**Monitoring and Testing the Athlete .**

As the training year goes by, the coach will want to see if his athlete is making progress and is the training programme being effective. Now, many down to earth individuals will say “Isn’t it easy to find out: just put him into a race and see how he does. That will soon tell you where he’s at”. And they certainly have a point; indeed, it may be fair to say that the real “acid test” of any training programme is whether the athlete’s performance in racing actually improves or not. Seb Coe did not particularly like or approve of indoor running, believing that it was preferable to train right throughout the Autumn/Winter/Spring, thereby harbouring all his resources for the outdoor track season. We saw in the article on Periodisation that his father and coach, Peter Coe, believed in just one major peak in the entire year. In spite of this, however, Coe always ran a couple of indoor races in the early Spring. But he always insisted that he wasn’t taking those races too seriously: he ran them simply to determine what was his level of fitness at that time. He wanted to know whether his fitness was at the desired level for that stage of the season or not.

But is this the whole picture? if an athlete turns in a disappointing performance in a race does this automatically mean that he is not making progress? I would suggest not. There may be several reasons for a runner having an “off day” or “a bad day at the office”. He may have a cold or tummy bug (witness the virus that affected athletes in the World Championships in London this year). He may have some emotional upset in his life; he may have lost some of his racing gear or has had it stolen;(remember Sonia O’Sullivan’s loss of her spikes before the World C’ship.5000m. in Paris 2003) He may have had his night’s rest totally disrupted by unforeseen circumstances. I remember the Irish cross-country team having to leave their hotel beds in the middle of the night due to a fire alert just hours before they were due to run the European Cross in Edinburgh in 2003. (It was a false alarm, set off by some inebriated guests at a wedding). Sometimes a tactical error can lead to a poor result. Seb Coe again (!) got his tactics all wrong in the 1980 Olympic 800 and was beaten by a man who was all of 4 seconds slower on paper. (“You ran like a donkey” was his father’s comment to him afterwards). Occasionally, we hear harsh critics (usually the arm-chair variety) dismiss these as “excuses, excuses” but there is a major difference between an excuse and a legitimate reason.

So, apart from races, what are the other means of monitoring the progress or lack of it in a distance runner? In my opinion there are four main ways to do so: (A) Blood tests . (B) Lab./treadmill testing, incorporating Vo2 max. and lactate testing . (C) Threshold ( “Tempo” ) runs using a heart rate monitor. (D) Time trials.

**A . Blood Tests:** Blood tests are more a means of monitoring the health of the athlete rather than his athletic progress. But, when one considers that improved performance is impossible if the athlete’s blood profile is below par, then it is apparent that the two are inextricably linked. When the athlete goes to his GP for a blood test, he should ask for a **full blood count.** Otherwise, the GP may only ask the lab.to test for the more standard, conventional readings such as cholesterol, haemoglobin, white cell count, etc. Sometimes an athlete can get a print-out of his results but may not understand half of them! So the athlete and his coach should ask the doctor to explain them in straightforward English! Here is a simple explanation of the aspects most relevant to the athlete:

**RBC (Red Blood Cells ):** The primary function of red blood cells is to carry oxygen ,via the haemoglobin contained in each red blood cell, to various tissues as well as giving blood its red colour. A decrease in the number of RBC can result in anaemia which usually stems from dietary insufficiencies. The normal range is 4.2 to 5.4/L for a female and 4.7 to 6.1/L for a male.

**Haemoglobin (Hgb.):** Haemoglobin is what serves as a carrier for both oxygen and carbon dioxide transportation. Molecules of Hgb. are found in each red blood cell. Haemoglobin can be increased by training (or simply living) at high altitudes and by various other means, not all of which are legal. ( e.g. the use of artificially generated EPO ). The normal ranges are 12- 16 g/dL for females and 14-18g/dL for males. A decrease in Hgb. is usually a sign of anaemia and it is virtually impossible for an athlete with low Hgb.to compete well. Strangely, athletes with low Hgb. can, sometimes, produce reasonably good performances in training. But the Hgb. reading is one of the key indicators of potential performance in races. Please check the article on Nutrition for the best food sources to boost haemoglobin. ( g/dL=grammes per decilitre).

**Haematocrit :** this is the percentage of the total blood volume that’s made up of red blood cells. Again, a decrease in percentage levels may be indicative of anaemia or more serious illnesses. A massive increase in percentage levels may be an indicator of blood doping or EPO use. The normal range is 37% -47% in females and 35% to 55% in men.

**MCV : ( Mean Corpuscular Volume ) :** The MCV is the average volume of red cells. It is one of three cell indices used to check for abnormalities. Low MCV indicates small (microcytic ) average RBC size, high MCV indicates large ( macrocytic ) average RBC size. Both low and high MCV readings can indicate different types of anaemia. High MCV may be indicative of a vitamin B12 deficiency or even liver disease.( It can also be elevated due to excessive alcohol intake!) Low MCV can indicate iron deficiency anaemia. Normal range: Female:79-98. Male: 80-100.

**MCH: ( Mean Corpuscular Haemoglobin ):**  The MCH is the weight of haemoglobin in the average blood cell. This is another way to assess whether some sort of anaemia or deficiency is present. Normal range is 26- 34 pg for both Males and Females.

**MCHC ( Mean Corpuscular Haemoglobin Concentration ) :** This is the measurement of the amount of haemoglobin present in the average red blood cell as compared to its size. A decrease in number is an indicator of iron deficiency. Normal range: Female : 30-36 g/dl ; Male : 31-37 g/dl.

**RDW ( Red Cell Distribution Width ):** the RDW is an indicator of the variation in red blood cell size. An increase in RDW can be indicative of iron deficiency anaemia, vitamin B12 or folate deficiency and diseases like sickle cell anaemia. Normal range for both Male and Female is 11.7%-14.2 %.

**Plt ( Platelets ) :**  platelets are essential for the body’s ability to form blood clots and thus stop bleeding. They’re measured in order to assess the likelihood of certain disorders or diseases. Normal range is 150-450.

W**hite Blood Cells ( WBC ) :**  they are sometimes referred to as leukocytes. A fluctuation in the number of WBCs can be an indicator of things like infections and disease states dealing with immunity e.g. stress. Normal range is 4.5 to 10.5.

**Neutrophils:** these are a type of white blood cell that is in circulation for only a very short time. Basically, their job is to kill bacteria that cause infection. Metabolic disorders and stress, can cause an increase in the number of these cells. Having a low number of neutrophils can be indicative of a viral or bacterial infection or even a very poor diet. Normal range: 2,500-8,000 per cubic mm.

**Iron :( Fe.)**  is the mineral needed for haemoglobin; it is the protein in red blood cells that carries oxygen. It is also needed for energy, good muscle and organ function. About 70% of the body’s iron is bound to haemoglobin in red blood cells. The rest is bound to other proteins such as ferritin in bone marrow. *( Again, cf. the article on Nutrition for a list of iron rich foods ).*  Normal iron levels are between 35% to 45% for a woman and 39% to 50% for men.

**Ferritin :** ferritin is a blood cell protein that contains iron. A ferritin test reveals how much iron your body is storing. It has been colloquially described as “the reserve tank” for iron. When getting a blood test, athletes should ask specifically for a ferritin test. (It’s unlikely that it will be done if you do not ask for it). It is highly significant because, while your haemoglobin levels may be fine, if your ferritin level is low then you will suffer from an iron deficiency before long as there is nothing to replenish it. Normal ferritin levels are 18- 160 micrograms per Litre for a woman and 18- 270 mcg/L for a man.

**B. Lab.testing ( treadmill test ) :** Lab. Testing is the most comprehensive and accurate means of testing the progress of an athlete. But be warned: such testing does not come cheap. If you are an elite athlete (or a scholarship athlete in some of our third level colleges) you will get tested for free, otherwise you have to foot the bill yourself. The most significant element of these tests is determining precisely the athlete’s VO2 max. and Lactate Threshold ( OBLA point ). **A biomechanical profile ,which can reveal any imbalances ,is also highly important.** Sometimes, however, the person or persons performing the tests may not explain in layman’s language the significance of the test results and sometimes the coach may be reluctant to ask questions for fear of revealing his lack of knowledge of these rather esoteric matters. The first lab. test that I witnessed was back in 1988 when members of the Kerry Gold Squad were tested in Trinity College by the inimitable Dr. Bernard Dunne. Quite frankly, back then, I did not understand a lot of the procedure or the arcane terminology: luckily, Dr. Dunne was a man who was only too happy to explain in “layman’s language” what exactly was going on. The National Director of Coaching, Jim Kilty, was present and was also very helpful. The coach should be enlightened about the results and the possible reasons for them. A high VO2 max., for instance, may look very impressive but coaches should be made aware that much more important is the percentage of VO2 max. at which the athlete is able to run. As stated in one of the very early articles, many great marathon runners, like Frank Shorter , did not have phenomenally high VO2 max. readings but they were able to run at almost 100% of their max. which was one of the reasons why they ran such phenomenal times for the distance. **Much more significant is the Lactate Threshold or OBLA point.** Coaches and athletes should not allow themselves to be confused by such esoteric jargon as “First Threshold”, “aerobic threshold”, “ Second Threshold”, “ Onset of plasma lactate accumulation” ,etc. They should ask the tester **“ What is my OBLA point ?”** **or “At what running speed ( or at what heart rate ) do I start to generate** **so much lactate that my body can no longer metabolise it and convert it into energy? ”** Remember that our bodies are generating lactate all the time (even while we sleep ) and “re-cycling” or reconverting it into energy. But, with strenuous exercise, we reach a point where we start producing so much lactate that we can no longer metabolise it and our systems become “flooded” with lactic acid and our muscles effectively seize up. After doing a treadmill test, the athlete is usually presented with a graph of his lactate production. His speed, in metres per second ( or kilometres per hour or miles per hour ), is plotted on the horizontal axis ( the X axis ) , his heart rate and VO2 max. on the two right hand side vertical axes ( Y axes )and his rate of lactate production is plotted on the left side vertical axis .The latter (the lactate ) is measured in millimoles per litre ( mmol/L ). He will notice that when he was running at a comfortable, easy or “steady” pace, the graph of his lactate was rising very gradually and slowly but then, when he reached a certain speed, there was a sudden spike in the graph and it rose almost exponentially. This is the all-important OBLA point. By dropping a perpendicular line down from this point to the horizontal axis he can discover at what speed he was running when he hit his Lactate Threshold. By drawing a horizontal line across from this point to one of the right vertical axes, he can see what his heart rate was when he reached his LT. It usually occurs (in highly trained athletes) at between 80 % and 90 % of VO2 max. I remember our most recent Olympian, Mark Kenneally, being tested 12 years ago (7 years before he ran in the London Olympics) and finding that his LT occurred at a speed of 20.6 Km./hour and at a heart rate of 178 beats per minute. This indicated that Mark had the wherewithal to become the elite runner which, of course, he eventually became. It meant that he could (and should) do his tempo runs at just about 20 Km. per hour (12.5 miles per hour, approx. 4:50 mile pace ) and that at his OBLA point his heart rate was just about 89 % of his maximum .His lactate level at the OBLA point ( found by drawing a horizontal line from the OBLA point to the left vertical axis ) was just about 4 mmo/L which is the classical level for this to occur. Indeed ,as a result of the findings of Mader et al. (in 1976), 4 mmo/l became a synonym for the Lactate Threshold. This was not quite accurate however, as the LT can occur at levels between 2 and 7 mmo/L. I remember having a panel of athletes, who were all members of the Irish International cross-country squad, tested in the University of Limerick some years ago and most of their LT levels were about 2.8 which indicated that they were not particularly fit and a fair amount of training was still required! (in fairness,it was only early October). As a result of Mader’s theory, it was assumed ( incorrectly ) that the OBLA point for all athletes was 4mmo/L. This unfortunately meant that many runners trained at the wrong pace for many years: some (those whose OBLA point was less than 4 ) were over trained incurring fatigue and staleness while others ( with an OBLA point greater than 4 ) were undertrained and did not achieve their goals. It is important to know the precise OBLA point for each individual athlete as it is most certainly NOT a case of One Size Fits All. **Now let’s look at VO2 max**. Some athletes and coaches seem to think that it is the ultimate key to reaching elite levels of performance. But, as stated earlier, it simply is NOT. Indeed Tim Noakes asserts that it is a relatively poor predictor of performance due to variations in running economy and fatigue resistance during prolonged exercise. There is no doubt, however, that a high VO2 max. constitutes a kind of membership card for entrance into the world of top level middle and long distance running excellence. (Incidentally, Mark’s VO2 max. on that day was 78, considerably higher than Frank Shorter’s or Derek Clayton’s!). I imagine most people know that VO2 max. is the maximum rate of oxygen consumption as measured during incremental exercise. It can be expressed as an absolute rate in litres of oxygen per minute (L/min.) or as a relative rate in millilitres of oxygen per kilogram of body weight (mass) per minute ( mL/Kg.min. ) The importance of the ability to run at a very high percentage of the VO2 max. was referred to earlier and this will be a function of three other factors: (a) the pace at which the OBLA occurs (b) the VO2 max. pace, which is approximately the athlete’s best 3000m. pace, ( Billat and Koralsztein in 1996 ) and (c) the runner’s economy . Now we know that the VO2max. occurs at approx. the runners best 3000m. racing pace and that the OBLA point occurs between 80 % and 90 % of VO2 max. pace. This leaves running economy. There are **three** factors which affect running economy : 1**. Metabolic factors** i.e. the ability of the aerobic system to metabolise glycogen and fats effectively. 2**. Neural factors**, which refer to the body’s ability to recruit the appropriate muscle fibres which are necessary to maintain the desired pace. 3.**Good mechanics** which transfer most of your effort into forward motion. Improved biomechanics can eliminate such problems as misaligned gait and excessive lower limb rotation. ***This was referred to in the last article on weight training, plyometrics and drills.***

If an athlete is about to undergo a VO2 max. test for the first time , he should be made aware of a number of very important factors : First, he should taper his training for at least two days beforehand in exactly the same way as if he were going to run a race. In a VO2 max. test, the athlete is ran to exhaustion (or even collapse!) so it is imperative that he enters the test fresh and rested. Second, he should try to familiarise himself with the equipment used. Many athletes find it uncomfortable and extremely inhibiting to have a type of mask put over their nose and mouth or to have a tube put in their mouth and be still expected to run – and run hard and fast. Furthermore, many people do not like having a medic or lab. technician stick needles in them at regular intervals ( the athlete has his earlobe or finger pricked in order to have a minute quantity of blood extracted so that the increasing lactate levels can be monitored.) Some simply don’t like running on a fast moving, slightly sloped treadmill whose gradient is gradually increased. Many runners do not do particularly well on their first test as they can find the entire procedure a little disconcerting. But with practice, they cope much better.

### Of course, if you want to avoid a lab. test , it is possible to buy one of the many lactate testing kits which are now on the market. While it is possible to purchase such a kit for as little as €25 it might be wise to spend considerably more; top of the range kits cost €300 or more.

Some readers may be wondering if there is any other method of calculating VO2 max. pace and Lactate Threshold pace without having a lab. test. Such a method was explained in an earlier article ***(cf. Correct Training Pace*** ) but let’s look at it once more : suppose an athlete has ran 3000m.in 8:20.This means he has ran 3000m.in 500 seconds. Dividing 3000 by 500 gives an average speed of 6 metres per second or 2 mins. 47 seconds per kilometre.. This is his VO2 max. pace. Converting this to the more familiar miles per hour, it is 4 minutes 28 seconds. (1609\* /6). Now, the Lactate Threshold pace is approx. 85% of this. 85% of 6m. is 5.1m. Dividing 1609 by 5.1 gives 315.49 i.e. 5 minutes 15.5 seconds. This is his LT or “Tempo” pace. Running tempos faster than this will not bring extra benefits; it will simply mean that the athlete will take longer to recover. (\**1609m.=1 mile)*

C. **Threshold Runs using a Heart Rate Monitor**. This is one of the most popular methods of monitoring an athlete’s progress. Using either the lab .test results or the method just described above, the athlete runs a certain distance, usually between 5 and 8 miles (8K to 12.8K ), at the correct Lactate Threshold pace . The correct pace is ensured by keeping the H/R within the correct parameters i.e. if the LT or OBLA point occurred at a H/R of 178 then the athlete should try to keep the monitor showing a rate between 175 and 180. (It would be impossible to keep it at precisely 178 ). Of course, if the athlete has not had a lab. test and is, instead, using the method outlined above, then he will need to check his watch at each mile or Km. marker. (Or the coach will need to give him a time check. Needless to say, the course must be measured beforehand with accurate Km. or mile markers determined. This is why many coaches prefer to get their athletes do their tempos on a track ) Obviously progress can be measured by doing this tempo at regular intervals ( on the same course and with the same, or similar, weather conditions -not easy ! ) and if the athlete runs it faster **with no extra effort** , then he is getting fitter. **But it is essential that he does NOT turn it into a time trial**. Some athletes and their coaches preferto run their tempos for a certain length of time rather than a set distance i.e. for 25 or 40 minutes. If this method is adopted, then progress can be monitored by seeing does the athlete run **further** in the **same time** with **the same effort** (same H/R).

D. **Finally, we come to time trials**. These were also discussed in an earlier article. *(cf. Further Quality Sessions: Cruise Intervals, Hill Work ,Parlauf, and Time Trials.)* I’ll just repeat some of the more pertinent points:

1.Only do a time trial if the weather conditions are favourable. 2. A time trial should generally be held over a shorter distance than the race distance e.g. 800m. runners should do a time trial over 600m.; 1500m. athletes should run time trials over 1000m. and 1200m. 3. It is probably wise not to have a definite time target; just run at a pace which you hope to maintain over the full distance and see how that feels. Obviously, if the time trial goes well both athlete and coach know that progress is being made. A satisfactory time trial can give a huge boost to a runner’s confidence. ( of course, the converse is also true ! ) . So time trials should be approached with some caution !

These are the main methods of keeping track of an athlete’s progress or lack of it. Of course, as stated at the outset, race results are, perhaps, the best indicator of positive development or not. If we are to judge progress by times, then we must concentrate on track times. Running a “PB” on the road is not quite legitimate (except in the marathon) as road courses can vary so much and the method of measurement in some cases do not comply with I.A.A.F. rules. Only electronic times posted on an approved 400m.track have the assured guarantee of being 100% accurate. Finally, the athlete or his/her coach should also **keep a check on the athlete’s weight .** If we look at the profile of the runners who line up for the Morton Mile (say) we are struck by just how slim they are . If you are even 5 lbs. ( approx.2.25 Kg.) overweight , it will have a detrimental effect on your racing performance . ( Imagine running a race with a bag of sugar in each hand ! .) Athletes should not ,however, become obsessed with their weight. This is particularly true in the case of female athletes who can become hyper-sensitive to the whole issue of their weight. We have all seen some female athletes who are border line anorexic and we have all heard scare stories about college athletes in the USA who became ill as a result of their obsession with ultra light weight and body image . Needless to say, an athlete who is too light is in greater danger of incurring injury. If the athlete is not well nourished, (s)he is much more prone to injury as (s)he is not ingesting sufficient protein to repair the micro-breakdowns which occur in his/her muscles and ligaments after hard training. All athletes and coaches should be familiar with what constitutes good nutrition and the daily calorific requirements of an athlete who is training every day or perhaps more than once a day every day. ( cf. the earlier article entitled ***Nutrition and Hydration*** in Coaching Corner. )