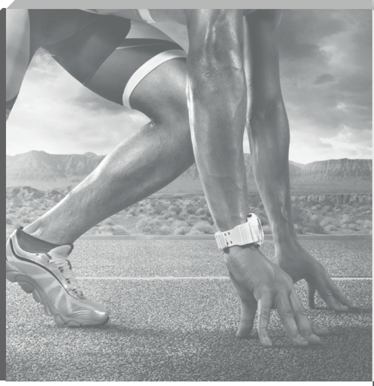
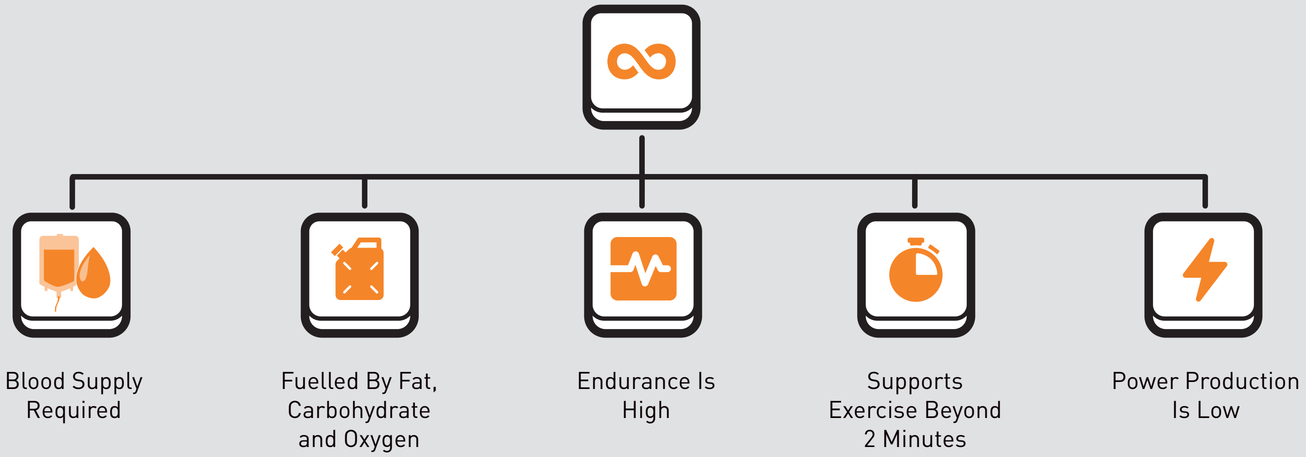
TORQ®

ENERGY SYSTEMS

CONTENTS

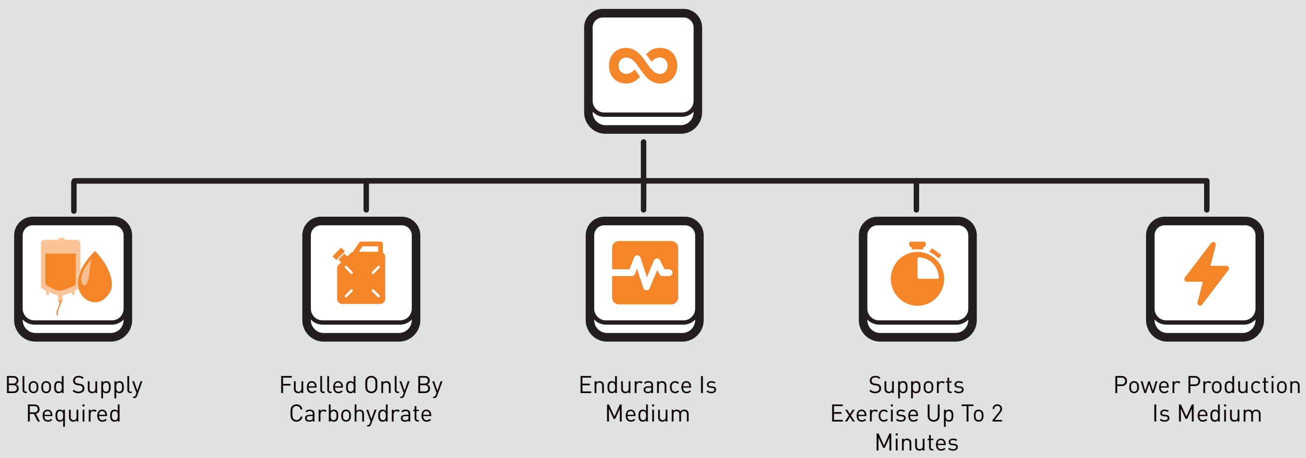


AEROBIC ENERGY SYSTEM



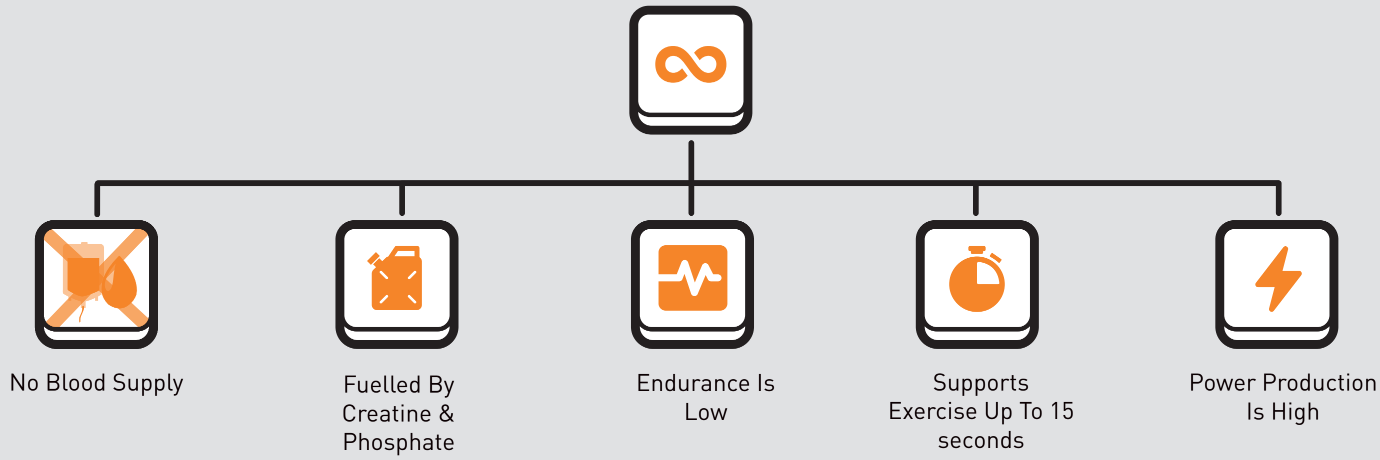
The above diagram provides insight to the purpose and function of the aerobic energy system. The aerobic energy system provides the capacity for endurance exercise, where the demand for sustained effort is required.

LACTIC ACID ENERGY SYSTEM



The above diagram provides insight to the purpose and function of the lactic acid energy system. The lactic acid energy system is responsible for supporting the aerobic energy system during periods of high energy demand. For example, when pace increases, or terrain becomes more challenging.

PHOSPHO-CREATINE ENERGY SYSTEM

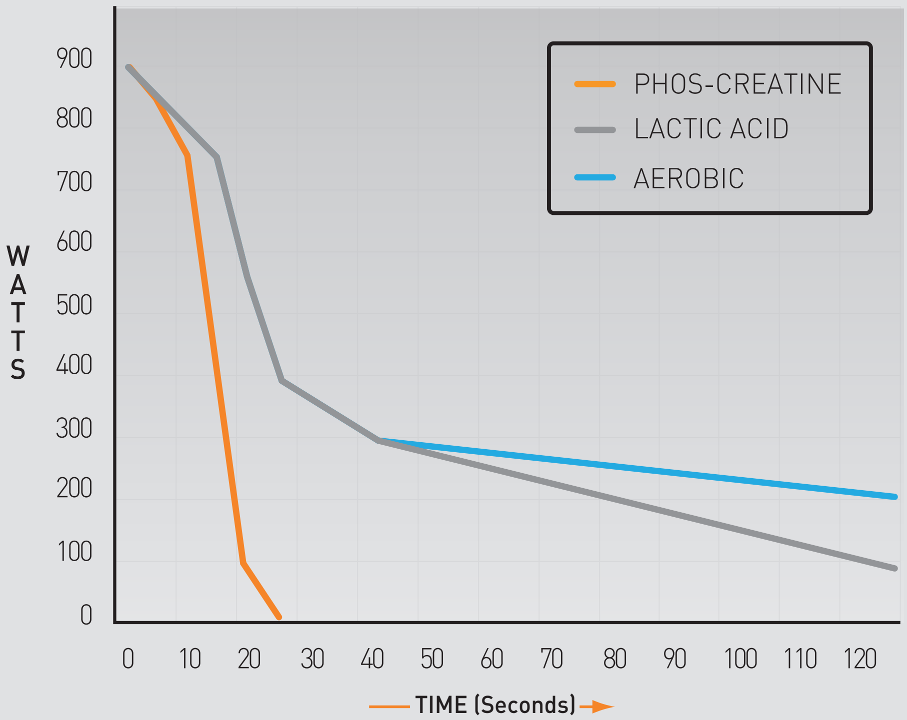


The above diagram provides insight to the purpose and function of the phospho-creatine energy system.

This energy system allows for short, intense exercise such as sprinting. Because power production is very high, the pay-off is that production duration is very short (~15 seconds).

ENERGY SYSTEM ACTIVATION

The below diagram explains how each energy system functions during an explosive, exhaustive, 120 second sprint. During the first 15 seconds, maximal power values are reached via the use of the phospho-creatine energy system.

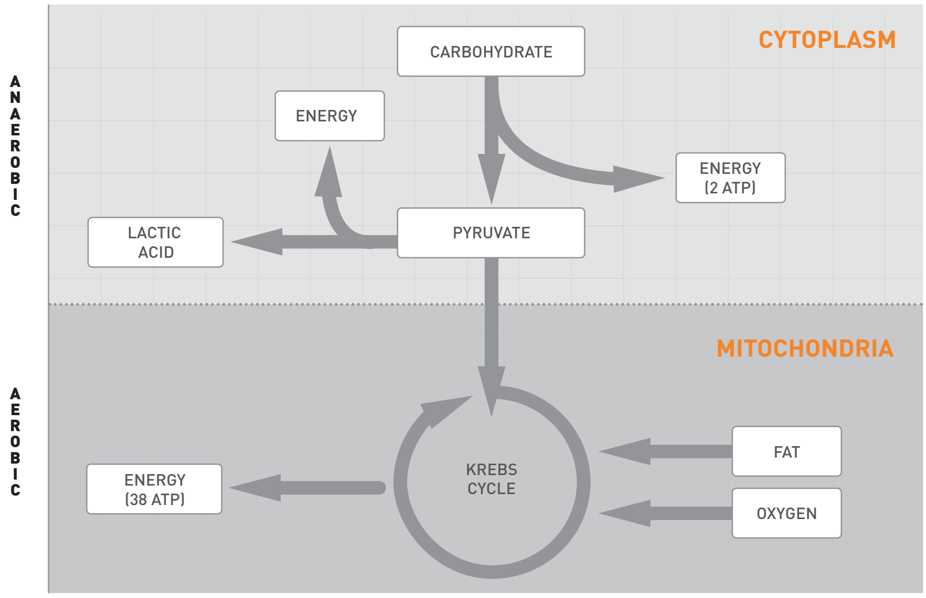


At 20 seconds, the creatine fuel source becomes depleted and the lactic acid energy system must support the demand for energy production. Between 20 & 50 seconds, the lactic acid energy system is working to capacity. However, as high quantities of lactic acid are being produced, the lactic acid accumulation within the muscle starts to limit performance and muscular power is reduced. At 50 seconds, a major introduction of energy contribution comes from the aerobic energy system.

As it takes time for oxygen to pass from the lungs to the working muscle, the aerobic energy system then works with the anaerobic energy system to share the exercise intensity of the workload, allowing for lactic acid removal and high rates of energy production.

METABOLISM

Allowing the human body to perform various exercise sessions are 3 energy systems. In the below diagram, we aim to provide clear insight to the functions of the aerobic and anaerobic energy systems.



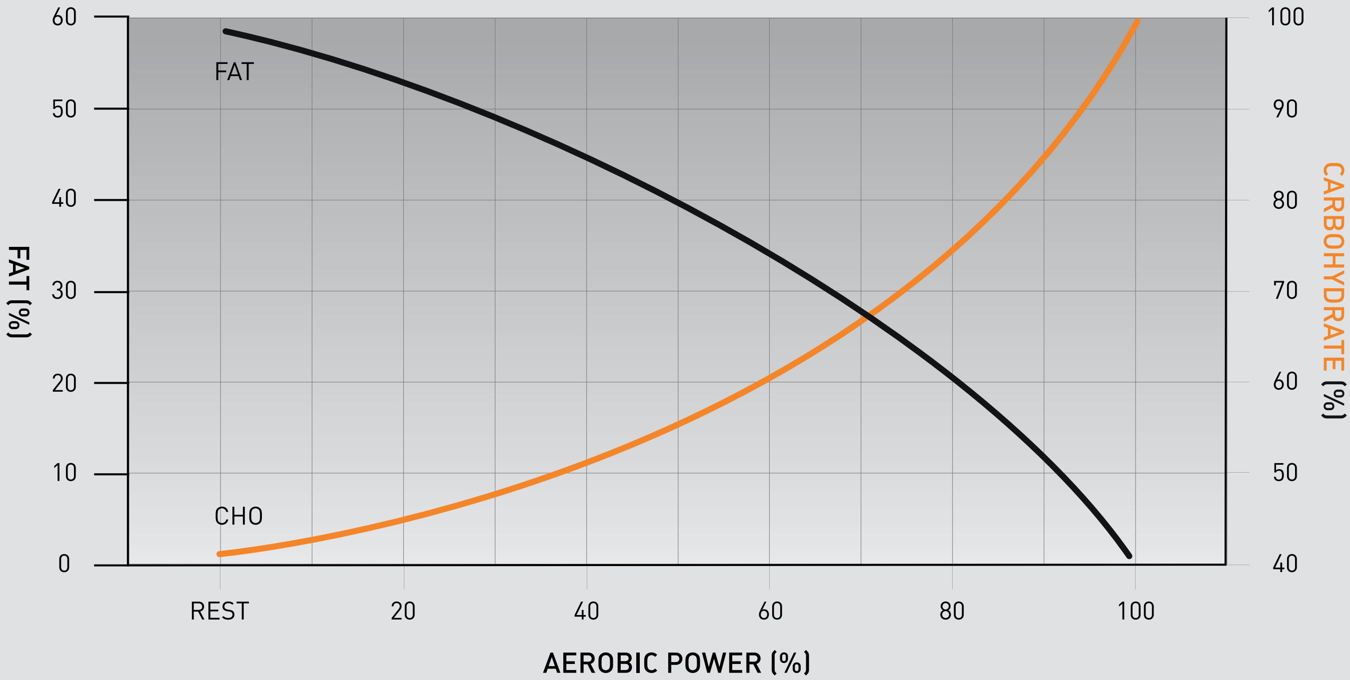
The aerobic energy system is often considered as your "endurance energy system". This energy system supports low to moderate exercise intensities. Fat, with oxygen, is broken down to produce ATP, (the body's energy currency) at very low exercise intensities. However, as energy demand increases, fat can no longer support the rates of energy demand and so, carbohydrate (with oxygen) supports the elevated exercise intensity. When fat and carbohydrate pass through the krebs cycle, 1 full turn produces 38 ATP, making the aerobic energy system very efficient. The aerobic energy system has a maximal work capacity, however the body has the capability to exercise beyond this threshold, and therefore, needs an energy production pathway that can quickly break down fuel to "top up" the energy produced from the aerobic system. This second energy system is called the anaerobic energy system.

Energy can be produced without the presence of oxygen via the anaerobic pathway. Carbohydrate from glucose or glycogen is broken down via a 10-step reaction, producing 2 ATP's. Although 2 ATP may not seem like a lot, lots of 2 ATP's can be produced within a short period of time, allowing you to produce very intense, but often short exercise efforts. A bi-product of this process is lactic acid production.

FUEL UTILISATION CROSS OVER DESIGN

As exercise intensity increases, aerobic fuel contributions shift from fat breakdown to carbohydrate. Carbohydrates are broken down easier than fats and because of this, during moderate intensity exercise, carbohydrate becomes a predominant fuel source.

It is important to remember that carbohydrates are broken down within the aerobic and anaerobic energy systems, whereas fat is only broken down under very light exercise loads, through the aerobic system.

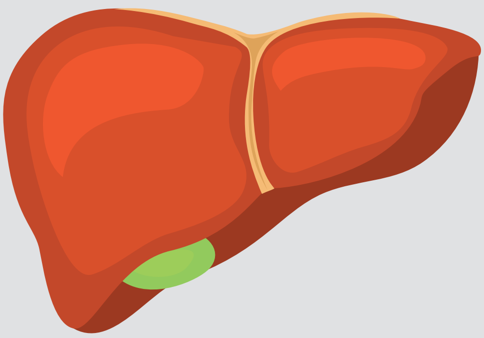


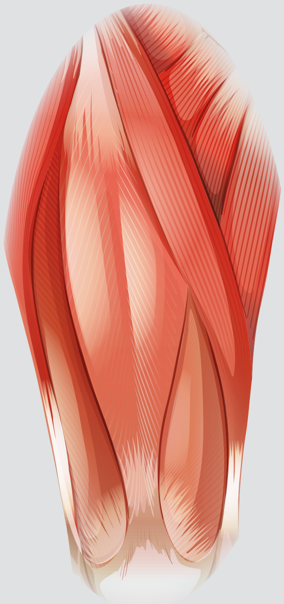
STORAGE OF FAT AND CARBOHYDRATE

Muscle

Liver

Fat





100g CHO
(400 Kcal)

400g CHO
(1600 Kcal)

5.5 – 6.5kg As Fat
(50,000 – 60,000) Kcals

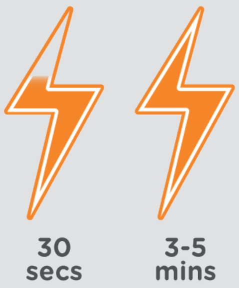
Within the human body, there are 2 storage sites of carbohydrate and 3 of fat. Carbohydrate storage is of limited capacity, with maximal saturation established at 500g (2000kcals). Carbohydrate is stored in the following sites;

Liver:	100g	(400kcal)
Muscle:	400g	(1600kcal)

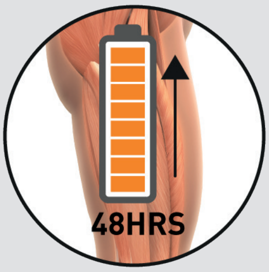
Unlike carbohydrate, fat storage is not limited and will continue to develop if calorie intake exceeds expenditure. Fat is stored in the following locations;
Adipose tissue: Fatty tissue found directly underneath the skin
IMTG's: Fatty substrates that sit around a single muscle cell (often found in well trained individuals)
Visceral tissue: Fat that sits surround the major organs of the body (unhealthy storage site)

FACTORS CAUSING FATIGUE

Physiologically, there are a number of factors causing fatigue.

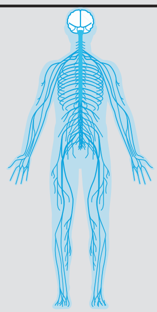


Phospho-creatine Depletion
A maximal sprint of just 10-15 seconds is enough to deplete your muscle phospho-creatine stores. The feeling of fatigue associated with a short duration maximal sprint co-insides with the depletion of the muscle phospho-creatine fuel stores.
Restoration of phospho-creatine occurs rapidly.
30 seconds Recovery – Restores 70%
3-5minutes Recovery – Restores 100%



Carbohydrate Depletion
When exercising for an extended period at high intensity glycogen stores can be rapidly depleted in as little as 60minutes, with lower intensity exercise breaking down glycogen at a slower rate. Depletion of glycogen stores co-insides with a catastrophic drop in performance and a significant increase in perceived exertion.

Muscular Acidosis
Completing high intensity exercise results in the accumulation of metabolic by-products such as lactic acid which when broken down leads to the accumulation of hydrogen Ions which change the pH within the muscle, preventing it from functioning at its optimal, causing fatigue.
The body uses buffers to help control for this acidity and this is where the use of sports supplements which increase the bodies buffering capacity, such as beta alanine and sodium bicarbonate can be beneficial.



Central Fatigue
Fatigue can also be associated with the disruption of the neural transmission of impulses from the brain to muscle as a result of completing strenuous exercise, as well as through a central effect of strenuous exercise on the brain. This is where psychology can play a major role in performance as although your muscle may not be completely fatigued your brain may reduce performance.

APPLYING RPE

(RATE OF PERCEIVED EXERTION)

ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6	ZONE 7
Nothing	Light	Moderate	Somewhat Heavy	Heavy	Very Heavy	Maximal

1 2 3 4 5 6 7 8 9 10 11 12

RPE simply stands for rate of perceived exertion. RPE can be applied to all aspects of your training. Simply give the task you are completing a rating from 1 – 12 in relation to its difficulty based upon the sensations you are experiencing.

TRAINING ZONE OVERVIEWS

ZONE	PURPOSE	DURATION
ZONE 1	Active Recovery // Training bi-product removal	Up To 1 Hour
ZONE 2	Aerobic Endurance // Promote fat utilisation & cardiovascular adaptations	Up To 4 Hours
ZONE 3	Aerobic Power // Promotes increased oxygen utilisation & transport, improving power at a sustainable pace.	1 – 3 Hours
ZONE 4	Enhances aerobic power along with lactic acid buffering capacity	45 Mins – 2 Hours
ZONE 5	Tax both aerobic and anaerobic energy systems. Pushing both CHO breakdown and lactate clearance	10 – 40 Minutes
ZONE 6	Tax the anaerobic energy system! Promote lactate tolerance and clearance // increase raw power	3 – 10 Minutes
ZONE 7	Sprint power! Promote muscular strength and neuromuscular firing.	1 – 15 Seconds

The table above provides a clear breakdown of the purpose of each training zone. The table also explains how long a session within a specific zone should be.

WORK/RECOVERY RATIOS

WORK INTERVAL	RECOVERY INTERVAL	ENERGY SYSTEM ACTIVATION	TRAINING ZONE
10 – 15 Seconds	3 – 5 Minutes	PCr	7
30 Seconds	2 Minutes	PCr / Lactic Acid	6
1 Minute	2 Minutes	Lactic Acid	6
2 Minutes	1 Minute	Lactic Acid / Aerobic	6
5 Minutes	1 Minute	Lactic Acid / Aerobic	5

The above table describes the work to recovery ratios you should employ during a session to ensure that you maximise the time spent during training.