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## ADVANCED TRAINING (ANAEROBIC/AEROBIC & WEIGHT TRAINING)

DR. PAUL WARD 2/28/01 – 11/24/01 – Revised 5/15/02

# **BEYOND THE BASICS!**

## INTRODUCTION

When you are successful in your efforts to improve your fitness state (muscular and cardiovascular) you develop a desire to move on to higher levels of achievement. This is a natural response and it is noble and wise to pursue it. The big task is to avoid the tendency to drive yourself into an over-trained state which leads to physical injuries and mental distress and great dissatisfaction. Your objective is to intelligently approach advanced training to ensure optimal results and high satisfaction.

Harder is “not smarter” nor is “more -- better.” The usual human response is to think the following. I have made good progress with my program so I will just perform it HARDER and LONGER. **THIS IS A BIG MISTAKE!** To be successful in training (general fitness or for high level performance) the training process needs to be periodized (cycled). Periodization is the planned and frequent changing of the many variables of training throughout the year and over the years of life. The overall object is to “STIMULATE, DON'T ANNIHILATE!” For all kinds of training, periodization (cycling) of training is the best method to ensure success in training.

Research and practical experience has shown that the planned variation of training variables (periodization or cycling training) produces better results and ability to maintain the training effort (any level of experience) over a long time, hopefully a lifetime. This chronic manipulation of the training variables allows the physiological, psychological, hormonal, nervous, cardiovascular and the muscle systems to optimally adapt to higher levels of performance. Moreover, the periodization approach to training minimizes injury and maximizes the response of the human organism to physical activity. This is applicable to all levels of training from the beginner to the advanced exerciser and extends from youth to very old age. Periodization of training programs makes the engagement in exercise programs enjoyable and effective throughout life.

The basic components of physical fitness are: strength, muscular endurance, cardiovascular endurance and optimal body composition. Flexibility and motor fitness are not part of physical fitness and need separate programs to develop. It is prudent to balance your approach to life in a rational way which is to include the training of as many aspects of physical fitness and motor fitness that matches your needs and desires.

All physical fitness components are highly variable dependent upon the activity level and types and methods of exercising utilized in training. A scientifically sound training program that is periodized over the lifespan can maximize enjoyment, maintain functionality, maintain and improve appearance and health, and reduce the risk of chronic diseases while enhancing the quality of life.

During the human lifespan people are confronted with a number of ailments, including: (1) cardiovascular disease; (2) cancer; (3) high blood pressure; (4) depression; (5)

osteoporosis; (6) bone fractures; (7) diabetes; (8) arthritis; (9) orthopedic impairments; (10) hearing impairments; (11) cataracts; and (12) visual impairments. Exercise has been shown to dramatically improve 9 of these health problems (1 through 9). All of these ailments (1-9) can be ameliorated by exercise intervention. All people should be engaged in an exercise program at some level until they die, excluding those people who are disabled by injury or sickness.

Periodization should be applied in muscle training and fat reduction programs and in the programs applied to improve the anaerobic and aerobic qualities. The following sections will present advanced training concepts for: (1) muscle training and (2) the development of anaerobic and aerobic qualities.

### ADVANCED MUSCLE TRAINING

To achieve optimal muscle development you must design and implement your program according to scientific principles. The following basic principles must be understood to plan and engage in all exercise programs, but they are even more important for advanced programs. These fundamental principles are: overload, progression, unloading, periodization, use & disuse, specificity and individual differences.

#### OVERLOAD

There must be application of stress (resistance, weight, speed, and duration) beyond what you are accustomed. Strength, size and shape of a muscle or muscle group is most effectively developed when there is an application of overload (i.e. exercising against higher intensity loads [weight]). This is commonly known as the “principle of overload”. The degree of improvement is directly proportional to the degree of overload (the percent of 1 repetition maximum (1RM) and the total work performed at this intensity).

There must be overload to produce a training effect. If the overload is insufficient (below 40 % 1RM) then the exercise is of little value. On the other hand, if there is too much overload, then the exercise becomes too much for body adaptation. Too much overload applied over too long a time produces a “state of being overtrained.” This is usually manifested as muscle, tendon and soft tissue injuries. In weight training, overload is produced by increasing the duration (increases in number of sets and/or repetitions), the frequency of training (the number of training sessions per day or per week) and the intensity (increases in percent of 1RM). The cycling objectives will dictate the exact manner in which progression is accomplished. Remember: there must be a period of unloading to allow for the delayed training effect to become manifested.

#### PROGRESSION

The application of stress must be in a progressively greater amount to match the adaptation of the body to previously imposed stress levels. This is characteristically called the “principle of progression”. Progression is properly applied when the resistance (load) against which a muscle or muscle group works is periodically and systematically changed or cycled, i.e., increased or sometimes decreased.

To ensure that there be continuous improvement, one must progressively adjust their sets, repetitions or intensity. Generally, it is necessary to provide more difficult work (training sessions) as one increases muscle mass and strength. It is important to note that overload and progression must be fitted into the concept of periodization or cycling for optimum improvements. The objectives of the cycling plan will dictate when the sets, repetitions or intensity should be changed. See the concept of periodization below.

## UNLOADING

There must be planned periods of unloading to prevent an overtrained state and to allow the body to make complete adaptations, which can be thought of as a “delayed training effect.” This is called the “principle of unloading.” This period may last from 1 to 3 weeks when the volume is reduced drastically while the intensity can vary as desired. It has been observed that large increases in strength, mass and/or shape occur after a cycle of intense training and during a cycle of reduced intensity and volume or a cycle of increased intensity combined with a drastic reduction of the volume. Therefore, the delayed training effect should be planned for when formulating the training program. See the concept of periodization below. Figure # 1 displays an example of periodization (cycling) in an effective weight training program. Remember there are numerous periodization cycles that could be formulated.

## PERIODIZATION – THE CONCEPT OF CYCLING

Periodization or cycling is the planned variation of intensity (load) and volume (repetition or total poundage) throughout the total training year. In reality, the training year should be composed of many undulations of volume and intensity. It is important to remember that periodization of weight training is applicable and needed for general fitness training participants and body builders, as well as athletes. Figure # 1 exhibits an example of a general periodization weight training program. Examples of various cycles are:

1. PREPARATION (CONDITIONING PERIOD): A conditioning period is utilized when re-entering an exercise program after a period of inactivity or for an unloading cycle. During this cycle the load (weight) is kept light (40% to 60% of 1RM) and the volume (repetitions and work load) medium. This might call for an exercise prescription of three to five sets of ten repetitions (3-5 sets X 40%-60% of 1RM). Also, circuit weight training or super circuit weight training can be very effectively applied during this cycle. This type of training will condition the contractile proteins, connective tissue and the metabolic components of the muscles. This cycle typically runs between 4 and 12 weeks with increases in the training loads every 2 weeks or as desired providing the number of prescribed sets and repetitions can be performed.

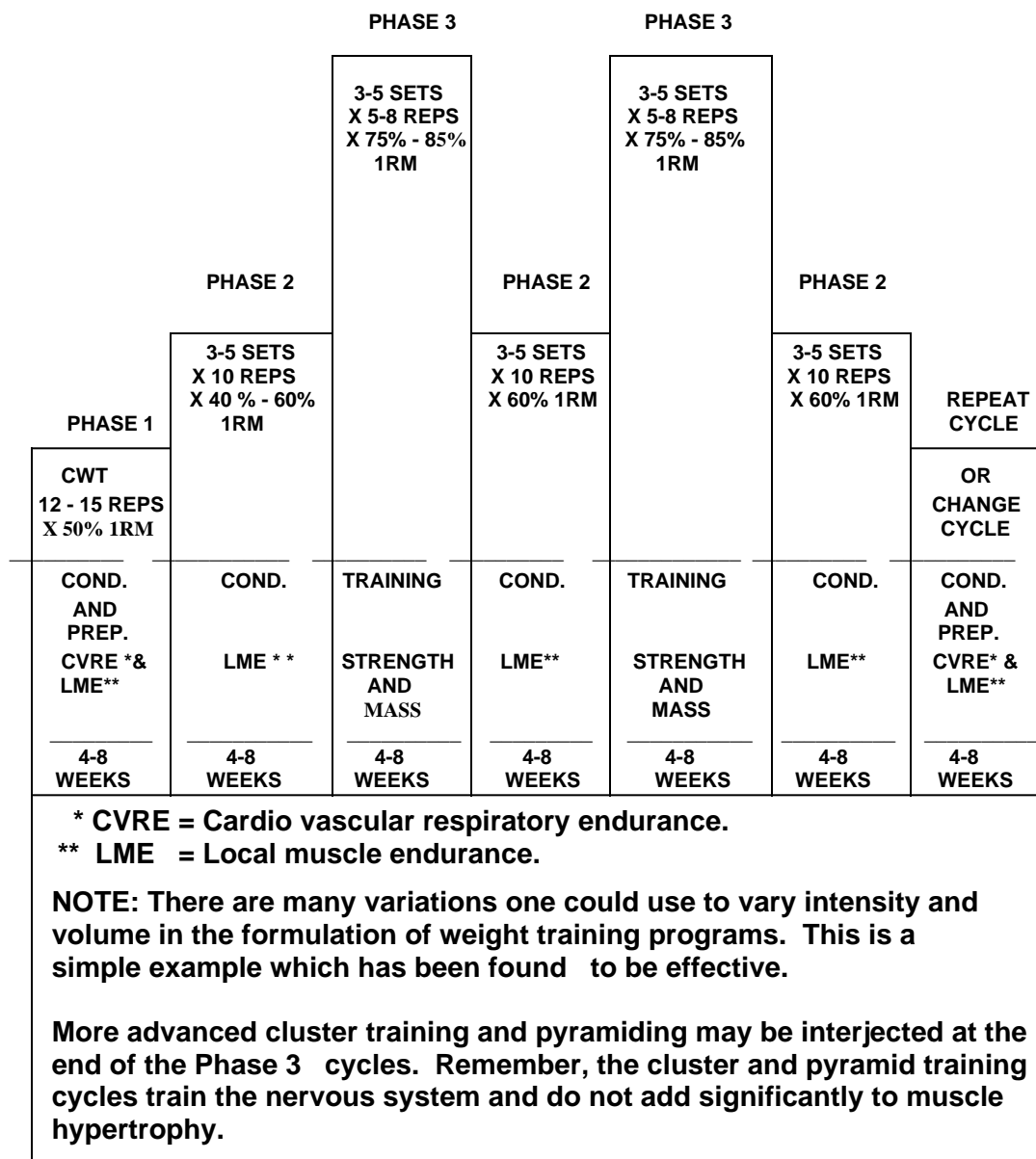


Figure # 1. An Example of Cycling in an Effective Weight Training Program

From the **ENCYCLOPEDIA OF WEIGHT TRAINING** –  
**Dr. Paul Ward & Dr. Bob Ward**

2. **THE TRAINING PERIOD:** During the training cycle an effort is made to increase size and strength. In this cycle the main emphasis is to focus on the structural aspect of strength, i.e., increasing the contractile proteins. This calls for an exercise prescription of three to five sets of five to eight repetitions with 75% to 85% of 1RM (3-5 sets X 5-8 reps X 75% -85% 1RM). This cycle typically runs between 4 and 12 weeks with increases in the training load for each exercise every week if the number of the prescribed sets and repetitions can be performed.
3. **THE NEURAL TRAINING PERIOD:** The neural training period includes 2 distinct cycles: (1) Cluster Training; and, (2) Pyramid Training. During these cycles an effort is made to focus upon the neural-muscular aspect of strength (the recruitment of motor units or developing the utilization of as much muscle fiber as possible through greater nervous control). This calls for the implementation of 3-7 sets of 3, 2, or 1 repetitions (cluster training) using 90% - 100% 1RM. There are two training techniques you can apply in this specific training cycle: cluster training and pyramiding. Cluster training includes the performance of 3-7 sets of 3 or 2 reps at 90% - 97% 1RM (3-7 sets X 3-2 reps X 90% - 97% 1RM). The pyramiding technique involves progressively increasing the weight and reducing the repetitions performed until a near maximum lift is performed (3-7 sets X 1 rep X 90% - 100% 1RM). These cycles typically are performed in sequence after the training cycle with cluster training for 2 – 4 weeks followed by pyramiding for 2 – 3 weeks.

The use of cluster training (sets of 3 or 2 repetitions) or pyramiding will not increase the size of the muscle. It will only impact the expression of strength as controlled by the recruitment of motor units, i.e., the central nervous system involvement. When using cluster training (3 or 2 repetitions per set) the training loads should be increased weekly if the prescribed number of sets and repetitions can be performed. When pyramiding the weight goes up as desired.

4. **ACTIVE REST:** The active rest period consists of drastically reduced training intensity and volumes. This allows for a maximum manifestation of the delayed training response as well as prudent rest period. During the active rest period one would engage in low intensity activity that might include very light weight loads and a variety of new and different exercises or various light sports activities.

Each phase of periodization training has a specific purpose, so volume and intensity has to be very different in each of the training phases. Because the volume and intensity differs in each phase, the expected outcomes or benefits of each stage are completely different. The training effects produced by each specific cycle have been briefly discussed in each the respective preceding sections.

There are four practical reasons for planned variation of volume, intensity and sometimes exercises in strength training and muscle building programs:

- 1 **GRADUAL PREPARATION OF MUSCLES AND SOFT TISSUES.** There must be gradual progressive preparation of the muscles and soft tissue (tendons, ligaments and connective tissue) for future exposure to greater volumes and higher intensities.

2. **TWO ASPECTS OF STRENGTH.** There are two physiological aspects of muscular strength. Each aspect requires the application of different volumes and intensities. The two different and unique physiological components of strength which require distinctly specific programs are:
  - A. **THE HYPERTROPHY ASPECT:** Hypertrophy is the increasing of the contractile protein cross-section of the muscle. In other words this means increasing the size of the muscle itself. The best way to increase muscle size is to perform 3-5 sets of 5-8 repetitions with 75% to 85% of 1RM. This cycle typically runs from 6 to 8 weeks.
  - B. **THE CENTRAL AND PERIPHERAL NERVOUS SYSTEM COORDINATION ASPECT:** This aspect of strength involves the teaching of the total nervous system how to recruit the maximal number of motor units. This is the ability to use more of the muscle fibers. It involves the execution of 3-7 sets of 1-4 repetitions performed with 85% to 100% of 1 RM. This cycle is a short cycle and should not extend beyond 4 weeks.
3. **PREVENTS OVER TRAINING.** Continued high intensity or high volume training without recovery time leads to constant stimulation of the nervous and endocrine (hormonal) systems. The repeated energizing of these systems without rest periods can lead to over training and can be responsible for decreases in performance and/or training progress. It is vitally important that you periodically insert an unloading cycle for optimum success in your training program.
4. Increases in strength and muscle mass are large and more stable when cycling programs are utilized.

To achieve the best results from your training you must periodize (cycle) your training. When you do not periodize your training you set yourself up for failure, chronic injuries, and dissatisfaction and will most assuredly move into a state of being over trained. When this happens you destroy your desire to continue to train. **BE WISE – PERIODIZE!**

#### **THE USE/DISUSE (REGULARITY) PRINCIPLE OR THE PRINCIPLE OF REVERSIBILITY**

If you use the muscle or physiological support system it will improve. Regular and consistent training produces positive adaptations. If you do not use the muscle or physiological support system it will deteriorate. Use promotes improved function while disuse promotes deterioration. Periodization (cycling) of your training program will ensure long term success and prevent injuries and prevent acquiring the over training syndrome.

#### **SPECIFICITY**

You must train the muscle, muscle groups or physiological support system with a specific method in order to obtain a specific goal. There is no transfer of unlike elements between exercise programs or physical activities. There are very specific adaptations to imposed demands (known as the “SAID” principle). The body responds according to the specific demands placed upon it; i.e., sets, repetitions and percent 1RM. Improvements in strength and size, local muscular endurance, anaerobic endurance and aerobic endurance require specific training programs. Again the requirements of the exercise program and the specific performance characteristics will dictate “THE SPECIFIC PROGRAM” that should be employed.

## **INDIVIDUAL DIFFERENCES AND UNIQUE BIOLOGY**

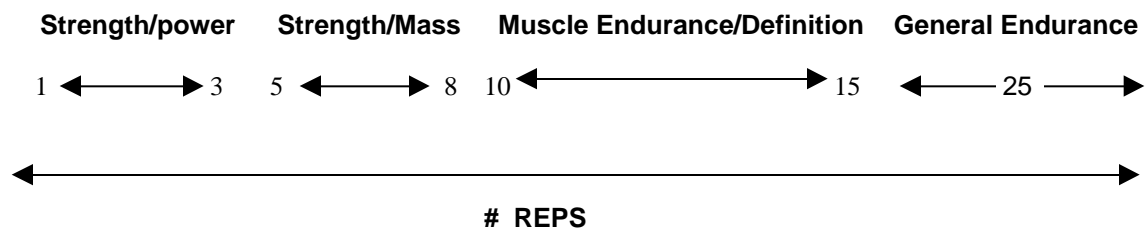
Everyone responds to an exercise stimulus in their own unique way in terms of magnitude and speed of improvement, as well as the amount of effort needed to elicit a specified level. This factor is basically determined by the genetic organization of an individual. Heredity is the primary determinant and controlling factor for human response to exercise and nutrition programs. However, regardless of how one responds to the exercise stimulus, all people must obey the laws of biology. Other factors that may modify the genetic potential of a person involved in a weight training program are: hormone output, age, body type, obesity, rest patterns and sleep habits, nutrition, injury, disease and motivation.

## **THREE INVIOLETE LAWS OF WEIGHT TRAINING**

There are three inviolate laws of weight training. These laws of weight training will determine how you go about planning your training program. These general training principles are simple stated as follows:

- 1. INCREASE IN MUSCLE STRENGTH AND SIZE** can be accomplished by executing a few repetitions against a heavy resistance. Research and empirical observations have established that the number of sets range from 3-5 and the number of repetitions should range from 1-8 at a percentage of maximum strength for each exercise ranging from 70% - 100% depending upon what specific aspect of strength you want to train (develop).
- 2. INCREASE IN LOCAL MUSCLE ENDURANCE AND MUSCLE DEFINITION** can be accomplished by executing many repetitions with moderate resistance. Research and empirical observations have established that the number of sets be from 3-5 and the number of repetitions range from 10-15, while the intensity (load) should range from 40% - 60% of maximum strength. Muscle definition is derived from the reduction of body fat which is produced by the increase in the total amount of work of moderate intensity combined with a sensible nutrition program.
- 3. THE ABOVE TWO METHODS (#1 AND # 2) ARE NOT INTERCHANGEABLE; I.E., ONE CANNOT BE SUBSTITUTED FOR THE OTHER.** Each method of training produces a specific training effect; either strength/size or local muscle endurance/definition. The training responses the human makes consequent to the application of either principle, number one or two above, does not produce the training effect of the opposite principle, to a large extent. In other words, in general, heavy weight and few repetitions does not contribute greatly to improvement in local muscular endurance and definition; while on the other hand, many repetitions and light weight does not contribute, in a large way, to strength improvement. However, it must be noted, each method of training may enhance to a small degree the attributes produced by the opposite method but any changes will be small.

Figure # 2 graphically displays the three inviolate laws of weight training. In addition, Table 1 displays the 3 inviolate laws of weight training in another way.



### REPETITION AMOUNTS FOR SPECIFIC TRAINING EFFECTS

**Figure # 2. The repetition amounts for specific training effects.**

Table 1. Three inviolate laws of weight training.

### 3 INVIOLETE LAWS OF WEIGHT TRAINING

LOAD	REPETITIONS & SETS	PHYSIOLOGICAL EFFECT
1. <u>HEAVY WEIGHT</u> 70% TO 100% 1RM	<u>FEW REPETITIONS</u> <b>1 TO 8 REPETITIONS</b> <b>3 TO 5 SETS</b>	<u>STRENGTH &amp; SIZE</u>
2. <u>LIGHT WEIGHT</u> 40% TO 70% 1RM	<u>MANY REPETITIONS</u> 9 TO 15 REPETITIONS 3 TO 5 SETS	<u>DEFINITION AND MUSCLE ENDURANCE</u>
3. PRINCIPLES # 1 AND # 2 ARE NOT INTERCHANGEABLE	_____	WRONG APPLICATION DOES NOT PRODUCE DESIRED RESULTS!

## **DEVELOPMENT OF ANAEROBIC AND AEROBIC QUALITIES**

Just as in weight training, different cycles (modes of training) produce different qualities in the muscular and cardio-vascular-respiratory systems. In addition, training the cardio vascular respiratory (CVRE) system, which includes aerobic and anaerobic training, impacts the muscle system to some extent but obviously not like weight training. Therefore, periodization (cycling) of volume, intensity and methods of training is vitally important when developing aerobic and anaerobic qualities. Another reason for periodization of training (varying the volume and intensity of training) is to keep from slipping into an over-trained state. Variation in training factors (frequency, intensity, duration, and mode of training) is needed to maintain a steady progression and to produce various aerobic and anaerobic qualities as desired. Moreover, the various modes of training provide for diversity, which helps to maintain a high level of motivation and ensuring success in the training program.

Anaerobic and aerobic cycles are easily applied to running programs but other modalities can just as easily adapted for use in a program designed to develop these qualities. These exercise modalities include upright bikes, recumbent bikes, treadmills, steppers, elliptical trainers, rowing machines and upper body ergometers. You can apply the general aerobic and anaerobic training principles used in running programs just as effectively when using any of these other modalities. You are only limited by your intelligence, creativity and perseverance.

**MARATHON OR STEADY STATE TRAINING:** This type of training is known by many names, among them are: marathon or steady state training, long slow distance (LSD): continuous activity; or aerobic training. This type of training is slow, continuous and of relatively low intensity. The heart rate ranges between 120 and 160 beats per minute. Since the intensity (speed) is low, this type of training offers little stimulus to strengthening the muscle of the legs nor does it maximally stimulate the heart. The primary benefits of Steady State training is to increase the number of functional capillaries with a slow improvement in aerobic capacity along with the preparation of the body for more advanced training methods.

The physiological changes that can be expected with Steady State Training are:

1. Increases number of functional capillaries.
2. Increases in red blood cells, hemoglobin & muscle glycogen.
3. Increases in heart muscle size but not a large amount.
4. Strengthening of ligaments, tendons and connective tissue.
5. Development of red (slow twitch) muscle fibers.

Everyone should start exercising at the beginning training cycle (a steady state training program) to prepare the body for more intense training. It should be used for the beginner and for the advanced person who is re-entering a fitness program after a lay off. This cycle should be considered as a foundation building training period. There is gradual improvement of the physiological qualities enumerated above. This gradual development is because of the lower intensity of activity which is needed to complete long training efforts. When starting an exercise program you should always start with a short (15 minutes) duration of the chosen exercise mode and should progressively increase to longer periods (60 minutes or more). For general fitness training, most people exercise for a duration between 20 to 45 minutes.

The physiological changes occur slowly over time but there is a steady increase in aerobic capacity. After a 4 to 8 week cycle, more advanced training modalities (Speedplay or Interval Training) can be used to enhance the aerobic as well as to develop anaerobic capacities. In steady state (LSD) training, the training heart rate should be gradually elevated to within a 120 –160 beats per minute

range (rule of thumb). More sophisticated people can use the ACSM guidelines of 60% to 90% of maximum heart rate. A really unfit person should start with a heart rate range that is very low, 55% to 64% of maximum heart rate.

As mentioned above, the exercise duration should start with a short duration and gradually increase to longer periods. A suggested range would be from 15 minutes to 60 minutes or more depending upon the age and fitness level of the participant. **REMEMBER:** always start your program at an easy intensity and short duration and progress slowly to your goal. The length of time in this training cycle should range from 4 to 6 weeks but can be longer if desired. However, as time progresses the benefits become less and less until all you are doing is maintaining what you have attained. To advance to higher levels you must move on to more effective techniques and learn to periodize or cycle your training program.

**SPEEDPLAY (FARTLEK) TRAINING:** Fartlek or Speed Play originated in Sweden. It is characterized by a long low intensity effort, which has intermittent bursts of high intensity of short duration efforts that are random in appearance, level of intensity and length of time. This training technique takes good mental discipline by the participant to properly implement.

The physiological changes that can be expected with Speedplay (Fartlek) Training are:

1. Increases number of functional capillaries.
2. Increases in red blood cells, hemoglobin & muscle glycogen.
3. Increases in heart muscle size to a greater degree than steady state training (LSD).
4. Strengthening of ligaments, tendons and connective tissue.
5. Increases in size & strength of skeletal muscle.
6. Development of red (slow twitch) and a few white (fast twitch) muscle fibers.

The length of time for a Speedplay workout should range between 15 to 60 minutes. At the conclusion of a Speedplay workout the participant should be in a state of exhaustion from the self-sustained push over a long duration. The heart rate will vary from 120 to 180 beats per minute.

An example of a typical Speedplay workout pattern would be to start with a 5 minute steady state low intensity effort and then move to a 2 minute higher intensity effort followed by a 5 minute low intensity effort followed by 5 high intensity efforts for 45 seconds with 2 minute low intensity efforts in between. This would be followed by a low intensity 5 minute effort. The total time for this Speedplay workout would be 30.75 minutes. It would be considered a moderate workout.

There are thousands of combinations that could be used. This is only one example of the concept. This concept is easily applied by using the manual programs of most computer controlled exercise devices that are found in most health clubs like: upright bikes, recumbent bikes, steppers, treadmills, rowing machines and upper body ergometers.

**INTERVAL TRAINING:** Interval training is a form of training featuring a series of high intensity efforts followed by low intensity efforts or rest (relief). Interval training is the best training technique to condition the heart muscle that exist. Moreover, it provides for fast development of the cardiovascular respiratory system. This is due to the greater emphasis on speed and intensity of work. The net result of interval training is the concomitant development of the aerobic and anaerobic components of fitness. There are 7 training variables that must be controlled and can be remembered by the acronym **DIRSRIF:**

1. D – Distance or time of effort.
2. I – Intensity (rate) of work – (HR of  $\geq 140-180$ ).

3. R – REPETITIONS in the workout (3-50 Reps).
4. S – SETS in the workout (1-5 Sets). A group of repetitions.
5. R – Ratio of work/relief (1:\_, 1:1, 1:2 and 1:3).
6. I – Interval intensity of rest (HR of  $\leq$  120-140)
7. F – Frequency per week (2 X Week).

The physiological changes that can be expected with Interval Training are:

1. Increases number of functional capillaries.
2. Increases the heart size. This is the most effective way to increase the strength of the heart muscle.
3. Increases the stroke volume. This is the fastest method for improving stroke volume.
4. There is hypertrophy of adrenal glands to compensate for higher stress levels (a positive adaptation).
5. There is development of red (slow twitch) and a few white (fast twitch) muscle fibers.
6. There is concomitant development of the anaerobic and aerobic energy systems.

There are 4 basic energy systems that require very different programs to enhance their capacity. These systems are shown in Table 2.

**Table 2. GUIDELINES FOR IMPLEMENTING INTERVAL TRAINING PROGRAMS**

<u>WORK EFFORT AREA</u>	<u>ENERGY SYSTEM</u>	<u>REP TIME</u>	<u># OF REPS</u>	<u># OF SETS</u>	<u>REPS/SET</u>	<u>WORK/RELIEF RATIO</u>
1	ATP-PC System	0:10 – 0:25	20 – 50	4 – 5	8 – 10	1:3
2	ATP-PC-LA	0:30 – 1:20	10 – 25	2 – 5	5	1:2 – 1:3
3	LA – O <sub>2</sub>	1:30 – 3:00	4 – 8	1 – 2	4 – 6	1:1 – 1:2
4	O <sub>2</sub>	3:00 – 5:00	3 – 4	1	3 – 4	1:_ - 1:1

The non-athlete should perform two-thirds of their interval training in work effort area numbers 1 and 2. The other one-third should come from areas number 3 and 4. Athletes would emphasize the work effort area that corresponds to their specific athletic event.

For shorter and more intense the work effort, more repetitions are needed to induce a training response. In longer and lower intensity efforts fewer repetitions are required to induce a training response.

If you desire to perform more than one set of repetitions you can use longer rest periods between sets. This allows for maintaining a optimal intensity throughout the workout and also execute more work.

A rule of thumb for ascertaining the length of the rest (relief) interval is to not perform another repetition until the heart rate during relief drops to somewhere between 120 and 140 beats per minute. The intensity of the repetition can be determined by performing an effort that will elicit a heart rate immediately after finishing a repetition of between 160 and 180 beat per minute. Another method is to arbitrarily select the intensity and length of rest with intermittent monitoring of heart rate to insure proper work effort and optimal rest periods. During the rest interval you should either walk or jog as desired and in accordance with your age and fitness level. The primary objective is to maintain an active rest cycle to facilitate the return of blood to the heart. It is in this rest interval that the heart receives its maximal training, i.e., the stroke volume is greater immediately after the cessation of each training effort.

It is important to note that as you work through the selected number of sets and repetitions, the heart rate will increase on successive repetitions and the recovery (relief) heart rate will be more slowly reduced. This will require an on the field judgment to lower the work effort or maybe to stop the interval training. Over time you will be able to determine what gives you the best guidance.

Research has shown for general conditioning that a seven to eight week program consisting of two to three interval workouts per week is effective for improving the ATP-PC system, the LA system and the O<sub>2</sub> system. Longer interval cycles with more interval training days per week do not significantly enhance these energy systems beyond a seven to eight week program with two to three interval training days per week. It recommended that the length of an interval training cycle extend from four to eight weeks with two days of interval training per week.

Below are some steps to take in applying an effective interval training program.

1. Determine the energy system (s) needed to be improved (for example, ATP-PC, lactic acid or O<sub>2</sub> systems).
2. Select the type of exercise machine or exercise to be used during the interval program. These include, running tracks, upright bikes, recumbent bikes, steppers, treadmills, elliptical trainers, and rowers.
3. Select the proper rate and distance of the work interval.
4. Select the proper number of repetitions and sets to be used.
5. Select the proper duration and intensity of the rest (relief) interval.
6. Use your heart rate to monitor the work effort, the rest interval, and the conditioning effect.
7. Keep a record of your training and recovery to assist in evaluation of your interval training program.

The next two modes of training are Repetition Training and Sprint Training. These cycles are very intense and therefore are shorter in duration. Speed becomes more important with endurance taking a subordinate position. The Repetition cycle and Sprint cycle develops the nervous system as well as developing the greatest capacity to tolerate anaerobic activity. A consequential improvement in mental toughness is noted with successful application of Repetition and Sprint training.

**REPETITION TRAINING:** Repetition training consists of a number of repeated efforts at higher than moderate intensity with a rest interval long enough to permit almost complete recovery of the heart rate and a breathing rate to near normal. It includes primarily speed and muscle work with the quality of endurance subordinated to a secondary position. It develops specific endurance for a specific distance or time, which is performed at a specific intensity (speed). There is more emphasis on strength and muscle development with very good development of anaerobic capacity.

The use of this technique of training does not have to be included in a training program unless there is a desire and need to produce speed qualities. In this program there is a series of repeat at 80% - 90% efforts with almost complete recovery between repetitions. At this intensity level the heart rate is between 160 and 190 beats per minute (age and fitness dependent). Between repetitions the resting heart rate should be allowed to return to between 100 and 110 (age and fitness dependent).

A basic rule of thumb is that the more intense the work (short times) the more repetitions should be performed. The less intense the work (longer times) the fewer number of repetitions that should be performed. Generally an exerciser would perform one set of 3 to 10 repetitions.

The physiological changes that can be expected with Repetition Training are:

1. Optimal development of adrenal glands.
2. Development of anaerobic capacity (ATP-PC and lactic acid energy systems.)
3. Increases in strength & size of muscles.
4. Development of white muscle (fast twitch) fibers and a few red (slow twitch) fibers.
5. Concomitant development of the ATP-PC and lactic acid energy systems.

Repetition training efforts should be longer than interval training efforts with almost complete recovery between repetitions. Performing repetition training is more exhausting than Interval Training and continues to be so as the intensity increases and the duration of effort extended. For this reason, when longer repetitions are performed the intensity should be reduced. In this case the number of repetitions to be performed in a workout should be small.

This cycle should be utilized for 3 to 6 weeks and then another cycle introduced in the training pattern.

**SPRINT (SPEED) TRAINING:** Sprint or speed training is ultimate expression of anaerobic training. The central nervous system is strongly involved in the utilization of this system. Aerobic qualities have very little to do with sprinting while on the other hand the strength and power of the nerve/muscle apparatus is maximally employed. To engage in this type of training takes consummate discipline and motivation. It is not for the weak willed and casual mentality.

The use of this technique of training does not have to be included in a training program unless there is a desire and need to produce speed qualities. It is adequate to use steady state training, speedplay and interval training for most people. On the other hand, speed training does provide a variation to training that enhances motivation.

Sprint (speed) training consists of a series of all out efforts with maximum recovery between repetitions. The number of repetitions performed ranges from 5 to 10 repetitions. Speed workouts probably should be applied twice per week and mixed with some short intense interval training and short intense repetition training in a combination training program. The length of this training cycle should be about 2 to 3 weeks in duration. It is difficult to tolerate this kind of training over long periods of time. Be careful not to stay in this training cycle too long. It could lead you into the overtraining state.

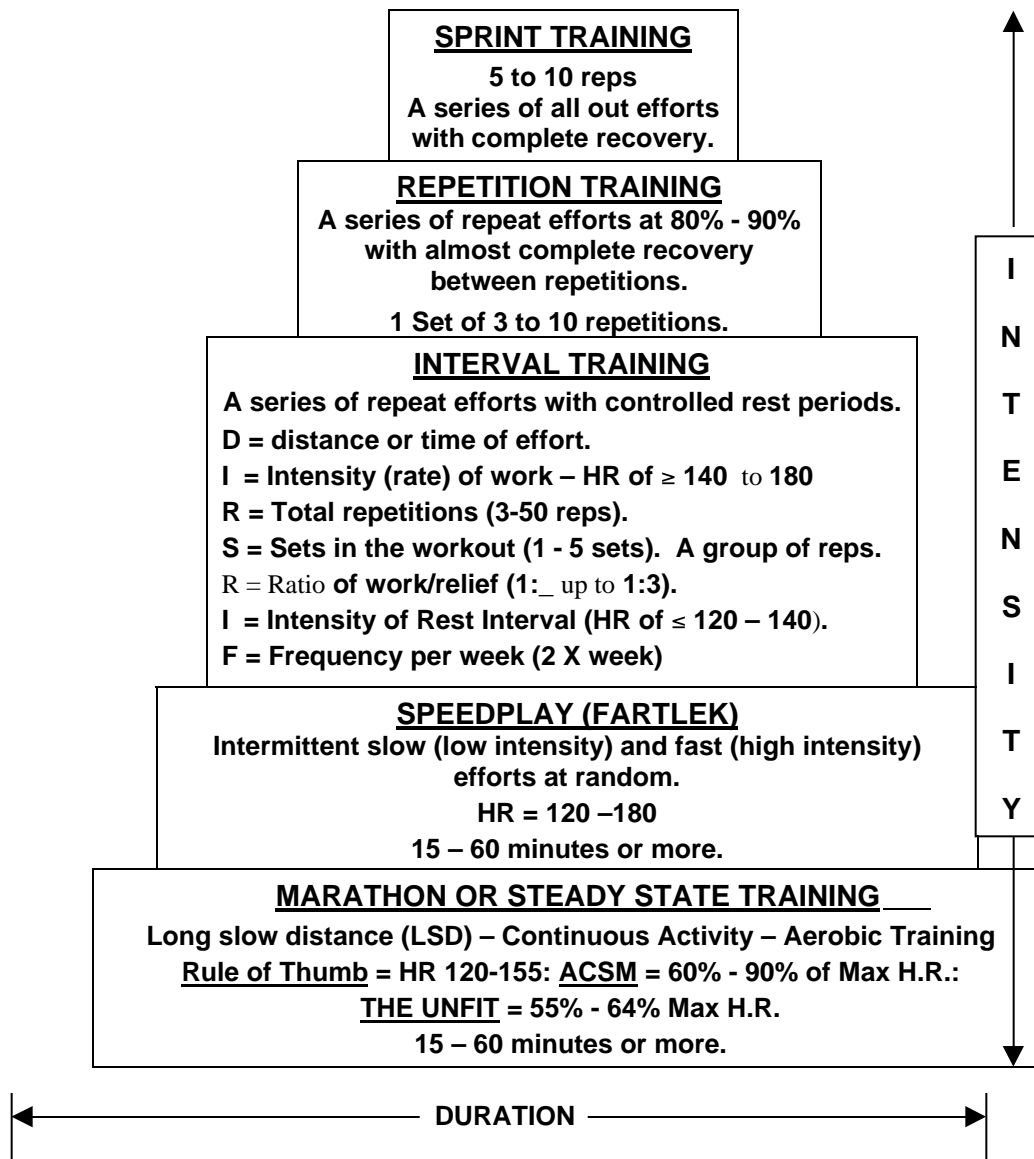
The physiological changes that can be expected with Sprint (speed) Training are:

1. Increase in size of the major muscles involved in the movement.
2. Positive changes in the nerve transmission and impulse.
3. Development of the white ( fast twitch) muscle fibers.
4. Maximal development of the ATP-PC and moderate development of the lactic acid energy.

Figure 3 presents all the possible aerobic and anaerobic training modalities. The less intense and usually longer in duration training methods are at the bottom of the pyramid. As you work up the

pyramid, the intensity of each of the various training modalities becomes more intense and by necessity the length of the training period becomes shorter.

Figure 3. The development of anaerobic and aerobic qualities.



Dr. Paul Ward, American Training Pattern, 1969

The following sections (#1 through # 5) present the various modalities that can be used to develop any desired aerobic and anaerobic qualities that you might want. Moreover, this information can be

used to construct a periodized training program where duration and intensity can be modulated, and combined to develop any level of aerobic or anaerobic fitness. All the necessary information needed to develop a training program is contained in each section.

The training modalities are Long Slow Distance (LSD) Training, Fartlek (Speedplay) Training, Interval Training, Repetition (Repeats) Training and Sprint Training. For general fitness training LSD, Speedplay and Interval Training are usually all that is used. However, if one desires to attain higher levels of anaerobic fitness they should include Repetition (Repeats) Training and Sprint Training.

Another reason for utilizing Repetition Training and Sprint Training is to provide variation and change to facilitate and enhance motivation. Moreover, as with weight training programs the cycling of aerobic and anaerobic training has been demonstrated to be much more effective for improving performance and enhancing motivation than continuous application of just one form of training. In addition, there are physiological reasons to utilize each mode of training, as each technique will more effectively condition either aerobic or anaerobic fitness. Moreover with intelligent and knowledgeable integration of these training modalities can produce a reasonable but not maximal development of both aerobic and anaerobic fitness. One can also bias or emphasize either the aerobic or anaerobic aspect of fitness.

## **DEVELOPMENT OF ANAEROBIC AND AEROBIC QUALITIES**

Adapted from "The American Training Pattern" by Paul Ward, et al – 1969

### **I. LONG SLOW DISTANCE (LSD)**

#### **AKA:**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. Over-Distance</li> <li>2. Marathon Training</li> <li>3. Steady State Training</li> <li>4. Continuous Activity</li> <li>5. Aerobic Training</li> </ol> | <p>Develops endurance capacity more slowly than other types of training but the training effect is more stable and long lasting.</p> |
|---|--|

#### **QUALITIES DEVELOPED:**

1. Slow development of cardiovascular-respiratory endurance.
2. Development of aerobic capacity.

#### **REST PERIOD:**

1. None – Continuous Activity.

#### **HEART RATE:**

1. Gradual elevation to 120-155 (rule of thumb).
2. ACSM GUIDELINES:
  - A. 60%-90% of maximum heart rate (age and fitness dependent).
  - B. 55%-64% of maximum heart rate should be utilized for those who are quite unfit.

#### **PHYSIOLOGICAL CHANGES:**

1. Increases number of functional capillaries.
2. Increases in red blood cells, hemoglobin and muscle glycogen.
3. Increases in heart muscle size but not a large amount.
4. Strengthening of ligaments, tendons and connective tissue.
5. Development of red (slow twitch) muscle fibers.

## **II. FARTLEK (SPEED PLAY)**

Extended effort with random mixture of a variety of intense efforts, moderate efforts and very easy efforts. There is an infinite number of combinations that can be performed.

Effort is to be random and free flowing.

Performed correctly, speed play is tough, demanding and very effective. You must be disciplined to use it correctly.

### **QUALITIES DEVELOPED:**

1. Development of cardio-vascular respiratory endurance with some speed or strength depending upon how much of the higher intensity is used in the variations.
2. A speed factor (increased intensity) is introduced in a long training effort.
3. Development of aerobic capacity and some speed/strength capacity (anaerobic).

### **REST PERIOD:**

1. None – Continuous Activity.

### **HEART RATE:**

1. Varies with intensity of the effort.
2. It will vary from 120 to 180 beats per minute depending upon the intensity of effort (age and fitness dependent).

### **PHYSIOLOGICAL CHANGES:**

1. Increases in the number of functional capillaries.
2. Increases in red blood cells, hemoglobin and muscle glycogen.
3. Increases in heart muscle size to a greater degree than Long Slow Distance (LSD).
4. Strengthening of ligaments, tendons and connective tissue.
5. Increases in size and strength of skeletal muscle (not a large amount).
6. Development of red (slow twitch) and a few white (fast twitch) muscle fibers.

## **III. INTERVAL TRAINING**

A series of repeated exercise efforts (work) alternated with periods of relief (rest). Can be used in all forms of exercise and at all levels of physical fitness and age.

### **QUALITIES DEVELOPED:**

1. Fast development of cardio-vascular respiratory endurance.
2. More emphasis on speed or intensity.
3. Development of aerobic and anaerobic components of fitness.

**REST PERIOD:**

Work/Relief ratio varies – always use an active rest period, i.e. keep moving during the rest interval.

1. For intense work use a 1:3 ratio. This trains the quick energy system.
2. For moderate work use a 1:1 or 1:2 ratio. This trains the lactic acid energy system.
3. For light work use a 1:1/2 ratio. This trains the lactic acid and aerobic energy systems.

**HEART RATE:**

1. Work heart rate: 150 to 180 (age and fitness dependent)
2. Rest heart rate (relief heart rate range): 110 to 140 (age and fitness dependent)
  - A. Sets = 1 to 5 sets.
  - B. Reps /Set = 3 to 10 repetitions.
  - C. Total reps = 3 – 50 repetitions.
  - D. When working harder (short time – with high intensity) use more sets and repetitions.
  - E. When working easier (longer times – with lower intensity) use less sets and repetitions.

**PHYSIOLOGICAL CHANGES:**

1. Increase in the number of functional capillaries.
2. Increases in the heart size. This is the best way to increase the strength of the heart.
3. Increases in the stroke volume. This is the fastest method for improving stroke volume.
4. Hypertrophy of adrenal glands to compensate for higher stress levels (a positive adaptation).
5. Development of red (slow twitch) and a few white (fast twitch) muscle fibers.
6. Concomitant development of the anaerobic and aerobic energy systems.

**IV. REPETITION TRAINING (REPEATS)**

A series of repeated efforts at a higher than moderate intensity with a rest interval long enough to permit almost complete recovery of the heart rate and breathing rate to near normal.

It is primarily speed and muscle work with the quality of endurance subordinated to a secondary position.

**QUALITIES DEVELOPED:**

1. Specific endurance for a specific distance or time performed at a specific intensity (speed).
2. More emphasis on strength and muscle development.
3. Development of anaerobic capacity.

**REST PERIOD:**

1. Long Rest – long enough for almost complete recovery between repetitions.

**HEART RATE:**

1. **WORK HEART RATE:** Work at a heart rate of 160 to 190 (age and fitness dependent)

2. **REST HEART RATE (relief heart rate range)**: Rest until the resting heart rate decreases to a range of 100 to 120 (age and fitness dependent).
3. One set of 3 to 10 repetitions. If the work is harder (short time) use more repetitions. In the work is easier (longer time of work) use less repetitions.

#### **PHYSIOLOGICAL CHANGES:**

1. Optimal development of adrenal glands.
2. Development of anaerobic capacity (ATP-PC and lactic acid energy systems).
3. Increases in strength and size of muscles.
4. Development of white muscle (fast twitch) fibers and a few red (slow twitch) fibers.
5. Concomitant development of the ATP-PC and lactic acid energy systems.

### **V. SPRINT TRAINING**

A series of all-out efforts (maximum intensities). These efforts are of relatively short duration, **10 seconds to 60 seconds**.

Each repetition is followed by a relatively long rest where the heart rate and breathing rate returns to near normal.

#### **QUALITIES DEVELOPED:**

1. Development of specific speed or maximum amount of work performed in a unit of time.
2. Development of the strength and to a small degree the size of the major muscles utilized in the activity engaged.

#### **REST PERIOD**

1. Complete recovery between repetitions.

#### **HEART RATE**

1. Intensity that increases the heart rate up to 185 to 195.
2. Repetitions – 10 – 20 reps.
3. Harder work (shorter time) use more repetitions. Easier work (longer time) use less repetitions.

#### **PHYSIOLOGICAL CHANGES**

1. Increase in size of the major muscles involved in the movement.
2. Positive changes in the nerve transmission and impulse.
3. Development of the white (fast twitch) muscle fibers.
4. Maximal development of the ATP-PC and moderate development of the lactic acid energy system.

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