Poor anaerobic fitness

**Horseriding -Extended trot**

## C1: Cause – Poor muscular endurance due to poor anaerobic fitness

For this particular skill I suffer from poor muscular endurance. This affects my performance negatively as when I go into sitting trot I struggle to maintain an upright balanced position which also affects my lower leg position, causing me to slouch in my back position and my legs to swing underneath me and not fall long to take my weight. This means that I bounce in the saddle and these factors cause my horse to speed up and not extend in its stride. This is due to the fact that I am unable to maintain the contraction in my gastrocnemius due to muscular fatigue. Poor muscular endurance is the inability of a muscle to maintain contractile force as a result of repeated contractions.

Lactic acid starts to build up in my muscles when I am in the sitting trot due to a lack of oxygen for respiration by cells in the body. Glycolysis burns glucose and this generates energy by creating pyruvate, which enter the Krebs cycle. The Krebs cycle is able to generate some ATP (most ATP is generated in the electron transport chain), which will provide energy in my body. However, if there is a lack of oxygen, the Krebs cycle will get backed up as oxygen acts as an electric sink for the process and cannot continue (most energy is created during the electron transport chain). In this case, pyruvate is converted into lactic acid/lactate in the cells. So, when I am in the sitting trot my muscle cells will use up my body's oxygen quickly and this will resort to me anaerobically respiring, creating lactic acid in my muscles. Lactic acid builds up when excess hydrogen has no oxygen to join with and joins pyruvate instead.

An increasingly acidic environment (acidosis) is a factor which contributes to muscular fatigue as it causes a breakdown in the chemical reactions that produces muscle fibre contractions (acidosis is caused by the build up of lactic acid and the release of hydrogen ions). This happens in my performance when I tense my gastrocnemius to stay in the sitting trot position. Another reason for my muscular fatigue would be that there is a change in the balance of my chemicals that circulate my action potential (nervous stimulus) within my muscle fibres. This will decrease the excitability of my muscle fibres and as a result reduces my gastrocnemius ability to contract as it fatigues. As sitting trot in the extended trot is a prolonged and continuous form of exercise I am likely to be using my aerobic energy system and using the breakdown of glucose to provide the energy I need for ATP reformation. This means that my fatiguing factor is a build up of lactic acid. The main problem is that there are lots of quick muscle contractions in this skill and so there is not enough time to get oxygen to my working muscles. So therefore all the hydrogen being released from Glycolysis in the Krebs cycle doesn’t have enough oxygen to join to in to the electron transport chain, therefore it joins to pyruvate and forms lactic acid. This point is the lactate threshold (2 mmol per litre of lactic acid above resting levels). The build up in lactate acid is a contributing factor for fatigue. It produces an acidic environment which slows down enzyme activity and stops the breakdown of glucose. It also affects nerve endings causing some pain. This is why I find it hard to maintain my sitting trot position and stay relaxed as I get an onset of tiredness and a significant drop in pace.

## C2: Corrective measure – Interval training

Interval training will help to train my aerobic system and anaerobic system. This will help to develop the stamina in my legs to enable me to maintain the sitting trot position and maintain sitting still in the saddle. It will also help to develop my body’s ability to deal with lactic acid levels. This type of training programme will involve alternating periods of effort and recovery so that my body may be exposed to a greater total workload than it could manage during a continuous period of training. If I adjust the duration, intensity and type of activity undertaken, it will give me a variety of possible training sessions. The aerobic intervals that I should take should be sprints e.g. 50m sprint and walk back, 50m sprint and walk back. This would give me periods of work with a short rest periods after.

Here is an example of a training plan that I could use:

It is recommended that there should be a 1:2 work rest ratio for interval training, meaning that my rest interval is twice as long as my work interval. An example of this would be sprinting for 30 seconds and walking to recover for a minute. If I am working at maximum effort I may need longer to recover.

I should start my training with a 10 to 15 minute warm up to make sure my body is ready for intense exercise. The first stage of my warm up should be light cardiovascular exercise e.g. jogging to increase my pulse. This will increase my cardiac output and breathing rate and will direct more blood to my working muscles via the vascular shunt. The second stage should involve stretching around my joints and muscles that will be most active during mu interval training session. The warm up will release adrenaline increasing my heart rate and dilating my capillaries, increasing my muscle temperature (leading to greater elasticity of muscle fibres), increase my nerve impulse conductions (raising my alertness) and allows efficient movement at joints occurring through an increased production of synovial fluid. Then after my warm up I should carry out my interval training of work and recovery intervals e.g. the 50m sprints and walk backs for about 20 to 30 minutes. I will then end my training session with a cool down consisting of light exercise (to keep my heart rate elevated)and stretching (to prevent the effect of DOMS) as this will help to return my body to its pre-exercised state more quickly. A cool down will keep my blood flow high and will allow oxygen to be flushed through my muscles, oxidising and removing any lactic acid that remains. Also my doing a cool down it allows my skeletal muscle pump to keep working, which will maintain my venous return and will prevent my blood from pooling in my veins.

I should do this training around 1-2 times a week so that I do not overdo it and cause myself an injury as it is high intensity exercise.

Interval training will help to improve my performance by helping my body to deal with the lactic acid better. My body will improve at getting oxygen into my body and working muscles and breaking lactic acid down into pyruvate.

Following exercise, bodily processes do not immediately return to resting levels, especially after intense exercise. The higher than resting level of oxygen consumption is called excess post exercise oxygen consumption (EPOC). This is made up of two components. One, the fast (alactacid) component, where oxygen is used to re-synthesise ATP and phosphocreatine levels, re-saturates myoglobin (which transports oxygen from blood to muscle fibres). This component will be very short after highly aerobic exercise. Secondly, slow (lactacid) component, where oxygen is used to remove lactic acid.

EPOC will help by restoring my ATP levels. My body will be continually restoring ATP by re-synthesis. After intense exercise, levels will take 48 to 72 hours to restore to normal. This will require energy from the breakdown of glucose, which requires oxygen.

It will also help by restoring phosphocreatine in my body. When energy for ATP synthesis is needed very quickly e.g. during intervals of intense work such as the extended trot skill, this will be given to my body by the breakdown of phosphocreatine. This reaction can be reversible.

PC 🡪 Phosphate + Creatine and releasing energy (used for ATP re-synthesis)

To regain levels of phosphocreatine the reaction above must be reversed.

Phosphate + Creatine 🡪 PC but requires energy (from glucose breakdown)

Another way EPOC will help improve my anaerobic fitness is by reloading my myoglobin with oxygen quickly. Myoglobin transports oxygen in the blood called oxymyoglobin, through muscle cells and into the mitochondria in the body. So the quicker that my blood can be replenished with oxygen, the more oxygen can be given to my working muscles and the longer the lactic acid build up can be prevented.

The main benefit that interval training will have on improving my performance of this skill is by allowing my body to deal with excess lactic acid. It will help to convert the lactic acid in my muscles to pyruvate (oxidation). This means that the pyruvate can go through the normal aerobic steps in the Krebs cycle to produce energy for ATP reformation. This process will occur in my mitochondria and will require oxygen. Another way is by improving the transport of the lactic acid accumulated in my working muscles to my liver through the blood stream where it can be reconverted to glucose through the Cori cycle (producing more energy for my working muscles, stopping the lack of muscular endurance). This will also use oxygen.

The fitter I become and the higher my VO2 max is, the longer I will be able to resist lactic acid forming and so the higher my lactate threshold. My VO2 max will increase due to cardiac hypertrophy, increasing my capillary density in my lungs and muscle cells and improving the transfer of oxygen to my mitochondria via myoglobin and improving the take up and use of oxygen by my mitochondria. This training therefore will allow me to continue in sitting trot throughout the whole extended trot movement.

Rugby - Tackling

C1- Tackling

Poor Anaerobic Fitness

For my specialist position, like other positions, I need to be able to tackle. And be able to tackle with the same intensity throughout a whole game. However, specialist for my position I need to have good acceleration off a scrum, in an attempt to tackle the opposing fly half. And in open play, it is a requirement for me to be filling in the back line. I am required to have a high level of aerobic capacity, in order to last the duration of a match, but as the tackle situation is a very quick action, the main energy system being used would be my anaerobic systems- ATP-PC and Lactic Acid system. The ATP-PC system takes place without the presence of oxygen as it is anaerobic and used for short duration exercises (0-10 seconds). It doesn’t produce any by-products and is specifically targeted to be used for very high intensity exercise, therefore suitable for a tackle. And finally, it has quick recovery period of 30 seconds to 1 minute. Which means it is very useful for during a game as there may be a short break in play as the ball goes in to touch where it can be replenished and allow you to complete another tackle of high intensity. It is a process that provides energy for the resynthesis of ATP without the use of oxygen. The breakdown and resynthesis of ATP is a coupled reaction. ATP gets broken down into ADP + P+ Energy, which is used for the muscle contraction. This is followed by the ADP re-joining with P + Energy, from the energy systems to create ATP. In the process of creating ATP-PC, it only has a few reactions, therefore is very quick. Phosphocreatine (a compound of creatine and phosphoric acid) is created by the creatine joining with phosphoric acid in the presence of energy. The reaction that takes place is ADP (adenosine diphosphate) joining with P (phosphate) hence creating ATP (adenosine triphosphate). This combines with PC, to create the final formula ATP-PC. The other anaerobic energy system is the Lactic Acid system, it is similar to the ATP-PC system as it also used for high intensity exercises, although not quite to the same extent. It would be used for activities that from 60-95 per cent of maximal effort. This system normally kicks in just after my ATP-PC stores are depleted after 10 seconds and last for 3 minutes. Therefore would be used when performing a tackle as the whole movement from the preparation phase to the end of the recovery phase usually lasts longer than 10 seconds. However, in comparison to ATP-PC, it takes from 20 minutes to 2 hours to recover and replenish stores. The removal of lactic acid can be helped by stretching, replenishing glucose stores. The process of the lactic acid system is as follows; glucose goes the process of glycolysis (where 2 ATP are produced), this creates pyruvate, form here the excess hydrogen join with the pyruvate, forming lactic acid. This process continues and I reach my lactic threshold of 2mmol. However , if it still continues and reaches 4mmol you go through OBLA (Onset of blood lactacid accumulation), this is the point at which lactic acid starts to accumulate within the blood and muscles as a result of the lactate system producing more than is able to be dealt with.

The issue for me is the inability to resynthesize PC quickly enough in between play, as the stores are continuously being depleted from the intensity of different skills. EPOC (Excess post-exercise oxygen consumption) is part of the recovery of the two energy systems. It can be the fast alactacid component, or the slow lactacid component. During the fast component, ATP and PC levels are restored, as well as the reloading of myoglobin with oxygen. 75 per cent of PC is restored within one minute and is fully restored within four minutes. And generally the myoglobin reloads with the oxygen in 2 minutes. I need to be able to maximise the potential of these short recovery times in order to be more effective on the pitch.

C2- Interval Training

In order to improve my tackle I need to improve the use of my anaerobic energy system. This can be done through interval training. Interval training is periods of intense exercise followed by rest, or lower level of expenditure (effort). It is necessary to have a good level of aerobic fitness before doing interval training to make the most from the training. I would design an interval training workout to replicate a game scenario- make it specific to rugby and the tackle situation, incorporating lots of power movements. The training programme will consist of high-intensity activities that raise the heart rate to 80% or more of its capacity, in order to see the greatest benefits and imitate a game scenario. Interval training is based on the principles of intensity, duration, length of recovery and number of repetitions.

An anaerobic threshold can be improved through quite short, very intensive intervals and longer, slightly less intensive intervals. These are best considered at three levels:

1. Very short (less than 30 seconds), very high-intensity work with rest periods of less than 30 seconds. This training will produce heart rates at between 95 and 100% of maximum and primarily address the anaerobic systems, though evidence suggests that intervals of this length will also provide an aerobic stimulus.
2. Work periods of two to four minutes and rest periods of between 30 seconds and two minutes, with a heart rate of approximately 90% of maximum, will work both the anaerobic and aerobic pathways.
3. Longer, intensive endurance methods can also be used, particularly earlier in the training year or with young players. Workouts take eight to 15 minutes, and these are also conducted in blocks or intervals. Here, intensity is at 85% to 90% of maximum and recovery time is up to five minutes. The number of repetitions is four to five, and the frequency is once or twice a week.

After considering all three different levels that interval training can take place at, I have decided to choose the first one. This consists of high intensity workload and short rest periods, therefore specifically targeting my anaerobic energy system and is also the most realistic to apply to rugby as a whole, with minimal opportunity to rest and recover.

The leg drive is one of the key aspects of performing a tackle; therefore I would set up a routine that involves multiple exercises which target the groups of leg muscles. The session becomes more effective if active recovery – in the form of walking or jogging – is undertaken between repetitions.

A suitable program could look something like this:

Gradual warm up- Here I would prepare my body for the exercise/ workout ahead, increasing the supply of oxygen to my muscles, get in the right frame of mind and to prevent injury, it also generally increases chemical reactions. I would pay particular focus to my leg muscles as they are going to be targeted in the workout ahead. After this I would begin my set of exercises;

To make it specific to rugby, I would do this session outside when possible; to factor in the environment I would be playing in, as opposed to in a gym. Furthermore, I would use the tackle shields to incorporate ‘the tackle’ itself.

1. Start lying on the ground, a partner will be holding a tackle bag 5m away. I will run into the tackle shield and perform the driving phase on the bag to particularly focus on initial low body positioning and leg drive upwards, but not taking the player to the ground.
2. From here, I would jog backwards and return to the starting line, as soon as I reach the line I would accelerate off on a 10m sprint passed the bag. This whole motion should take less than 30 seconds, therefore fits into the high intensity bracket I am aiming for.
3. After this I would walk back to the start and repeat 10 times. Making sure I began on the floor each time.
4. This exercise is directly transferable to a game. It imitates getting off the floor from a breakdown at the start, accelerating up to make a tackle, dropping back 5m when in defence and finally a sprint up to represent a blitz defence. The short walk back gives my ATP-PC stores just enough time to replenish before carrying out another short burst of exercise.
5. As I repeat the drill, I will begin to tire, this means I will have to also focus on my technique when making a tackle and sprinting through.

There are other drills and exercises that may be done for interval training. However, I feel that this is the best one for improving my effectiveness in a tackle situation and represent other factors that need to be considered in between each tackle that is made. As I repeat interval training sessions, I will become fitter and my VO2 max will improve and I will be able to work at a higher percentage of it before I cross my lactate threshold. This will allow me to eventually train for longer and not tire as quickly in a game whilst attempting to make repeated tackles.

Downhill Biking – Pedalling

**C1 Pedalling – Poor anaerobic fitness**

The length and physicality of downhill tracks are ever changing. No single track is ever the same and different tracks require different levels of fitness to be able to ride them effectively. With tracks varying in length from between around 2 to 6 minutes, it is evident that aerobic fitness will be a key factor in a rider’s ability to maintain high performance. Fatigue can come from a range of factors. Arm pump, body movements and balancing the bike all require strength and fitness and can contribute to a rider becoming fatigued. Pedalling however is the dominant factor that requires high levels of aerobic fitness. It is my lack of aerobic fitness that means that my performance when racing drops as I get further down the track.

There are a number of factors which lead to or help contribute to me becoming fatigued. Downhill is fast and high intensity and will typically last for around 4 minutes, this is too long for anaerobic energy systems alone to be used as the build-up of lactic acid would be too much for the body to withstand. However, it is evident that both aerobic and anaerobic energy systems are used as the build-up of lactic acid when riding is noticeable. But the longevity of the event means that anaerobic energy sources alone cannot be used and therefore the use of oxygen to breakdown glucose must be capitalised.

Aerobic energy systems involve the use of ATP for energy. ATP is broken down into ADP + P + Energy to provide us with energy. However, these ATP stores cannot last long (2-3’s of intense activity) and therefore need to be resynthesized. This can be done through the breakdown of Carbohydrates (into glucose), fats (into fatty acids) and protein (into amino acids). Aerobic systems use oxygen to break down glucose effectively. This occurs in the mitochondria and produces CO2, H2O and energy. No fatiguing by products are made as a result of aerobic systems meaning no lactic acid is produced which would hinder performance if prolonged. The breakdown of glucose into energy involves three stages. These include Glycolysis, Kreb’s cycle and the electron transport chain.

Glycolysis:

This is the initial stage of glucose breakdown. Glycolysis results in a net gain of 2 ATP. A total of 4 are made however 2 of these are used in the steps of glycolysis itself. Pyruvic acid is also produced however cannot form lactic acid as oxygen is abundant and therefore the pyruvic acid has no need to bond with H ions.

Kreb’s Cycle:

The Kreb’s Cycle follows on from glycolysis and again 2 ATP are produced at the end. This stage does not take place in anaerobic respiration as it can only occur in the presence of oxygen. The pyruvic acid formed from glycolysis is added to coenzyme A to produce acetyl coenzyme A; this kick starts the cycle, which takes place in the mitochondria. Many complicated reactions take place to create 2 ATP.

The Electron Transport Chain:

This is the final stage of glucose breakdown. A series of carrier molecules are involved in the oxidising of the hydrogen contained within the hydrogen carriers. Large amounts of oxygen are required at this stage and the largest yield of ATP is produced as a result. 34 ATP are produced in this stage giving an overall yield of 38 ATP.

The making of 38 ATP will give me sufficient energy to complete my downhill run. A race track is very short relative to a full football or hockey match and is high intensity. Anaerobic systems would produce large amounts of lactic acid which would considerably hinder my performance. For the first section of track I would be producing energy via anaerobic systems however this will be replaced by aerobic as time increases. As I get further down the track my body will start to struggle to get sufficient O2 into the muscles quickly enough and therefore lactic acid will build up too quickly.

**C2 pedalling – Altitude training**

Pedalling a bike fast requires a lot of energy. The aerobic strain is high meaning appropriate methods of training must be put in place in order to improve my aerobic fitness, and allow me to perform at a higher level. By increasing my aerobic fitness I will be able to maintain my performance throughout the entire length of a track. And therefore will not feel the effects of fatigue so quickly, and prevent lactic acid build up.

To maximise the effect of training on my aerobic energy system I must make sure to use appropriate and specialised methods. I intend to use altitude training as my corrective measure. This will allow me to practice on some of Europe’s best downhill trails, in the Alps mountain range where rocky slopes allow for long and challenging downhill tracks. Some of these tracks are also at high altitude. This means that I can practice and improve my aerobic fitness at the same time.

The body’s aerobic performance is improved because a higher number of red blood cells are produced due to a lack of oxygen. The body adapts to this lack of oxygen by creating more red blood cells which allow the oxygen to be more efficiently taken into the body to the working muscles. These increases in red blood cell numbers are stimulated by an increase in the secretion of the hormone erythropoietin; this naturally regulates red blood cell production.

[](http://www.google.co.uk/url?sa=i&rct=j&q=Morzine+summer&source=images&cd=&cad=rja&docid=_swiRZ9uphHk9M&tbnid=-0x15XazQIK5mM:&ved=0CAUQjRw&url=http://www.morzineapartments.com/summer.html&ei=uA5kUe72Kcr07AaSzIHgAQ&psig=AFQjCNFgewyt_8iV7Zfes6DMe06RWx49dw&ust=1365598219019191)In order for altitude training to work and be effective it needs to be done at a height of between 2,000-8,000 feet above sea level. With the Alp's resort Morzine ranging from between 3,281 and 8,088 feet above sea level the conditions will be perfect for me to train at altitude. Morzine will be the main area for my training and would involve sleeping at the base level of 3,281 feet and training up to 8,088 feet. This means that I will continuously be between the optimal height for training, and will also allow me to firstly acclimatise at a lower altitude and then work my way up.

Morzine in the Portes Du Soleil will be an ideal base camp and are for carrying out my altitude training.

There are three different types of altitude training that can be carried out by an athlete:

1) Live high/train high - This involves training and living at high altitude in order to continuously acquire the best results. However this method has potential negative effects on the athlete’s ability to maintain high levels of training and skill. This is because the athlete is unable to reproduce the necessary training intensity to improve performance. The athlete will be unable to train at the same level that they could at sea level and subsequently may see a drop in performance when they do return to sea level. Due to the continuous exposure to high altitude the athlete may also be unable to practice the skills required for their sport effectively, meaning their skill level may drop. All in all this isn't a suitable method for me as primarily I am unable to live in high altitude conditions due to the UK's relative low altitude.

2) Live high/train low - This involves training at sea level and living or sleeping at high altitude. The athlete would continue to train at sea level but sleep at high altitude. This method has recently become more common due to the introduction of altitude tents which mimic the conditions found at high altitude. However this method has less scientific backing than the other two methods and also requires either the ability to travel to high altitude at night or the funds/backing to use an altitude tent. Therefore this is not a suitable method for me.

3) Live low/train high - This involves living at sea level and training at high altitude. This method is most suited to me for a number of reasons. Firstly I live in a low lying area anyway, meaning little or no disruption to my everyday life will incur. This method is also the easiest and requires the least sacrifice on the athlete’s part. This method also has a lot of scientific backing. Recently, the AIS published research suggesting that the addition of altitude exercise to a training program can improve performance more than altitude sleeping alone.

Altitude training involves three stages that must be carried out in order to gain the benefits:

**Acclimatisation** - This starts as soon as the athlete arrives at altitude. This stage usually lasts between 3 to 10 days and allows the athlete to get used to the reduced pO2. During this time the athlete must not train strenuously and must also allow more time for recovery.

**Primary training** - This is the main section of training and is when the athlete will improve their fitness the most. The aim is to progressively increase the amount and intensity of training until the athlete reaches the same level of fitness as they had at sea level. This stage usually lasts between 1 to 3 weeks.

**Recovery** - This stage is to allow the athlete to prepare for returning to sea level and recover fully from the fatigue produced from high altitude training. Training intensity is gradually reduced rather than a sudden stop in training. This stage usually lasts between 2 and 5 days.

For me to fully gain the benefits of altitude training I must make sure to follow these three stages. Many long and challenging downhill tracks can be found at high altitude in mountain ranges where terrain is long and rocky. Therefore I would be able to incorporate riding these tracks into my regime as both aerobic fitness and skill level will increase.

Upon return to sea level there are also three stages.

The positive phase - The oxygen carrying capacity of the blood is increased meaning the athlete has an increased level of fitness. This stage lasts between 1 to 4 days.

Following from this there is a general flattening of performance where an athlete is unlikely to perform at their best. This can be due to the altered fitness levels and loss of coordination while training at altitude. Usually after 3-10 days there will be improvements in fitness and coordination.

Finally there is a fitness peak whereby the athlete as at optimal fitness for competition. A combination of factors contributes to this including increased oxygen transport and improved breathing adaptions. This phase occurs 15-20 days after return to sea level.

When choosing the best time to train at altitude it is important for me to time the training with an upcoming event of significant importance e.g. national champs. I will need to allow time to rest upon return and therefore would need to time my return from altitude to include a 15-20 day rest before my event. This would allow me to fully gain from the training and perform at my peak.

Volleyball – spike

**C1- Inefficient Energy Systems**

When playing a match the onset of fatigue (slower muscle contractions) starts to occur. The matches can last up to 3 hours depending on the strength of the opposition and the amount of sets the game is played for. When hitting a spike throughout the game the preparation for my run up starts to deteriorate as it becomes slower and weaker. This means that I can’t get into position quickly, I can’t jump as high and therefore I can’t hit the ball powerfully. This is due to my anaerobic systems becoming depleted and the build-up of lactic acid which starts to occur.

The anaerobic energy systems are a vital part of the body’s way of getting energy to resynthesise adenosine triphosphate (ATP). ATP is important for the body as it is the only energy source that cells, including muscle cells, can use. However, we only have limited supplies of ATP within the body and we must therefore constantly resynthesise ATP to ensure that we can carry out the tasks and exercise. The body transfers chemical energy from stored forms of glucose (glycogen) and uses that energy to resynthesise ATP.

Sport performers such as myself are frequently working at much higher levels of intensity and more ATP is being used to provide energy for muscle contraction. Under these conditions, such as the repetitive action of the spike, it becomes impossible for the body to provide the energy required to resynthesise ATP from the aerobic systems because it can’t work fast enough in breaking down glucose, and other energy systems come into play, such as the anaerobic systems. The more intense the exercise, the more ATP is used to provide energy for muscle fibre contraction, and therefore the more ATP we need to resynthesise. Throughout the game being an outside hitter means that I am constantly repeating the same leg movement and effort in the jump. It’s an explosive skill and a quick action, therefore the body becomes unable to provide the oxygen for the complete breakdown of glucose quickly enough at this stage of the set. In sufficient quantities to ensure that enough energy is available for ATP resynthesise. The muscles have sufficient ATP available for very short bursts of high intensity activity (less than two seconds). For anything longer than that, it is necessary to resynthesise the ATP during the activity to ensure that it can be sustained.

There are two anaerobic systems: The phosphocreatine (PC) energy system or ATP-PC system and the lactate anaerobic energy system.

Phosphocreatine is an energy-rich compound that when broken down releases energy to resynthesise ATP. No oxygen is involved so the process is entirely anaerobic. For every one molecule of PC that is broken down, sufficient energy is released to resynthesize one molecule of ATP. The benefit of the PC system is that energy is released rapidly because very few reactions need to occur and it allows for the rapid resynthesis of ATP that is necessary if the body is undertaking short burst of maximal work, for example the explosive jump at the end of my run up to carry out the spike. However, the disadvantage of the PC system is that stores of phosphocreatine are limited, only sufficient for approximately five to eight seconds of high-intensity or maximal flat- out work. The PC stores are replenished but it can take up to three minutes to fully refuel which isn’t any good when I have to switch from position two (when setter is running through) to position four which is the opposite side of the court and then I have to make sure I am far enough out for my run up to undertake the hit. Therefore, if I want to carry out the explosive jump just after (high-intensity) my body needs to use another anaerobic energy system known as the lactate anaerobic system.

The lactate anaerobic energy system provides energy for ATP resynthesis by partial breaking down glucose without oxygen and producing lactate as a by- product. If the body continues to work hard i.e. the repetition of the spike preparation and the length of the sets, more hydrogen is released as a result of the glycolysis of glucose and the Krebs cycle, enters the electron transport chain (ETC) to be combined with oxygen. At some point (depending on the VO2 max) so much hydrogen enters the ETC that it exceeds the amount of oxygen available. The excess hydrogen ions cannot remain unattached and so combine with the end product of glycolysis, pyruvate to form lactate or lactic acid. The point at which this occurs is known as my lactate threshold. When my body begins to tire and starts to use the anaerobic energy system the drawback with it is the production of lactic acid and its accumulation in the muscle cells and the blood. Conventionally, it is thought that the accumulation of lactic acid affects the muscle contractions and that this is what causes fatigue, which we see in my game as it draws to an end.

Another reason I begin to tire quickly is because of my aerobic system is weaker. If I have a weak aerobic system this leads to a weaker anaerobic system and therefore, because I have a smaller VO2 max O2 is necessary when breaking down lactic acid and restoring PC. The amount of oxygen used by our body is called oxygen consumption. If I had a higher VO2 max I would have more oxygen available and could therefore I will be able to replenish PC stores and help convert lactic acid back into pyruvate. This will help me go on for longer until I reach my lactate threshold and become dependent on anaerobic system. During exercise we need more ATP (energy) so O2 consumption increases until it meets a point of max known as VO2 max. A higher VO2 max means a higher level of aerobic fitness. VO2 max is the body’s ability to get O2 to the lungs, transfer it to the blood, transport it to muscle cells and mitochondria, and use the O2 in energy processes. It is dependent on many factors such as the surface area of alveoli (however this is genetically determined making it impossible to alter), the levels of red blood cell and haemoglobin, the capillary density in the lungs, the efficiency of the heart and circulatory system, the capillary density in muscle cells, the transfer of O2 to mitochondria via myoglobin and the take-up and use of O2 by mitochondria, so improving them will help improve my aerobic system and subsequently my spiking.

**C2- Circuit Training**

The way in which my I am going to improve my anaerobic system along with my lactate threshold is by carrying out a circuit training programme. The reason for using this method of training is because I can focus on specific things which can help benefit my spike. I can work on my upper body and lower body all which involve short sharp exercises to help improve my anaerobic system along with benefiting my strength and power within my spike by making the circuit last a long duration it will also benefit aerobic system.

Improving my aerobic energy system and my lactate threshold will have many effects on my body, such as: cardiac hypertrophy and increased resting stroke volume; a decrease in resting heart rate; an increase in muscle stores of glycogen and triglycerides; an increase in capilliarisation of muscle along with an increased in the number and size of the mitochondria; also a more efficient and effective transport and finally the use of O2 means that fat is used more during exercise and maximal oxygen consumption (V02 max) increases.

If cardiac hypertrophy begins to take place as a result of this training programme, my stroke volume will increase and this will lead to several benefits all linked to this one improvement. Having an increase in stroke volume my body has more oxygen being supplied to the working muscles because each contraction of the heart forces more blood around the body. Therefore, if there is more blood being pumped around, then there is more oxygen being transported. As a result of this effect there will be an increase in my VO2 max. If my VO2 max increase this means I will constantly have more oxygen available to join up with the hydrogen molecules as a by-product of glycolysis and the krebb cycle. If this happens it prevents the pyruvate joining to the hydrogen molecules which would create lactic acid and create muscle soreness.

Lactate threshold training is high intensity endurance performance training. While V02 max may indicate an athlete's genetic potential and natural ability, their lactate threshold can be increased substantially with the right training program. Athletes often use their lactate threshold to determine how to train and what sort of a pace they can maintain during endurance sports. The lactate threshold can be increased greatly with training; such as an interval training programme.

My circuit training regime will consist of me having 5 to 6 stations which last 60 seconds and I will repeat the circuit once or twice a week. After I have carried out a thorough warm-up I would go and begin my circuit. My first station would be press-ups, this will work on my upper body to help improve the power within my spike, however my main focus would be anaerobic so doing this for 30 seconds will force my anaerobic system to be pushed to its limits. My second station would be sit ups as this will focus on my core muscles but will still influence and aid to an increase in performance of my anaerobic system. My third station would be shuttle runs, improving my overall fitness. My fourth station would be squat jumps, improving my lower body. My fifth station would be burpees and my final station would be step ups. All of the stations will focus on a specific part of my body but carrying them out for 30 seconds each will help improve my anaerobic fitness, because all of these exercises are explosive. Between each station I will give myself a 30 second rest as this will help my body restore my systems before carry out the next station. Within these rest periods of 30 seconds, the activation of the excess post-exercise oxygen consumption (EPOC) will begin. EPOC is the volume of oxygen consumed above resting levels following exercise/during recovery. In this time my energy demand is much lower compared to when I am exercising but my demand for oxygen is still high (oxygen debt). There are two components of EPOC fast alactacid component and slow lactacid component. However, the main one which will have most effect in my 30 seconds of rest will be fast alactacid as this deals with resynthesising my levels of phosphocreatine and the resaturation of myoglobin this will help my body gain more energy to go on and complete further exercises. The slow lactacid component deals with removing latic acid which can help remove the soreness of my muscles and aid me to work harder for longer.

During circuit training, lactic acid is produced and a state of oxygen debt is reached. During the interval (recovery), my heart and lungs are still stimulated as they try to pay back the debt by supplying oxygen to help break down the lactates. The stresses put upon the body cause an adaptation including capillarisation, strengthening of the heart muscles, improved oxygen uptake and improved buffers to lactates. All this leads to improved performance.

Improving my anaerobic energy system will have many positive effects on my spike. I will be able to repeat the explosive action of the spike significantly more without seeing the onset of fatigue occur as quickly as it does now. This will mean that I will be able to get outside quicker ready to carry out the spike and hopefully because I am in the correct position and I can gain an advantage for my team as I would be able to move faster, jump higher and hit the ball harder.

Athletics – 100m Dipping for line

**C1 Speed maintenance and dip finish, poor anaerobic fitness.**

The major limiting factor on my performance is my anaerobic fitness levels, leading muscular fatigue which causes a breakdown in technique which inhibits my ability to sprint through the line.

An increasingly acidic environment (acidosis) causes a breakdown in the chemical reactions that produce the muscle fibre contractions I need to continue sprinting, by denaturing the enzymes needed, such as ATPase. Acidosis is caused by the build-up of lactic acid and the release of hydrogen ions.

There is a change in the balance of the chemicals that propagate the action potential within the muscle fibre. This decreases the excitability of the muscle fibre and therefore reduces its ability to contract. This is has a massive effect on a sprint which requires all the muscles used to be contracting with the highest force the muscle can produce for the whole race. Any decrease in the output of the muscle fibres results in a decrease in speed which severely inhibits my ability to maintain my sprint through the line.

Another factor affecting my anaerobic fitness is my stores of phosphocreatine running out, this means that I cannot resynthesize ATP to continue to provide energy to continue sprinting at high speed. Although the aerobic and lactic acid systems are available, they cannot provide energy quickly enough to sustain ATP levels at the level of work in a 100m race.

**C2 Interval Training**

**The Anaerobic (ATP-PC) Energy System**

ATP-PC System - 'ATP-PC system' stands for 'Adenosine-Triphosphate - Phosphocreatine system'. This energy system is used as a rapid way to resynthesise ATP in the body, and lasts for approximately 10 seconds. It is only able to last for a short duration longer than that of normal ATP, as 1 PC molecule can reform only 1 molecule of ATP, once all the PC in the muscle cell is broken down, this energy system no longer functions, and the lactic acid system takes over. The ATP-PC system allows high intensity activity such as very explosive movements to last longer.

Adenosine Triphosphate (ATP) stores in the muscle last for approximately 2/3 seconds and the resynthesis of ATP from Phospho-Creatine (PC) will continue until PC stores are depleted, which takes approximately 4 to 5 seconds. In total this gives me around 5 to 7 seconds of ATP from these two combined

For me to develop this energy system, for specificity I will need sessions of 4 to 7 seconds at high intensity, working at near peak velocity. A training session would look something like this:

* 3 sets of 10 repetitions over a distance of 25/30m. There would be recovery of 30 seconds per repetition and 5 minutes rest per set.
* Using the I would then progress to doing 15 x 60m with 60 seconds recovery
* 20 x 20m shuttle runs with 45 seconds recovery
* This series of sprints can be easily altered to produce overload and the varying exercises help to prevent tedium. Listening to an iPod whilst training can also reduce tedium.

**The Anaerobic Lactate (Glycolytic) System**

Only used at the very end of the 100m, possibly for the last 10 or 15 metres.

Once the PC stores are depleted the body resorts to stored glucose for ATP. The breakdown of glucose or glycogen in anaerobic conditions results in the production of lactate and hydrogen ions. The accumulation of hydrogen ions is the limiting factor causing fatigue, as it causes an imbalance of the chemicals that propagate the nervous stimulus (the action potential) within the muscle fibre. This decreases the excitability of the muscle fibre and therefore reduces its ability to contract.

Sessions to develop this energy system:

* 5 to 8 x 300m fast - 45 seconds recovery - until pace significantly slows
* 150m intervals at cruising pace, this should be maintaining a speed of approximately 75% of my maximum- 20 seconds recovery - until pace significantly slows
* 8 x 300m - 3 minutes recovery (lactate recovery training)

Speed Endurance can be developed using a session such as this:

|  |  |
| --- | --- |
| Speed Endurance |  |
| Intensity | 95-100% |
| Distance | 80-150m |
| No of Repetitions per Set | Up to 5 |
| No of Sets | 3 |
| Total distance covered per session | Up to 2250m |

The effects of this training should be that as I near the end of the race I will be able to maintain my speed right through the line. The training will have increased the resynthesis of Adenosine triphosphate by increasing the saturation on Phosphocreatine so the Adenosine diphosphate will find it quicker, which will decrease the time taken to resynthesize the ATP, which will mean I will have more speed endurance and not tire as much at the end of the race. My body will also have become more efficient at removing lactic acid from my system from this repetitive high intensity training. These results will allow me to continue driving my knees high and extending my strides, and sprint through the line, maintaining or gaining position in the race.