



BLOOD LACTATE TRAINING GUIDE

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1. What is blood lactate, and why does it matter

During exercise, muscles break down carbohydrates for energy through a process called glycolysis, which produces lactate as a byproduct. Despite a common misconception, lactate is actually a usable fuel, with the heart, liver, and slow-twitch muscle fibers all consuming it directly. The problem arises at higher intensities, when lactate is produced faster than the body can clear it. As it accumulates, it brings with it a rise in hydrogen ions that lowers muscle pH, which is what produces the burning sensation athletes feel when they're pushing hard.

Blood Lactate testing measures this accumulation in real time by taking a small sample at different intensities, which, over time, can paint a precise picture of important training paces for athletes. Your blood lactate levels directly correlate with muscle usage, as every muscle contraction needs energy to occur and will produce lactate past a certain threshold.

Elite programs at the NCAA and Professional levels use lactate testing data as a way to help guide and reinforce training decisions.

2. LT1 vs LT2 vs VO2 Max

LT1, also known as the aerobic threshold, is the intensity at which blood lactate begins to rise above its resting baseline. Most athletes severely underestimate how slow their LT1 is, for example, it's not uncommon to see 13:5x 5k runners run 5:15 pace for their LT1 workouts. This can be even more extreme in 800-meter specific athletes, where some elite (sub 1:48) athletes will go as slow as 5:50 pace.

Most athletes' LT1 is somewhere between 1.5 mmol and 2.0 mmol of blood lactate. This can of course vary beyond these ranges depending on the individual. Ideally, to get the maximum benefit, the athlete should be training just below their LT1, achieving the "sweet spot" between aerobic development and metabolic stress.

LT2, also known as the anaerobic threshold, is the point where lactate begins to accumulate rapidly and can no longer be cleared at the same rate that it is produced. This typically falls around 3.5mmol and 4.0mmol. As with LT1, this can vary beyond these ranges depending on the individual. This is often the pace that most coaches and athletes call "threshold", the effort an athlete can hold for roughly 60 minutes in a race scenario.

VO2 Max is a term that most runners are familiar with, but for a quick recap, VO2 max is the maximum amount of oxygen your body can take in and use during all-out exercise. The higher it is, the higher your aerobic ceiling, meaning more potential to run faster before your body hits its limit. On the blood lactate scale, the VO2 Max system is "activated" by anything higher than 8.0 mmol; however, most VO2 Max intervals ideally should be run in 8.0–10.0 mmol range. As always, variance and nuance applies.





3. How to conduct an initial blood lactate test

What you will need:

- A lactate analyzer and test strips (we recommended the LACTATE PLUS)
- Blood lancets
- Alcohol wipes and cotton swabs
- A track with good weather
- A lab assistant (coach/teammate/parent)
- A reliable heart rate monitor (something better than just your watch)

Once you have gathered the needed supplies, go through your normal warmup procedure, then start the following workout: run an 800 at what you would consider an easy pace (in this example, we'll call that 3:40 per 800, or 7:20 per mile). Have your lab assistant set up by the finish line and perform the following steps:

1. Put on gloves
2. Wipe the fingertip with an alcohol wipe and let it dry completely (moisture ruins the reading).
3. Use the lancet to prick the side of the fingertip, not the pad
4. Wipe away the very first drop of blood — it is contaminated with skin fluid
5. Gently squeeze the finger to produce a fresh drop and apply it to the test strip
6. Record the lactate value, heart rate, and pace immediately.

Ideally, this test is done in about 30 seconds, providing only a short rest before the next rep begins.

Once the test has been completed, the athlete should start their next rep, running 10 seconds faster than the previous rep (so in this example, the athlete would run 3:30 for the next rep)

Repeat this process until the athlete fails to hit the time. If you believe that the athlete can not complete a full 800 for the final rep, but could hit the pace for 400/500/600 meters, that is ok for the final rep.

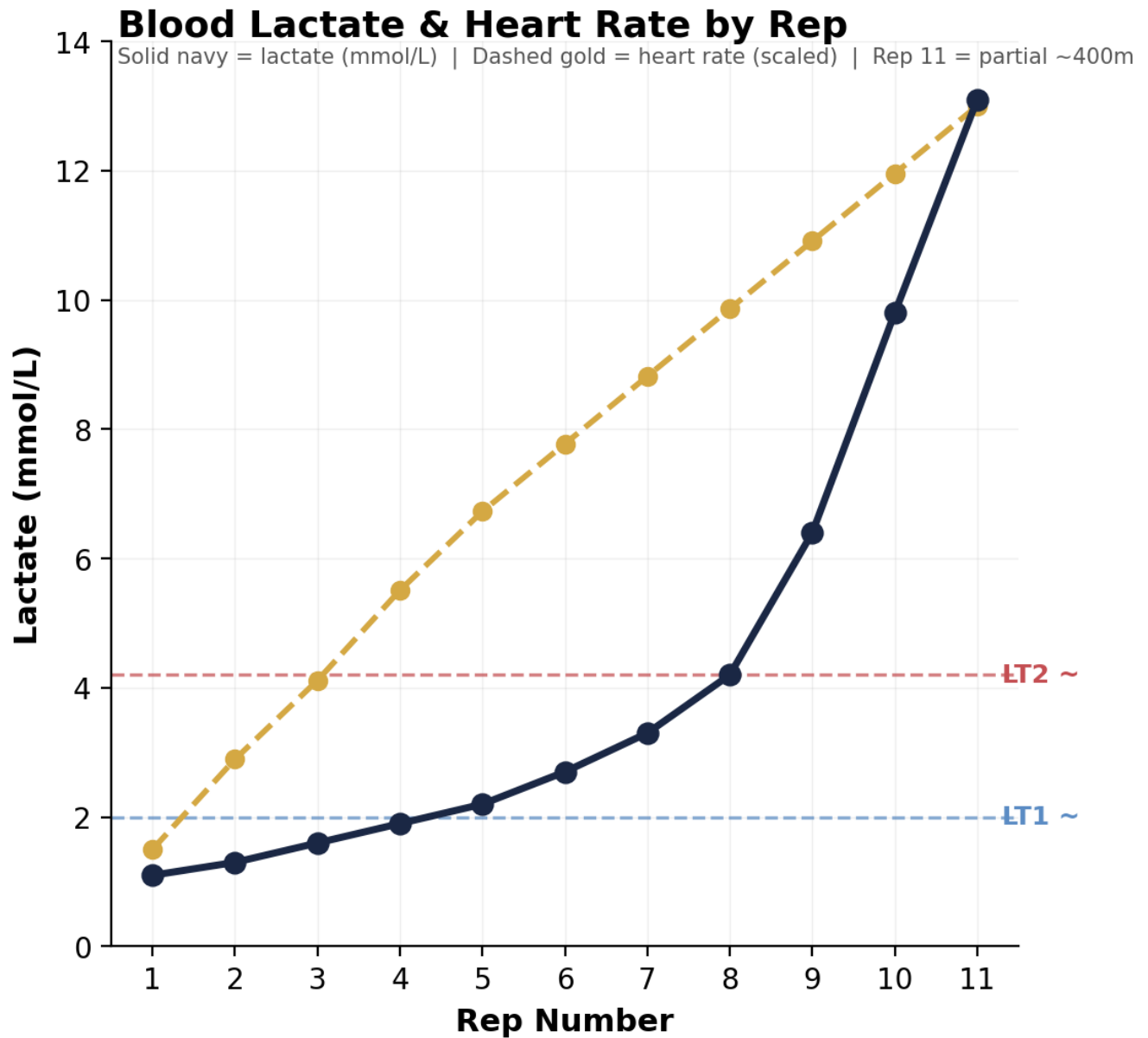
Once you have completed the final rep, wait 2 minutes and then record Lactate and Heart rate one final time

Once you have completed the test, plot the data so it looks something like this:



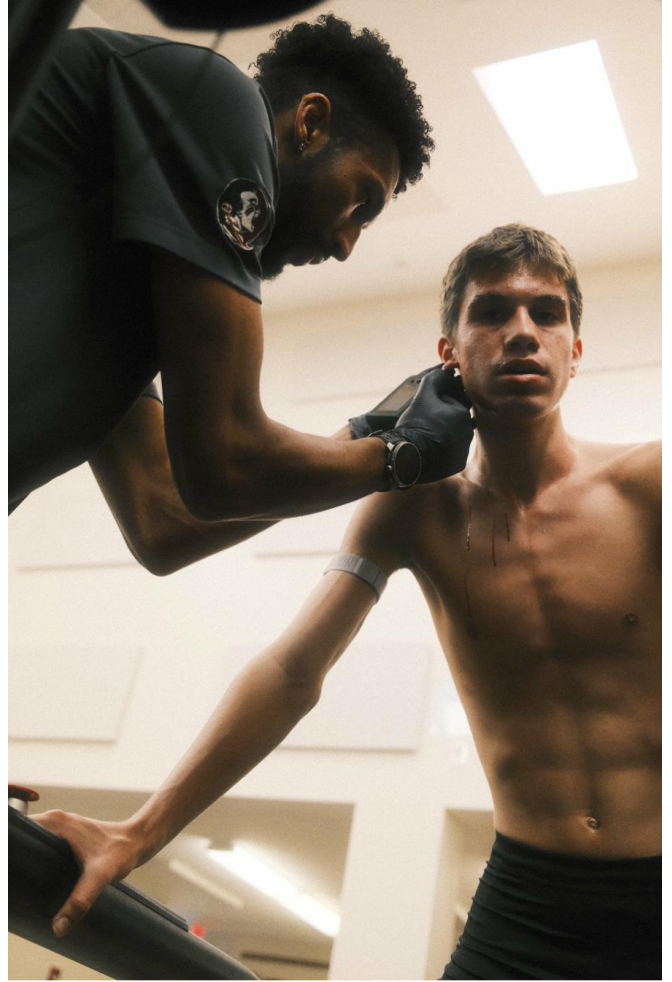
Rep	800m Time	HR (bpm)	Lactate (mmol/L)
1	3:40	128	1.1
2	3:30	136	1.3
3	3:20	143	1.6
4	3:10	151	1.9
5	3:00	158	2.2
6	2:50	164	2.7
7	2:40	170	3.3
8	2:30	176	4.2
9	2:20	182	6.4
10	2:10	188	9.8
11	1:02 (400 rep)	194	13.1
Post 2'	—	178	15.8





Using this data, you can find your LT1, LT2, and VO2 Max paces. It's important to look at this data and try to find your own LT1, LT2 and VO2 Max, as each athlete can vary. Additionally, you can now use heart rate as a training indicator rather than testing for blood lactate, as lactate testing strips can get quite expensive after a while, and testing can get complicated if you don't have a lab assistant for each workout. However be aware that heart rate can be highly variable depending on weather, caffeine, location, and many other session factors.





4. How to interpret Lactate and Heart Rate test results

Once your test data is plotted with pace on the X axis and lactate on the Y axis, you are looking for two specific points where the curve changes direction.

LT1 is the first noticeable inflection, the point where the line begins to rise above its flat baseline. In most athletes, this looks like a gentle upward bend, often somewhere between 1.5 and 2.2 mmol/L. The pace just before that bend, where the curve was still relatively flat, is your LT1 pace. The heart rate recorded at that stage is your LT1 heart rate.

LT2 is the second and more dramatic inflection, where the curve stops rising gradually and begins climbing sharply upward. This is typically between 3.5 and 4.0 mmol/L. The pace at that point is your LT2 pace, and again, the corresponding HR is your LT2 heart rate. Everything above LT2 is VO2 max territory, and the steep climb of the curve in that range reflects how quickly the system is being overwhelmed.

If the curve looks smooth without obvious bends, look for the stage where lactate increased by more than 0.5 mmol/L in a single step, that jump usually signals LT2. LT1 is subtler, so when in doubt, identify the last stage where lactate was clearly still below 2.0 mmol/L and relatively stable.

Once you have completed your initial lactate test, you have the heart rate values that correspond to each threshold. Because HR and blood lactate rise together in a predictable pattern, the readings recorded during your test serve as a reliable daily proxy for lactate, no invasive retesting required. Using equivalent heart rates will give you roughly a 90% accurate picture of your training intensity on any given day.

Simply find the HR recorded at each threshold during your test. If LT1 occurred at a HR of 151 bpm, that becomes your ceiling for easy runs. If LT2 occurred at 176 bpm, that becomes your target for threshold sessions. Your watch becomes the testing device for every workout going forward.

5. Potential factors that affect Blood Lactate readings

As much as we like to think we live a perfect life set up for perfect running conditions each day, we all know that's not the case. Things such as sleep quality, nutrition, life stress (academics can take a serious toll in particular), footwear and most importantly, your attitude!

As far as technical errors that can give faulty lactate readings, the biggest culprit for faulty readings is sweat. If you don't properly wipe the sweat off the athlete's finger, it can easily generate high readings. For this same reason, it's important to avoid making direct contact with the skin whenever possible.

Onto weather concerns, it's important to note that testing should never occur when it's actively raining or snowing outside, as the moisture could effect the readings. Similarly, testing should never be conducted when the temperature drops below 40 degrees, as the cold will often produce lower blood readings.



6. No wasted workouts and the consequences of going too hard

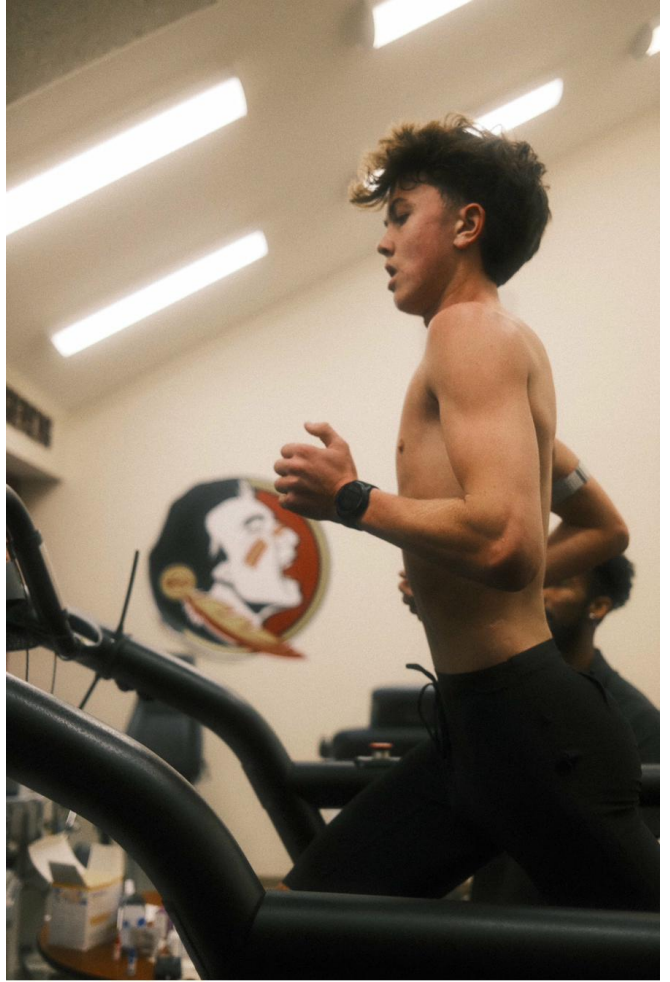
So by now you're probably wondering what the biggest benefit of blood lactate training is. It's that there's no wasted workouts. Meaning that if you use lactate testing (or the corresponding heart rate data) properly, you and your coach can guarantee you're getting the desired stimulus for that point in your season or training block.

When an athlete runs at LT2 pace on days that should be easy, the body never gets the true recovery it needs to absorb the hard work. Easy runs done correctly below LT1 are where aerobic base is actually built — new mitochondria develop, muscles repair, and the body rebuilds stronger. Push those easy days too hard and you short-circuit that process. The same problem occurs when VO2 max sessions are used too frequently; those workouts cause substantial muscle breakdown and suppress immune function for up to 72 hours. If they're stacked too close together, the athlete spends more time repairing damage than adapting to the training stimulus.

Layer that pattern of over-working across weeks and months and the cost quietly accumulates. Resting heart rate creeps upward, athletes feel flat on days they should feel good, and performances plateau or regress despite consistent hard training. Physiologically, stress hormones remain chronically elevated while the hormones responsible for muscle repair and tissue rebuilding are suppressed. The athlete is stuck in a near-constant state of breakdown with insufficient recovery to balance it out. Lactate data will often confirm this drift: an easy pace that once produced 1.5 mmol/L now generates 2.2 mmol/L, showing that the aerobic system is working harder just to maintain what used to be effortless.

The solution is never more training. It's protecting easy days and spacing hard sessions far enough apart for adaptation to actually occur. This is where blood lactate training becomes invaluable. The biggest benefit is that there are no wasted workouts. By using lactate testing, or the corresponding heart-rate markers derived from it, athletes and coaches can guarantee that each session delivers the exact stimulus intended for that phase of the season. Easy days stay truly easy, hard days stay purposeful, and the risk of overtraining drops dramatically because intensity drift is caught early. Before it shows up in fatigue, stalled performances, or injury.





7. The Metabolic Load

Every workout carries a cost. That cost is what coaches and physiologists call metabolic load, and simply put, it's a measure of how much stress your body is carrying at any given point in your season. It's not just about how hard today's workout was. It's about how much your body has been asked to do over the past few days, and whether it's had enough time to recover from it.

The easiest way to think about it is like a phone battery. Training drains the battery, and recovery charges it back up. The harder the workout, the more battery it uses. The problem isn't one hard workout — it's when you keep draining the battery faster than you're charging it, day after day, until you're running on five percent and wondering why your legs feel like concrete.

What makes this especially important in lactate-based training is that different workouts drain the battery by very different amounts.

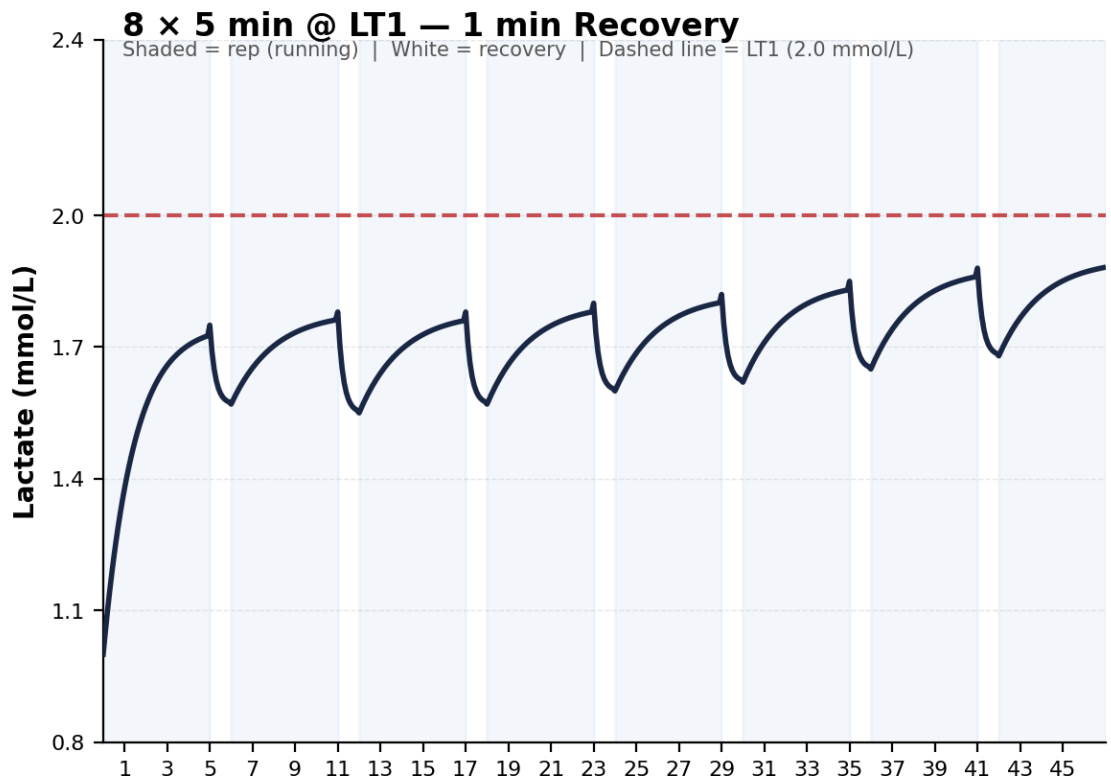
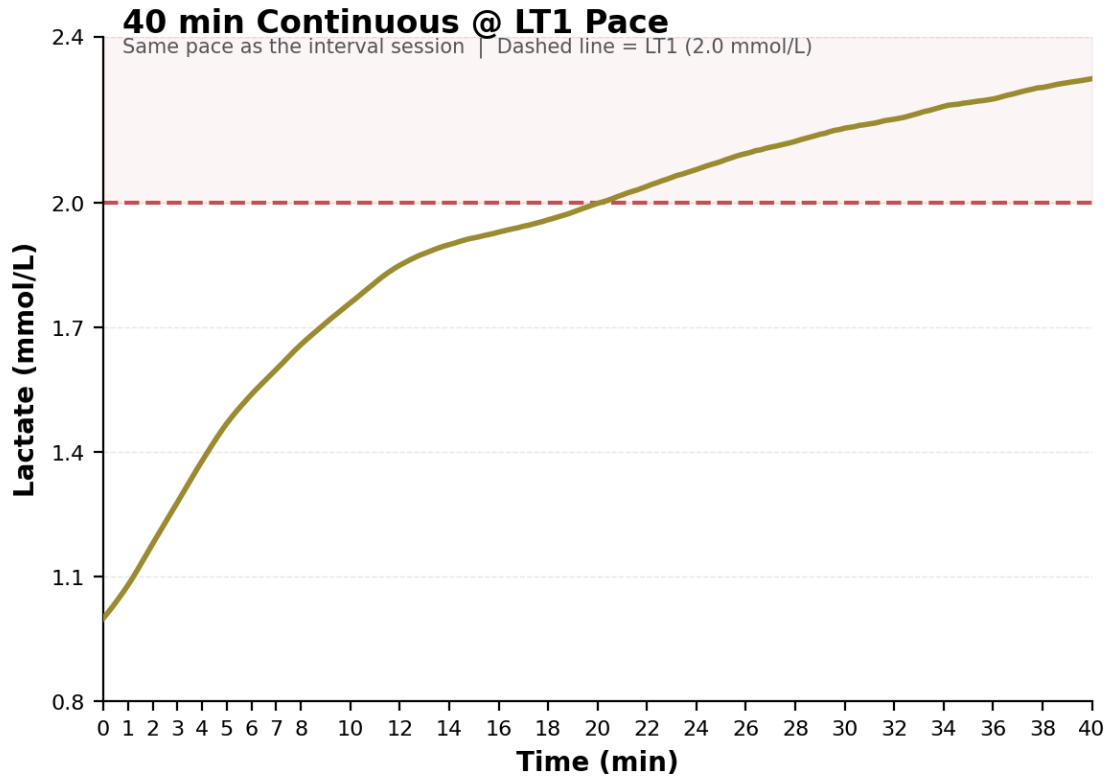
For most runners an LT1 session is a small drain, you get a real fitness benefit without asking a lot of your body, which is why you can do them often. An LT2 session costs more, and your body typically needs a full day or two before it's ready to go hard again. A VO2 max session is the most expensive workout you can do, it causes real muscle damage, cranks up inflammation, and can leave your immune system suppressed for up to three days. Do too many of those without enough recovery in between, and you're not getting fitter. You're just getting more tired.

Understanding metabolic load is what separates smart training from just hard training, and it's exactly why lactate data is so valuable. With it, you can see what your body is actually doing, not just what you think it's doing.

8. Split Reps vs single reps and overtraining

One common question when it comes to how to set up LT1 workouts is whether to do them straight through (40 mins @ LT1) or broken up (8 x 5 mins @ LT1 with 1 min recovery). In this case, it is almost always better to use "broken" reps, as it allows plan breaks for the blood lactate to dissipate, and keep the workouts in the intended zones. If breaks aren't included, then the workout will slowly shift out of the intended zone and cause more metabolic strain than intended (see the graphs below).





When an athlete trains at LT2 intensity on days meant for recovery, the body never gets the downtime it needs to actually absorb the hard work. Easy running below LT1 is where aerobic fitness is built, mitochondria develop, muscles repair, and the body reaps the gains from the previous session.

Push those days too hard, and you're not recovering, you're just adding fatigue without a good reason for it. VO2 max sessions make things worse when overdone; they can cause real muscle damage, spike inflammation, and suppress the immune system for up to 3 days. Stack all of this across a full season without enough genuine rest and cortisol stays chronically elevated while the hormones responsible for rebuilding muscle get steadily suppressed, or in common terms, it means that you peak too early, dig yourself into a hole and don't hit the PRs you're capable of.

9. Event-Specific Context

We all know that the 800 and 10k are wildly different events, one is a pseudo-sprint that lasts roughly two minutes, and the other is a test of aerobic endurance lasting anywhere from 27 minutes to well over 30. The athletes who run them are built differently, train differently and race with entirely different physiological demands. Yet both events are primarily aerobic. The 10K is 97–98% aerobic and the 800m is roughly 55-60%, which means both can benefit significantly from LT1 training and a well-developed aerobic base.

The difference lies in how that training is applied. Distance runners can handle longer, more continuous LT1 efforts, extended tempo reps, higher weekly mileage, and longer sessions that build the aerobic base their events demand. Their muscle fiber composition and recovery profile support higher volumes of this type of work, and they respond to it well. Middle-distance runners, by contrast, carry a higher proportion of fast-twitch muscle fiber, which fatigues more quickly at sustained aerobic efforts and takes longer to recover from volume-heavy training. For these athletes, shorter broken reps at LT1, rather than long continuous runs, allow them to accumulate the same aerobic development without the same neuromuscular and metabolic cost.

Despite these structural differences, both groups benefit enormously from lactate testing. For the 10K runner, it confirms that easy days are genuinely easy and that threshold work is landing at the right stimulus. For the 800m runner, it ensures that the aerobic engine, which can often be neglected in favor of speed work, is being developed safely and systematically. The event changes the application; the underlying physiology does not.





10. Periodization

One of the most common mistakes I've observed throughout my time in the sport is that athletes gradually stop refilling what I like to call the "aerobic well" as the season progresses toward championship meets. The aerobic system is built through consistent LT1 work, but it doesn't simply stay where you left it. Without ongoing maintenance, it quietly compresses, losing the depth and capacity you spent months building. This is a pattern I see repeatedly across all levels of the sport, from coaches and athletes alike.

Most traditional training plans follow a familiar arc: easy running at the start of the year, a progression into LT1 and LT2 work, a shift toward VO2-focused sessions, and finally a sharpening phase as championship season arrives. There's logic to that structure, and it isn't wrong on its face, but in practice, it often means that LT1 work is quietly phased out right when it still matters most. By the time the championship meets arrive, the aerobic foundation has been slowly compressed, and athletes find themselves peaking in February when they needed to peak in May.

The four factors most responsible for compressing the aerobic system are:

1. Time off. While time off is a necessary part of training, it will affect your aerobic system.
2. Speed work, fast, high-intensity training shifts the body's demands away from the aerobic system if not balanced carefully.
3. Insufficient recovery. Without proper rest, the body can't consolidate aerobic gains between sessions.
4. Racing. Frequent competition carries a high physiological cost that, without compensating LT1 work, slowly erodes the aerobic base.

The fix is simpler than most coaches make it out to be. Treat recovery with the same intensity and discipline you bring to your running, and never fully remove LT1 work from your training, no matter how deep into the season you are. For newer runners, aim for at least one dedicated LT1 session every ten days. For more advanced runners, once a week is the gold standard. It doesn't need to be long, and it doesn't need to be complicated. It just needs to happen consistently.

11. Sample workouts

The possibilities for workouts are endless. You can manipulate the four main factors that compose workouts (extension, volume, pace, and recovery) in a million different ways, but here are a few of the favorites that I've collected during my time in the sport.

- 2 x (12 x 400) @ LT1 with 30 seconds rest after each rep, 2 minutes after each set. Useful for getting the legs used to faster paces while still providing a safe metabolic stress and useful aerobic stimulus.



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- 3-4 x 5k @ LT1 with 3 minutes standing rest. Great for getting a prolonged, continuous effort and building the mental focus that comes with longer workouts without providing a ton of unneeded fatigue.
 - 2 x (10 x 300) @ light VO2 (shooting for 6.0-6.5mmol) with 60/2:30 seconds rest. Great session for athletes, slowly dipping their toes into VO2 work for the first time during a season.
 - 3 x (10 x 200) @ LT1 with 30 seconds between reps and 90 seconds between sets. Really useful for 800-meter athletes who may struggle to complete longer sustained reps while keeping their blood lactate down.
 - 4 x 5 mins @ LT1, 1 min jog recovery. A perfect session to do when you don't have access to a track, or to stack as part of a double-threshold day.
 - 5-6 x 3 mins @ LT1, 1 min jog recovery. The mid-distance version of the previous workout.
 - 10 x 600 @ VO2, 2 minutes rest. Classic VO2 workout with slightly more rest than needed to ensure you don't "cook yourself."
 - 8 x 800 @ VO2, 2:30 rest. Another Classic VO2 workout. Probably the longest VO2 rep I'd have anyone do if they are using the double threshold system.
 - 4-6 x mile @ light VO2 (shoot for 6 mmol), 4 minutes rest. The longest VO2 workout I'd ever have an athlete do. Anything longer than this, I'd consider "not worth the risk" for all but elite marathoners.
 - 6 x 800 @ LT1, 1 minute standing recovery, 4x200 @ mile, 2 minutes recovery. A great session to touch the important systems the week of a race, while keeping your body fresh.

While these are just some of my favorites, one must remember that the workout possibilities are endless and that there is no one "special workout or zone," and that a good coach will step back and look at a workout as just one piece of an extremely complicated system designed to produce elite athletes.

