Strength and Conditioning
For Cross Country

Should all cross-country participants engage in strength and conditioning programs to reduce their risk of injury and improve their athletic performance? The answer is yes. Should both boys and girls perform strength and conditioning programs? Yes. Every athlete should have, and take part in, a strength and conditioning program that focuses on developing their optimum performance. Without question, all athletes who compete in sports should perform the appropriate exercise program to enhance not only their physical fitness but also their best possible chance at achieving success. Of course, some of the training procedures will vary based on the demands of the activity. For example, football players should emphasize power exercises such as sprinting, cross-country runners should focus on endurance exercises such as three to five mile runs, and soccer players should include both sprinting and sustained running such as 100 yard dashes and half-mile repeats.

When it comes to muscle conditioning strength and conditioning programs can be successfully applied to all athletes, however, there will be some differences, such as the number of repetitions completed. Generally speaking, power athletes respond best to fewer repetitions (4-8) utilizing heavy weight loads. Endurance athletes respond best to many repetitions (12-20) utilizing light weight loads, and combination athletes respond best to a moderate number of repetitions (8-12) with moderate weight loads.

When it comes to the selection of resistance exercises all athletes should be strong in all of their major muscle groups. Regardless of your sport, there is no advantage in having a weak upper body or a poorly conditioned midsection core. Going a step further, training some muscle groups more than others can be a serious disadvantage. I will use sprinters as an example. Sprinters should have powerful quadriceps muscles to explode out of the blocks and flexible hamstring muscles to prevent hamstring pulls. If during the off-season the sprinter strengthened their quadriceps and stretched their hamstrings one would think that they would be faster and therefore run faster times. However, the problem would be that a vast majority of the sprinters would probably have an imbalance in leg strength. The hamstrings will become sore and/or injured because of the quadriceps muscles being stronger than the hamstring muscles. The coach and/or athlete would have made the mistake of unintentionally promoting a serious imbalance between the sprinters' opposing muscle groups. The problem would result because a relatively strong hamstrings group must properly decelerate the powerfully accelerating quadriceps group. If the hamstring muscles are significantly weaker the stronger quadriceps muscles will overwhelm them, and injury is inevitable in spite of their flexibility. This is a situation that is not too uncommon for some programs and athletes. Cross country runners and endurance athletes are just as susceptible to muscle imbalances as is a sprinter, thrower, jumper, etc.

The proper training regimen for a high school cross-country runner must, of course, have mileage, interval workouts, speed workouts, etc… However, the predominant thought process among coaches of endurance runners is that strength training is not needed or that it is even bad for a cross-country runner. Some believe that strength and conditioning programs add unneeded bulk and weight, cause injury, inhibit VO2 levels, etc… Research shows that this is not true and strength training will enhance the development of optimum performance for endurance athletes, especially cross-country runners.

The properly trained cross country runner or endurance athlete needs to develop all areas of their body in order to become the best possible athlete they can. To develop a high standard of fitness, you need to train using a mixture of:

1. Steady long distance running (aerobic) to develop both cardiovascular and muscle endurance.
2. Interval running (anaerobic) to develop speed, strength and lactic acid tolerance.
3. Speed endurance running (aerobic - anaerobic) to develop both physical and mental strength and simulate race speed.
4. Strength training and plyometrics
5. Flexibility (stretching)
6. Balanced diet
7. Rest

Cross-country runners must to be able to handle several different variables during a training session and/or race. These variables may include hill running, cold weather training and racing, warm weather training and racing, fast courses, and slow courses to name just a few. Later on in this paper I will discuss building, implementing and maintaining a strength and conditioning program. However, I have found that some runners and coaches think and feel that all that is needed is a good mileage base in the off season and then interval training during season. This is not true if the athlete expects to develop into the best runner they can become. Optimum performance is a combination of several different parts. The following list, while not all-inclusive, gives some of the important areas that need to be addressed in addition to the typical cross-country training prescription.

1. Avoid sickness and injury through sensible training, good diet, fluid intake, and regular sleep. Try to drink extra water every day but especially after competition and training runs. If you feel tired and run down during the day, you may find that dehydration is the problem. You should drink a minimum of 8 - 10 glasses of water a day. Ensure you get at least 8 hours sleep per day during the training and competition season.
2. Watch your diet and carbohydrate intake. Follow a balanced diet with foods from each of the basic food groups:
    A. Breads, Cereals, Rice, Pasta and Grains
    B. Fruit and Vegetables
    C. Meat and Other Protein foods
    D. Milk and Dairy products
    E. Fats and oils
    F. Don't forget the water
3. Stretching should be done gently and easily (never "bouncing") both before and after any form of training or competition. Proper stretching is often overlooked, but it is vital to improving flexibility and recovery, and preventing injury. If you do get muscle soreness after training or competition, apply ice or a similar cold compress for 15-20 minutes every 60 minutes as soon and as often as possible. A bag of frozen peas is ideal. The bag is ideal because it can be kept in the freezer at home, is non-messy, and molds to the shape of the area being iced.
4. Substantial strength and conditioning benefits for runners can be achieved through strength and conditioning programs. These programs should develop power, strength, and

endurance in the muscular system. Overall musculoskeletal strength also reduces the potential for injury. Discuss your needs with your coach.

5. Equipment
    A. Have a set of appropriate running shoes. The shoes should not show excessive wear and should be comfortable. It is a fact that 75% of injuries to the ankles, shins, knees, hips or back can be traced back to the feet and how you run, thus your shoes play an important part in correcting or reducing the possibility of injury. Use your running shoes only for running, nothing else.
    B. Always wear good sport socks to help avoid injury to your feet.
    C. Shorts should be comfortable and light.
    D. Shirts should be light and comfortable.
    E. The proper warm up and cool down clothing is imperative. It is equally important to have dry, warm clothing for after your workout or race. This reduces the chance of widespread temperature variation and catching a cold.

If a cross-country runner trains the entire body, both physically and mentally, he or she will see the benefits in terms of overall performance and also feel good about their training as well as themselves. Many people mistakenly believe that strength training inevitably results in larger muscles and more bodyweight. This is not necessarily true. Strength training produces stronger muscles in all cases, but gains in muscle size and bodyweight are very dependent upon training protocol. For example, most football players have mesomorphic physiques that respond to strength exercise with relatively large changes in muscle size and body weight. On the other hand, most cross-country runners have ectomorphic physiques that respond to strength exercise with relatively small changes in muscle size and body weight. Furthermore, the heavy weightload, low repetition training followed by football players maximizes muscle strength and size, whereas the lower weightload, higher repetition training performed by cross-country runners emphasizes muscle endurance without additional bodyweight. The main point is that all sports participants will benefit from a properly prescribed strength and conditioning program and the results will be specific to each type of athlete. A stronger athlete in any sport is a better athlete, and more importantly, a more injury resistant athlete.

Endurance athletes often neglect to include strength training in their conditioning program, fearing they will become muscle bound and hurt their performance. Research has shown what many strength coaches have known for years, strength training, when performed properly will not hinder but in fact improve an endurance athlete's performance.

In one study, elite cross-country runners performed 9 weeks of endurance training combined with either a large or small amount of strength training. The total training for both groups was the same throughout the study. The strength training exercises performed included barbell squats and leg presses with approximately 40% of each subject's one repetition maximum. This intensity was used to maximize the subject's muscular power. Subjects from both groups were tested prior to the study and at weeks 3, 6, and 9 during the study. Tests performed included each subject's percent bodyfat, measurements of muscle size, aerobic endurance, muscular power and force production, running economy, and 5km running time.

Results from the study indicated that the subjects that included a greater percentage of strength/power training in their workouts made the greatest improvements in performance including their 5km running time. The primary reason that strength/power training improved the endurance performance is due to the greater adaptation of the athlete’s nervous system as a result

of the strength/power training performed by these subjects. Performing a strength and conditioning program improved the subject's muscular force production and running technique, thus, allowing them to run faster without improving their aerobic endurance.

The following strength and conditioning program will focus on the development of a strength and conditioning program for high school track and field athletes. The program will be appropriate for beginning, intermediate, and advanced level athletes.

Proper Amount of Exercise

Fitt Formula

There are several types and variations that can be used when circuit training. The possibilities are endless. If safety rules and proper exercise components (duration, frequency, and intensity) are followed then your imagination is the limit. Frequency, intensity, time (duration) and type, commonly called the "Fitt" formula, are the key to proper exercise and achieving the best possible results for the time you spend exercising.

According to the American College of Medical Sciences (ACMS) guide to physical exercise the following guidelines should be used concerning the "Fitt" formula: minimum **frequency** 3-5 days per week, however, research indicates that 4-6 days per week is more accurate. Frequency refers to how often you do physical exercise. In order for exercise to be beneficial, one must do it several times per week. Remember that exercise will vary according to several factors. These factors include: what goals you have, what level of fitness you are currently at, medical concerns, and age to name just a few. For example, if you want to develop strength you might need two days per week, but to lose fat daily exercise is needed. One should strive for a mixture of cardiovascular and strength conditioning for the best overall benefits. An example is if you conduct cardiovascular workouts on Monday, Wensday, and Friday and strength conditioning on Tuesdays, Thursdays, and Saturdays. If you do not have this amount of time commitment combine workouts on four different days each week and you do not need all six days. Remember that exercise is like any other area of your life, you need to pay attention to it and make time for it.

Intensity is the area that is most often misunderstood when exercising. Intensity refers to how hard you perform physical exercise. If an activity is too easy, you will not build fitness and gain other benefits. However, extremely vigorous activity can be harmful if you do not work up to it gradually. Intensity is determined differently depending on the type of exercise you do and the fitness level you want to attain. The old saying, "no pain, no gain" is not applicable in this setting; one must be careful when using this belief in any workout setting. Most often people believe that they must workout as hard as possible to achieve positive benefits, this is not true. One must workout smart to achieve their goals. The other side of the coin is that people are lead to believe that they can achieve their goals in a very short period of time, this is not true either. Exercise is no different than any other goal you have achieved; you only achieve the goal through hard work and desire. You must persevere through hard times as well as easy times. There are two basic ways to measure the intensity of a work out maximum heart rate and perceived exertion.

Maximum heart rate is found by subtracting your age from 220 (age – 220 = MHR). Once you find your maximum heart rate (MHR) you can develop any exercise intensity you wish. You would simply multiply the intensity by you MHR and you get the target heart rate

(THR). For example: you are 20 years old so you find your MHR. This is done by 220-20(age) = 200. Now you can find the intensity by multiplying by your desired intensity. Most people use 60% – 75% intensity levels to achieve their exercise goals. 60% -75% intensity level will give you an adequate level to achieve a training adaptation. This in turn will give you the correct level of exercise difficulty. For example: you have already found your MHR now multiply the desired intensity level. If your MHR is 200 and you want an intensity level of 70% you would multiply .70 (70% in decimal form) by 200. This would give you a THR of 140 beats per minute. You would then take this number and use it during your exercise period to see if you are working to hard or too little. Simply check your pulse approximately every 2 – 3 minutes and see what your pulse rate is. If your pulse is higher than this number then you are working too hard and can to slow down accordingly if you chose. If your pulse rate is below this number then you need to pick up the pace. There are two easy places to find your pulse the carotid (neck) and radial (wrist).

Perceived exertion is based on a number system that corresponds to the way you are feeling when performing exercise. The numbers run from 1-10 with one being completely at rest and ten being 100% effort. The individual should try and stay in the 6-8 range. However, the problem lies in the interpretation of fatigue. Each person is different in their perception of how tired they feel. This "feeling" of fatigue is affected by several factors. Examples are: what fitness level you are currently at, current health, mood, etc… Perceived exertion is a good way for a beginner to start exercising until they learn about the "FITT" formula. They should move to the target heart rate method as soon as they are ready.

Duration (time) refers to how long you perform the exercise session. The length of time depends on the exercise you are doing and the part of fitness you want to develop. For example, to build flexibility you should exercise for 10 – 15 seconds at least three repetitions for each muscle group, when building cardiovascular fitness you need to be active continuously for a minimum of 20 to 30 minutes. Remember that quality is better than quantity in a majority of training, especially for overall good health.

Type refers to the kind of exercise you do to build a specific part of fitness or to gain a specific benefit. The basic rule of thumb is that if you are getting the other three parts of the formula correct and you enjoy the activity, the exercise is fine. The "Fitt" formula is not hard to use and understand, however, it is the correct way to achieve overall cardiovascular and strength fitness. In summary you need to workout several days per week (frequency) at 60%- 70% intensity level for 20 –30 minutes minimum (duration) using an exercise (type) you enjoy. This will help you to get on and stay on an exercise program. Please remember that in order to attain a specific goal, such as training for a sporting event, you will need to adapt your work out schedule accordingly.

Basic Principles of Exercise

Remember that after exercising for several weeks, or months depending on the individual, you will see some positive results. Examples would include you are no longer as tired at the end of your exercise session, a self assessment shows that your strength and conditioning has improved, your positive mental attitude has become stronger to name a few. However, you will start to notice that you are not progressing like you did at first, you may notice that your strength and/or cardiovascular fitness has not improved after your first retest. If you are sure you are correctly performing your strength and conditioning program on a regular basis, see the

"FITT" formula in previous section and you are adhering to three basic principles of exercise: overload, progression, and specificity.

Overload

The principle of overload, the most basic law of exercise, states that the only way to produce fitness and health benefits through physical activity is to require your body to do more than it normally does. An increased demand on the body (overload) forces it to adapt. The body was designed to be active; so if you do nothing (underload), your fitness decreases and your health suffers. Therefore, if you are not overloading when exercising you will not gain fitness and health benefits. You will need to increase the amount of physical activity if you expect to continue improving your cardiovascular fitness. Athletes must be in good physical shape before specificity training can reach its desired goal of optimum performance.

Progression

The principle of progression states that the amount and intensity of your exercise should be increased gradually. After a while your body adapts to an increase in physical activity (load) and your activity becomes too easy. When this happens, increase your activity slightly. The minimum amount of overload you need to build physical fitness is your threshold of training. Activity above your threshold builds fitness and promotes health and wellness benefits. However, it is possible to exercise too much and to go above your upper limit of activity, also called your target ceiling. Ideally you should do exercise that is above your threshold of training and below your target ceiling. This correct range of physical activity is called your target training zone. When you do physical activity in your target-training zone, you build fitness and other benefits. However, when you go above your target ceiling, you can increase the possibility of injury and you can develop muscle soreness. The principle of progression provides the basis for rejecting the "no pain, no gain" theory. If you have pain when you exercise, you are probably overloading too fast for your body to adjust, thus increasing the possibility of injury.

Specificity

The principle of specificity states that the specific type of exercise you do determines the specific benefit you receive. Different kinds and amounts of activity produce very specific and different benefits. Remember that an exercise that promotes health may not be equally good in promoting high levels of fitness in another part of fitness. Finally, exercise for specific body parts, such as the calf muscle, may provide benefits only for that body part. For example, if you started doing an exercise that stretched the muscles on the posterior side of the leg, you would not build flexibility in the muscles on the anterior side of the leg; unless you do exercises designed to improve the flexibility of that specific area of the body.

Types of Flexibility

As with so many physical qualities, flexibility is specific. There is no correlation between the flexibility of one joint and another. People who are flexible in one area of their body are not necessarily flexible in another. Consequently, while one person may be flexible in most joints,

another is inflexible in most joints, however, most people will be somewhere in between these extremes. There are several methods of stretching.
The four main stretching methods are:

1. **Ballistic Stretching**-involves repeatedly swinging and bouncing through a full range of motion. Toe touches and high kicks are examples of ballistic stretching. Ballistic stretching has been criticized because of the supposed potential for causing injury.
2. **Static Stretching**-there is a slow move towards the full range of motion in a given position but stops short of the point where significant pain is felt. This position is generally held for 20-30 seconds, with the range of motion gradually increased as the muscles relax.
3. **PNF Stretching**-called fatigue stretching or proprioceptive neuromuscular facilitation generally involves the use of a partner. There are several varieties of PNF, but the most common method is one in which the person assumes a starting position for the stretch which is similar to static stretching. While in this position, the person pushes (isometrically) in the opposite direction of the stretch, against resistance supplied by the partner, for 4-6 seconds. Then the person stretches further than the original stretched position.
4. **Active Isolation**-the person stretches as far as possible and then assists himself or herself to go further, until a point of mild irritation is achieved. That position is held for 2 seconds or a little less. The person then returns to the starting position, relaxes for 2 seconds and repeats the exercise. Two sets of eight to twelve repetitions are generally performed in this manner.

The aims of flexibility are to gently lengthen muscles before and after any form of exercise, and to improve tissue elasticity / flexibility. If done correctly, flexibility will help prevent injuries and increase performance.

Begin with gradual mobility exercises of all the joints, i.e. simply rotate the wrists, bend the arm and roll your shoulders. This will allow the body's natural lubrication (synovial fluid) to protect the surface of your bones at these joints. Always warm up the body prior to stretching, as this increases blood flow around the body, this in turn makes the muscles more supple.

After exercise, slowly bring your heart rate down before you begin stretching in order to avoid blood pooling within your muscles, which can lead to cramps and dizzy spells. If you’re wet and sweaty, take a bath or shower then stretch, as the hot water will help relax the muscles, and prevent you from catching a chill. Never bounce while you stretch, unless you are doing specific stretches for certain sports, i.e. ballistic stretching for martial arts. Hold the stretch until

you feel the muscle loosen then repeat for a further 15 seconds (static stretching). While stretching you should feel some slight discomfort, if you don't feel anything, then you may be doing the stretch incorrectly or simply the muscle has eased off. Stop immediately if you feel any severe pain.

Remember to breathe regularly and rhythmically, do not hold your breath.
Start with your legs, and work up the body, in order to make sure you utilize a full array of flexibility exercises.

Balance Effect of a Strength and Conditioning Program

Before I begin discussing the development of a strength and conditioning program for cross country and endurance athletes I must mention the proper balance involved in a strength and conditioning program. Imbalances are a leading cause of injury and/or chronic orthopedic problems; thus, a sound program must include movements for every major muscle group. It is very possible to make big gains in strength and see little or no functional transfer if certain movements are neglected, allowing antagonistic muscle-group deficits to develop.

The concept of using power and control to achieve overload largely takes care of itself, at least during lower-body workouts when the program consists of free-weight movements. A useful rule of thumb is to include a "pulling" or flexion exercise for every "pushing" or extension exercise. This is done so that each movement plane is worked equally in both directions. In the case of lower-body training, primary movements can be balanced out to a large extent with exercises such as the glute-ham raise, abdominal/trunk flexion and various isolation exercises. However, this becomes more challenging in the case of upper-body training because of the mobility of the shoulder girdle and resulting need to offset traditional pressing exercises; hence the value of high/low cable stacks and various free-body exercises.

Plyometric Exercises Verse Concentric Exercises

Exercises for the development of power and speed can be divided into different categories based on their speed of movement and whether the exercises contain a plyometric element. For example, jumping movements can be performed as heavy squats or heavy jump squats or they can be performed as speed-strength exercise, however, both would have a preliminary counter-movement. In some sports a movement may be initiated without a counter-movement, for example a sprinter coming out of the blocks. Therefore some of the training exercises should attempt to duplicate this type of start. For example, heavy squats could be performed by descending then stopping for several seconds before ascending or squats could be performed from a pin at a set height in a power rack.

Basic Exercises

Basic exercises are exactly that - basic. In general, they are very straightforward and there is little need to substitute other movements in their place or supplement them with different types of exercises. Considering the concept of basic exercises, resistance-training exercises can be classified into three main categories: primary, secondary, and tertiary.

Primary, or structural, exercises are multi joint, weight bearing types of exercises, such as squats and dead lifts. The second category of basic resistance exercises is called supplemental or

secondary. These exercises are multi joint, non-weight bearing exercises; such as upper body pressing or pulling exercises. The last category is called tertiary, or isolation, exercises. These types of exercises are single joint and non-weight bearing such as wrist curls.

Primary exercises are movements that, by definition, tend to yield the most profound results. Where as, those exercises further down the continuum do not have as great of an effect but are usually technically simpler. The examples cited above for each category are certainly not comprehensive and it is not difficult to create hybrid movements. For example, weightlifting movements in which explosive impulse and power are the fundamental objectives represent a special case of primary exercises that are semi-ballistic, meaning that the exercise is performed with some degree of speed.

The lunge and step-up each meet the criteria for a primary exercise, where as, machines such as a hip sled or leg press arguably does not, despite the fact that these exercises involve similar muscle mass and exertion. In fact, the latter may be a viable option during extremely intensive workloads and/or when the athlete's trunk cannot safely support the weight required to train the legs in movements such as the squat or dead lift.

The pull-up, dip, push-up and related exercises can be considered multi-joint weight-bearing movements, which would place them in the primary category according to this scheme. However, they often receive less emphasis than the traditional upper-body exercises mentioned above. Furthermore, they usually do not involve the same muscle mass or resistance used in other primary movements, making it difficult to justify placing them in the same group. All things considered, however, they may deserve greater consideration than "standard" upper-body movements.

There are other examples as well, but the point is that this classification scheme is not an attempt to label certain movements as being good or bad. It is simply a place to start making rational decisions about selecting and prioritizing them. As is the case with all aspects of a program, principles should be used as a guide rather than preferences. Perhaps most importantly, this means that training effect has precedence over strength demonstration. The objective is to choose the most effective movements and execute them in the most beneficial way as to elicit the best possible training effect, which in turn will optimize performance.

With the obvious exception of the competitive lifter, there comes a point in an advanced athlete's development when it may no longer be judicious for the trunk to support the heaviest weights that the hips and legs are capable of moving. This is not intended to dissuade athletes from performing heavy structural movements. Indeed, one of the most effective ways to strengthen a healthy trunk is to load it in a fixed position while the lower body does the work, transferring force through the segments of the body. Likewise, lack of torso strength is an underlying cause of many so-called back problems. However, it is important to realize that the human spine is a tower, which was originally designed as a bridge. One should therefore consider its limitations, and corresponding training options, when approaching advanced levels of strength. My recommendation is to view the primary exercises as a family of ground-based movements, which are interchangeable to some extent. It is a simple matter of whether the weight is supported across the shoulders or suspended from them. If an athlete is better able to handle heavy squat weights by substituting the conventional dead lift in its place, it may be appropriate to do so because the two movements are more similar than they are different. Furthermore, if the athlete has difficulty maintaining good posture when dead lifting from a static bottom position, it may be appropriate to set the bar up on blocks or racks and descend into

each rep from an upright position. In this way, the best features of each movement can be combined to achieve an optimal training effect.

Many athletes reach a point where they simply cannot maintain a flat back when venturing into very heavy squats or dead lifts. The trunk must then be unloaded and/or supported in order to train the hips and legs to their limit. One option is to progressively introduce other structural movements that do not load the trunk as heavily, such as the lunge or step-up. Another is to include assistive hip/trunk strengthening movements such as the glute-ham raise, stiff-legged dead lift, or trunk/reverse extension into the program in order to work the major structures in different combinations while unloading the torso. An additional option is to use barbell exercises for sub-maximal weights, and perform the heaviest sets on hip sled, leg press or other apparatus, which supports the torso. When pursuing a specific objective, the pros and cons of various alternatives should be considered.

Training Methods

A hierarchy of training methods for specialized strength development is given below. As can be seen, this classification scheme is largely a matter of practicality and there is some overlap. The key to applying these methods lies in their skillful combination rather than exclusive or disproportionate use of any one of them.

1. **Brief Maximal Efforts -** this method is intended to improve intra- and inter-muscular coordination, and to minimize neuromuscular inhibition. Although a relatively narrow corridor of motor units is activated, this method allows high-threshold and fast fatigue motor units to be recruited at their greatest discharge frequency and synchronicity. It is useful for advanced athletes, but is generally inappropriate for novices. This method tends to improve the ability to accelerate heavy loads, but has minimal hypertrophy.
2. **Repeated Sub-maximal Efforts** - this method is usually applied with various intermediate intensities and a traditional "repetition maximum" approach. It is an effective means of developing basic strength and muscle mass in novice athletes, as well as, maintenance of advanced athletes. This method targets a relatively large population of motor units, and has a lower effect on high resistance acceleration ability, at least in highly qualified athletes.

It is important to understand that high-speed movements are not the only way to activate and train fast twice muscle fibers. Motor units exist in a spectrum and are progressively recruited as power or force output increases. Given the range of force-velocity combinations possible in any movement it is not surprising that the neuromuscular system activates motor units as well as muscles in functional groups. Furthermore, force production is not just a matter of motor unit recruitment, but also of coordination and synchronization. Adaptation is a function of activation, and maximal effort at a given resistance.

Practically speaking, a wide range of workload intensities and volumes can be justifiably recommended. And yet despite all these options, a strength training program's effectiveness will be limited if it is approached exclusively in terms of weights and reps, while ignoring the accelerative quality of force. Likewise, it is a mistake to assume that full activation automatically occurs whenever the bar is moving; or that the last rep of a set triggers the desired training effect. These are particularly costly errors for those who abbreviate work volume to the point where

they cannot afford anything less than extreme emphasis on training quality. The solution is to maximize force output and neuromuscular activity on each repetition by accelerating through the sticking region at full power, regardless of resistance or rep count.

Organizing a Strength and Conditioning Program

The initial aim for all runners and endurance athletes is general strengthening of all major muscle groups of the upper and lower body and core. Once that is accomplished, specialized training is performed to focus on individual needs like reducing specific muscular weaknesses and imbalances, and rehabilitating prior and current injuries. For a strength training program to be safe and effective in the long term, principles of periodization should be followed when designing the program. Periodization is the gradual cycling, the allocation of a specific period of time in terms of days, weeks, or months, as related to, specificity, intensity and volume to achieve peak levels of fitness. These time periods are divided into three time periods: pre-season, in-season and post-season. Each period has its seasonal demands and training variables are adapted to them to reduce the potential for overtraining and bring optimum strength.

The greatest strength gains should be made during pre-season. This is the period of time before the competitive season. This is when volume (sets x reps) and intensity (weight lifted) is highest and either training volume has been decreased and/or sport specific exercises have decreased in intensity.

During the competitive season, in-season, when training volume and intensity are at their peak, the goal of strength training is to maintain the strength gained in the pre-season. Over training must be avoided.

The final part of the training calendar is the post-season during which recovery is paramount. Training mileage is usually diminished and strength training volume and intensity are moderate.

General Guidelines for Strength Training and Conditioning

1. Workout two to three non-consecutive days per week. Different events require different training, be sure to read the section that deals with your event(s).
2. Select exercises that strengthen the core (abdomen and lower back), upper body (chest, shoulders, upper back and arms) and lower body (buttocks, front, rear, and inner thighs, calves, and feet).
3. Since the lower body is the very critical and exercises for the lower body are the most challenging, they are performed first. Upper body exercises are done second and core exercises are done last (individual needs may necessitate a change in exercise order). Remember to perform the exercises from larger muscles groups to smaller muscle groups.
4. Perform one to two sets. The number of sets will depend on the training effect desired.
5. Perform 10 to 15 repetitions for endurance efforts, fewer repetitions, 2-8, for power and strength needs. Remember that each event requires different needs in order to achieve optimum performance.
6. Weight will vary considerably from exercise to exercise. To start, pick a weight with which you can perform 10 to 15 reps without straining. You should feel like you

would be able to do three to five more reps, this applies for every beginner regardless of event. As the athlete becomes more advanced change the weight used according to desired effect on performance. However, do not increase weight in more than 5% increments, approximately 1 to 5 pounds.

7. Rest 30 to 60 seconds between sets.
8. Controlling the movement of the weight is paramount. Lift the weight in two seconds and lower the weight in four seconds, the six-second rule.

TRADITIONAL ACTIVITIES

The following activities are the more common, or traditional, exercise forms used in strength and conditioning programs. The work being performed is largely dependent on the equipment available and your desired needs. This is not an all-inclusive list; however, these exercises will produce the results that all athletes are seeking for optimum performance.

1. Isotonic exercises are performed using a fixed resistance and varying the muscle speed using free weights.
2. Isometric exercises are performed using a fixed resistance with no limb movement. The main problem with this method for the distance athlete is the absence of natural ballistic action. Distance running requires fast motion and multiple joint actions integrated in a repetitive, ballistic footstrike pattern that includes: mid support, takeoff, follow through, forward swing, foot descent and another foot strike. However, isometric strength work plays a vital role in the development of core strength.
3. Isokinetic exercises are performed using variable resistance machines which provide a velocity profile through a range of motion that differs greatly to that needed for running. Isokinetic exercises inhibit acceleration and are not functional as little of the strength gained can be transferred to the running track.
4. Plyometrics exercises are performed by concentric contraction of muscles following an eccentric contraction. Hopping, bounding, depth jumping are examples and often are used more by sprinters, throwers, and jumpers, however, middle distance and distance athletes will benefit from plyometrics as well. Another great advantage of plyometrics is that while developing great elastic and functional strength it doesn't lead to hypertrophy. Other advantages include: allowing the muscles to be overloaded at speeds closer to competition situations compared with traditional weight training. Plyometrics movements are performed in an explosive fashion, thus, forcing the athlete to rapidly develop force, therefore improving power. Plyometric training also enhances the neurological benefits associated with the performance of power and speed events.

Many distance coaches and runners have the mistaken impression that strength exercise is counter-productive for better running. When questioned further, many indicate that strength training will increase bodyweight, decrease flexibility and interfere with running form. Fortunately, most successful distance runners have ectomorphic physiques that resist gains in bodyweight. The two to four pounds of muscle that may be added through strength training is like putting more cylinders in your automobile engine. That is, the overall weight gain is minor, but the greater power output is highly desirable.

With respect to joint flexibility, no studies have shown sensible strength training to decrease range of motion, and several have demonstrated significant improvements in movement

parameters. This is especially true when you combine strength training with stretching exercises. For example, a combined strengthening and stretching program will result in muscle gain, fat loss, increase in muscle strength, and an increase in joint flexibility.

The next question is what about running form? For example, look at sprinters. Most of these athletes strength train regularly and their times keep getting faster and faster. Running speed is the interaction of stride length and stride rate, and strength training is advantageous for both of these abilities. During the latter stages of a race when your leg muscles are fatigued and your arm action keeps you moving, the benefits of more upper body strength will be better appreciated. Another aspect of long distance running, especially cross-country and road racing, where greater strength makes a difference is kicking at the end of a race. In cross-country when running hills, both up and down, stronger muscles will provide more power. Stronger muscles also offer better shock absorption, therefore, more injury protection.

With all the benefits that strength exercise can offer, why do so few distance runners include this activity in their conditioning program? Primarily because the typical strength training workout is just as aversive to distance runners as the typical distance running workout is to weight lifters. Distance runners do not need a two-hour strength workout to improve their muscular fitness anymore than bodybuilders need a two-hour run to improve their cardiovascular fitness.

In summary, successful performance in endurance training depends on physiological, biochemical, psychological, and nutritional factors. A critical factor in the physiological domain is the force production of the contracting musculature. While any running at all certainly satisfies the definition of force production, it has been proven that a greater force production must be generated to achieve a more desirable training effect for greater adaptation. One component of training for performance that addresses this point is specific, targeted, resistance training. Resistance training accurately describes all types of strength training. The proper strength and conditioning program will benefit the endurance athlete. Scientific research shows that concurrent resistance and aerobic training does not inhibit either's development. Runners who avoid resistance training for fear it will compromise their performance fail to realize that resistance training leads to physiological adaptations, both acute and long-term, that will actually improve performance. The physiological gains from progressive resistance work include: increases in capillarization in the muscle fiber, increased availability of fuel to the muscles, improved muscular endurance through increases in cell mitochondria, increased inter-cellular fiber density, stronger bones, and stronger connective tissue. These gains will benefit any distance runner. Additionally, other biomechanical benefits include increases in flexibility and greater coordination of the entire muscular system.

Recommended Strength Training Program

First, research shows that two strength-training sessions per week are about 85 percent as productive as three strength training sessions per week. I therefore suggest that you begin with two strength workouts per week, on days when you do easy to moderate effort training runs.

Second, since single set strength training seems to be as effective as multiple set workouts, I recommend one good set of each exercise. This greatly reduces the exercise time as well as the risk of overtraining problems.

Third, because successful distance runners typically have higher muscle endurance, due to a greater percentage of slow-twitch muscle fibers, they generally attain better results by

strength training in higher repetition ranges. Whereas, power athletes thrive on four to eight repetitions per set, endurance athletes are better served with 12 to 16 repetitions per set.

Fourthly, I recommend resistance training for distance runners that has full movement control, which is best, accomplished by moderate to slow speed repetitions (6-second rule). Fast weight training movements involve momentum that reduces strength development and increases injury potential. A safe, effective, and time-tested training speed is six seconds for each repetition, or about one minute for a set of 10 repetitions. Each lifting movement should be performed in about two seconds and each lowering movement should be performed in about four seconds. By slowing down the lowering movement, both phases of each repetition become productive for building strength. Keep in mind that one set of exercise performed at six-seconds per repetition requires as much muscle tension as three sets of exercise performed at a more typical two seconds per repetition.

Finally, the key to building musculoskeletal strength is progressively increasing the training resistance. This is what makes free weights and machines superior to bodyweight exercises. Whenever you can complete 16 properly performed repetitions of an exercise, increase the resistance by about five percent for continued progress. Generally speaking, you should see about a 40 to 50 percent increase in your exercise weight loads after eight to 10 weeks of regular strength training. Although some of the initial strength gain is due to motor learning factors, you should notice a significant improvement in muscle function during your training runs. You should also be much more resistant to typical running injuries.

The following chart presents the 12 major muscle groups of the body and recommended selectorized or free-weight strength building exercises. This is a comprehensive program of basic exercises designed for overall muscle conditioning. Make every repetition as productive as possible by using the 6-second rule.

Muscle Group	**Selectorized/Machines**	**Free Weights**
Quadriceps	Leg Extensions	Squat (barbell/dumbbell)
Hamstrings	Leg Curl	Squat (barbell/dumbbell)
Gluteals	Hip Extension	Squat (barbell/dumbbell)
Pectoralis Major	Chest	Bench Press (barbell/dumbbell)
Latissimus Dorsi	Pullover	Bent Rowing (dumbbell)
Deltoids	Lateral Raise	Lateral Raise (dumbbell)
Biceps	Biceps Curl	Biceps Curl (bar/dumbbell)
Triceps	Triceps Extension	Triceps Extension (bar/dumbbell)
Spinal Muscles	Low Back	Back Extension (body weight)
Abdominals	Abdominal	Trunk Curl (body weight)

Trapezius	Neck and Shoulder	Shrug (barbell/dumbbell)
Neck Flexors Neck Extensors	Four Way Neck	Neck Pulls/resistance drills

There are physiological and biomechanical adaptation specificity's resulting from proper strength training that can be achieved in no other way. Endurance runners will become better athletes through intelligent utilization of strength training. When the runner becomes a better, stronger athlete, they will post faster times through better performances.

Seemingly forever, most distance runners have resisted a structured strength-training program for a variety of reasons. They do not have the time to spend on it, they do not have access to facilities, they are embarrassed by their lack of strength compared to other athletes on the team, or they just lack the drive to do it. The assumption has been that running alone is enough to reach full performance potential. Contemporary research on endurance training and resulting performance has proven that endurance runners that want to optimize their performance in track and field endurance events must add a properly structured strength and conditioning program.

CORE STRENGTH AND STABILITY

Coaches can often pick out poor technique in an athlete, however, they don't always know why and therefore how to correct the problem. Some classic examples of poor technique which stem from poor core, midsection, strength and consequently poor pelvic control are as follows:

1. Excessive head movement
2. Flat-footed
3. Crossing over of feet
4. Round shoulders
5. Over striding
6. Excessive hip movement
7. Arms swinging across the body
8. Increased lordosis
9. Quadriceps tend to shorten due to the often anteriorally rotated pelvic posture associated with abdominal and glute weakness
10. In the absence of gluteal strength the hamstrings take on a greater role and become the prime hip extensors that can in time lead to irritation of the hamstrings
11. In general, if shorter muscles designed for stability are not working then longer muscles may be recruited and can then generate trunk movement

Finally, a word of warning in regard to developing strength and conditioning programs for cross country runners and endurance athletes. Unless an extensive stretching program is incorporated with this program progress will not be optimum or even evident. As stated earlier, pelvic instability can be caused by several factors. Strengthening the associated muscles is only part of the training program and must be carried out in conjunction with the other components.

Final Comments

Endurance can be divided into two metabolic categories; aerobic (needed for sustained sub-maximal activity) and anaerobic (needed for intermittent, high intensity activity). Thus, an endurance program based primarily on running, which will improve aerobic endurance, will fail to prepare the runner for the anaerobic needs of cross-country races. An endurance training program must take into account not only the metabolic (energy production) demands of a task, but also the neuromuscular (messages between nerves and muscles) and musculoskeletal (muscle and bone) requirements.

The metabolic demands of a task, like running, are dependent on the intensity and the duration of the run. ATP (adenosine triphosphate) fuels running. A sprint of up to about 15 seconds uses the ATP that is already stored in the muscles. Hard running of a longer duration requires that ATP be produced from glucose (carbohydrates broken down to sugar) stored within the muscles (called glycogen). A 400-meter dash, for example, primarily uses ATP from muscle glycogen. If the distance (and duration) is increased beyond 400 meters, lactic acid begins to build up in the muscles (burning sensation) demanding that we stop or decrease the intensity of the run. Both the 15-second and 400 meter sprints occur without oxygen present in the muscle and are therefore anaerobic. In fact, the reason for the lactic acid build-up is the lack of oxygen to support the continued use of glycogen. Distance runners limit the intensity of their run so that sufficient oxygen is present as muscle glycogen is broken down to make more energy (ATP). This is aerobic activity that in addition to muscle glycogen (stored carbohydrate) uses fatty acids for energy. When sprints or longer dashes are repeated, recovery from the previous efforts determines the quality of anaerobic tasks. Aerobic training will help to improve recovery. In addition, running beyond what is required to develop an aerobic base steals valuable time that should be spent on activities that develop mobility (movement proficiency) performance factors such as power (explosive strength). Running farther faster requires speed, strength, and endurance.

The neuromuscular demands of running are minimal. Challenging the neuromuscular system requires activities that demand balance, maintaining equilibrium, coordination (performing multiple tasks), agility (stopping, starting and gracefully changing body position), and power. Without stops, starts, changes of direction, and changes in intensity, running does little to prepare the neuromuscular system for any other task. In contrast, activities such as the shuttle Run and hill running place high neuromuscular demands on the body. When performed with precision, these activities improve mobility.

The musculoskeletal demands of running are repetitive. Running repeatedly stresses the same muscles, bones, and joint structures of the legs, pelvis, and low back. Proper progression, variety, and recovery in a running program will improve performance while minimizing injury risk. Runners strike the ground with each foot approximately 50-70 times per minute with a force upwards of 2-3 times their body weight. Lower extremity injuries are a major problem for endurance runners.

Strength and Conditioning Program for Endurance Events

The following program encompasses an 8-week program that will develop strength and flexibility:

Week 1 - Muscles of the Trunk

Exercise	Muscle group	Main Purpose	Sets	Reps
Low Back	Erector Spinae	Force transfer Injury prevention	1	8-12
Abdominal	Rectus Abdominis	Force Transfer Injury Prevention	1	8-12
Abdominal Bench	Internal Obliques External Obliques	Force Transfer Injury Prevention	1	8-12

Guidelines:

1. Perform each repetition at a slow movement speed (6-second rule).
2. Perform each repetition through a full movement range.
3. Upon completing 12 repetitions add more resistance (1 to 5 lbs.).
4. Train 2 or 3 non-consecutive days per week.

Week 2 - Muscles of the legs

Exercise	Muscle Group	Main Purpose	Sets	Reps
Leg Press	Quadriceps Hamstrings Gluteals	Power Production	1	8-12
Hip Adduction	Hip Adductors	Power Production Hip Drive	1	8-12
Hip Abduction	Hip Abduction	Power Production Hip Drive	1	8-12
Low Back	Erector Spinae	Force Transfer Injury Prevention	1	8-12

Abdominal	Rectus Abdominis	Force Transfer Injury Prevention	1	8-12
Abdominal Bench	Internal Obliques External Obliques	Force Transfer Injury Prevention	1	8-12

Guidelines:

1. Perform each repetition at a slow movement speed (6-second rule).
2. Perform each repetition through a full movement range.
3. Upon completing 12 repetitions add more resistance (1 to 5 lbs.).
4. Train 2 or 3 non-consecutive days per week.

Week 3 - Muscles of the Torso

Exercise	**Muscle Group**	**Main Purpose**	**Sets**	**Reps**
Leg Press	Quadriceps Hamstrings Gluteals	Power Production	1	8-12
Hip Adduction	Hip Adductors	Power Production Hip Drive	1	8-12
Hip Abduction	Hip Abduction	Power Production Hip Drive	1	8-12
Chest Press	Pectoralis Major Triceps	Power Production	1	8-12
Seated Row	Latissimus Dorsi Biceps	Power Production	1	8-12
Lateral Raise	Deltoids	Power Production	1	8-12
Low Back	Erector Spinae	Force Transfer Injury Prevention	1	8-12
Abdominal	Rectus Abdominis	Force Transfer Injury Prevention	1	8-12
Abdominal Bench	Internal Obliques External Obliques	Force Transfer Injury Prevention	1	8-12

Guidelines:

1. Perform each repetition at a slow movement speed (6-second rule).
2. Perform each repetition through a full movement range.
3. Upon completing 12 repetitions add more resistance (1 to 5 lbs.).
4. Train 2 or 3 non-consecutive days per week.

Week 4 - Muscles of the Arm

Exercise	Muscle Group	Main Purpose	Sets	Reps
Leg Press	Quadriceps Hamstrings Gluteals	Power Production	1	8-12
Hip Adduction	Hip Adductors	Power Production Hip Drive	1	8-12
Hip Abduction	Hip Abduction	Power Production Hip Drive	1	8-12
Chest Press	Pectoralis Major Triceps	Power Production	1	8-12
Seated Row	Latissimus Dorsi Biceps	Power Production	1	8-12
Lateral Raise	Deltoids	Power Production	1	8-12
Biceps Curl	Biceps	Upper Body Control Speed Production	1	8-12
Triceps Extension	Triceps	Upper Body Control Speed Production	1	8-12
Wrist Roller	Wrist Flexors Wrist Extensors	Arm Strength	1	8-12
Low Back	Erector Spinae	Force Transfer Injury Prevention	1	8-12
Abdominal	Rectus Abdominis	Force Transfer Injury Prevention	1	8-12
Abdominal Bench	Internal Obliques External Obliques	Force Transfer Injury Prevention	1	8-12

Guidelines:
1. Perform each repetition at a slow movement speed (6-second rule).
2. Perform each repetition through a full movement range.
3. Upon completing 12 repetitions add more resistance (1 to 5 lbs.).
4. Train 2 or 3 non-consecutive days per week.

Week 5 - Muscles of the Neck

Exercise	Muscle Group	Main Purpose	Sets	Reps
Leg Press	Quadriceps Hamstrings Gluteals	Power Production	1	8-12
Hip Adduction	Hip Adductors	Power Production Hip Drive	1	8-12
Hip Abduction	Hip Abduction	Power Production Hip Drive	1	8-12
Chest Press	Pectoralis Major Triceps	Upper Body Control Speed Production	1	8-12
Seated Row	Latissimus Dorsi Biceps	Upper Body Control Speed Production	1	8-12
Lateral Raise	Deltoids	Upper Body Control Speed Production	1	8-12
Biceps Curl	Biceps	Upper Body Control Speed Production	1	8-12
Triceps Extension	Triceps	Upper Body Control Speed Production	1	8-12
Wrist Roller	Wrist Flexors Wrist Extensors	Arm Control	1	8-12
Low Back	Erector Spinae	Force Transfer Injury Prevention	1	8-12
Abdominal	Rectus Abdominis	Force Transfer Injury Prevention	1	8-12
Abdominal	Internal Obliques	Force Transfer	1	8-12

Bench	External Obliques	Injury Prevention		
Neck Exercises	Neck Flexors Neck Extensors	Head Stability	1	8-12

Guidelines:

1. Perform each repetition at a slow movement speed (6-second rule).
2. Perform each repetition through a full movement range.
3. Upon completing 12 repetitions add more resistance (1 to 5 lbs.).
4. Train 2 or 3 non-consecutive days per week.

Weeks 6 - 8 - Comprehensive Strength Training Program

Exercise	**Muscle Group**	**Main Purpose**	**Sets**	**Reps**
Leg Press	Quadriceps Hamstrings Gluteals	Power Production	1	8-12
Hip Adduction	Hip Adductors	Power Production Hip Drive	1	8-12
Hip Abduction	Hip Abduction	Power Production Hip Drive	1	8-12
Chest Press	Pectoralis Major Triceps	Upper Body Control Speed Production	1	8-12
Seated Row	Latissimus Dorsi Biceps	Upper Body Control Speed Production	1	8-12
Lateral Raise	Deltoids	Upper Body Control Speed Production	1	8-12
Biceps Curl	Biceps	Upper Body Control Speed Production	1	8-12
Triceps Extension	Triceps	Upper Body Control Speed Production	1	8-12
Wrist Roller	Wrist Flexors Wrist Extensors	Arm Control	1	8-12
Low Back	Erector Spinae	Force Transfer Injury Prevention	1	8-12

Abdominal	Rectus Abdominis	Force Transfer Injury Prevention	1	8-12
Abdominal Bench	Internal Obliques External Obliques	Force Transfer Injury Prevention	1	8-12
Neck Exercises	Neck Flexors Neck Extensors	Head Stability	1	8-12

Guidelines:

1. Perform each repetition at a slow movement speed (6-second rule).
2. Perform each repetition through a full movement range.
3. Upon completing 12 repetitions add more resistance (1 to 5 lbs.).
4. Train 2 or 3 non-consecutive days per week.

Exercise Tips

The following list is not all-inclusive; however, it suggests some of the basic tips for exercise. Remember that you are only going to get results after time. Results will come, but not in one day, it takes time. You will benefit from strength and conditioning and the results will be worth the work you put into the program.

1. Always consult a physician before beginning an exercise program
2. Warm up prior to exercise and cool down after exercise
3. Start slowly and build up gradually. If you are not accustomed to exercising, start with a little bit less exercise than the program recommends (for example: reduce the total time spent on cardiovascular conditioning and perform fewer repetitions of strength training movements)
4. Wear clothing made from breathable fibers to allow for adequate cooling.
5. Wear proper footwear
6. When exercising outdoors, protect your skin and eyes from sun exposure
7. Stay hydrated, drink plenty of fluids
8. Listen to your body. Discontinue exercise if you feel faint, dizzy or pain. Do not perform strenuous exercise if you feel sore or ill
9. Give yourself at least one full day of rest in between strength training Sessions
10. If you are feeling tired, do not perform jumping, bounding, hopping or high-speed sprinting exercises. These movements should be performed when you feel strong and after a proper warm up
11. Make sure your exercise area is large enough to complete movements (especially throwing and swinging movements) and free of tripping hazards
12. Don't release shots, discs, etc… if you don't have the space to do so
13. Use a rubberized "practice" shot or disc when indoors for exercises and releasing drills

14. Perform one set of each conditioning exercise for fifteen repetitions twice a week. A "repetition" is one complete movement, including both right and left sides where applicable. A "set" is a group of repetitions.

The above training protocol/program is a general summary, designed to address the specific demands of the sport presented. Programs may be modified for individual needs. When beginning a program to focus on a highly competitive sport, as with any exercise program, consult your doctor before beginning.

Flexibility

The aims of flexibility are to gently lengthen muscles before and after any form of exercise, and to improve tissue elasticity / flexibility. If done correctly, flexibility will help prevent injuries and increase athletic performance.

Begin with gradual mobility exercises of all the joints, i.e. simply rotate the wrists, bend the arm and roll your shoulders. This will allow the body's natural lubrication (synovial fluid) to protect the surface of your bones at these joints. Always warm up the body prior to stretching, as this increases blood flow around the body, this in turn makes the muscles more supple.

After exercise, slowly bring your heart rate down before you begin stretching in order to avoid blood pooling within your muscles, which can lead to cramps and dizzy spells. If you're wet and sweaty, take a bath or shower then stretch, as the hot water will help relax the muscles, and prevent you from catching a chill. Never bounce while you stretch, unless you are doing specific stretches for certain sports, i.e. ballistic stretching for martial arts. Hold the stretch until you feel the muscle loosen off, then repeat for a further 15 seconds (static stretching). While stretching you should feel some slight discomfort, if you don't feel anything, then you may be doing the stretch incorrectly, or simply the muscle has eased off. Stop immediately if you feel any severe pain.

Remember to breathe regularly and rhythmically, do not hold your breath.
Start with your legs, and work up the body, in order to make sure you utilize a full array of flexibility exercises.

Week 1 - Muscles of the Trunk

Exercise	**Muscle Group**	**Main Purpose**	**Stretch Time**
Front Trunk Stretch	Rectus Abdominis Hip Flexors Pectoralis Major	Injury Prevention Longer Stride Stronger Efficiency	20-60 seconds
Rear Trunk Stretch	Erector Spinae Latissimus Dorsi	Injury Prevention	20-60 seconds

Guidelines:
1. Hold the restraining bands with a firm but relaxed grip, if not using bands hold your position firmly, but do not bounce.

1. Move slowly and gradually into a comfortable stretched position.
2. Maintain the final stretched position without bouncing, jerking, or other movements.
3. Move slowly and gradually out of the stretched position

Week 2 – Muscles of the Legs

Exercise	Muscle Group	Main Purpose	Stretch Time
Rear Thigh Stretch	Hamstrings	Injury Prevention	20-60 seconds
Front Thigh Stretch	Quadriceps	Injury Prevention	20-60 seconds
Hip Stretch	Gluteals Hamstrings	Injury Prevention	20-60 seconds
Front Trunk Stretch	Rectus Abdominis Hip Flexors Pectoralis Major	Injury Prevention Longer Stride Stronger Efficiency	20-60 seconds
Rear Trunk Stretch	Erector Spinae Latissimus Dorsi	Injury Prevention	20-60 seconds

Guidelines:
1. Hold the restraining bands with a firm but relaxed grip, if not using bands hold your position firmly, but do not bounce.
1. Move slowly and gradually into a comfortable stretched position.
2. Maintain the final stretched position without bouncing, jerking, or other movements.
3. Move slowly and gradually out of the stretched position.

Week 3 - 8 – Muscles of the Torso

Exercise	Muscle Group	Main Purpose	Stretch Time
Rear Thigh Stretch	Hamstrings	Injury Prevention	20-60 seconds
Front Thigh Stretch	Quadriceps	Injury Prevention	20-60 seconds
Hip Stretch	Gluteals Hamstrings	Injury Prevention	20-60 seconds

Front Trunk Stretch	Rectus Abdominis Hip Flexors Pectoralis Major	Injury Prevention Longer Stride Stronger Efficiency	20-60 seconds
Rear Trunk Stretch	Erector Spinae Latissimus Dorsi	Injury Prevention	20-60 seconds
Back and Shoulder Stretch	Latissimus Dorsi Deltoids	Injury Prevention Longer Stride Stronger Efficiency	20-60 seconds

Guidelines:

1. Hold the restraining bands with a firm but relaxed grip, if not using bands hold your position firmly, but do not bounce.
2. Move slowly and gradually into a comfortable stretched position.
3. Maintain the final stretched position without bouncing, jerking, or other movements.
4. Move slowly and gradually out of the stretched position.

Conclusion

The above mentioned strength and conditioning program for cross country runners and endurance athletes is not intended to be the complete and perfect source of training. There are changes that will have to be made in order for each individual athlete to achieve his or her optimum performance. However, this program will address the needs of a proper strength and conditioning program and does offer a fully functional training situation that can be followed and success achieved. Remember that each coach and athlete must build the program that is best suited to the goals that are set. Keeping this in mind, when putting together the strength and conditioning program the proper format needs to be followed. If the program is written properly then the athlete will achieve their best performance.

Recent studies have shown that as few as six weeks of proper weight training can significantly reduce or completely relieve kneecap pain or "runner's knee." It also reduces the recurrence of many other common injuries, including nagging hip and low back pain. By strengthening muscle the bones and connective tissues (ligaments attach bone to bone; and tendons attach muscle to bone) will also be positively affected. Weight training not only helps to prevent injury but also helps to reduce the severity of injury when it does occur.

In addition to injury prevention, weight training improves performance. Studies show that with as little as ten weeks of weight training, 10K times decrease by an average of a little over one minute. The research has also shown that running economy defined as the steady-state oxygen consumption for a standardized running speed (milliliters per kilogram body weight per minute), will be improved due to weight training. By improving running economy, a runner should be able to run faster over the same distance due to a decrease in oxygen consumption. Improved running economy would also increase a runner's time to exhaustion.

In closing please remember that the athlete must develop not only their anaerobic capacities but their anaerobic as well. Obviously the cross country runner must train in the traditional manner, which includes distance base mileage, interval training, fartrlik training etc…

However, the runner must utilize the proper strength and conditioning program in order to achieve his or her optimum performance.