
USA
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RUNNING CAMPS

Training Distance Runners

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Some Basic Laws of Coaching

Every coach must follow some basic guidelines when dealing with others**.**

- Treat each runner as an individual who has unique strengths and weaknesses.
  - *Time available is not the same for all
  - *Time of day is not the same for all
  - *Background varies a great deal among individuals
  - *Age, health, body composition and fitness can vary considerably
- Always find positive comments that you can give regarding how training is going
- Everyone has good and bad days of training
- Subject your runners to a variety of types of training so they know what feels best
- Encourage being flexible in regard to changing workouts, days of training, etc.
- Support the idea of not training when ill or injured – care for health concerns
- When your runners run together, make sure they run together – no "lead dogs"
- Try to eliminate the feeling of inferiority to others who are doing more training
- Teach your runners how to breathe properly
- Teach your runners how to use an economical running stride
- Use intermediate goals that pave the way for long-term success
- Expose your runners to a variety of flexibility and warm-up activities
- Encourage good eating and sleep habits and teach proper hydration
- Don't worry about sleep on the pre-race night – it will avoid negative thoughts
- Learn as much as possible about coming race conditions – course, weather, etc
- Try to have your runners enter some low-key practice races to experience details
- Have your runners experiment with shoes, socks, clothing, visors, caps, etc
- Wear the exact apparel and shoes for a long run that will be used in the marathon
- There is no such thing as a "fluke" good run; but maybe some fluke bad runs
- Training should be rewarding; not always fun, but always rewarding
- Trust positive responses to training, question any negative responses
- No one should feel bad during training runs; if so there is a health problem, possibly: Diet, Sleep, Losing weight, Dehydrated, Illness, Over-training
- Be available to your runners
- Consistency is the key to success as a runner
- When running, concentrate on the task at hand
- Learn proper pacing for various distances of running
- Most mistakes are made early in a run so be alert to improper pacing
- Use your head during the majority of a marathon, use your heart later in the run
- Care about your athletes first as people, then as runners

Ingredients of Success

There are four key ingredients for success in distance running, or any other pursuit in life, for that matter. In order, they are inherent ability, motivation, opportunity, and direction.

Inherent Ability

It is easy to see the important role that genetics (inherent ability) plays in becoming successful in sports. Picture in your mind an Olympic female gymnast, a male shot-putter, an NBA center, and a jockey. You undoubtedly see a petite, trim girl; a large, powerful man; an extremely tall man; and a short, lightweight man or woman. These are simply the necessary body types for success in women's gymnastics, shot putting, rebounding basketballs, and riding a winner in the Kentucky Derby. Such athletes don't achieve their anatomical structure through training; they are born with bodies that adapted perfectly to their sport. The individuals have little control over their basic body designs. Their genetic makeup was inherited from their parents.

Now think about a successful distance runner. What do you see? Someone who is short, tall, muscular, or very lean? There have been, and still are, outstanding runners with a variety of body types, but physiologically they are as similar in their anatomic design as are female gymnasts or NBA centers. You can't see the physiologic characteristics that make some distance runners great and others not so great, but there are inherent qualities that separate one runner from another, just as surely as body size and composition are factors in shot putting or horse racing.

Genetic ability is the first ingredient of success. You have a certain amount given to you at birth on which you can, of course, improve, but the potential is set for you and it is up to you to do what you will with your particular gifts.

Motivation

Motivation to use your God-given talent is the second ingredient of success, and must come from within. It is easy for a basketball coach to be motivated for a seven-foot-tall high school player, but if this seven-footer wants to be an artist rather than a basketball player, chances are that success will not be realized on the court. I believe that there are four kinds of distance runners:

1. Those who have inherent ability and the motivation to use that ability
2. Those who have the ability to do well, but are not motivated to use their ability
3. Those who are lacking in ability, but have great motivation to achieve success
4. Those who lack ability and are not motivated

The first group of people is made up of champions—they almost always perform well. The second group can be referred to as "coach frustrators." The coach sees the potential but little or no desire on the part of the athlete to use it. "If only you had some desire, you could be a champion," is often heard from the coach. The coach is motivated for the athlete, but intrinsic motivation is lacking and the coach becomes frustrated. The third type of people often can be categorized as "self-frustrators." This group has tremendous motivation to be great runners but doesn't have the necessary genetic makeup. These runners usually will do anything the coach says; they try every workout imaginable and

run as much mileage as can be fit into a day. They are candidates for overtraining and for being beaten by the second category of runners. You probably have seen these two types in action—the "natural" athlete, who seldom trains, eats, or sleeps right but who still beats the highly motivated, non-gifted, frustrated runner. It is sad but true.

I don't think coaches should remind Type 2 runners about their lack of motivation any more often than they castigate Type 3 runners for their lack of ability (which is almost never). It is very possible that the Type 2 runner is running only because of coach, family, or peer pressure. The coach should discuss options with the runner and the possibility that running may not be the right place to be spending time, even if there is obvious talent for such a pursuit. Having the coach on your side, in an understanding role, may go a long way in converting a Type 2 into a Type 1 individual, a transformation that is impossible for a Type 3 runner. However, Type 3 runners are fun to have on your team,

Finally, there are the no-ability, no-motivation individuals, who usually never even try running, nor would they be any good if they did give it a shot. Keep in mind, however, that Type 4 runners may be Type 1 people in some other, possibly more important, aspect of life.

Opportunity

The third ingredient of success is opportunity. Opportunity includes a variety of factors, paramount among which may well be the environment in which you grow up or live. Someone born with outstanding ability for downhill skiing, but living in a warm, southern climate, may never have the opportunity to develop in the sport. Even if highly motivated (through movies and videos, for example), the person may fail due to inaccessible facilities.

Swimming pools are not available to much of our society. Horseback riding and jumping, yachting, and skating are unavailable sports for most individuals. A talented and motivated golfer or tennis player may see success become unattainable because a warm geographic location is not available during the important years of development.

Certainly, there are always individuals who, for one reason or another, break away from a prohibitive environment and unexpectedly achieve success in a particular sport. Still, the opportunity to participate in a sport is a very important ingredient of success.

In addition to having the climate, facilities, and equipment necessary for the pursuit of any given sport, an athlete also needs opportunity in terms of time and money. For example, merely living in a hotbed of golf doesn't guarantee access to the sport.

Finally, the opportunity to compete in a chosen sport is also important. A young fencer who truly loves the sport of fencing, has a good teacher, and possesses adequate time for training may still find the road to success a long one if there are few or no other fencers nearby with whom to compete.

Opportunity is an important ingredient of success, yet it is difficult for us to perceive it as

a limiting factor in our affluent society. Nevertheless, it often is. In the United States, the business of providing opportunity in the sport of running is left primarily up to high schools and colleges. Schools with adequate finances have track facilities, good equipment, and travel expenses. Perhaps the greatest obstacle many aspiring runners face is the lack of opportunity outside the framework of the schools.

The lack of clubs for post-school competition also hurts American runners at the very time when they need the most support—in their early 20s. Another drawback of a school-based support system is the lack of continuity of coaching. A high school athlete may have more than one coach during early development, and may attend a community college before finishing at a four-year university; the athlete may run for three or four different coaches before reaching the best running years. American runners face a difficult task: consider the fact that learning a new training system often takes a full season to accomplish, and many athletes are not in a stable coaching environment for more than a couple of years at a time. Without steady, consistent guidance, many American runners falter and never have the opportunity to develop their full potential.

Direction

Direction, the final ingredient of success, refers to a coach, a teacher, or a training plan that can be followed. Of the four ingredients of success, direction is probably the one of least significance, should one of the ingredients have to be eliminated. I say this because direction is the only ingredient that can have either positive or negative influence on the athlete.

If you consider inherent ability, you'll realize that everyone has some degree of this basic ingredient. The same can be said for motivation and opportunity. However, it is possible for absence of direction to be better than bad direction. Examples of bad direction might be telling a beginning runner that anything less than 150 miles of running per week won't lead to success in distance running, or that one must do repetition work every day for the final two weeks leading up to an important marathon race.

When I think of all the great runners I have known who, at one time or another, had to suffer through a tough coach–athlete relationship, it is amazing to me that they reached the degree of success that they did. What we all tend to overlook more often than we should is the importance of positive individual attention given to each athlete on the team. Nothing can replace the encouraging comments or understanding words of support from a quality coach. To become an elite runner, an individual needs a support system, and this support system must have the best interests of each athlete in mind at all times.

How do we coach?

Eggs against the wall theory? How my coach coached me?

Train like the champions? Train like the current record holder trains?

I think we need some basic principles of training to consider.

Principles of Training

In order to take full advantage of all the training you expect of your runners, it is important to understand some basic training principals.

Training principle #1 -- the body reacts to stress. There are two types of reaction to the stress of exercise: (1) An acute reaction, such as you would experience if you got up from your seat, went outside and ran to the corner. Heart rate speeds up, stroke volume (the amount of blood pumped with each beat of the heart) increases, ventilation rate and depth of breathing increase, blood pressure rises, your muscles feel some fatigue, etc. If you perform this ritual--running to the corner--on a regular basis, then you will continue to get regular, acute reactions to this activity. You will also get a different reaction to the repeated, chronic exercise, or *training*, as we favor calling it.

(2) Training produces changes throughout your body, which allow you to perform the daily run-to-the-corner with less discomfort (and probably in less time as well). The muscles that are stressed become stronger and blood flow to the exercising muscles becomes more generous. Changes inside the muscle cells provide more energy for the muscles, and less lactic acid accumulates during the bout of exercise. Your resting heart rate will undoubtedly be slower (due to a stronger heart being able to pump more blood per beat and, therefore, needing fewer beats to deliver the needed blood). Also, you'll probably develop a lighter, springier step (due to fitter leg muscles), lower resting blood pressure, lower body weight, and less fat under the skin.

Training principle #2 -- Specificity of training. The system which is stressed is the one which stands to benefit from the stress. While training for one particular sport usually has little or no beneficial effect on your ability to perform a second sport, in some cases there may actually be a detrimental effect. An example of this would be the negative effect that long-distance running has on explosive leg activities, such as sprinting and jumping. The same thing could be said for what body building would do for distance running; the extra muscle mass developed can act as dead weight, interfering with a runner's ability to optimize his or her distance-running capabilities.

To become really accomplished at something, you must practice doing that thing, not some other activity, which may not only take time away from the activity of primary interest, but may also actually produce results which limit performance in the main sport. This is not to say that all non-specific activity is bad, but considerable thought must be given to every aspect of training, and you must know what everything you do is doing for (or to) you.

Training principle #3 -- Specificity of overtraining Just as training benefits those body systems which are properly stressed by the exercise, over-training has a negative impact on the systems which are over-stressed.

Naturally, it is possible for a single, over-stressed system to affect a variety of activities other than the one which caused the damage. For example, a stress fracture in the leg, brought about by too much, or improper, running, can prevent a runner from performing

other activities which also put stress on the injured extremity. However, too much running doesn't always mean you become over-trained in other types of physical activity, and it may be beneficial to limit running for periods of time in favor of other types of training.

Training principle #4 -- A specific stress produces a specific result. This is common sense, but still important to bear in mind. This principle really says that the benefits that can be expected from doing 3 1-mile runs at 8 minutes each, with 5-minutes recovery between runs, 3 days a week, are specific to that *frequency* (3 times each week), *amount* or *load* (3 miles of running per session), *intensity* (8:00 pace), and *recovery* between runs (5-minutes). Someone who carries out this training regimen regularly, will reach a level of running proficiency which will remain stable (and which will be different from the proficiency level reached if the training program consisted of five-mile runs at a speed of 7:00 per mile pace. **Figure 1** shows how a new fitness level is reached over time.

At that point, the possibilities for training modifications are limitless. You could increase the training frequency, from 3 to 4 or more days per week; increase the amount of training, from 3 to 4 miles per session or by increasing each of the 3 individual workbouts from 1 mile to 1-1/2 miles each. Another possibility would be to increase the intensity (speed of running each mile), from 8-minute pace to 7:30 pace, for example. A final possibility would be to change the recovery time allowed between the mile runs within a workout. Any one of these changes in training (frequency, duration, intensity, or recovery) or any of these changes in combination with one another, will affect the result of the program, resulting in a new level of fitness being reached over time (see **Figure 2**).

Training principle #5 -- Rate-of-achievement principle. This principle is depicted by the curves in both **Figures 1 and 2.** You will notice that the rate of achieving the ultimate benefits of a particular type of training program, is rapid at first and then tapers off over time. A look at the time scales on these curves shows that most of the benefits of a particular training regimen are quite adequately realized in a matter of four to six weeks. Keep in mind, that sticking with a training program for longer than six weeks may continue to produce more benefits, because without an increased stress of training there might be continued changes in body composition (loss of unnecessary fat, for example), which can produce better performance. However, quite adequate benefits are realized in a matter of weeks.

If the runner described in **Figure 1** wanted to increase training, a good time would be after about six weeks, and **Figure 2** shows how the reaction to such changes would look if the alterations were imposed at six-week intervals. The danger of changing (increasing) training too often, is primarily increased risk of injury, or overstress caused by taking on too much too fast. Remember, it is very difficult to get a feeling of what a particular training load is doing for you if you don't stay with it for awhile.

Training principle #6 -- Personal limits. Another principle of training, which is related to the curves I have been presenting, is that each individual has unique personal limits. In fact, you could probably safely say that every system in a person's body has limits.

Figure 1 Rate of Achievement

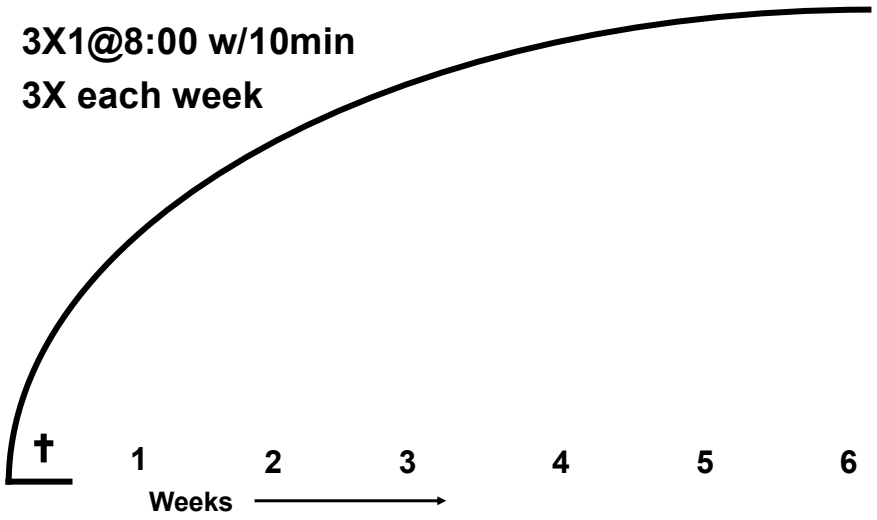
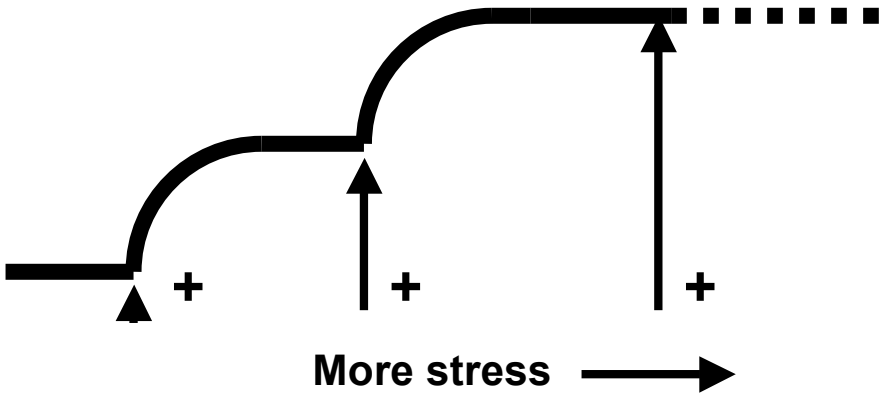
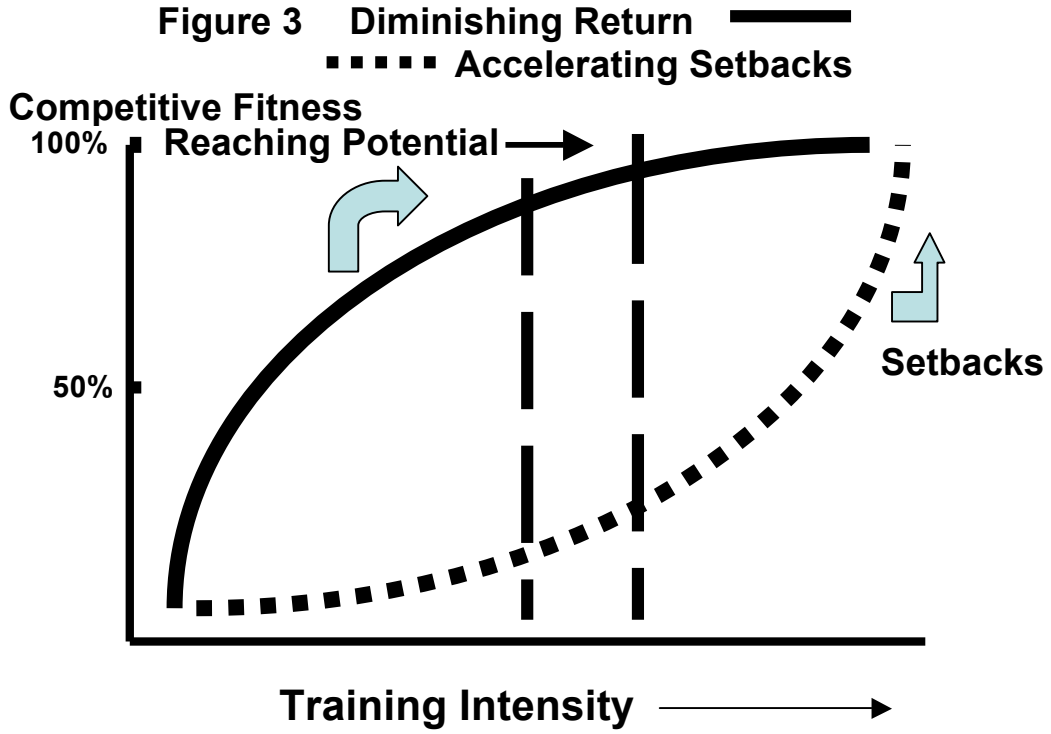


Figure 2 Improvement (or not) with Increased Stress



For example, there is a limit as to how tall you will be, how strong a particular muscle in your body can get (the heart muscle being an important one for all of us), how much air you can breathe in and out of your lungs, how much blood can be transported to your running muscles, how much oxygen your running muscles can use in converting fuel to energy, and how fast you can run a mile, a 10K or a marathon. It may be sad, but we all have limits, and these limits can vary greatly from individual to individual. Different ones of us will reach different degrees of success, which are greatly dictated by what our limits are. The good news is that probably few people realize their limits, relative to running, and improvement is almost always possible. Further, the limit often is seasonal and next year things will continue to improve, to a new "limit."

Training principle #7 -- Diminishing return The upper (left) curve of **Figure 3** uses mileage to clarify this principle. The benefits of increasing weekly mileage are shown in this figure, with an all-inclusive term, "competitive fitness," plotted against weekly mileage. Take the example of someone who starts training with 10 miles per week, then doubles it to 20, then again doubles to 40 and finally to 80 miles per week, allowing a couple months at each level. It doesn't matter how gradually this runner progresses from 20 to 40 to 80 weekly miles of training. The point is that the benefits reaped from 40 miles per week are not double those realized as a result of 20-mile weeks. Nor are the results of 80 double that of 40 or 4 times the benefit of 20 miles per week. Adding more and more mileage to your weekly training does not produce equal percentages of improvement in competitive fitness. The same thing applies to increasing the amount of faster, quality training.



Training principle #8 -- Accelerating setbacks. The nature of the curve that depicts this principle is the mirror image of the diminishing-returns curve and is shown in lower (right) curve of **Figure 3**. Here, increases in training stress are plotted against the chance of encountering a setback, which might take the form of an injury or illness or even a lack of interest in training. A setback is a setback and all must usually be avoided at all costs. The setback principle simply states that low levels of training produce few setbacks, and as a person trains harder and harder, the potential for setbacks increases exponentially.

Training principle #9 -- Ease of maintenance This principle holds particularly true for maintenance of a level of competitive ability, which must at least in part be a function of reaching a particular level of confidence. Although I am primarily referring to physiological fitness, it is no secret that psychological factors play an important part in how fast you can race. Once you break the 8-minute mile barrier, or any other personal goal, doing it again is not the task it was the first time, and the effort required (in training) to repeat the task is usually well short of what was initially involved.

The maintenance principle is an important one to consider when planning a long-term training program, because it allows you to shift your training emphasis from one system (say development of cellular adaptations that respond favorably to long, easy mileage) to another system (repetition work for the enhancement of economy, for example), and yet still maintain the cellular benefits through less-frequent attention to the longer runs.

Developing a desirable and economical running stride

One of the first things new runners should learn and one of the last things many new runners do learn, is proper stride rate or stride frequency, commonly referred to as "turnover."

There are only two ways to increase the speed at which a runner can get from point A to point B. One is to increase stride length, without slowing down stride rate, and the second is to increase turnover without shortening stride length. Generally speaking, an increase in stride length demands greater energy expenditure (and typically getting stronger), whereas an increase in stride rate is pretty much a voluntary thing and not only may not increase energy demand, but may actually *decrease* the energy demand of running at any given speed.

Mechanics of turnover. Imagine using a very slow, exaggerated turnover. A slower turnover means you spend more time in the air, which, in turn means lifting you body mass to a greater height, which costs energy. Now, if the extra cost comes with a faster running pace, then the cost may be worth it, but if the increase in pace is not worth the cost then you are working more than necessary to get the job done. Possibly even more important is the fact that a longer stride rate, and the accompanying greater body lift, means coming down harder on each foot strike, and landing impact is the greatest cause of injury in runners. No need to increase impact anymore than necessary. Just think, if

you take 90 steps (with each foot) each minute, that's 5400 foot strikes (with each foot) during a one-hour run. Naturally, slowing stride rate by 10 foot strikes each minute would eliminate 600 landings in that one-hour run. However, to maintain the same running pace, with this slower turnover, would mean hitting the ground considerably harder for the remaining 4,800 footstrikes that you would still have to endure with each foot.

Studies that have measured the cost of running at different turnover rates, suggest that each individual has an optimum stride rate, which may vary some with changes in fitness. Still, the rate among accomplished runners varies little, even with considerable changes in run pace.

The 180 turnover rate. Of the hundreds of elite distance runners whom I have tested, I have seen only two who took fewer than 180 steps per minute (90 with each foot). On the other hand, of the thousands of non-runners or beginning runners I have tested, only a handful have ever taken as many as 180 steps per minute. Further, in my 30+ years of coaching distance runners, those who start out with slower turnovers invariably move up to a faster rate with time spent training. The better economy (lower cost of running) and the lessened chance of impact injury tend to lead to runners finding out for themselves that it pays not to turnover too slowly.

180 footfalls each minute seems to be a threshold number for most runners. Interestingly enough, the rate changes very little with rather dramatic changes in running velocity. In other words, when good runners run faster, they just lengthen their stride, but keep the same (or very nearly the same) turnover. It is not unusual for a runner to change a training run pace by as much as 2 minutes per mile and not see stride rate change by more than 2 or 3 footfalls.

I spent considerable time at the Los Angeles Olympic Track venue counting stride rates of both male and female runners, in preliminary and final events, of every distance from the 800 meters to the full marathon. We even compared mid-race stride rates to those used during the final "sprint" to the finish, and this supported the idea that there seems to be a most comfortable stride rate at which most elite runners race, and that is in excess of 180 meters per minute.

What about beginners? People will often question comparing beginners to elite runners, in the area of stride rate. However, we use elite runners to guide our habits in every aspect of running, from what to wear to what to eat, to tactics, breathing patterns and training routines, why not stride rate? Chances are a beginner will eventually adjust to the ways of the elite as time goes by, but in the area of stride rate, which is strictly a voluntary adjustment, you can save yourself a lot of energy and potential injury by accepting the ways of the proven without waiting to achieve the same end through trial and error. By contrast, a beginner would make a big mistake (and probably would quickly become injured) trying to match an elite runner's stride length, something that takes conditioning and time to achieve. So, copy the best in matters that take nothing more than understanding and acceptance and let time spent being a runner take care of

those aspects of running that demand an improvement in fitness or strength.

How to measure stride rate. The simplest way to measure your own stride rate is to settle into a nice steady pace of running and count how many times your right foot strikes the ground over a time period of one minute. Then you just double the number of right footfalls to get your stride rate. If you are not getting in 90 or more right footfalls per minute (180 total steps), make a conscious effort to take quicker, shorter steps. It is important not to just run faster to increase stride rate; the trick is to be able to hold a steady pace and increase turnover by shortening stride length. Running on a treadmill is an ideal place to check and adjust stride rate because the speed is set for you and you can more easily concentrate on different turnovers without changing the speed at which you are running.

If you want to have someone else count your stride rate, or if you count someone else's, the easiest way to accomplish this is to count arm swings, rather than foot strikes. This is especially true if trying to count one individual's stride rate while that individual is among a group of runners. Of course, using arm swing to determine leg turnover relies on the premise that legs swing at the same rate as do the arms. If you can make it work otherwise, please let me know; or, if you can make one leg turnover at a faster rate than the other, you may have really come up with something.

Should you really count stride frequency when running? Not normally, but it is good to have an understanding of stride rate. For one reason, you can initially use this knowledge to improve your running economy -- too slow a turnover is too costly and in longer races you really want to use as little energy as you can get away with. Also, as mentioned earlier, a quicker (and lighter) stride rate minimizes landing shock and this may help you prevent an injury in training. By occasionally counting your stride rate during long training runs, you can keep yourself aware of how economically you are running. Often as a runner tires, turnover drops off and this leads to "sloppy" technique, which is a quick road to injury. Always attempt to run as relaxed and as easily as you can, and being aware of your stride frequency will go a long way in accomplishing that goal. Remember, stride rate is under your control -- you can use any rate you wish to – so spend some time working on it.

Proper breathing patterns for distance runners

Compared to many sports, running is relatively simple. Just about anyone can run so it is mostly a matter of training to become a better runner; there is little to work on in terms of technique. There are a few basic matters that are worth mentioning, however, because these little things can make running more enjoyable, not to mention more successful. Proper body carriage, foot plant, stride rate and breathing patterns are of few things that need special attention.

What are you accomplishing when you breathe? Most people realize that the purpose of breathing is to bring fresh air into the lungs and remove not-so-fresh air from the lungs. What you are doing is ventilating the lungs, a process that is referred to as

pulmonary ventilation. How much air that is moved in and out of the lungs in a period of time (minute ventilation is the standard way of expressing pulmonary ventilation) is the product of the size (volume) of each breath multiplied by the number of breaths taken each minute. At rest, we don't need to ventilate the lungs to a very great degree and minute ventilation is typically about 5-6 liters, which is the product of 10-12 half-liter (500ml) breaths taken each minute. This relatively small minute ventilation is adequate to supply our lungs with necessary oxygen and to rid the lungs of the low levels of carbon dioxide that resting metabolism produces. Keep in mind that even if you hold your breath for an extended period of time, the lungs are still taking in carbon dioxide from the blood and are releasing oxygen to the blood. If you breathe harder than is needed to meet the demands of whatever you are doing, then less of the inspired oxygen will be used and the expired air will also contain less carbon dioxide. In other words, your body takes what it needs and gets rid of what it doesn't want.

Breathing during exercise. The main difference between breathing during rest and while running is that you increase pulmonary ventilation a great deal during running – the harder you run the more you breathe. Not only do you increase ventilatory frequency, but also the depth of each breath (referred to as "tidal volume") increases dramatically. The typical resting frequency of 10-12 breaths per minute may go as high as 60 breaths per minute (1 each second) when running hard. Tidal volume also increases about 5-6 fold. Some runners may reach minute ventilations of as much as 200 liters (I have tested a 155-pound male runner who breathed 226liters per minute at maximum exercise). It should be pointed out that during a marathon, ventilation is by no means the limiting factor and minute ventilations may reach only about half of a runner's maximum potential. In fact, if you feel ventilatory stress during a marathon, you are clearly running too fast for the distance that has to be traveled.

A closer look at ventilatory frequency. The rate at which a runner breathes is (and should be) very closely associated with running cadence (stride and arm-swing rate). In fact, in all sports, breathing rhythm is associated with the rhythm of the sport. Swimming is the simplest example to understand, since you can only breathe when the mouth is out of the water and (with the exception of backstroke swimming) the mouth is free to breathe in rhythm with stroke rate. Experienced runners almost all use a similar breathing pattern – 2 steps (1 right-foot fall and 1 left-foot fall) while breathing in and 2 steps while breathing out. This is referred to as a 2-2 breathing rhythm, and it provides for a comfortable frequency and a relatively large tidal volume. It is possible (and comfortable for some runners to use a 3-3 breathing rhythm (3 steps breathing in and 3 breathing out), but 2-2 usually is more comfortable in a prolonged effort, such as a marathon. If you consider that most runners take 180 steps per minute while running, this means a 2-2 rhythm involves 4 steps per breathing cycle or 45 breaths per minute; a 3-3 rhythm equals 30 breaths per minute (180/6 = 30) and this can prove to be a little too slow for some people.

What's the best breathing frequency to use? Without doubt I recommend a comfortable 2-2 breathing rhythm, and the sooner you adjust to that rhythm, the better. For the sake of understanding the effects of different breathing rhythms, I always suggest

that a beginner try everything from a 4-4 rhythm to a 1-1 rhythm. It is not too uncomfortable to use 4-4 at the beginning of an easy run, but it won't remain comfortable after a few minutes so there is no sense in even starting with something you can't maintain. A 1-1 pattern is even worse than 4-4 because the frequency is so fast (90 breaths per minute) that you can't ventilate the lungs. Carbon dioxide will quickly build up in the bottom of the lungs and you will constantly find yourself taking an extra deep breath a couple times a minute, just to clear things out. Still, try all of the mentioned breathing patterns in practice just so you know how each feels. When the chips are down you will want to use a nice, comfortable 2-2 rhythm, so use that in practice and you will quickly become used to it. At the beginning of a run it may seem too fast, so just take shallower breaths. As the run continues you may have to increase the depth of your breaths, but the rate can stay the same.

What else can breathing patterns tell you? First, how fast you find yourself needing to breathe, the harder you are working, and if 2-2 is not fast enough, then you are definitely working hard Another use of breathing rhythm is to help eliminate a side stitch (pain in the side that sometimes strikes you during a run -- usually harder runs, but not always). To lessen this problem change to a 3-3 rhythm, the deeper slower pattern is useful in combating stitches. Again, avoid the 1-1 rhythm, which aggravates side stitches.

Runners who find themselves traveling to altitude for periods of time should let their breathing rhythm guide how hard they go on altitude runs. The same running speed at altitude is more stressful than is that speed at sea level, and to maintain the same stress level (not the same speed) is the goal, and breathing rhythm can gauge that for you.

Breathe easy. Most importantly, especially when training at marathon pace or when running a marathon, breathing would not be a stressful function. Any time breathing is labored, this means you are working very hard and marathon-pace running should not be hard, especially on the breathing muscles. In fact, unless running quite hard, inhaling is the only part of a ventilatory cycle that involves work; exhaling is primarily passive -- accomplished by just relaxing the muscles you contracted to allow you to breathe in.

Using heart rate as a guide

Individual heart rates vary a great deal. Athletes often count their heart rates during rest and work, and this information can be useful, especially if you understand some basic principles about heart rates. First, it should be made clear that heart rates can vary a great deal among individuals, and using formulas that estimate maximum heart rate based on age can be quite misleading. For example, I have measured maximum heart rates among many elite runners of various ages and have seen some rather astonishing results, including an Olympic Champion whose maximum heart rate at age 30 was 148. Twenty-five years later (at age 50), this same individual had a maximum heart rate of 146, basically no change over 25 years. Another runner, at age 25 had a maximum heart rate of 186 and when he was 50 years old his maximum was 192. Age-related tables would not be very useful in estimated these two individuals' maximum heart rates.
In addition, the idea that a very slow resting heart rate is typical for a very fit individual,

isn't always accurate. A reasonable resting heart rate for a normal young adult is about 72 beats per minute and well-trained endurance runners may have resting rates in the low 40s or even upper 30s. One of my subjects was a triple world record holder in distance-running events and never recorded a resting heart rate below 60. No doubt, if you take a large population of individuals, the fitter ones will have slower resting heart rates, but that does not mean that there may not be some who do not fit that mold. Same is true of maximum heart rates, in which case most people will see a drop in maximum as they age, but there may be some individuals who do not hold true to that observation of the group.

Resting heart rates. If using heart rates in evaluating state of rest or intensity of effort, it is important that each individual use personal data for comparisons, and shy away from group averages. For example, when evaluating resting heart rate, always do it under the same circumstances, a good time being upon awakening each morning. If when you wake up you measure a resting heart rate of 66 to 72, then this can be considered your resting rate, and if you have a few days during which your waking heart rate is 8 or 10 beats higher than normal, you may be in need of some more rest or may be dehydrated and in need of some additional fluid intake.

Determining your maximum heart rate. Same approach can be used in measuring heart rates during or following hard running sessions. In this case, you first must get a relatively accurate measure of what your true maximum heart rate is, and a good way to do this is to measure your heart rate during or at the end of several hard runs, runs that last 2 or 3 minutes each. These can be repeated 800 or 1000meter runs or steady uphill runs that last the desired time to complete. If you run these pretty hard and check your heart rate at the end of each of the repeated runs, you will probably get the same heart rate during the last few seconds of each or during the first 10 or 15 seconds upon completion of each run, and this will be a good measure of your maximum heart rate. If the second run produces the same rate as did the first run, then that is probably maximum and no additional runs are necessary. If the second run has a higher rate than the first, then try additional runs until one does not produce a higher heart rate than did the previous run. Consider the highest measured heart rate to be your maximum and use that for calculating various training intensities.

Use of VDOT in place of heart-rate data. If you have some recent races that represent solid efforts for you, then you are probably better off using these performances and associated VDOT values (explained in this document) for coming up with the best speeds of running for the different types of training you perform.

Support Systems

There are a few aspects of training that I call, "Support Systems," or "Supplemental Training," and I believe that each individual has special needs in this area of training. Support-system training is designed to produce fewer direct benefits, but may mean the difference between success and failure.

Some things to work on in support-system training include flexibility, muscle strengthening, mental/psychological approaches to performance enhancement, and so on. Different individuals benefit to varying degrees from these different types of support-system training. As with all types of training, be sure that what you are doing helps satisfy the needs that you have and doesn't just add unproductive activity to your overall training program. Often, trial and error is the way to see if something works for you, and always remember to give a new approach to training a fair trial, not just a few days.

Certainly, some strengthening exercises help prevent injury, as can flexibility training, massage, etc., but there is a reasonable limit to every type of support system. Always keep foremost in your mind what your goals are. For example, are stretching exercises used to improve your running, or just to become more flexible?

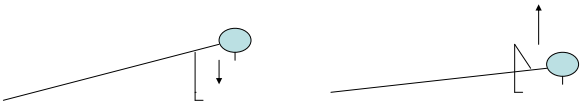
The same thing can be said for the various types of training -- are you doing a particular type of training because you like it and are good at it, or because it will produce the results you want in races? It all depends on your goals and expectations; be clear and realistic with these and you will almost always be happy with your performance.

Available time is always a concern for many runners and when the goal of a beginner, is to finish a marathon with limited time available for training, then it may be detrimental to spend time doing supplemental training, if it takes away from accumulating more time running.

Here is a circuit training routine that many runners find useful for general fitness.

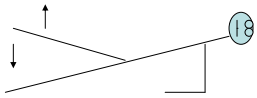
Circuit station 1

(½ of 1-minute max)



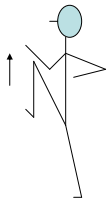
Circuit station 2

(10 lifts to right side & 10 lifts to left side)



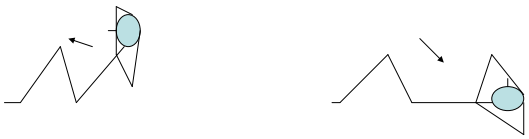
Circuit station 3

(30 hi-knee with each leg)

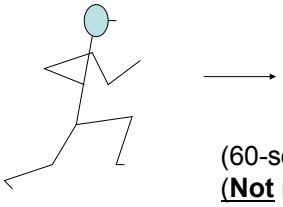


Circuit station 4

(½ of 60-second max)



Circuit station 5



(60-second **or** 400-meter run)
(**Not** meant to be 60-sec 400)

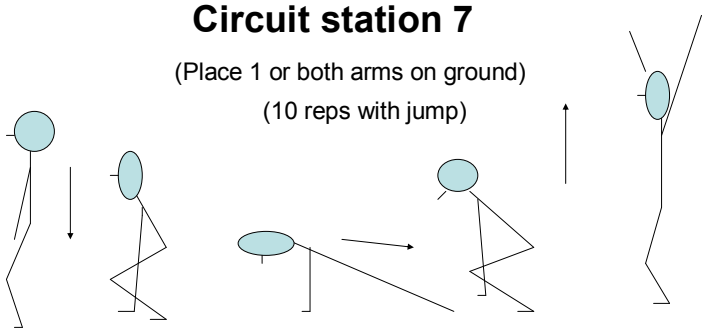
Circuit station 6

(2 minutes of any stretching)

Circuit station 7

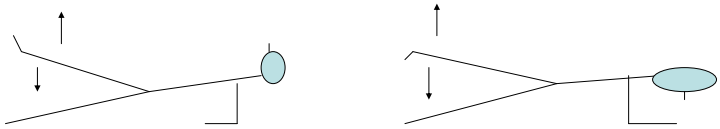
(Place 1 or both arms on ground)

(10 reps with jump)



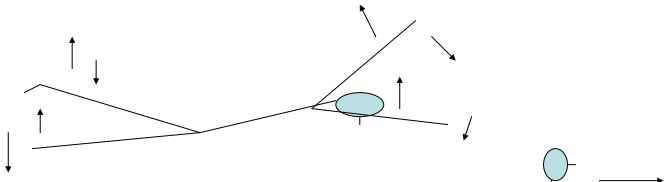
Circuit station 8

(10 lifts with each leg, facing up and facing down)



Circuit station 9

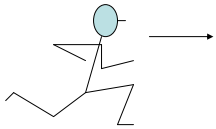
(20 up and down flaps with alternate arms and legs)



Circuit station 10

(2-minute run **or** 800m run)

(Then return to station 1)



The importance of fluid balance

Everyone is concerned about dehydration (fluid loss) and fluid replacement. I often have runners and coaches ask me how much and how often they should be drinking. Before addressing this issue directly you need to understand the tremendous variation that exists among individuals, in the rate at which fluid is lost from the body.

Variations in fluid loss. A study we conducted on this issue some years ago showed that one of our subjects lost fluid at the rate of 100 ml per kilometer of running, when running a 25 k race in a temperature of 80 degrees and low humidity. Another of our subjects in this same research project lost fluid at the rate of 200 ml per km of running. This subject weighed the same as the former subject, ran within one minute of the same time, and both of these runners consumed 1000 ml of fluid during the run.

Consider the consequences of this 100-ml-per-km difference in the rate at which these two runners lost fluid. At a 100-ml-per-km loss, a runner would lose 2500 ml in a 25 km run. With a 1000-ml fluid intake, this leaves a net loss of 1500 ml, which is approximately 3.3 pounds of loss – 2% of body weight for this 165-pound runner. The other runner lost 5000 ml, replaced 1000 ml and had a net loss of 4000 ml – 8.8 pounds, which translates to more than a 5% loss of total body weight. A 5% loss in weight is starting to get pretty serious and is certainly enough to affect performance. What if these two runners had both gone on to finish a full marathon (42 km) – both losing and taking in fluid at the same relative rate? The first guy would have been able to make it OK, but the second runner probably would not because he would have had greater than a 14-pound net loss, which is right at 9% of his body weight, and is extremely dangerous.

Nutrition

Often, one of the first things runners are concerned about is what to eat, how much to eat and when to eat, relative to workouts and races.

Weight loss as a result of running. The first things that should be pointed out are (1) running burns about the most calories per minute of exercise than any other activity, and (2) even running is not a fast way to lose weight. Consider this – a 143-pound individual will need to run about 36 miles to burn off the calories associated with one pound of body fat. A smaller, say 110-pound, runner will run 42 miles to burn off one pound and a 176-pound runner would need "only" 30 miles to burn off a pound of fat. It should be clear that running is not going to produce a rapid loss of weight and the sooner new, or even serious, runners realize this fact, the better they will be in evaluating their weight situation. Simply put, most runners will burn off the equivalent calories of a pound of fat, by running about 36.5 miles and that is likely what many will run in a week of training. Consider this, however – just 1mile of running every day of the year will result in the loss of 10 pounds of fat or saving you from putting on an additional 10 pounds, however you want to look at it.

What to eat. The best approach relative to what to include in your diet is not to think primarily about what is good for your running, but what is good for your health. The majority of your food should be quality carbohydrate, some protein and less than you normally would choose of fat. However, keep in mind that your body does need some fat and it is not a good idea to try cutting out too much of anything. If you don't eat enough of some nutrients, cholesterol for example, then your body will produce some from other foods that you do eat. Think in terms of fresh fruits and vegetables, complex carbohydrates, quality protein, and don't worry too much about some fat that comes along with some of the protein foods you eat. Naturally, you must follow any particular plan that your doctor has prescribed or recommended, and possibly a very important factor is to not try restricting your diet to the point of rapid weight loss. Such an approach will almost certainly result in your feeling pretty dead legged in your training runs and may lead to a poor performance on race day.

How much to eat. If your body weight has been staying stable over the past several weeks, this means your food intake is meeting your needs. Of course, as you increase the amount of training that you do, you will have to consume a little more food to meet the additional energy demands of exercise. If you see a gradual drop in weight you may want to take in a little more, mostly in terms of carbohydrate foods, or energy fluids. If some weight loss is desirable or necessary and you have the approval of your doctor, then stick with a food intake that allows you to drop about a pound every week, but not more than that or you will feel short on energy as you train and you will definitely have trouble with your longer training runs. It is most important that you feel good on your training runs, and also that you take on some energy drinks and/or carbohydrate foods within the first 30 to 45 minutes following your runs, The body does a better job of storing energy when intake is soon after training runs. Get in the habit of noticing what foods tend to settle best for you and which don't upset you, so you can use those foods prior to runs.

When to eat. When to get in the habit of eating, relative to training and racing, can be of major concern, and the best way to come up with the best plan is to make note of what and when you eat relative to your more demanding training runs. Just as is the case with knowing what shoes to wear and what clothes to wear, it is important to find out in practice runs, what to eat, how much to eat and when to eat, so you feel great during your longer or more demanding training runs, and especially during less-important races that lead up to your more important races. It is critical that you not try something new on the day of important races ; everything you eat, everything you wear and everything you do should have been practiced on a few occasions. If you like to drink some fluid with caffeine, get in the habit of doing so a couple hours before your race or within the final 30 minutes leading up to the race; avoid this in the 30- to120-minute time prior to the race, as it may affect your blood sugar level and increase the need to make a pit stop.

When you will be taking a prolonged time to complete your marathon, it is important to be regular with fluid and energy consumption during the race itself, and this should follow the same routine that you have practiced in long training runs. Take on the amount you have learned is necessary to avoid losing more than 2 or 3 % of your body weight, and get in the habit of smaller amounts of intake, more often, rather than greater amounts, less often. Practice, practice, practice and then stick with what you have learned in practice.

Injury and Illness

The single most important thing athletes must do is to avoid illness and injury. I seriously doubt if there is ever an Olympic Games at which the best athletes are actually competing, generally because some of the best are at home with an illness or injury.

Avoiding injury. The best way to avoid injury is to avoid over-doing it in training. This usually means taking the conservative approach when trying to decide what workout to do when you have a choice of training sessions to choose from. It is always better to be a little less than optimally trained, but healthy, than to do some awesome workouts, but having to deal with some nagging injury. Another great way to help avoid injury is to include some regular supplemental training, along with your regular running training. Remember, supplemental exercises (strengthening and stretching) won't usually make you a better runner, but they strengthen your body against injury when you run, so you can run more and run harder, which allow you to become a better runner.

Dealing with injury. When you feel a pain somewhere in your body, when you run, the first thing you should do is try to determine if this is truly an injury or just some temporary soreness resulting from a recent workout, or maybe you just played a game you hadn't done in some time and you overdid it a little.

Go out for an easy run and if the pain diminishes as you continue running, then it is often OK to just continue on and see how it is the next time you run. If the pain doesn't get less as you run, then take a break and try again the next day, and see if the pain diminishes as days go by (just as you decided if it diminished as time went by in the first

test run). If the pain gets worse as you go on in your test run, then you must stop running and try again in a day or two. If the pain continues bothering you over a number of days, then you must see a doctor and get treatment so you don't cause further damage.

The human body is very adaptable and will do its best to heal injured tissue, but sometimes you need to take a break from activity in order to speed the process. Most runners worry about missing a day of training, but it usually takes at least five days of complete inactivity to start losing any fitness (as long as you don't take five days off every week). When an injury does force you to take some time off, then it is a good idea to get involved in some additional supplemental training, but don't do another activity that aggravates the very injury you are trying to get healed. If an injury forces you to not do any physical activity then you may want to also evaluate your diet so you don't keep eating quite as much as you were when training hard.

Get in the habit of keeping a log of your training, including injuries and illnesses you encounter along the way. This will allow you to look back at how you successfully treated a particular problem that may have bothered you in the past.

Avoiding illness. Avoiding illness is often easier said than done, especially when you have youngsters in your house; bringing home illnesses from school is certainly a common occurrence. However, you can do a great deal to ward off illness by eating well and getting adequate rest, especially when stressing your body with regular training. Eat well, rest well and be up to date on any precautionary shots or medications that are recommended by your doctor.

Dealing with illness. If you are being seen by a doctor, then by all means adhere to your doctor's orders. If you feel you are experiencing a minor illness that you have experienced before and you believe it will just take some time to resolve itself, then you may have to take some days off. Common colds that don't affect your lungs, or anything below your head level will often allow you to continue with some exercise, but it is usually best to limit your running to easy runs (which may continue to be relatively long in duration), or to short, quick repeated runs that don't last long enough to force you to be breathing hard (repeated runs of 15 to 20 seconds each usually will do the trick).

Upon return to regular running, following injury or illness, you must be cautious with your training. The tendency, after some time off or after some easy training days, is to want to make up for lost time and it is very easy to overdo your training. Your body or some body parts have been weakened by the injury or illness and you should ease back into normal training intensities with some caution. I recommend an easy day of running for every day of training that you missed. And, always try to learn from any mistakes that may have led to an injury or illness.

Following is a Table that can be used to monitor your daily stresses and may be useful in helping you avoid too much stress that would lead to a problem. Make copies if you feel this will be useful over time.

2-wk date range	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat
#1 Sleep last night														
#2 Aches Pains Illness														
#3 Last session recovery														
#4 Flexibility														
#5 Nutrition & Energy														
#6 General mental														
#7 day's Physical stress														
#8 Mental re today's training														
Day totals														

Dates_____ & Week 1 total_____ Dates_____ & Week 2 Total _____

For each of the 8 items, for each day, assign one of the following scores
1 (outstanding) **2** (good) **3** (OK) **4** (not so good) **5** (terrible)

Scores for items 1 & 2 should be assigned within 2 hours of awakening. Score items 3-4-5-6 by early afternoon each day. Score items 7 & 8 toward the end of each day.

Enter 2-week total here _____ Below, make any overall comments regarding your training

_____

_____

_____

_____

In arriving at scores for each item, consider the following: #1 how desirable was last night's sleep. #2 are you having any current injury, illness unusual pains. #3 how well do you think you recovered from yesterdays training. #4 how is your flexibility. #5 rate the previous 24 hours of rest, energy, nutrition. #6 rate your general mental condition #7 how stressful was today, in a physical context #8 rate your mental attitude regarding today's training session(s) (this is different from your overall mental feeling)

Aerobic Profile

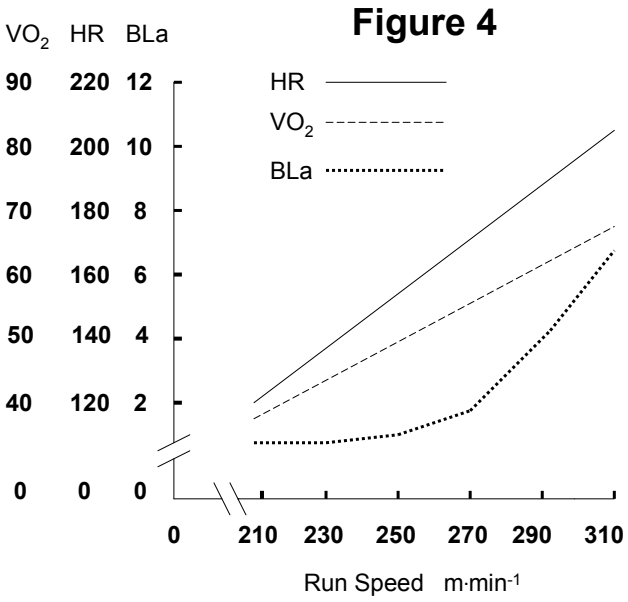
The following discussion summarizes the importance of VO_2max, (maximum oxygen consumption), economy (VO_2submax), and lactate threshold for a distance runner.

VO_2Submax. Let's say we have a runner who has reached a "steady state" of exercise, by running for about six minutes at a submaximal speed (6:00 per mile pace, for example) and a bag of expired air is collected from this runner, during the final minute or two of this six-minute run. The analysis of this runner's expired air will tell us what the aerobic (oxygen) demand of running at 6:00 pace is for this particular runner. Heart rate, also taken during the final minute or two of the run, and a small, finger-stick blood sample (drawn immediately upon completion of the run) will provide information on the pulse rate and blood-lactate accumulation, associated with this velocity of running, for this particular individual.

If the same procedure is repeated several times at increasingly faster (but still sub-maximal) running velocities, then the VO_2, HR (heart rate) and BLa (blood lactate accumulation) responses can all be plotted against running speed. **Figure 4** shows such data, which I have collected on one of the many athletes I have tested over the years. Notice that the VO_2 response is a relatively linear (straight line) one, as is HR. Blood-lactate accumulation, on the other hand, shows a different picture. Easier running speeds show little change in BLa, but as the speed of running reaches a more demanding intensity, there is a dramatic increase in blood lactate. This lactate-response curve is typical of what any runner would show, with the exception that the better the runner, the faster would be the running pace at which the lactate-response curve would demonstrate the change from a flat to a rather steep slope. The intensity at which this transition from a gradual to a steep lactate curve takes place is referred to as threshold intensity.

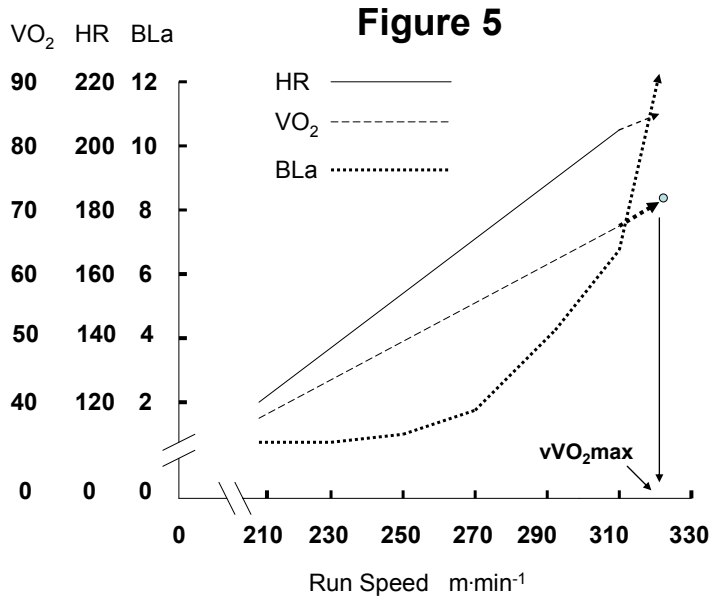
If the runner being tested completes three or four submax tests (at increasingly faster speeds, up to about 10K race pace or a little faster), and then performs a "max" test, the response picture becomes adequate for determining current training, and even competitive intensities of running.

VO_2Max. The max test is one in which the runner starts running at the same pace as was used for the final submax test (about current 10K race pace). This speed is held for two minutes on a treadmill (or for about 400 meters, if being run on a track). After this initial two minutes, a one percent grade is added to the treadmill each minute (or the pace is increased to 5K race pace in a track test). In a treadmill test, when the intensity of the ever-increasing treadmill grade forces the runner to not be able to continue, then the test is over. In the case of a track test, after two or three laps at 5K race pace, the runner completes a final 400 meters at an all-out speed, after which the test is terminated.
In either case, expired air samples are continually collected, starting with about the third minute of the max test and ending when the runner stops. Heart rate is taken at the end of the test (or recorded during the final one-half minute of the test if using a monitor). The final blood sample (used to detect maximum lactate accumulation) is drawn two minutes after completion of the max test (when blood lactate reaches its peak).



Velocity at VO_2max. By adding the highest VO_2 measured during the max test (this is VO_2max) and the HRmax and BLamax data points to the submax data shown in **Figure 4**, we get **Figure 5**, what I refer to as a runner's "*aerobic profile*." VO_2max is placed on an extension of the economy curve (the line drawn through the previously-calculated VO_2submax data points), and this permits the determination of the velocity at which VO_2max would first be realized. This velocity is simply called vVO_2max (velocity at VO_2max) and is used to calculate a "VDOT" value, which, in turn, determines training paces and race potential. VDOT will be clarified later.

Differences in Aerobic Profile. If the results of VO_2 tests performed on different individuals or groups of runners are plotted, as is done in **Figure 6**, then we see some interesting information become apparent.



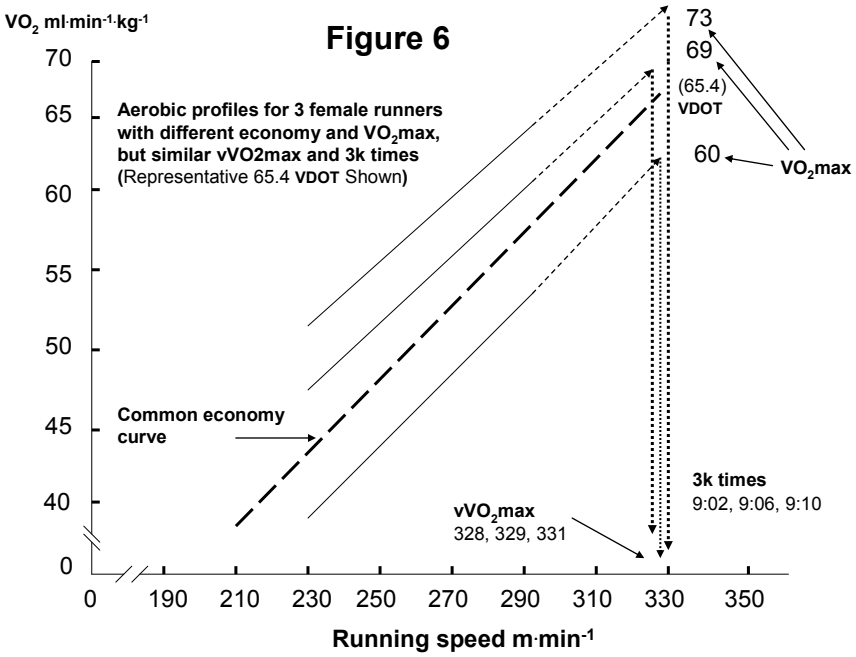


Figure 6 compares three female distance runners, all of whom ran very similar times for 3000m, but with different aerobic profiles. Notice that all three runners have similar vVO_2max values, but one is much more economical (has a lower economy curve), but also has a much lower VO_2max, than the others. Their similar vVO_2maxes suggest that if

all three ran a 3K race at their respective vVO_2maxes, they would finish in times of 9:04, 9:07and 9:08, times which are within a few seconds of what they actually did run, which are also shown in Figure 6.

The Importance of VO_2Max. By now it should have become apparent that the measurement of VO_2max, by itself, provides very little information in terms of discriminating between groups of good runners. As a result, when I hear that some runner was found to have a VO_2max of 90 ml/kg/min, I have one of two immediate reactions. First, the tests may have been poorly controlled (inaccurate reference gases used for the gas analyzers, faulty equipment used in measuring ventilatory gas volumes, leaky equipment, etc.). Second, if the tests were well controlled, why doesn't this runner outperform everyone else, hands down?

Assuming that this runner with the high VO_2max really does have an accurate assessment of his aerobic capacity, the most logical reason why he doesn't outperform everyone else is because his economy is poor. When a runner with a 70 VO_2max runs a 2:10 marathon and outperforms a 90 VO_2max runner, imagine how poor the latter's efficiency must be. And who is to say the 90-VO_2max runner can improve efficiency (economy) any more than can the 70-max runner improve his VO_2max? Learning your actual VO_2max can be useful for monitoring changes, in response to training, but learning your VO_2max, without supporting information concerning your economy can be misleading.

Changes in Aerobic Profile. Keep in mind that VO_2max, economy and lactate accumulation all respond to training. Specific types of training should be used to optimize each of these components of performance. An important relationship between VO_2, HR, BLa and vVO_2max should be pointed out here. The configuration of the economy curve (which plots VO_2 against running velocity) is such that a one-percent change in velocity is nearly also a one-percent change in VO_2. This results in an intensity of 70% VO_2max being equal to 75% vVO_2max and 88% VO_2max equal to 90% vVO_2max. Both of these intensities are important and will be referred to in detail when I get into training.

The relationship between velocities and intensities are extremely useful; they signify that if vVO_2max can be identified, there is no need for VO_2max or economy testing for the purpose of setting training intensities. Fortunately, current vVO_2max can be very closely estimated from knowing the race performance capabilities of a runner-- You can use current race information to determine how hard to train. Furthermore, I believe this is a better way to do it than to rely on laboratory tests. Also, laboratory testing is simply not necessary for the masses of runners and coaches who should be using more concrete information to plan training intensities. After all, what is better than using how good you are as a measure of how fast you should train?

Goals of Training

What a runner is really trying to accomplish through training are the following.

(1) ***Improve the body's ability to transport blood and oxygen***, (2) ***Increase the ability of the running muscles to effectively utilize their available oxygen (to convert carbohydrate and fat fuel into useful energy)***, (3) ***Increase VO_2max, which is a sum of #1 and #2, above***, (4) ***shift lactate threshold to correspond to a faster running speed***, (5) ***improve speed***, and (6) ***lower the energy demand of running (improve economy)***.

(2) Naturally, there are other goals of training, such as improving race tactics, elevating self-confidence, changing body composition, bettering self-image, etc., but these less-tangible factors will all result from improvement in one or more of the above-mentioned factors.

Types of training used by runners

Basically, there are five types of training that are used by most runners. Following are the types and main purposes of these various types of training.

Easy (E) running. This is, as the name implies, running at an easy intensity, a pace you could keep up for a prolonged period of time, with minimal stress. Some refer to this pace of running as "conversational," and it is just that, a pace that does not stress your breathing to a noticeable degree and one during which you could carry on a normal conversation with a running partner. The benefits of easy runs are (1) they gradually build a solid foundation of fitness upon which more strenuous runs can be added, and (2) they produce a variety of benefits at the level of the muscle cells that are performing the task of running. Some refer to this type of running as building a "base;" easy runs build resistance to injury so there is less chance of problems when you increase the speed of your running.

Marathon-pace (M) running. As is the case with easy running, marathon-pace runs are as the name implies, runs that are carried out at the pace you intend to use during an upcoming marathon. The advantages of this speed of running is that you learn to get a good idea how your marathon will feel (not that difficult, but definitely a little faster than just easy running). Doing runs at marathon pace also provide you with an opportunity to practice drinking during longer runs and races..

Threshold (T) running. Threshold runs are at a speed that I refer to as "comfortably hard." This is a speed of running that you could maintain for about 1 hour in an all-out race. Usually you do shorter, but still prolonged, runs at threshold pace – often runs that last about 5 to 10 minutes each, but with several repetitions of the 5 or 10-minute efforts. Threshold runs do a good job of improving endurance.

Interval (I) running. Runs at interval pace are typically repeated runs of 2 to 5 minutes each, and the intensity of these runs is what I refer to as "hard." This type of training tends to maximize your aerobic power and is good to include in the middle of the season,

but not particularly desirable late in the program as it imposes a fairly high stress on runners at a time that they hope to start feeling ready to race. Interval running is probably the least enjoyable of the various types of training.

Repetition (R) running. This refers to repeated runs of up to 2-minutes each that are repeated a number of times and between which full recoveries are normally taken. Repetition runs improve economy of running and speed. Developing speed and good mechanics is of great importance for all runners who are trying to improve on previous race times, and the economy benefits make including some "reps" a good addition to the training program. "Strides" are a form of reps that involve relatively short (20 or 30-second) runs at a quick, light pace, and are often used as part of a warm up or at the end of an easy run or threshold workout. Hill running is a form of repetition training.

How much is enough for a "Long Run?"

For runners who have some experience training for longer races I like to suggest some approaches that can be used to determine the length of the "long run" that marathoners can include in their training program. What I suggest is that, if peak mileage is up to 40 miles in a single week, then the long run can be **the lesser of** 1/3 of the week's total mileage and 2 hours. For example, if weekly mileage total is 30, then a 10-mile long run is good enough (1/3 of the week's total), unless the pace of the long run is so slow that it takes more than 2 hours to complete that 10-mile run, in which case the long run becomes a 2-hour run. With peak weekly mileages of 41 to 80, then the long run can be **the lesser of** 1/3 peak and 2-1/2 hours. In this case an example may be a 75-mile peak, which would put the long run at the lesser of 25 miles and 2-1/2 hours. If peak weekly mileage is 80 to 100 per week, then the long run can be **any amount between** 1/4 peak and 2-1/2 hours. If over 100-mile peak, then the long run is **the lesser of** 1/4 peak and 2-1/2 hours.

How long to make the "Long Run" is always a hot topic of conversation when marathon training is discussed. There are plenty of people willing to offer advice in this matter, and most have some valid points about the duration of the long runs. However, as is the case with any type of training session you include in the overall training program, you should always be able to answer a couple basic questions, (1) "What is the purpose of this workout?" and (2) "Am I ready for this workout?"

Use of VDOT in determining training intensities

As I indicated earlier, I think using your recent performances are the best way to establish proper training intensities. By testing many runners in the lab and on the track we were able to learn that there are some very predictable demands for running at different speeds and for different durations of time. This information has allowed us to calculate a numeric value that describes your current level of fitness, and we call this value, "**VDOT**." Following are tables that identify **VDOT** values with race times over a variety of distances, and that also provide proper training intensities to be used in various workouts.

TABLE 1. VDOT values associated with running times raced over popular distances

VDOT	1500	Mile	3000	2-mile	5000	10km	15km	1/2 Mara	Marathon	VDOT
30	8:30	9:11	17:56	19:19	30:40	63:46	98:14	2:21:04	4:49:17	**30**
31	8:15	8:55	17:27	18:48	29:51	62:03	95:36	2:17:21	4:41:57	**31**
32	8:02	8:41	16:59	18:18	29:05	60:26	93:07	2:13:49	4:34:59	**32**
33	7:49	8:27	16:33	17:50	28:21	58:54	90:45	2:10:27	4:28:22	**33**
34	7:37	8:14	16:09	17:24	27:39	57:26	88:30	2:07:16	4:22:03	**34**
35	7:25	8:01	15:45	16:58	27:00	56:03	86:22	2:04:13	4:16:03	**35**
36	7:14	7:49	15:23	16:34	26:22	54:44	84:20	2:01:19	4:10:19	**36**
37	7:04	7:38	15:01	16:11	25:46	53:29	82:24	1:58:34	4:04:50	**37**
38	6:54	7:27	14:41	15:49	25:12	52:17	80:33	1:55:55	3:59:35	**38**
39	6:44	7:17	14:21	15:29	24:39	51:09	78:47	1:53:24	3:54:34	**39**
40	6:35	7:07	14:03	15:08	24:08	50:03	77:06	1:50:59	3:49:45	**40**
41	6:27	6:58	13:45	14:49	23:38	49:01	75:29	1:48:40	3:45:09	**41**
42	6:19	6:49	13:28	14:31	23:09	48:01	73:56	1:46:27	3:40:43	**42**
43	6:11	6:41	13:11	14:13	22:41	47:04	72:27	1:44:20	3:36:28	**43**
44	6:03	6:32	12:55	13:56	22:15	46:09	71:02	1:42:17	3:32:23	**44**
45	5:56	6:25	12:40	13:40	21:50	45:16	69:40	1:40:20	3:28:26	**45**
46	5:49	6:17	12:26	13:25	21:25	44:25	68:22	1:38:27	3:24:39	**46**
47	5:42	6:10	12:12	13:10	21:02	43:36	67:06	1:36:38	3:21:00	**47**
48	5:36	6:03	11:58	12:55	20:39	42:50	65:53	1:34:53	3:17:29	**48**
49	5:30	5:56	11:45	12:41	20:18	42:04	64:44	1:33:12	3:14:06	**49**
50	5:24	5:50	11:33	12:28	19:57	41:21	63:36	1:31:35	3:10:49	**50**
51	5:18	5:44	11:21	12:15	19:36	40:39	62:31	1:30:02	3:07:39	**51**
52	5:13	5:38	11:09	12:02	19:17	39:59	61:29	1:28:31	3:04:36	**52**
53	5:07	5:32	10:58	11:50	18:58	39:20	60:28	1:27:04	3:01:39	**53**
54	5:02	5:27	10:47	11:39	18:40	38:42	59:30	1:25:40	2:58:47	**54**
55	4:57	5:21	10:37	11:28	18:22	38:06	58:33	1:24:18	2:56:01	**55**
56	4:53	5:16	10:27	11:17	18:05	37:31	57:39	1:23:00	2:53:20	**56**
57	4:48	5:11	10:17	11:06	17:49	36:57	56:46	1:21:43	2:50:45	**57**
58	4:44	5:06	10:08	10:56	17:33	36:24	55:55	1:20:30	2:48:14	**58**
59	4:39	5:02	9:58	10:46	17:17	35:52	55:06	1:19:18	2:45:47	**59**
60	4:35	4:57	9:50	10:37	17:03	35:22	54:18	1:18:09	2:43:25	**60**
61	4:31	4:53	9:41	10:27	16:48	34:52	53:32	1:17:02	2:41:08	**61**
62	4:27	4:49	9:33	10:18	16:34	34:23	52:47	1:15:57	2:38:54	**62**
63	4:24	4:45	9:25	10:10	16:20	33:55	52:03	1:14:54	2:36:44	**63**
64	4:20	4:41	9:17	10:01	16:07	33:28	51:21	1:13:53	2:34:38	**64**
65	4:16	4:37	9:09	9:53	15:54	33:01	50:40	1:12:53	2:32:35	**65**
66	4:13	4:33	9:02	9:45	15:42	32:35	50:00	1:11:56	2:30:36	**66**
67	4:10	4:30	8:55	9:37	15:29	32:11	49:22	1:11:00	2:28:40	**67**
68	4:06	4:26	8:48	9:30	15:18	31:46	38:44	1:10:05	2:26:47	**68**
69	4:03	4:23	8:41	9:23	15:06	31:23	48:08	1:09:12	2:24:57	**69**
70	4:00	4:19	8:34	9:16	14:55	31:00	47:32	1:08:21	2:23:10	**70**
71	3:57	4:16	8:28	9:09	14:44	30:38	46:58	1:07:31	2:21:26	**71**
72	3:54	4:13	8:22	9:02	14:33	30:16	46:24	1:06:42	2:19:44	**72**
73	3:52	4:10	8:16	8:55	14:23	29:55	45:51	1:05:54	2:18:05	**73**
74	3:49	4:07	8:10	8:49	14:13	29:34	45:19	1:05:08	2:16:29	**74**
75	3:46	4:04	8:04	8:43	14:03	29:14	44:48	1:04:23	2:14:55	**75**
76	3:44	4:02	7:58	8:37	13:54	28:55	44:18	1:03:39	2:13:23	**76**
77	3:41+	3:58+	7:53	8:31	13:44	28:36	43:49	1:02:56	2:11:54	**77**
78	3:38.8	3:56.2	7:48	8:25	13:35	28:17	43:20	1:02:15	2:10:27	**78**
79	3:36.5	3:53.7	7:43	8:20	13:26	27:59	42:52	1:01:34	2:09:02	**79**
80	3:34.2	3:51.2	7:37.5	8:14.2	13:17.8	27:41	42:25	1:00:54	2:07:38	**80**
81	3:31.9	3:48.7	7:32.5	8:08.9	13:09.3	27:24	41:58	1:00:15	2:06:17	**81**
82	3:29.7	3:46.4	7:27.7	8:03.7	13:01.1	27:07	41:32	:59:38	2:04:57	**82**
83	3:27.6	3:44.0	7:23.0	7:58.6	12:53.0	26:51	41:06	:59:01	2:03:50	**83**
84	3:25.5	3:41.8	7:18.5	7:53.6	12:45.2	26:34	40:42	:58:25	2:02:24	**84**
85	3:23.5	3:39.6	7:14.0	7:48.8	12:37.4	26:19	40:17	:57:50	2:01:10	**85**

TABLE 2. Training intensities based on current VDOT

VDOT	E(Easy) & L(Long) Runs		MP	T(Threshold Pace)			I (Interval Pace)				R (Rep Pace)		
	per km	per mile	per mile	400	km	mile	400	km	1200	mile	200	400	800
30	7:14-8:20	11:39-13:25	11:02	2:33	6:24	10:18	2:22				67	2:14	
31	7:03-8:08	11:21-13:06	10:45	2:30	6:14	10:02	2:18				65	2:10	
32	6:53-7:57	11:05-12:48	10:29	2:26	6:05	9:47	2:14				63	2:06	
33	6:44-7:46	10:49-12:30	10:14	2:23	5:56	9:33	2:11				61+	2:03	
34	6:34-7:36	10:35-12:14	10:00	2:19	5:48	9:20	2:08				60	2:00	
35	6:26-7:27	10:21-11:58	9:46	2:16	5:40	9:07	2:05	**km**			58+	1:57	
36	6:17-7:17	10:07-11:43	9:33	2:13	5:33	8:55	2:02	5:07			57	1:54	
37	6:09-7:08	9:54-11:28	9:20	2:10	5:25	8:44	1:59	5:00			55+	1:51	
38	6:02-6:59	9:42-11:14	9:08	2:07	5:19	8:33	1:56	4:54			54	1:48	
39	5:54-6:51	9:30-11:01	8:57	2:05	5:12	8:22	1:54	4:48			53	1:46	
40	5:47-6:43	9:19-10:48	8:46	2:02	5:06	8:12	1:52	4:42			52	1:44	
41	5:41-6:35	9:08-10:36	8:35	2:00	5:00	8:02	1:50	4:36			51	1:42	
42	5:34-6:28	8:58-10:24	8:25	1:57	4:54	7:52	1:48	4:31			50	1:40	
43	5:28-6:21	8:48-10:13	8:15	1:55	4:49	7:44	1:46	4:26			49	98	
44	5:22-6:14	8:38-10:02	8:06	1:53	4:43	7:33	1:44	4:21			48	96	
45	5:16-6:08	8:29 - 9:52	7:57	1:51	4:38	7:25	1:42	4:16	**1200**		47	94	
46	5:11-6:01	8:20 - 9:42	7:48	1:49	4:33	7:17	1:40	4:12	5:00		46	92	
47	5:05-5:55	8:12 - 9:32	7:40	1:47	4:29	7:10	98	4:07	4:54		45	90	
48	5:00-5:49	8:03 - 9:22	7:32	1:45	4:24	7:02	96	4:03	4:49		44	89	
49	4:55-5:44	7:55 - 9:13	7:24	1:43	4:20	6:55	95	3:59	4:45		44	88	
50	4:51-5:38	7:48 - 9:05	7:17	1:42	4:15	6:51	93	3:55	4:41		43	87	
51	4:46-5:33	7:40 - 8:56	7:09	1:40	4:11	6:44	92	3:51	4:36		43	86	
52	4:52-5:28	7:33 - 8:48	7:02	98	4:07	6:38	91	3:48	4:33		42	85	
53	4:37-5:23	7:26 - 8:40	6:56	97	4:04	6:32	90	3:44	4:29		42	84	
54	4:33-5:18	7:20 - 8:32	6:49	95	4:00	6:26	88	3:41	4:25		41	82	
55	4:29-5:14	7:13 - 8:25	6:43	94	3:56	6:20	87	3:37	4:21		40	81	
56	4:25-5:09	7:07 - 8:18	6:36	93	3:53	6:15	86	3:34	4:18		40	80	
57	4:21-5:05	7:01 - 8:11	6:31	91	3:50	6:09	85	3:31	4:15		39	79	
58	4:18-5:01	6:55 - 8:04	6:25	90	3:45	6:04	83	3:28	4:10		38	77	
59	4:14-4:56	6:49 - 7:57	6:19	89	3:43	5:59	82	3:25	4:07		38	76	**800**
60	4:11-4:53	6:44 - 7:51	6:14	88	3:40	5:54	81	3:23	4:03		37	75	2:30
61	4:07-4:49	6:38 - 7:45	6:09	86	3:37	5:50	80	3:20	4:00		37	74	2:28
62	4:04-4:45	6:33 - 7:38	6:04	85	3:34	5:45	79	3:17	3:57		36	73	2:26
63	4:01-4:41	6:28 - 7:33	5:59	84	3:32	5:41	78	3:15	3:54		36	72	2:24
64	3:58-4:38	6:23 - 7:27	5:54	83	3:29	5:36	77	3:12	3:51		35	71	2:22
65	3:55-4:34	6:18 - 7:21	5:49	82	3:26	5:32	76	3:10	3:48		35	70	2:20
66	3:52-4:31	6:13 - 7:16	5:45	81	3:24	5:28	75	3:08	3:45	**mile**	34	69	2:18
67	3:49-4:28	6:09 - 7:11	5:40	80	3:21	5:24	74	3:05	3:42	4:57	34	68	2:16
68	3:46-4:24	6:04 - 7:05	5:36	79	3:19	5:20	73	3:03	3:39	4:53	33	67	2:14
69	3:44-4:21	6:00 - 7:00	5:32	78	3:16	5:16	72	3:01	3:36	4:50	33	66	2:12
70	3:41-4:18	5:56 - 6:56	5:28	77	3:14	5:13	71	2:59	3:34	4:46	32	65	2:10
71	3:39-4:15	5:52 - 6:51	5:24	76	3:12	5:09	70	2:57	3:31	4:43	32	64	2:08
72	3:36-4:12	5:48 - 6:46	5:20	76	3:10	5:05	69	2:55	3:29	4:40	31	63	2:06
73	3:34-4:10	5:44 - 6:42	5:16	75	3:08	5:02	69	2:53	3:27	4:37	31	62	2:05
74	3:31-4:07	5:40 - 6:37	5:12	74	3:06	4:59	68	2:51	3:25	4:34	31	62	2:04
75	3:29-4:04	5:37 - 6:33	5:09	74	3:04	4:56	67	2:49	3:22	4:31	30	61	2:03
76	3:27-4:02	5:33 - 6:29	5:05	73	3:02	4:52	66	2:48	3:20	4:28	30	60	2:02
77	3:25-3:59	5:29 - 6:25	5:01	72	3:00	4:49	65	2:46	3:18	4:25	29	59	2:00
78	3:23-3:56	5:26 - 6:21	4:58	71	2:58	4:46	65	2:44	3:16	4:23	29	59	1:59
79	3:20-3:54	5:23 - 6:17	4:55	70	2:56	4:43	64	2:42	3:14	4:20	29	58	1:58
80	3:18-3:52	5:19 - 6:13	4:52	70	2:54	4:41	64	2:41	3:12	4:17	29	58	1:56
81	3:16-3:49	5:16 - 6:09	4:49	69	2:53	4:38	63	2:39	3:10	4:15	28	57	1:55
82	3:14-3:47	5:13 - 6:05	4:46	68	2:51	4:35	62	2:38	3:08	4:12	28	56	1:54
83	3:13-3:45	5:10 - 6:02	4:43	68	2:49	4:32	62	2:36	3:07	4:10	28	56	1:53
84	3:11-3:43	5:07 - 5:58	4:40	67	2:48	4:30	61	2:35	3:05	4:08	27	55	1:52
85	3:09-3:40	5:04 - 5:55	4:37	66	2:46	4:27	61	2:33	3:03	4:05	27	55	1:51

TABLE 3 Speed-Endurance Finder

400	800	1500/mile
46.0	1:41.2	3:27.6 3:44.1
47.0	1:43.4	3:32.0 3:48.9
48.0	1:45.6	3:36.5 3:53.8
49.0	1:47.8	3:41.0 3:58.6
50.0	1:50.0	3:45.5 4:03.5
51.0	1:52.2	3:50.0 4:08.3
52.0	1:54.4	3:54.5 4:13.2
53.0	1:56.6	3:59.0 4;18.0
54.0	1:58.8	4:03.5 4:22.9
55.0	2:01.0	4:08.0 4:27.7
56.0	2:03.2	4:12.5 4:32.6
57.0	2:05.4	4:17.0 4:37.5
58.0	2:07.6	4:21.5 4:42.4
59.0	2:09.8	4:26.0 4:47.3
60.0	2:12.0	4:30.5 4:52.2
61.0	2:14.2	4:35.0 4:57.1
62.0	2:16.4	4:39.5 5:02.0
63.0	2:18.6	4:44.0 5:06.8
64.0	2:20.8	4:48.5 5:11.7
65.0	2:23.0	4:53.0 5:16.6
66.0	2:25.2	4:57.5 5:21.5
67.0	2:27.4	5:02.0 5:26.3
68.0	2:29.6	5:06.5 5:31.2
69.0	2:31.8	5:11.0 5:36.0
70.0	2:34.0	5:15.5 5:40.9
71.0	2:36.2	5:20.0 5:45.7
72.0	2:38.4	5:24.5 5:50.6
73.0	2:40.6	5:29.0 5:55.5
74.0	2:42.8	5:33.5 6:00.4
75.0	2:45.0	5:38.0 6:05.2
76.0	2:47.2	5:42.5 6:10.1
77.0	2:49.4	5:47.0 6:14.9
78.0	2:51.6	5:51.5 6:19.8
79.0	2:53.8	5:56.0 6:24.7
80.0	2:56.0	6:00.5 6:29.6
81.0	2:58.2	6:05.0 6:34.4
82.0	3:00.4	6:09.5 6:39.3
83.0	3:02.6	6:14.0 6:44.2
84.0	3:04.8	6:18.5 6:49.1
85.0	3:07.0	6:23.0 6:53.9
86.0	3:09.2	6:27.5 6:58.8
87.0	3:11.4	6:32.0 7:03.6
88.0	3:13.6	6:36.5 7:08.5
89.0	3:15.8	6:41.0 7:13.4
90.0	3:18.0	6:45.5 7:18.3
91.0	3:20.2	6:50.0 7:23.1
92.0	3:22.4	6:54.5 7:28.0
93.0	3:24.6	6:59.0 7:32.8
94.0	3:26.8	7:03.5 7:37.7
95.0	3:29.0	7:08.0 7:42.5
96.0	3:31.2	7:12.5 7:47.4
97.0	3:33.4	7:17.0 7:52.3
98.0	3:35.6	7:21.5 7:57.2
99.0	3:37.8	7:26.0 8:02.0
1:40	3:40.0	7:30.5 8:06.9
1:41	3:42.2	7:35.0 8:11.8
1:42	3:44.4	7:39.5 8:16.6
1:43	3:46.6	7:44.0 8:21.5
1:44	3:48.8	7:48.5 8:26.4
1:45	3:51.0	7:53.0 8:31.3
1:46	3:53.2	7:57.5 8:36.1
1:47	3:55.4	8:02.0 8:41.0
1:48	3:57.6	8:06.5 8:45.9
1:49	3:59.8	8:11.0 8:50.8
1:50	4:02.0	8:15.5 8:55.7

TABLE 4 **Intensity Training Table** Points awarded per number of minutes shown

%VDOT	%HRmax	HR	1min	5min	10min	20min	30min	60min
E Zone (easy running)								
59	65	____	.100	.500	1.00	2.00	3.00	6.0
60	66	____	.110	.550	1.10	2.20	3.30	6.6
61	67	____	.122	.610	1.22	2.44	3.66	7.3
62	68	____	.135	.675	1.35	2.70	4.05	8.1
63	69	____	.150	.750	1.50	3.00	4.50	9.0
64	70	____	.167	.835	1.67	3.34	5.00	10
65	71	____	.183	.915	1.83	3.66	5.50	11
66	72	____	.200	1.000	2.00	4.00	6.00	12
67	73	____	.217	1.085	2.17	4.34	6.50	13
68	74	____	.233	1.165	2.33	4.66	7.00	14
69	75	____	.250	1.250	2.50	5.00	7.50	15
70	75.5	____	.267	1.335	2.67	5.34	8.00	16
71	76	____	.283	1.415	2.83	5.66	8.50	17
72	77	____	.300	1.500	3.00	6.00	9.00	18
73	78	____	.317	1.585	3.17	6.34	9.50	19
74	79	____	.333	1.665	3.33	6.66	10.00	20

MP Zone (marathon-pace)			**HR**	**1 min**	**5 min**	**10 min**	**20 min**	**30 min**	**60min**
75	5:00	80	____	.350	1.750	3.5	7.0	10.5	21
76	4:40	81	____.	.367	1.835	3.7	7.4	11.1	22
77	4:20	82	____	.392	1.960	3.9	7.8	11.7	23.5
78	4:00	83	____	.417	2.090	4.2	8.4	12.6	25
79	3:40	84	____	.442	2.210	4.4	8.8	13.2	26.5
80	3:20	85	____	.467	2.340	4.7	9.4	14.1	28
81	3:00	86	____	.492	2.460	4.9	9.8	14.7	29.5
82	2:50	87	____	.517	2.590	5.2	10.4	15.6	31
83	2:20	88	____	.550	2.75	5.5	11.0	16.5	33
84	2:05	89	____	.583	2.92	5.8	11.6	17.4	35

(times – Hr::min – are approximate marathon times associated with %VDOT)

T Zone (threshold/tempo)		**HR**	**1 min**	**5 min**	**10 min**	**20 min**	**30 min**	**60min**
83	88	____	.550	2.75	5.5	11.0	16.5	33
84	89	____	.583	2.92	5.8	11.6	17.4	35
85	89.5	____.	.600	3.00	6.0	12.0	18.0	36
86	90	____	.617	3.09	6.2	12.4	18.6	37
87	91	____	.650	3.25	6.5	13.0	19.5	39
88	92	____	.683	3.42	6.8	13.6	20.4	41

10k Zone			**HR**	**1 min**	**2 min**	**5 min**	**10 min**	**20 min**	**30min**
89	60:00	92.5	____	.700	1.40	3.5	7.0	14.0	21.0
90	50:00	93	____	.723	1.45	3.6	7.2	14.4	21.7
91	40:00	94	____	.763	1.53	3.8	7.6	15.2	22.9
92	35:00	95	____	.800	1.60	4.0	8.0	16.0	24.0
93	30:00	96	____	.840	1.68	4.2	8.4	16.8	25.2
94	27:00	97	____	.883	1.77	4.4	8.8	17.6	26.5

(times shown are approximate 10k times associated with %VDOT)

I Zone (Interval)			**HR**	**1 min**	**2 min**	**5 min**	**10 min**	**20 min**	**30min**
95	21:00	97.5	____	.900	1.80	4.5	9.0	18.0	27.0
96	18:00	98	____	.917	1.83	4.6	9.2	18.4	27.5
97	15:30	98.5	____	.940	1.88	4.7	9.4	18.8	28.2
98	13:30	99	____	.960	1.92	4.8	9.6	19.2	28.8
99	12:15	99.5	____	.983	1.97	4.9	9.8	19.6	29.5
100	11:00	100	____	1.000	2.00	5.0	10.0	20.0	30.0

(times shown are race times – distance irrelevant -- associated with given %VDOT)

R Zone (Repetition)				**1min**	**2min**	**3min**	**5min**	**10min**	**20min**
105	7:02	XX	-- --	1.25	2.5	3.75	6.25	12.5	25
110	4:40	XX	-- --	1.50	3.0	4.50	7.50	15.0	30
115	3:00	XX	-- --	1.75	3.5	5.25	8.75	17.5	35
120	1:43	XX	-- --	2.10	4.2	6.301	0.50	21.0	42

(times shown are race times – distance irrelevant – associated with given %VDOT)

|----------Novice---------- | ----------PDG---------- | ----------Sub Elite---------- |---------Elite---------|

White Grey Yellow Lavender Orange Green Hot Pink Royal Blue Red Gold

VDOT Level 1 2 3 4 5 6 7 8 9 10

Age M / F M / F M / F M / F M / F M / F M / F M / F M / F M / F

VDOTO2 *levels based on age for* **male/female** *runners with male-female mile, 1500 & 1600 times for each level*

18 35.0/31.4 40.0/35.8 45.0/40.2 50.0/44.7 55.0/49.1 60.0/53.6 65.0/58.1 70.0/62.5 75.0/67.0 80.0/71.4

8:01-8:49 7:07-7:52 6:25-7:05 5:50-6:27 5:21-5:56 4:57-5:29 4:37-5:06 4:19-4:46 4:04-4:29 3:51-4:15

7:25-8:10 6:35-7:16 5:56-6:34 5:24-5:58 4:57-5:29 4:35-5:04 4:16-4:43 4:00-4:25 3:46-4:09 3:34-3:56

7:58-8:46 7:05-7:49 6:22-7:03 5:48-6:24 5:19-5:53 4:55-5:26 4:35-5:04 4:18-4:45 4:03-4:28 3:50-4:13

17 33.5/30.2 38.4/34.6 43.3/38.9 48.2/43.2 53.1/47.5 58.0/51.8 62.9/56.1 67.7/60.4 72.5/64.7 77.3/69.0

8:20-9:07 7:23-8:06 6:38-7:18 6:02-6:39 5:31-6:06 5:06-5:39 4:45-5:16 4:27-4:55 4:12-4:38 3:58-4:23

7:43-8:27 6:50-7:30 6:08-6:45 5:35-6:09 5:07-5:39 4:44-5:14 4:24-4:52 4:07-4:34 3:53-4:17 3:41-4:03

8:17-9:04 7:20-8:03 6:36-7:15 5:59-6:36 5:29-6:04 5:04-5:37 4:43-5:14 4:25-4:54 4:10-4:36 3:57-4:21

16 32.0/29.0 36.8/33.3 41.5/37.5 46.2/41.7 50.9/45.9 55.6/50.1 60.3/54.3 65.0/58.5 69.7/62.7 74.4/66.9

8:41-9:27 7:40-8:23 6:53-7:33 6:16-6:52 5:44-6:18 5:18-5:49 4:56-5:25 4:37-5:04 4:20-4:46 4:06-4:30

8:02-8:45 7:06-7:45 6:23-6:59 5:48-6:21 5:19-5:50 4:54-5:23 4:34-5:01 4:16-4:41 4:01-4:25 3:48-4:10

8:37-9:23 7:37-8:20 6:51-7:30 6:13-6:49 5:42- 6:15 5:16-5:47 4:54-5:23 4:35-5:02 4:19-4:44 4:04-4:28

15 30.5/27.8 35.1/31.9 39.7/36.0 44.3/40.1 48.9/44.2 53.4/48.3 57.9/52.4 62.4/56.5 66.9/60.6 71.4/64.7

9:03-9:48 8:00-8:42 7:10-7:49 6:30-7:06 5:57-6:31 5:30-6:01 5:07-5:35 4:47-5:14 4:30-4:55 4:15-4:38

8:23-9:04 7:24-8:03 6:38-7:14 6:01-6:35 5:30-6:02 5:05-5:34 4:44-5:10 4:26-4:50 4:10-4:33 3:56-4:17

8:59-9:44 7:57-8:39 7:08-7:46 6:28-7:04 5:55-6:28 5:28-5:59 5:05-5:33 4:45-5:12 4:28-4:53 4:13-4:36

14 28.9/26.5 33.3/30.5 37.7/34.5 42.1/38.5 46.5/42.5 50.9/46.5 55.3/50.5 59.7/54.5 64.0/58.5 68.3/62.4

9:29-10:12 8:23-9:03 7:30-8:07 6:48-7:22 6:13-6:45 5:44-6:13 5:20-5:47 4:59-5:24 4:41-5:04 4:25-4:47

8:47-9:27 7:45-8:23 6:57-7:31 6:18-6:49 5:46-6:15 5:19-5:46 4:56-5:21 4:36-5:00 4:20-4:41 4:05-4:26

9:25-10:08 8:20-8:59 7:28-8:04 6:46-7:19 6:11-6:42 5:42-6:11 5:18-5:45 4:57-5:22 4:39-5:02 4:23-4:45

13 27.3/25.2 31.5/29.1 35.7/33.0 39.9/36.9 44.1/40.8 48.3/44.7 52.5/48.6 56.7/52.4 60.9/56.2 65.1/60.0

9:57-10:39 8:48-9:25 7:53-8:27 7:08-7:39 6:32-7:00 6:01-6:27 5:35-5:59 5:13-5:35 4:53-5:15 4:36-4:57

9:13-9:52 8:09-8:43 7:18-7:49 6:36-7:05 6:02-6:28 5:34-5:58 5:10-5:32 4:49-5:10 4:32-4:52 4:16-4:35

9:53-10:35 8:44-9:22 7:50-8:24 7:06-7:36 6:29-6:57 5:59-6:24 5:33-5:57 5:11-5:33 4:51-5:13 4:35-4:55

12 25.7/23.9 29.8/27.7 33.8/31.5 37.8/35.3 41.8/39.0 45.8/42.7 49.8/46.4 53.8/50.1 57.8/53.8 61.8/57.5

10:28-11:07 9:14-9:50 8:16-8:48 7:29-7:58 6:51-7:17 6:19-6:43 5:51-6:14 5:28-5:49 5:07-5:28 4:50-5:09

9:42-10:19 8:33-9:06 7:39-8:09 6:56-7:22 6:20-6:44 5:50-6:13 5:25-5:46 5:03-5:23 4:44-5:03 4:28-4:46

10:24-11:03 9:10-9:46 8:13-8:44 7:27-7:55 6:48-7:14 6:16-6:41 5:49-6:12 5:26-5:47 5:05-5:26 4:48-5:07

11 24.1/22.6 28.0/26.2 31.8/29.8 35.6/33.4 39.4/37.0 43.2/40.6 47.0/44.2 50.8/47.8 54.6/51.4 58.4/54.9

11:03-11:39 9:44-10:18 8:43-9:14 7:54-8:21 7:13-7:38 6:39-7:02 6:10-6:31 5:45-6:04 5:23-5:41 5:04-5:22

10:14-10:48 9:01-9:33 8:05-8:33 7:19-7:44 6:41-7:04 6:09-6:30 5:42-6:02 5:19-5:37 4:59-5:16 4:42-4:58

10:59-11:35 9:41-10:14 8:40-9:10 7:51-8:18 7:10-7:35 6:36-6:59 6:08-6:28 5:43-6:02 5:21-5:39 5:03-5:20

10 22.5/21.3 26.2/24.8 29.8/28.3 33.4/31.8 37.0/35.2 40.6/38.6 44.2/42.0 47.8/45.4 51.4/48.8 55.0/52.2

11:41-12:13 10:18-10:47 9:14-9:39 8:21-8:43 7:38-7:59 7:02-7:21 6:31-6:49 6:04-6:21 5:41-5:58 5:21-5:37

10:50-11:20 9:33-10:00 8:33-8:56 7:44-8:05 7:04-7:23 6:30-6:48 6:02-6:19 5:37-5:53 5:16-5:31 4:57-5:11

11:37-12:09 10:14-10:43 9:10-9:35 8:18-8:40 7:35-7:56 6:59-7:18 6:28-6:47 6:02-6:19 5:39-5:55 5:19-5:35

9 20.9/20.0 24.3/23.3 27.7/26.6 31.1/29.9 34.5/33.2 37.9/36.5 41.3/39.8 44.7/43.0 48.1/46.2 51.5/49.4

12:25-12:51 10:58-11:22 9:50-10:10 8:54-9:12 8:07-8:24 7:28-7:44 6:55-7:09 6:27-6:41 6:02-6:16 5:41-5:54

11:30-11:55 10:10-10:32 9:06-9:25 8:14-8:31 7:31-7:47 6:55-7:09 6:24-6:37 5:58-6:11 5:35-5:48 5:15-5:27

12:20-12:46 10:54-11:17 9:46-10:06 8:50-9:09 8:04-8:21 7:26-7:41 6:53-7:07 6:24-6:38 6:00-6:13 5:39-5:51

8 19.3/18.7 22.5/21.8 25.7/24.9 28.9/28.0 32.1/31.1 35.3/34.2 38.5/37.3 41.7/40.4 44.8/43.5 47.9/46.5

13:13-13:33 11:41-12:00 10:28-10:45 9:29-9:44 8:39-8:54 7:58-8:11 7:22-7:35 6:52-7:04 6:26-6:36 6:04-6:13

12:16-12:34 10:50-11:07 9:42-9:58 8:47-9:01 8:01-8:14 7:22-7:35 6:49-7:01 6:21-6:32 5:57-6:07 5:36-5:46

13:08-13:28 11:37-11:55 10:24-10:41 9:25-9:41 8:36-8:50 7:55-8:08 7:19-7:32 6:49-7:01 6:24-6:34 6:01-6:11

7 17.7/17.4 20.7/20.3 23.6/23.2 26.5/26.1 29.4/29.0 32.3/31.9 35.2/34.8 38.2/37.7 41.2/40.6 44.2/43.5

14:08-14:19 12:30-12:42 11:14-11:24 10:12-10:20 9:19-9:27 8:36-8:42 7:59-8:04 7:25-7:30 6:56-7:02 6:31-6:36

13:07-13:17 11:36-11:47 10:25-10:36 9:27-9:34 8:39-8:45 7:58-8:03 7:23-7:28 6:52-6:57 6:25-6:30 6:02-6:07

14:03-14:14 12:26-12:37 11:10-11:20 10:08-10:16 9:17-9:23 8:33-8:39 7:56-8:01 7:22-7:28 6:54-6:59 6:28-6:34

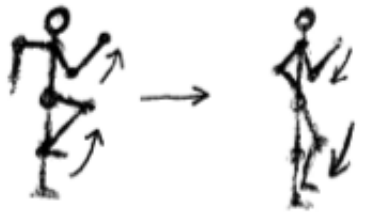
6 Male & 16.1 18.8 21.5 24.2 26.9 29.6 32.3 35.0 37.7 40.4

Female mile = 15:1 13:30 12:08 11:01 10:05 9:17 8:36 8:01 7:30 7:04

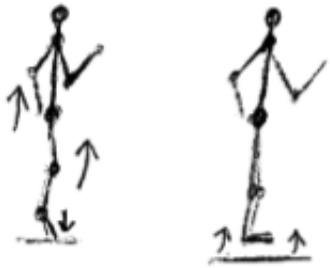
1500/1600 = 14:06/15:06 12:31/13:25 11:15/12:03 10:12/10:56 9:20/10:01 8:36/9:13 7:58/8:33 7:25/7:58 6:57/7:28 6:32/7:01

Form Drills

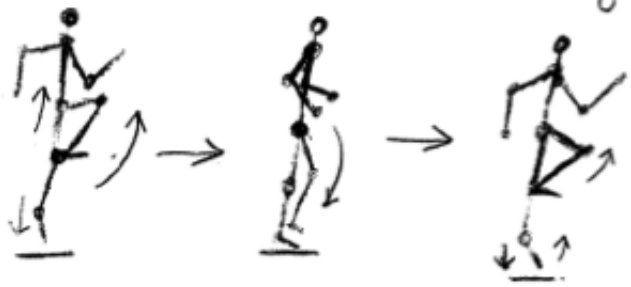
1) Static Leg Drive - standing still drive knee and arms up.
- Ankle should scrape inner knee. Foot dorsiflex



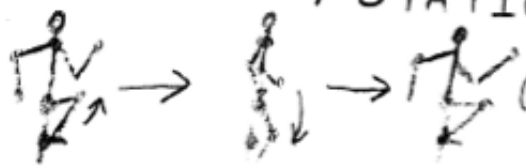
2) Ankle Bounces - legs straight with bounce coming from calves.
- imagine feet are in a bucket. Push back.



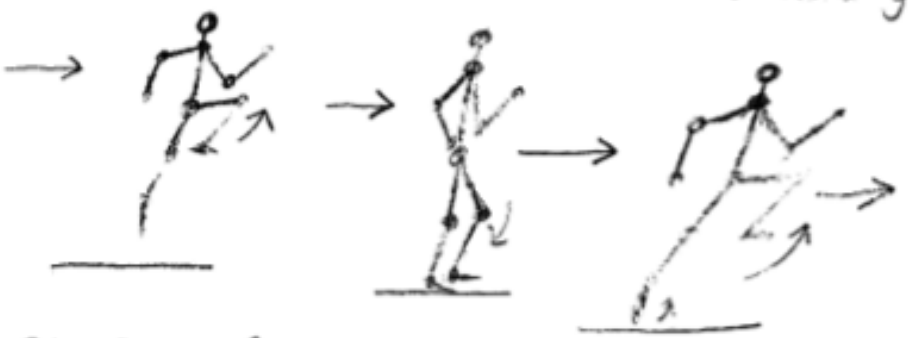
3) Foot Ticks - one leg is straight doing an ankle bounce, and the other is doing a leg drive. Good posture.



4) High Knees w/ Static Stop - High knees into a static knee drive.
(Stop there, hold for 3 seconds)



5.) RUNNING BOUNDS - Get a running start and overemphasize the knee lift. Land under body
-Ankle dorsiflexed and good posture



6) C-SKIP → front→side back to the front and repeat.