–85% max HR

Highly trained/competitive runners: 20–25 seconds per mile slower than 5K race pace (10–15 seconds per mile slower than 10K race pace); 85%–90% max HR

Comfortably hard pace:

- **3–5 miles at AT pace (about 25–30 minutes)**
- **4–6 x 1 mile (6–8 minutes) at AT pace with 1-minute rest**
- **6–10 miles (30–70 minutes) at 15–20 seconds per mile slower than AT pace**

AT/LSD Combo Runs

5 miles easy + 3 miles at AT pace + 5 miles easy + 3 miles at AT pace

10 miles easy + 4 miles at AT pace

VO_2max Intervals

Recreational runners: 1- to 1.5-mile race pace; 95%–100% max HR

Highly trained/competitive runners: 2-mile race pace; 95%–100% max HR

Hard but manageable pace:

- **5 x 800 meters (3–4 minutes) at VO_2max pace with 2- to 3-minute jog recovery**
- **3 x 1,000 meters (4–5 minutes) at VO_2max pace with 3-minute jog recovery**

pace before now high aerobic. One of the goals of marathon training is to increase AT pace and the ability to sustain as high a fraction of AT pace as possible.

VO_2MAX INTERVALS

Once the training secret of the world's best runners, interval training has become the new buzz term in the fitness industry. Interval training near the speed that triggers VO_2max is a potent stimulus for improving VO_2max (Billat 2001; Midgley, McNaughton & Jones 2007). The cardiovascular adaptations associated with VO_2max intervals—including an enlargement of the left ventricle and a greater maximum stroke volume and cardiac output—increase VO_2max, providing greater horsepower for the body's aerobic engine.

TAPERING

After your clients have spent months increasing their mileage, going on long runs and doing lots of AT workouts and VO_2max intervals, they're finally ready to taper their training. Tapering causes biological changes that reflect a reduction in training stress and a greater emphasis on recovery (Mujika et al. 2004), so that runners are fresh and ready to go on race day. The more your clients run before tapering, the more they'll benefit from it. You can't taper down something that hasn't been built up.

The trick to maintaining fitness during the taper is to maintain intensity with AT runs and VO_2max intervals while reducing the running volume. If your clients taper for 2 weeks (best for beginner runners), reduce their peak weekly mileage by 30% the first week and 60% the second week. For a 3-week taper (best for intermediate and advanced runners who have been running more than 50 miles per week), reduce their peak weekly mileage by 30% the first week, 50% the second week and 65% the third week (Karp 2012).

If your clients follow a smart enough training program, they will not only cross the marathon finish line basking in the glow of their accomplishments; they may even be able to chase Pheidippides. ■

Take the Quiz
www.ideafit.com/november-2013-quizzes
or mail the quiz on page 87.

Jason Karp, PhD, is a nationally recognized running coach, was the 2011 IDEA Personal Trainer of the Year and owns Run-Fit. He holds a doctorate in exercise physiology. He has authored five books, including Running a Marathon for Dummies; *is a frequent speaker at fitness and coaching conferences; and competed at the 2013 World Maccabiah Games in Israel.*

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