# PURPOSES OF THE LONG RUN

Long training sessions are a defining characteristic of endurance training. All athletes know they need to be done, but many often do not consider why. Below is a list of many of the important benefits for performing such a workout.

Increase glycogen storage

Glycogen is the storage form of a carbohydrate, an important fuel source for athletes during endurance sport. When muscle glycogen is depleted during long runs, the body will slowly adapt and increase it's ability to store higher levels for future use. Research shows that another method of increasing glycogen storage is to perform short, low intensity training runs after an overnight fast. This is because when you run in a fasted state, your body is stimulated to adapt by increasing more storage of glycogen similar to the storage process that occurs after a long run.

Improved fuel utilization

As well as storing more glycogen, long runs improve the ability of the body to use fat as a fuel source. This means a smaller percentage of energy will be coming from stored carbohydrates, making this limited supply last longer. Even the leanest runners have a near unlimited amount of fat to use while running.

More slowtwitch fibers

Generally muscle fibers are defined as Type I or Type II. For endurance athletes, Type I (slowtwitch) fibers are preferred. These fibers fire slower than their Type II counterparts, and are able to be worked longer before fatigue sets in. Slowtwitch fibers are also more efficient at using oxygen to generate fuel.

Increase capillaries around muscle fibers

Capillaries are the smallest of the body's blood vessels. So thin in fact, that blood cells can only pass through them single file! Capillaries enable the exchange of $H_2O$, $CO_2$, $O_2$, along with nutrients, fuel, and waste between the blood and the surrounding tissue. Long runs will increase the number of capillaries that surround muscle fibers. Research has shown that trained athletes can have 25% more capillaries per $mm^2$ than their untrained peers. However other research has shown that after only a 20 week endurance training program, those who are untrained can increase their capillary density by 25% as well.

Increase mitochondria counts

Endurance training increases the size and quantity of mitochondria in muscle fibers. Along with larger mitochondria, endurance training improves the activity of the enzymes in the mitochondria that produce aerobic (with oxygen) energy. The more mitochondria you have, the more efficiently you produce aerobic energy. It has been shown in mice that mitochondrial

factors were a more reliable predictor of endurance than VO2 max. Research points to lower intensity training, like long runs, to increase mitochondria in slowtwitch muscle fibers.
*Update: "Vitamin C and E supplements may blunt the improvement of muscular endurance – by disrupting cellular adaptions in exercised muscles – suggests a new study from February 2014. The results showed that markers for the production of new muscle mitochondria – the power supply for cells – increased only in the group without supplements."*

Increase myoglobin within muscle fibers
Long training runs increase the amount of myoglobin in each muscle fiber, which means an increased amount of O2 is transported to the mitochondria to produce more energy. Myoglobin is an iron and oxygen binding protein found in muscle fibers, similar to hemoglobin is blood.
Interestingly, the only time myoglobin is found in the blood stream is after hard training sessions that induce significant muscle damage. Research has shown that the number one method of reducing muscle damage and the markers that occur after a marathon, is proper training, including long runs.

Race simulation
There is a saying, "train like you race." Look at the long run as practice for the event. These are the testing grounds. Try different methods of carrying fuel, as well as different types and brands of calorie sources. Use these long training days to find your best morning meal. Try different pairs of shorts, shirts, socks, etc. Gear starts to act very differently after 10 or 15 miles! It is also very beneficial to execute your long runs on a course similar to the future race course.

Mental confidence
Building confidence should arguably be the ultimate goal of training. Perhaps the most important reason to do long runs at the proper pace is to give yourself confidence in your abilities, conditioning, and fitness. Being able to perform a 20 mile run at race pace is a perfect confidence boost for an upcoming marathon.

Psychological
It is said that running is 90% mental. Research is starting to show more and more that the brain is a major limiting factor when it comes to distance running. Author Tim Noakes, MD said that the feeling of fatigue, is fatigue. He and many others believe the brain's job is to safeguard the body. Fatigue sets in when the brain feels that the body is approaching it's limit. Performing long runs shows the brain that it can safely achieve these feats.
In the end
Remember that the ability to run long is a combination of a multitude of factors. None of this is possible without stress however. It is through stress that we are built up better than before. If you run 10 miles every day you are getting good base mileage in, but not stressing the body and mind with a long run. A good rule of thumb is that a long run should be 25% of your weekly total mileage reap all of the possible benefits.