

EBOOK: ENDURANCE TRAINING FOR KIDS

[This is a Training Manual for all of those 'trainers' who want to understand the best type of endurance training to do with children. By reading this manual you will discover all the secrets to getting the best out of your athletes in every endurance session.]

*The Fastest way to
turn Trainers into
Coaches-
Guaranteed*



Table of Contents

Introduction2
Stamina3



Introduction

About me and Athletic Performance Academy

My name is Daz Drake and I've been a qualified fitness trainer since 2000 and was one of the first 100 coaches to be passed as a UKSCA accredited strength & conditioning coach in 2007. I first started learning about sport science at university in 1998 and it's been my passion ever since! Throughout University and every month since I've been coaching children in one form or another and have been Head of Strength & Conditioning at Gosling International High Performance Centre (IHPC) since 2005.

'Athletic Performance Academy (APA)' was set up in 2011; a company which provides strength & conditioning services to athletes in schools, youth sport organisations and professional clubs as well as coach education on sports coaching. The '**Peak Performance Bible**' represents the 'cliff notes' of all the principles that I have developed over many years and used to create the very successful programmes run at Gosling IHPC for elite performance tennis players. APA has been created out of my passion for coaching and wanting to bring it to a wider audience.

I can pretty much sum up what keeps my passion ignited in two sentences. This is my purpose in life.

- 1. To continue to learn and develop myself**
- 2. To provide a service to develop others**

Athletic Performance Academy and this Training Manual is my way of achieving both!

Warning:

I can tell you this much; it'll be a damn sight more difficult to progress in any discipline if you're not passionate about it, so if this vocation just seems like a 'convenient' way of making a living because you happen to like 'working out,' you can't think of anything better right now and it sounds better than being stuck in an office then my organisation is NOT for you!

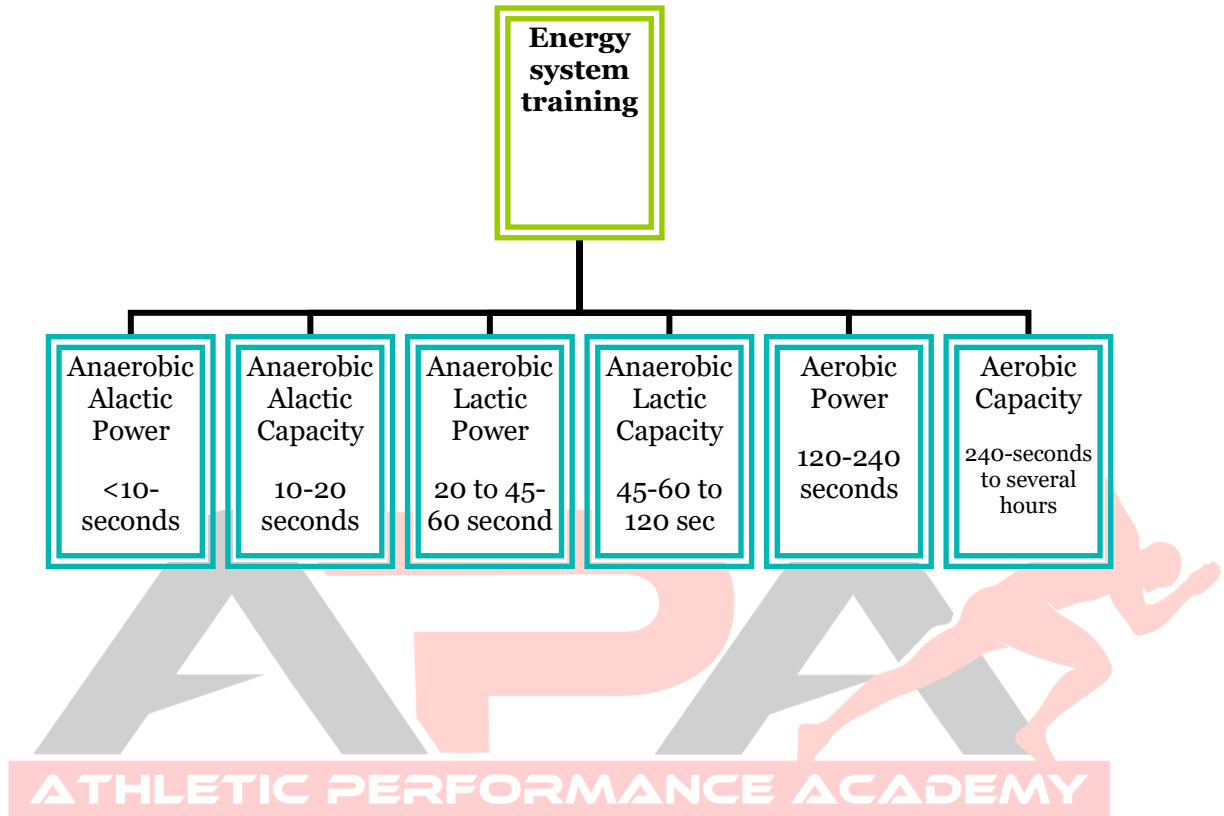
If on the other hand working with (young) athletes is something that, like me, lights your fire, then you have come to the right place and I intend on giving you all the benefit of my 10 plus years experience and relentless search for knowledge; a journey that has seen me seek out some of the best trainers and training methods that this industry has to offer.

To do this I have read hundreds of books, read thousands of articles and been to several seminars each year since the beginning, as well as constant communication with leading experts in related fields. It has been said that it takes 10,000 hours to become an expert, a feat typically worked at over 10 years! That's an average of 2 ½ hours of deliberate practice in this field every day of every year and I have done that.



Stamina

Over the last several years as ‘fat loss experts’ have become more efficient with their strategies it has become apparent that what these experts are recommending to get lean looks increasingly like the programmes many athletes are using for conditioning. All sports lie on a continuum from predominantly anaerobic to predominantly aerobic in their production of energy (although I use that word predominantly very cautiously as of course all energy systems are working all the time). See below for the full spectrum:



Fat loss experts have stopped advising weight loss clients to use steady state cardio work for weight loss or weight maintenance. S&C coaches have always been opposed to this idea for conditioning most sports as it undermines the strength and power work being done in the weight room. I think that there is no harm in having continuous running as a start point for someone with no training history in stamina training other than playing the sport itself such as few weeks of 20 minutes running. But it certainly wouldn't be a major focus of future training interventions.

Aerobic Intervals (Submaximal)

Modern thinking favours 'Interval training' more recently coined 'High Intensity Interval training' or HIIT for short. Interval training is nothing more than alternating periods of submaximal work and passive rest. The complicated part of interval training may be figuring out how to use it. How much work do I do? How hard should I do it? How long should I rest before I do it again? Truth is, you can also do low intensity interval training. In fact most deconditioned athletes should not start with HIIT but LIIT.

Beginners can start off with low intensity work intervals under 70% HRR using dynamic mobility drills up and down the gym floor. Note that these form acceptable fat loss strategies for conditioned athletes on recovery days to aid in fat loss without expending lots of energy. Those looking to get the recovery affect but not so much fat loss can move through the mobility drills a bit slower!

HIIT will make you vomit if you don't work into it. Generally the work is a high percentage of the maximum heart rate but still represents only about 40-50% of an athlete's maximum sprint speed. We're talking about a speed that one can sustain for a couple of minutes maximum, typically the speed we would drop out at during a VO₂max test. This would represent about 70% effort or 7 out of 10 on a Borg RPE scale. Scientific research refers to this as the Maximum Aerobic Speed (MAS).

Determination of Maximal Aerobic Speed (MAS) using an Incremental Treadmill test

I should say from the outset that at APA we use the Yo-yo Level 1 intermittent recovery test to determine the aerobic capacity of our athletes. Since I mainly work in Tennis which is an intermittent sprint sport this test has a good carry over to the demands of that sport. I have used the more common Bleep test but phased it out in favour of the Yo-yo test. Because it involves sharp changes of direction I have found that typically our professional male athletes will get to a speed of around 17.5km/h on the Yo yo test.

You can also determine MAS from an incremental treadmill test and in my experience the running speed at exhaustion is a little bit higher because there is no change of direction. I use a basic protocol starting at 6km/h for females and 9km/h for males and a 1% gradient. After a 3 minute warm-up at the starting speed I simply increase the running speed by 1km/h every minute until volitional exhaustion. A good speed to aim for in adults is 17km/h plus for females and 19km/h plus for males. This speed could be sustained by a lower conditioned athlete for around 1-2 minutes. The elite runners of the world may be able to hold onto this speed for 3-5 minutes.

You can also do the Billat 6 minute all out run test to determine MAS but I have found that with the majority of non-track athletes they end up running at a speed slightly below what they would get to on an incremental running test. There is something about having to hold onto a speed for 6 minutes that doesn't seem to get the best out of non-runners!

What do you do with this information on MAS?

Well as already eluded to earlier, we can use a modern approach to develop of aerobic fitness by breaking the workout into intervals. This allows the athlete to perform a large volume of work at a running speed that would normally elicit fatigue in just a few minutes. By giving the athlete rest periods at set intervals the athlete will be able to perform several minutes of work at this high running speed and in doing so increase their aerobic fitness.

I typically like to use intervals of between 30 and 60-seconds. In my experience short work and an equivalent or even shorter rest period approach such as 30:30 or 40:20 works really well for these high intensity interval training sessions at about 70% effort. Where I would use longer interval prescriptions is with fat loss clients due to more calorie expenditure. It might also be prudent to do a few weeks of these before the clay court season in Tennis where the rallies are longer.

I have seen various versions of Aerobic Intervals all based around the 100% MAS. Easier versions are 15:15 and 30:30 at 100% MAS: 70% MAS. I personally find these are pretty easy for highly trained athletes and I might push them by either extended the interval to 1 or 2 minutes or having a few sustained intervals for 2-3 minutes immediately after a short interval!!! But my personal favourite is to just crank up the speed of the interval and do the work at 130-140% MAS for 30-40 seconds!! Popular ones in the research are the Eurofit 15:15 at 120-130% MAS and the Tabata 20:10 at 130-140% MAS.

Getting your recovery time right

There are two primary ways of performing interval training. The first is the conventional Work-to-Rest method. You use a set time interval for the work period and a set time interval for the rest period. The athlete usually works for 30-120-seconds and generally rests for one, two or three times the length of the work interval before repeating the next bout. Please note that while this ratio is without doubt fantastic for stripping fat owing to the high rate of caloric expenditure certain alactic sports such as baseball, cricket and tennis involve explosive bouts for a few seconds followed by longer periods of rest with work-to-rest ratios of 1:2 going up to 1:10 plus so you have to match the ratio to the demands of the sport. So in this example we may also use shorter work to rest ratios of say 10- seconds work to 20-seconds rest. The big drawback to the Work-to-Rest method is that time is arbitrary. We have no idea what is actually happening inside the body. We simply guess.

With the mass production of low cost heart rate monitors, we are no longer required to guess. We can now also use the heart rate monitor and simply choose an appropriate recovery heart rate whether that be a percentage of heart rate reserve (e.g., 60% HRR) or a defined number such as 120bpm.

I personally feel I don't need to give a well-conditioned athlete such long rest from submaximal effort running. Ideally I like to keep the rest to a maximum of 1:1 even if the heart rate is still above the 120bpm value.

Now there have been some studies that show that you can get a great aerobic and anaerobic training effect with short work periods of 10-seconds and short rest intervals of 20-seconds. This has been thought to owe to the fact that intramuscular stores of myoglobin can sustain the oxygen demand of the short work period once ATP-CP stores get depleted.

Experiment with different protocols and see which ones work for your athlete and the sport they are in. Remember, if you are working with a really deconditioned athlete you are advised to spend a few weeks doing steady state running. Interval training of any kind can be stressful on the body so build up to it gradually.

Aerobic Interval Training with Children: A Good Idea?

There is no doubt that young athletes are metabolic non specialists. They are equally happy representing their school in a cross country race and sprinting around in the playground playing tag. We have a slightly out-dated understanding of the physiology in that we have always thought that children have a good aerobic capacity and therefore will get better training from doing more aerobic work.

Biochemical profile: children in comparison to adults

Anaerobic markers

- Similar resting values for muscle ATP and PCr
- Lower glycolytic enzyme activity (e.g. PFK) lower adrenergic stimulation
- Smaller glycogen stores, less fast-twitch muscle fibres?
- Lower maximal blood lactate concentrations
- Better regulation of blood pH and blood [H⁺] Schwankungen

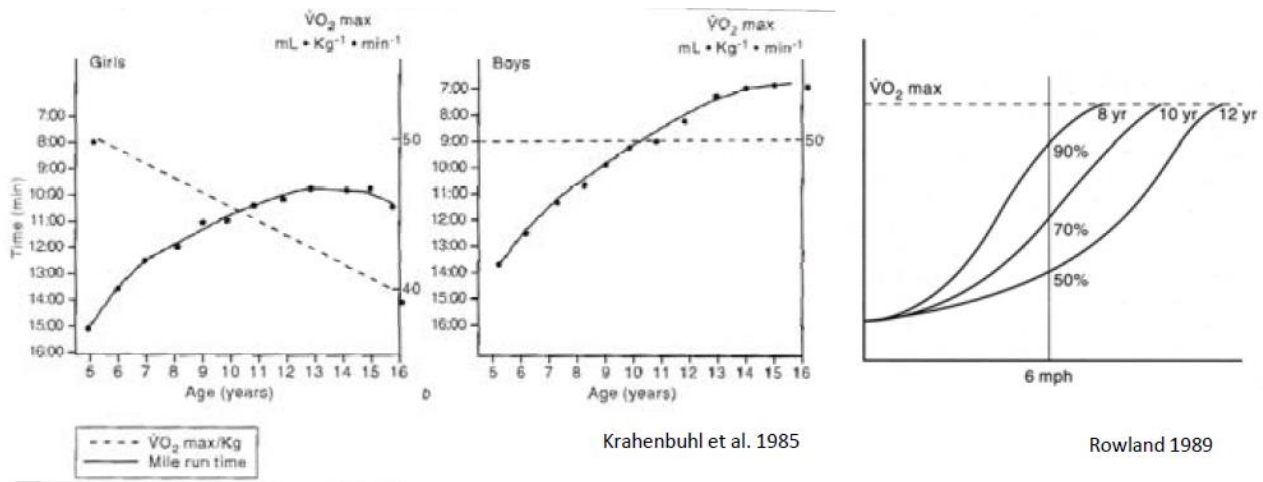
Aerobic markers

- Quicker VO₂ response
- Higher relative volume of muscle mitochondria and aerobic enzyme activity
- Lower RER with better fat utilization

Children seem to have lower anaerobic capabilities (in terms of enzyme activity, glycogen stores and blood lactate concentration) and a good capacity for aerobic exercise on the first view of their biochemical profile, but this has no implications for aerobic and anaerobic fitness and endurance training!

Let me explain!!! Research has now shown us that while children have a better aerobic profile than adults in as much as they can attain steady state quicker than adults, the biochemical profile does not correspond to aerobic performance.

The fact remains that older children always outperform younger children on running tests even when matched for VO₂max relative to body mass. See Figures below.



VO₂max related to body weight has no indication for aerobic performance

Running economy in children is lower (force production, co-contractions).

In spite of a high biochemical capacity, the aerobic performance has biomechanical limitations!

In practical terms this means that even if the VO₂max goes down or stays the same as the child ages the actual running speed they can sustain for a period of high intensity work still increases owing to more favourable mechanical advantages from growth and maturation.

Now I am not saying that children don't need to do aerobic training because growth and maturation will take care of all the improvements for us. That would be like saying that we don't need to do strength training because growth and maturation take care of all of the strength gains we need. We know that we can make accelerated gains in both strength and stamina through targeted training of these components, which will lead to greater gains than through maturation alone. Just appreciate that aerobic performance has biomechanical limitations! Also appreciate that many high performance young athletes are practising their sport for up to 10-20 hours per week. This is why that I feel that we can probably be smarter if we look to focus our stamina modules on anaerobic training because for most developing children they are getting more than enough aerobic work from the sport itself during practise and matches. The only exception to this is if you have a child who is clearly not getting enough aerobic stimulus in their activity. However, if I feel that a child is not active enough in general then I would always encourage them to first seek out opportunities to become more active by participating in physical education, sports and other social activities which develop a more rounded athlete BEFORE looking to add in extra stamina runs!!

I have the opinion that aerobic adaptations should be by-products of the games that children are playing in the Fundamental years and sports skills practises they do in the

Learning to Train years. Only when the athlete is approaching Puberty would I be more inclined to do structured interval training on a treadmill or equivalent, because at this point we may need to create an overload that the skills practise is not currently achieving. Coaches would call this '**work capacity**' training. This is about preparing the body for the higher intensity work to come by building the athlete's ability to recover. I like to call this training '**muscle conditioning**' as it relates to weight training but for running based modalities treadmill intervals can work really well.

This leads me onto my final point: if the training load on the practise court is insufficient then always try to raise the load of the practise session first before looking to supplement with extra training off the practise court. Experience tells me that the athlete will always work harder on their sport than chasing shadows on a treadmill!

My conclusion: children will benefit from developing a foundation of aerobic capacity as they approach puberty but appreciate that aerobic performance has biomechanical limitations. If the young athlete is already playing a lot of sport I would be inclined to move onto more anaerobic training. If they are not playing a lot of sport then aerobic HITT training is a good place to start!

Anaerobic Intervals (Repeated Sprints)

Aerobic and Anaerobic Interval Training are both important. It would be reasonable to assume that an athlete should be accustomed to performing aerobic intervals for a period of time before spending any significant volume of training doing Anaerobic Interval Training. Therefore I still maintain that some steady running for a few weeks followed by a period of aerobic intervals should be the focus of stamina training for as long as the athlete is still making gains in this area.

I spoke to Dave Hamilton who is a former Head of S&C for the GB Women's Hockey Team and he said that repeat sprint type work is one of the highest forms of training stress he could put his women through and as a result he has only just started to incorporate it into their training. This is after 3 years of development work with the women in the Olympic squad that went to London 2012!

He felt he was getting great gains from aerobic intervals and focusing on getting really strong in the gym; both of which contributed significantly to developing a robust athlete. Now he has achieved that he can put more focus on developing the repeatability of their efforts. So before we go on I guess I am just saying that you should always look to see if you can raise someone's fitness (via assessment on the Yo yo) with aerobic intervals first and then get into the Anaerobic work.

As far as the basics of anaerobic interval training are concerned, the longer the work interval the shorter the rest period as a percentage of the work interval. In other words, short intervals have a much higher muscular and neural demand and will require longer rest periods when viewed as a percentage of the intervals. However, for the most part if the work period is very intensive alactic work such as sprinting then the rest period can be at least twice or three times as long as the work period.

Examples below:

- 15-seconds work. Beginners at least 45-seconds rest (1-3) more advanced (1-2)
- 30-seconds work. Beginners at least 90-seconds rest (1-3) more advanced (1-2)
- 60-seconds work. Beginners at least 120-seconds rest (1-2) more advanced (1-1)

For very conditioned athletes the focus is on more anaerobic work and coaches should view the aerobic training as a by-product of pure anaerobic work. One approach is to start every session (even from the early stage) with very high intensity repeated sprinting (at or above 90% maximum effort in terms of absolute speed-not RPE or HRR) and simply increase the volume of this work and reduce the rest over the course of a training cycle. For example starting with 10 sprints of 15-60m separated by 10-60-seconds rest and moving to 30 sprints, ensuring the rest is reduced over the training sessions.

This type of training is called speed endurance training or repeated sprint training and represents the highest form of stress because each interval is performed at maximal sprinting speed. In recent years I moved away from pure 'speed' endurance and expanded the definition to sports conditioning. I felt that as it relates to tennis agility endurance and even power endurance were more relevant to that sport. In this way I could be working on repeating maximal bursts but it wouldn't just be limited to sprints, it could include anything that an athlete might have to do repeatedly in their sport.

Just remember that at the end of the day you have to match the work and rest intervals to the demands of the sport and the needs of the athlete. As long as you get that right then it opens up a world of creativity!

Anaerobic Interval Training with Children: A Good Idea?

At APA we specialise in working with the youth sports market. I used to feel that children are metabolic non specialists who are not 'fully' set up to maximise the benefits of full on anaerobic training with aerobic recovery- especially when you think of all the other stressors going on in their lives. I still think that this is true but I am starting to listen to the physiology which tells me that actually children are capable of performing anaerobic work and get some terrific benefits from doing it.

There is a bit of a contradiction that runs through child physiology. On one hand we can see that children have lower anaerobic capacities than adults but on the other hand they love running around at maximal effort. Just look at the playground and you'll see examples of this everywhere, and you don't see lots of puffed out kids stooped over and feeling feint from their efforts. They are very good at self-regulating.

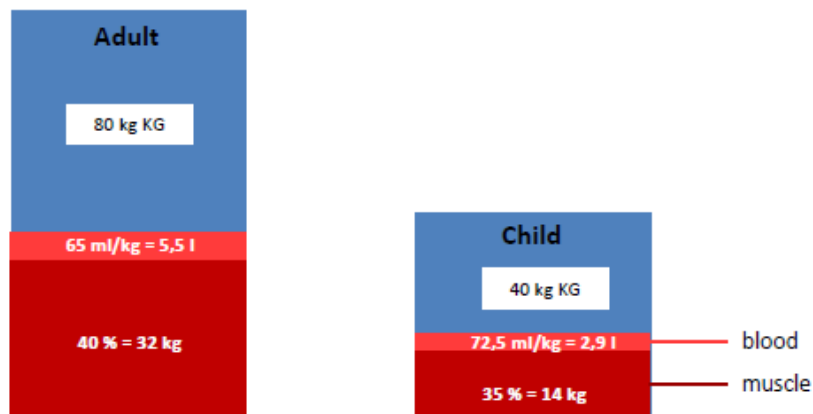
Just as with aerobic exercise, anaerobic capacity is adapted to body composition meaning adults always outperform children in terms of the absolute amount of power that they can produce repeatedly. Evidence to support this inability of children to work anaerobically comes from the research which shows that children produce a lower concentration of Blood Lactate ([BLa]).

However, as the figure depicts below, children have a lower relative and absolute muscle volume and a relatively higher blood volume.

Body composition from children and adults is different

Children have a lower relative (and absolute) muscle volume and a relative higher blood volume.

Consequently blood [La] is lower, but this is no indication for a lower anaerobic fitness!



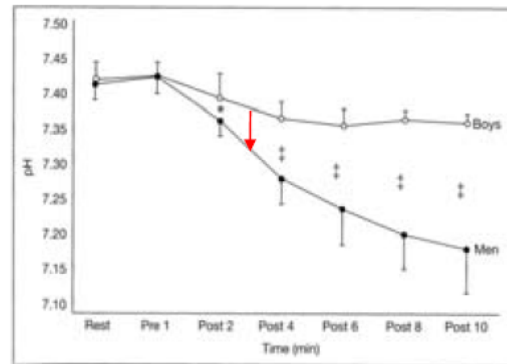
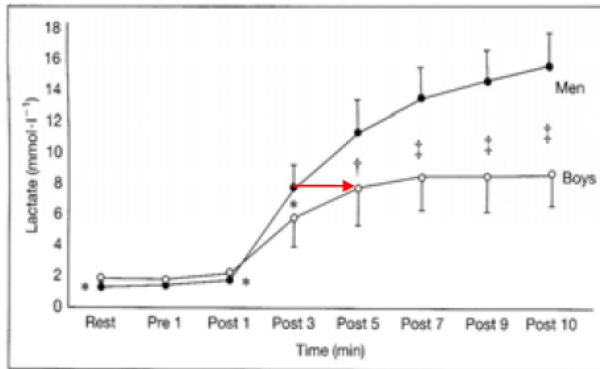
As a result of having less muscle volume and more blood volume children will not produce as much blood lactate. But this is no evidence of a lower anaerobic fitness- if you define anaerobic fitness as ability to repeatedly work at a high intensity within a defined drop of power. Adults will continue to produce more and more blood lactate as they repeat the same anaerobic work whereas children will only produce so much blood lactate. They have a smaller engine but they produce smaller emissions. They are efficient at being able to reproduce fairly stable levels of power!

But what is interesting is that even with this smaller but stable amount of blood lactate in the blood stream children are still able to regulate their pH at a constant level. This compares to adults where as the [BLa] increases there is a reciprocal decrease in pH. Consequently during repeated sprint activity children will achieve lower absolute power output values in every bout but the drop off in performance will be relatively lower as a percentage and they can maintain a higher overall level of performance!

Regulation of blood pH is better in children than in adults

Similar blood [LA⁻] correspond to higher blood pH.

Consequently children can better maintain performance during intensive repetitive work!



Ratel et al. 2002

This has caused me to view anaerobic training with children differently. I used to think that they were not equipped physiologically to handle anaerobic work. I now believe they are more than equipped; they just can't produce very high levels of power output because they have a relatively lower percentage of muscle volume so they have a smaller engine!

Children and adults alike enjoy running hard and fast and racing and being competitive rather than plodding along. I have found that I will make steady progress if I make sure I do enough aerobic work in the week and build on top of this with some anaerobic work too. If you are dealing with elite athletes it is relatively easy to get the aerobic work in because they are practicing their skills every day which has a big aerobic component. If they are not then add in some HIIT and you'll be golden.

So for my stamina development:

Stamina Focus	
Level 1	Games: (Tag games/relay races/partner activities/skipping contests)
Level 2	Continuous runs and Long intervals: Train Aerobic system using 20-30 min runs and shorter 6-8 minute fun obstacle courses / sports drills
Level 3	Medium and short HIIT intervals: medium: goal 1000 skips in 5 minutes, and footwork combinations for 2-5 minutes. Short: focus on up to 1-minute 100% MAS intervals using runs and SAQ circuits, progressing to 120-140% MAS
Level 4	Supra-maximal track: Train Aerobic and Anaerobic system using structured repeated maximal effort track sprints
Level 5	Shuttles: Train Anaerobic System using repeated there and back sprinting, known as shuttles. This is the basic form of sport specific conditioning.
Level 6	Power Circuits: Train Anaerobic System using multi-directional running and jumping. This is the highest form of sport specific conditioning

Level 1:

Here we are indirectly training the energy systems using fun games. I also like to teach skipping and running technique of course so as well as the tag games we can do lots of relay races and also skipping contests, with the goal of completing four progressive skipping challenges and being able to do 200 skips in a minute.

Level 2:

The aerobic and anaerobic systems are still being trained indirectly because the focus is on getting around an obstacle course that taxes the children's skill level. We do some continuous runs but this is a less preferred option.

Level 3:

This is where we start to train the aerobic system a bit more directly using high intensity sustained efforts of 3-5 minutes such as skipping or running (Fives). I also find that doing SAQ circuits for time where maybe you spend 30-seconds at a station doing ladders or tennis footwork then having 30-seconds rest is a good way of preparing the body for the HIIT running intervals that follow!

We then introduce traditional HIIT for development of the aerobic and anaerobic system. We look to build the athlete's general work capacity; their ability work and recover using short blasts of supra-maximal effort at 120-140% MAS.

Level 4:

Assuming the athlete has had a good build up period of doing aerobic intervals for a period of time- the longer the better- then we can start to test the robustness of our athletes by doing repeated sprint work on the track. Because the work is mainly linear it will be very stressful neuromuscularly on one hand but also very predictable and less sport specific on the other hand. Because it is anaerobic and repeated it is a form of sport specific conditioning.

ATHLETIC PERFORMANCE ACADEMY

Level 5:

Here we start to introduce change of direction using shuttles and tennis specific basket drills

Level 6:

This represents the highest level of sports conditioning. This is very specific conditioning and will often utilise more agility work and power work such as jumps and throws.

I tend to bring in extra shuttles and drills like this during the pre-competition phase for athletes in Level 6. Athletes will spend up to 3 sessions training anaerobically as they get closer to competitions. We will typically replace one of the strength sessions with an extra conditioning session during pre-comp. The younger athletes will do some of this but in much less volume. They might do mainly HIIT training and simply swap the HIIT session for an anaerobic session nearer the competition.

Typically across all levels I am doing between 1 and 3 sessions that develop the energy systems in addition to the constant development of these qualities as a by-product of skills training.