How Fast Should You Run Your Long Run?

Let's face it. Few of us have the luxury of having several hours a day to train and recover, so you really need to make the most of every minute of your training. And this means training smart. It means running easy when you're meant to be running easy, and hard when you're meant to be running hard.

Most recreational runners do too much training at a moderate level. They don't do enough at a low intensity, which leaves them too tired to do enough running at a high intensity. Somehow, it all just seems to fall in the mid intensity range. Whilst you *will* get fitter and faster doing all your training at a moderate level, especially if you are relatively new to training, you won't be getting as fit and as fast as you *could* be.

> Funnily enough, it's often harder to get the low intensity training in, than it is to complete a high intensity training session.

Many runners *THINK* they are running at a low intensity, when in fact they are running at a moderate intensity. As I write this today, I've just returned from a session with some of my runners in which we were addressing this issue. I had ten runners there with me, and every single one of them ran way too fast when I asked them to run easy. I even gave them the approximate pace I wanted them to hit for a kilometre. Some of them missed the mark by more than a minute, in spite of them tracking their pace along the way with their various GPS devices!!

Running easy takes a bit of getting used to!

Your long run is the ideal time to get some running into your legs at a reasonably light intensity. If you've been running for a few years, have a good training history, and don't have a history of injuries and niggles, you can do a few fast finishing long runs as you approach your goal race, to make your training more race specific. I won't be addressing fast finishing long runs in this paper, but be aware that these types of runs are a hard workout, and you need to build an extra few recovery days into your program after this type of workout.

Who should do a long run?

The short answer to that is anyone who has a goal race that will take them longer than about 30 seconds. Long runs train the aerobic energy system, and the aerobic energy system is the predominant energy system for all but the very shortest of races. Research on runners from 400m to 3000m has shown that for each of these distances, the aerobic energy system is the predominant energy system by the 30 second mark. [i] As race distances get longer, the proportion of energy contributed by the aerobic system is greater. For a 3000m race, over 90% of the energy required is generated by the aerobic energy system. [ii]

So, if you want to get good at running anything over about 200m, you'll want to get good at training your aerobic energy system.

How your body turns the stuff you eat into the stuff you do.

(Energy systems in brief)

You have three energy systems which your body uses. At any one time you'll be using a combination of these systems.

The ATP-CP System: we use this for very brief, powerful activities, like springing out of the starting blocks in a 100m sprint, or a single, powerful vertical jump.

The Glycolytic System: After about 10 seconds, when your ATP-CP system starts to pack it in, the glycolytic system starts to take over. For races up to about 90 seconds duration, this is the system that contributes the most to the TOTAL amount of energy required, though only marginally. After about 30 seconds of maximal effort, the oxidative or aerobic system will begin to take over.

The Oxidative, or Aerobic System: This is the most complex of the three systems. It's the only system that directly requires oxygen to make energy (hence the term aerobic). The aerobic system is the slow burning fire that's always chugging away in the background. It's the system that produces the energy required for you just to "be". To sleep, to read this paper. It's the predominant energy system for all but the most intense physical activity.

It's important to remember that throughout a distance race, all three energy systems play a part. The more intense parts of a race will see you increasingly draw on the anaerobic energy systems for those short bursts of more intense energy – think running up hills, surging to overtake that little kid who keeps darting in front of you, or kicking past that old guy who looks like he's about 170 in the shade and couldn't possibly be able to run faster than you!

Why it's important to know about energy systems

Once you know about energy systems – what they do and how they do it-you can tailor you training sessions to train specific energy systems. The focus of this paper is the long run, so we're focusing on training the aerobic energy system. Even though the aerobic system is the most important system for distance running in terms of energy production, keep in mind that to get the most out of your training, it's important to train the other two energy systems as well.

What happens on the inside during aerobic training?

Here's a brief summary of what's happening to your body when you're undertaking a *well planned* aerobic training program.

1. Capillary development
2. Increase in number and size of mitochondria
3. Increased myoglobin in muscle fibres
4. Increase in number and size of muscle fibre-reducing risk of injury
5. Glycogen sparing/increased use of stored fat for energy
6. Increasing glycogen stores in the muscles
7. Strengthening of muscles, ligaments and tendons
8. Increase in local muscular endurance → running muscles can keep working for longer and buffer lactic acid
9. Increase in stroke volume – the amount of blood your heart pumps out into your body each contraction of the heart (important as you want to get as much blood to the working muscles as possible)
10. Bone strengthening.

Capillary development

Capillaries are small blood vessels. It's the capillaries which are the final part of the infrastructure that delivers nutrients and oxygen to muscle tissue. The more capillaries you have surrounding each muscle fibre, the more efficiently you can deliver oxygen and nutrients to the muscles, so that you'll have more fuel to keep you running. The best pace to train at for maximising capillary development is between 25% and 40% slower than your 5km race pace.

Increase in number and size of mitochondria

Mitochondria are miniature organelles that are found in muscle cells. In the presence of oxygen they break down fat, protein and carbohydrates into usable energy. Build more mitochondria, and build denser, bigger mitochondria, and you've got yourself more usable energy for aerobic exercise. The best long run pace for enhancing the development of mitochondria is between 50% and 25% slower than your vo2 max pace. (or between 42% and 18% slower than 5km pace) If you're running for longer than 2 hours, your pace should be closer to the 42% slower mark. For a 90 minute run, it can be as fast as 18% slower than your 5km race pace. [iii]

Increase myoglobin content of muscle fibres

The protein myoglobin binds to oxygen. When your body demands more oxygen during exercise, myoglobin releases oxygen to mitochondria (which in turn use the oxygen with fats, proteins and carbs to generate energy). The more myoglobin you have in your muscle fibres, the more access you have to oxygen when you need it – like during a race. All muscle fibres contain myoglobin, but the ones we're looking at boosting during the long run are your slow twitch muscle fibres. By targeting slow twitch muscle fibres in your training, you can help to boost their myoglobin content. Running at 17% to 30% slower than your 5km pace (or 63-77% of vo2 max) will provide the best stimulus for slow twitch muscle fibres.

Glycogen sparing

At levels of low intensity exercise, the body uses fat as the main fuel source. So whilst you're resting, sleeping, walking around doing not much of anything, your body is mostly burning fat for energy. As your exercise intensity increases, the proportion of energy generated from the breakdown of fat decreases, and the proportion of energy generated by the breakdown of glycogen increases.

The problem with glycogen as a fuel source is that it has a tendency to run out, which can be extremely uncomfortable. When your body runs out of glycogen and is relying solely on fat to produce energy, you're going to slow down.

The problem with fat as an energy source is that it takes longer to liberate the energy in our stored fat to be used by the body.

The good thing about fat however, is that we have a lot of it. We have more than enough stored in our body to be able to keep us going for quite a while. If you weigh 60kgs, and your body fat is 15% (which is reasonably low), you're carrying around 9 kg of fat with you. Each gram of fat contains about 9 calories, so in theory, you have 81,000 calories of energy you can call on if needed. In practice, you're not going to be able to use all of these calories. If you got down to about 5% body fat you'd have some pretty serious problems, but even if you only used one third of the energy available, you'd still have around 27,000 calories to run on. Enough for at least 40 hours of moderately paced running.

An average, well nourished adult will store somewhere between 1400 and 1800 calories as muscle glycogen. To run a half marathon will take around about 1400 -1500 calories, and a marathon around about 2800-3000, calculated on a body weight of 65kg.[1]

If you're lucky, you'll have enough calories stored as glycogen to make the distance in a half marathon, but definitely not enough for a marathon.

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[1] It doesn't make much difference how fast you are running – the faster you run, the more calories you burn per hour, but the fewer hours you are running for – so a 2:10 marathoner will burn more calories per hour, but won't be out on the road for as long as a 4:10 marathoner, who burns less fuel per hour.

And, to make things really tricky, the brain will actually slow down the body before glycogen runs out. The brain will sense your dwindling glycogen stores, and force your body to slow down, by altering your perception of the intensity of your effort. So things will start to feel as if you're running out of glycogen, well before you actually are. It's your brain's way of helping you to avoid running out of glycogen (thanks a million brain!)

It's a good idea then, to turn you muscles into a massive glycogen warehouse, and also to use as little glycogen as possible when running at race pace.

Different levels of running intensity use different proportions of fatty acids and glycogen for fuel. The more slowly you run, the higher the proportion of energy comes from the mobilisation and break down of fats. As you up the intensity and run faster, a great proportion of your energy comes from glycogen. We all have a metabolic "crossover point", or "metabolic efficiency point". This is where the amount of energy coming from fat and carbohydrate intersect.

You'll reach your metabolic efficiency point when you're running somewhere between 42% and 28% slower than your 5km race pace. When you first start with this kind of metabolic efficiency training, the crossover point is more likely to be nearer an intensity of 42% slower than your 5k pace. As your body learns better how to spare glycogen, your crossover point will be reached at a higher intensity-up to about 28% slower than your 5k pace.

> If the point of your long run is to teach your body to spare glycogen, you should be running at between 42% and 28% slower than your 5km race pace.

Increased glycogen storage in the muscles

Closely aligned to glycogen sparing, is teaching your body to store more of the stuff.

The body stores carbohydrates as glycogen, largely in the muscles. The more glycogen you can store in your muscles, the further and harder you can run without running out of glycogen, and hitting the wall, or bonking. With respect to glycogen storage, the goal of an easy long run is to deplete your muscles of stored glycogen. The body doesn't like how this feels, so after your run, when you are recovering, it sets itself to work getting ready to be able to story more glycogen in the muscles, in the expectation that you are going to be silly enough to put your body under that sort of stress again.

One way to help to teach your body to store glycogen is to undertake some fasted running at around 23-28% slower than your 5km pace.

Glycogen storage and glycogen sparing are two competing objectives with the ultimate goal of you having more accessible fuel on the day of your race. It's pretty difficult to achieve both objectives in one run. To teach your body to spare glycogen you need to run 30-40% slower than your 5km race pace, whilst you need to run quite a bit harder than that to deplete your glycogen stores and encourage your body to over compensate when you're refuelling. Your training needs to be planned to include runs designed to improve each of these individually.

Strengthening of muscles, ligaments and tendons

Running at any pace will strengthen your muscles, ligaments and tendons. However, ligaments and tendons will not develop strength as quickly as muscles, so running at an easy pace, will provide your ligaments and tendons with enough stimulus to get stronger. Your muscles will not develop strength as quickly running at a slower pace, as opposed to say running flat out in a hill sprint session, but you'll greatly reduce your risk of injury by running slowly. That's not to say there's no place for hill strength sessions in a running program, but you need to have quite a few miles under your belt before you run full pelt up a hill. Your long runs will also serve to increase endurance strength in your running muscles.

Stroke volume

The ability of the body to make oxygen-rich blood available for working muscles is the biggest factor affecting aerobic performance. The more blood that the heart can put out per beat, the more work an individual will be able to do.

Aerobic training, over a period of time, increases stroke volume, and therefore the amount of oxygen and nutrients which can get to the working muscles, ultimately via blood capillaries. Training causes the size of the ventricles of the heart to increase, and the ventricle walls to become thicker and stronger. More blood can enter the heart because it is larger, and the muscles which pump blood out of the heart are larger and stronger so they are able to pump out more blood with each contraction, or heart beat.

What Does It All Mean?

It means you should be doing most of your long runs at quite a low intensity. It's a pace where you could EASILY hold a conversation in ***full*** sentences. As I said at the start, I find so many people have trouble with this, that it works better to have an approximate pace you should be sticking to. Don't be a slave to keeping to these paces though. You might find you need to walk up hills to keep your breathing easy and still be able to talk in sentences. It can take a lot of discipline, but this type of training can really pay off.

This table summarises what we know about optimal training pace for different aspects of the aerobic energy system.

Best Long Run Pace

Aerobic Adaptation	(% slower than VO2 Max)	(% slower than 5km race pace)	Example pace for 25 min 5km runner
Capillary Development	31.5-47%	25-40%	6:15-7:00 mins/km
Mitochondrial Development	25-50%	18-42%	5:54-7:06 mins/km
Increased Myoglobin	23-37%	17-30%	5:51-6:30 mins/km
Glycogen Sparing	35-50%	28-42%	6:24-7:06 mins/km
Glycogen Storage	30-35%	23-28%	6:10-6:24 mins/km

For maximum aerobic benefit your long run should be about 25% to 40% slower than your 5km race pace.

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Your 3km race pace closely aligns with your VO2 max pace, so if you've posted a recent 3km time, that'll be pretty close to your current VO2 max pace. A recent 5km race pace can also be used to calculate your VO2 max pace. *To get your VO2 max pace, just multiply your 5km pace by 0.95.*

What do we mean by race pace?

We mean just that, race pace. Not have a nice little trot around the course and enjoy the scenery type of pace. Not chat with your friend you've entered the race with. We mean the pace you would run if you were trying your absolute hardest to go as fast as you can, so if you don't tend to push yourself much in fun runs, using a fun run time to calculate your long run pace could have you running your long run a bit too slowly. If your 5km race time is much over 25 mins, or if you know you weren't giving it a good crack in your most recent race, you should look at reducing the 5km pace you're working with to calculate your long run pace, by up to 5%. So if your 5km time is 30 mins, a pace of 6 mins per km, you can use a pace of about 5 mins 45 secs for your 5km pace when calculating your long run pace.

If you haven't raced recently, you can do a time trial to estimate your VO2 max. I'd suggest a 3km time trial, rather than a 5km. You're bound to run your time trial more slowly than you would race 3km, so adjust your time trial pace by about 5% to estimate your VO2 max pace.

EG. 3km time trial is 16.5 mins, or 5.5 mins per km.

Adjust your time by 5% by multiplying the pace by 0.95.

5.5*0.95=5.225 mins per km.

Convert the answer to minutes and seconds and you have an estimated VO2 max pace of 5:15 per km.

Remember, as you get fitter, your 3km and 5km race paces will get faster, so you need to check this pace every 6 weeks or so.

IMPORTANT NOTE: If you are not already fairly well trained, it could be dangerous for you to go and do an all out 3km or 5km run first up, whether that be a time trial or a race. You should have a good 3 months running for at least 20 minutes 3 times a week before you race hard or perform a time trial.

If all those calculations are giving you a headache, you can use this table to work out the approximate pace of your long run.

Long Run Pace based on 5km Race Pace

5km pace-per km	3km/vo2 max pace	25% slower than 5km pace	40% slower than 5km pace
6:30	6:10	8:07	9:06
6:00	5:42	7:30	8:24
5:30	5:13	6:52	7:42
5:00	4:45	6:15	7:00
4:30	4:16	5:37	6:18
4:00	3:48	5:00	5:36
3:30	3:20	4:22	4:54

Use these pace estimates to get the most out of your long run

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Further tweaking of your long run pace

You’ve now got the basics of why it’s important to run a slow long run, and what that actually means in terms of pace. If you stick to between 25% and 40% slower than your 5km race pace, you should be ticking most of the boxes as far as training your aerobic system goes.

You can manipulate your training further, by more specifically targeting certain aspects of your aerobic training. You can mix up your long run by including race specific training such as hill, sustained efforts and fast finishes. These strategies are best left until you have a good couple of seasons of consistent training under your belt. They can be quite tough on your body and can increase your risk of injury if you are under-prepared for them.

And of course, the long run is just one part of a complete training program!!!!

[i] Spencer MR, Gastin PB. Med Sci Sports Exerc. 2001 Jan;33(1):157-62.
Energy system contribution during 200- to 1500-m running in highly trained athletes.

[ii] Duffield R, Dawson B, Goodman C. J Sports Sci. 2005 Oct;23(10):993-1002.

Energy system contribution to 1500- and 3000-metre track running.

[iii] Holloszy J, 1967 Biochemical Adaptations in Muscle. Journal of Biological Chemistry
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