Vol. 5 No. 5 September-October 2007

FUNCTIONAL 4®

Exercise and activity for healthy aging

International Council on Active Aging ICAA™

Contents

Published with the support of Philips Medical

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Periodize training for the masters athlete

by Joseph F. Signorile, PhD

Periodization is now a mainstay of athletic training. It is a method of cycling different training variables (volume, intensity, frequency and type of exercise) in a specific pattern designed to maximize performance and minimize fatigue. Put simply, periodization is a planning calendar to optimize the training responses.

The theories underlying the application of periodization are sport-specific overload and recovery. Therefore, training cannot simply be any exercise that will "get you in shape." Training must target the metabolic systems and motor patterns that are important to the sport.

Equally as important, a training scheme must offer days of higher and lower intensity exercises in a temporal (related to time) pattern that allows for recovery. Remember, it is during those shorter, lower intensity recovery workouts that the body can replenish its energy supplies and re-engineer its muscle and connective tissues. The recovery periods allow the body to increase training overload and, therefore, performance.

Periodization is as important to the recreational athlete as it is to the elite competitor, and it becomes even more important as we put a few more years under our belts. Remember, as we age our recuperative powers are compromised, and properly designed training and recovery cycles are even more critical for maximizing performance and decreasing the probability of injury.

The information in this article is applicable to everyone who trains for competition or personal fitness. Of course, the intensity and frequency of training should be adjusted for each individual's personal goals and fitness levels. And when in doubt, err on the side of caution. Remember, an extra week or 2 spent gradually increasing training loads is better than months spent recovering from an overuse injury!

Applying the periodization principles

Periodization training is usually divided into 3 major chronological cycles:

1. microcycle (one week in length)
2. mesocycle (typically 2 to 6 weeks, which encompasses 2 to 6 microcycles)
3. macrocycle (an entire training period or phase, a number of mesocycles)

Continued on page 3...

Glossary

Acute
Immediate, on the spot

Adaptation
Physiological improvements due to the training program

Fartlek
Short high-intensity intervals alternating with normal effort

Intensity
Level of effort exerted

Nonlinear
Changing, zigzag; not in a straight line

Overload
Increase in training volume and/or intensity to achieve a physiological adaptation

Recovery
Period of low-intensity or alternate activity

Taper
Reduced training prior to a competitive event

Temporal
Relating to time

Undulating
Rise and fall in smooth, wavelike motion

Volume
Quantity of exercise

How periodization works

The basic periodization curve contains 3 stages, as shown in Figure 1:

1. fatigue (depletion)
2. restitution (compensation or more simply, recovery)
3. supercompensation (overcompensation or more simply improved performance)

The shape of this curve has been attributed to the interactions between 2 opposing factors, the fatigue after-effect and the fitness after-effect (see Figure 2) (1).

The **fatigue after-effect** represents a drop in your performance because the acute impact of exercise makes you tired.

The **fitness after-affect** means that you will derive a positive impact on performance both immediately after an exercise session and following a prolonged training cycle.

These 2 factors demonstrate the need for periodization if the training effect is to be maximized throughout the training process—and especially at the point of competition.

While we clearly understand the need to overload our bodies to force a training adaptation, our willingness to incorporate lower intensity recovery periods into our training is often either ignored or delayed until our visit to the sports medicine clinic due to overuse injury.

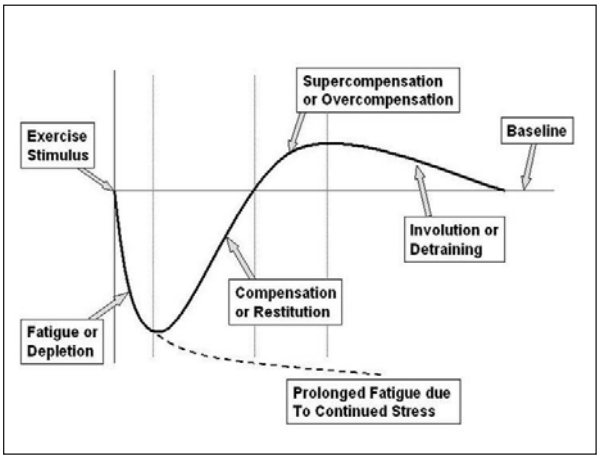

Figure 1. A classic periodization curve for performance showing the major cycles and a prolonged fatigue curve (dashed line) indicative of overtraining.

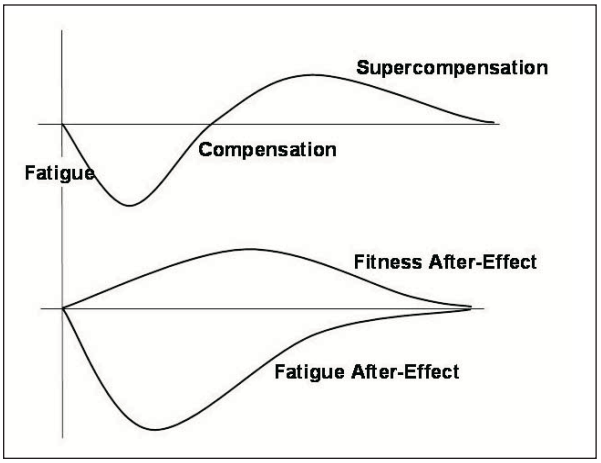

Figure 2. Fatigue and fitness after-effects as they relate to a classic periodization curve.

Plisk and Stone have concisely presented the importance of recovery in proper cycling of training in the following statement from their article "Periodization Strategies" (2):

> "Since fatigue is a natural consequence of training stress, especially with high-volume loads, and adaptations are manifested during subsequent unloading periods, fatigue management tactics are integral to a sound program."

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Continued from page 1

These cycles vary in nature depending on the sport or activity, point in time relative to the competitive event or in the competitive season, and the characteristics of the person in training.

A number of different names have been assigned to these cycles depending on whether the training is strength- or endurance-based, or if it is designed for seasonal or year-round sports. For this article, we will use Tudor Bompa's model of 3 phases: preparation, competition and transition (3). However, I have also included phases that are "nested" within these that are somewhat more descriptive in nature and perhaps easier to understand (2, 4).

The training phases are presented below. You will see how the cycles and phases interact in the sample periodization programs for marathon runners and tennis players that follow.

Let's look at each phase. But before we do, remember, as we age our systems are slower to adapt to overloads and our tissues are more susceptible to overuse injury than those in younger athletes; therefore, it is advisable to reduce the volume of work in favor of greater intensity during each of these phases, since intensity is the major factor that drives training adaptations.

Many masters athletes refer to this as a quality/quantity tradeoff, and have found it to be the most effective strategy to optimize training benefits.

Preparation phase. The preparatory phase provides structural adaptations that prepare the athlete for more intense and specific overloads. This phase can be divided into 2 sub-phases: general and specific preparation.

General preparation may be thought of as adapting the body's systems to training by developing to varying degrees (depending

Continued on page 4...

Periodization training cycles

PREPARATION		COMPETITION			EVENT	TRANSITION	
General Preparation	Specific Preparation	Pre-competition	Competition			Recovery	Off-season
MARATHON							
Base: Long runs, low to moderate intensity	Increased speed: Moderate to high intensity; Fartlek	Long interval: Submaximal intensity, Long recovery	Short interval: Maximal to supra-maximal intensity, Short recovery	Taper: Fun runs	Peak performance	Recovery	Competition break
TENNIS							
Base strength and mechanics (skill)	Max strength and mechanics (application)	Power, strategy and tactics	Speed and plyometrics; Match play	Taper: Points and imaging	Peak performance	Recovery	Competition break

Continued from page 3

on the sport) an aerobic background and a strength background. A primary goal is to adapt the body's muscles and connective tissues to the stresses of training.

The *specific preparation* phase is a time to transition to training techniques that are more biomechanically (movement patterns) and bioenergetically (energy systems) attuned to the specific sport.

Competition phase. The competition phase is well-defined by its name. There are 2 nested sub-phases: precompetition and competition.

The *precompetition* phase begins defined sport-specific training using activities designed to target performance at the competitive event.

The *competition* phase continues this training, but increases the intensity and mechanical specificity. Mechanical specificity means that the training should be performed using the muscles and movement patterns that reflect the sport in which the athlete competes. This phase usually ends with a taper.

A *taper* is a period of reduced training prior to a competitive event that is designed to maximize performance by reducing the fatigue after-effect and increasing the fitness after-effect.

Transition phase. The taper is followed by the event, and then by a recovery period. In the case of seasonal sports, an off-season recovery period may feature recreational activities to maintain some level of conditioning while providing recovery.

Overtraining is the final term in our vocabulary. This term can be confusing since it has both positive and negative connotations in the vernacular of training. In the positive sense, many coaches and sports scientists feel that overtraining is necessary to overload the systems and cause a training adaptation.

However, the more common negative connotation describes the overtraining syndrome. Let's use a modification of the definition by Kreider, Fry and O'Toole in their text *Overtraining in Sport* (5) to describe this condition:

> "Overtraining syndrome is an accumulation of training stress that results in a decrement in performance that even with recovery may last weeks or even months."

This definition recognizes that overtraining also can negatively affect performance.

Now that we have established our vocabulary, let's look at how you can plan and apply a periodization plan to your client's training regimen.

Manipulate the variables

The basic concept is to plan sufficient overload over time to produce change, while avoiding levels of fatigue that can lead to overtraining or overuse injuries. To accomplish this, most coaches and exercise scientists agree that a nonlinear pattern of training must be used (6-8). This nonlinear pattern involves the manipulation of 3 factors:

- volume
- intensity
- skill

Additionally, the type of exercise can be manipulated to affect sport-specific changes.

The general rule is that at the beginning of a training cycle, volume begins moderately high, increases and then decreases. Conversely, intensity starts low and increases until close to the end of the cycle, and then decreases. Finally, the skill component increases throughout the cycle (see *Figure 3. Changes in intensity, volume and technique* on the next page).

Obviously, for sports that have a greater skill requirement, such as tennis or softball, the skill component becomes a more dominant variable than for conditioning-dominated sports such as running or cycling.

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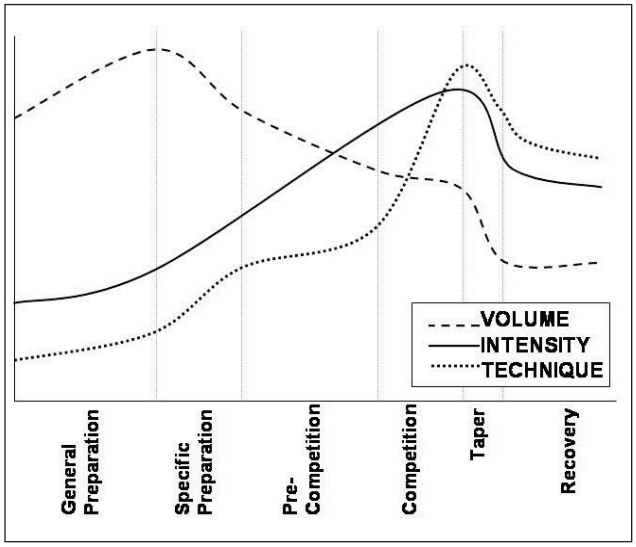
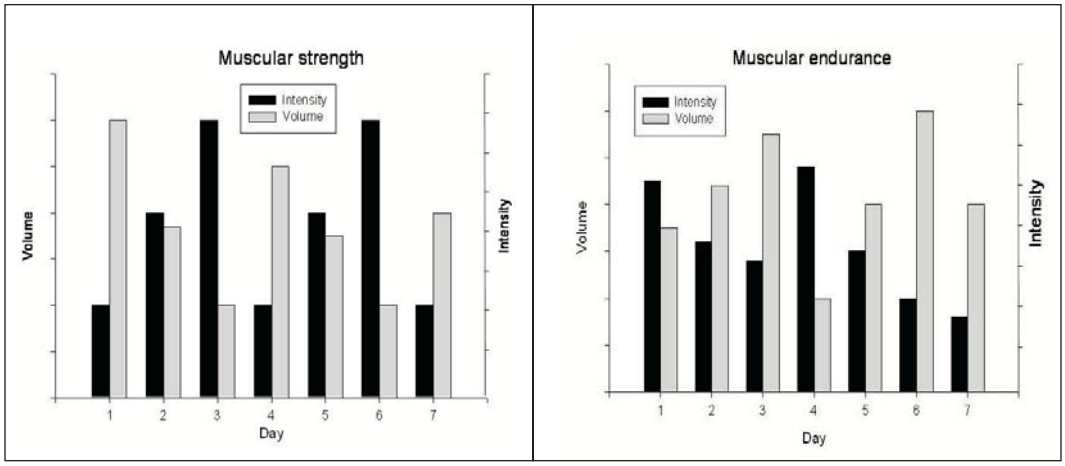


Figure 3. Changes in intensity, volume and technique across the phases of a periodization cycle.

Figures 4 a & b. Volume and intensity changes across a muscular strength and a muscular endurance microcycle.



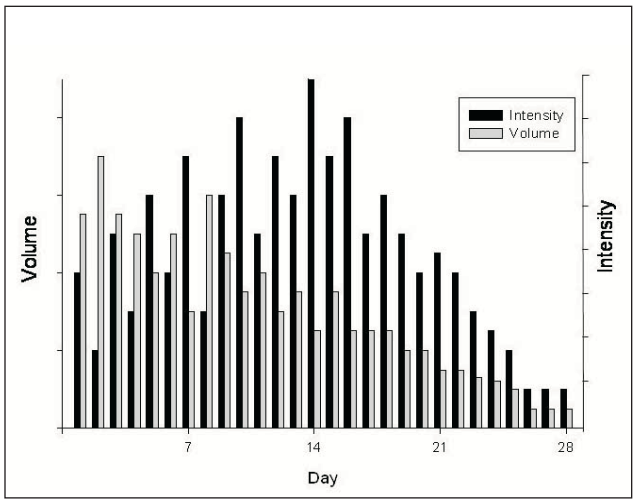


Figure 5. Volume and intensity changes across a typical mesocycle.

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The above changes can be made across a microcycle, mesocycle and macrocycle. *Figures 4a and 4b. Volume and intensity changes* provide illustrations of intensity and volume-based microcycles. The first cycle shows a typical pattern used by most athletes, the second is usually isolated to cycles designed to improve muscular endurance (7).

Figure 5. Volume and intensity changes across a typical mesocycle shows how microcycles may be manipulated across 4 weeks to create a macrocycle. The macrocycle presented typifies a competition phase. You will note the gradual undulating increase in intensity and decline in volume across the first 2 microcycles (days 1 to 14) and then the exponential decline in both during the last 2 microcycles (days 15 to 28).

In a summary paper on tapers, Drs. Inigo Mujika and Sabino Padilla showed that among 4 possible patterns, exponential decline (see *Figure 6*, below) was the most effective method of tapering (9). During **exponential tapers**, the decline is faster at the start of the taper, then plateaus. The researchers also noted that the optimal duration of the taper is about 2 weeks. However, duration can be affected by age, training status, the fitness component you're targeting and also the sport for which the athlete is training (10).

For example, individuals whose training requires longer durations or very high intensities will require longer tapers than those who train at a more moderate level. Additionally, better conditioned athletes will respond more quickly to a taper than those who are at a lower level of conditioning. For those of us who are a bit older, there is clear evidence that recovery takes a longer period of time, which indicates the need for a somewhat longer taper compared to younger athletes (11, 12).

Finally, the most effective pattern of taper seems to be to maintain intensity at a high level while decreasing volume. This strategy has been shown to have the greatest positive impact on both performance and physiological factors in distance runners (13) and strength athletes (14) alike.

One final point of interest concerning taper. It appears that taper has its greatest positive impact on performance when frequency of training is maintained at near 80% of normal training levels, while intensity and volume decline (especially in sports where technique is a dominant factor [9]). This means that taper should rely on exponential drops in how hard and long the person trains per session and not the number of training sessions performed per week.

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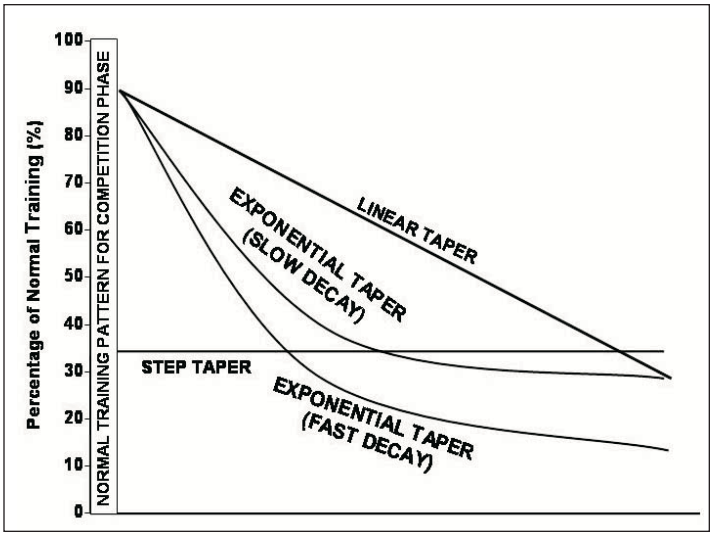

Figure 6. Patterns of taper (after Mujika I, Padilla S. Scientific bases for precompetition tapering strategies, *Medicine and Science in Sports and Exercise* 2003;35:1182-7) By permission.

Continued from page 6

Warning signs of overtraining

Even when a person adopts the principles of periodization, overtraining may still occur if the athlete is not sensitive to its onset. Even a periodization plan that has been designed specifically for a sport is most likely not designed specifically for an individual. When you design a periodization plan for your client, you can customize the training program, but you and the client still must be alert for signs of overtraining syndrome.

Remember, we all have different genetic capacities for adaptation, and those levels differ from individual to individual. Add to this the fact that people may differ in age, training status and competitive schedule, and a periodization template that is not customized may set the stage for overtraining or possible injury. Additionally, the difference between overtraining to stimulate change (often called over-reaching) and overtraining that causes prolonged performance decrements is not clearly defined. It is therefore important to have some sort of training "yardstick" to allow you to modify the training to meet each person's specific pattern of adaptation.

The most important marker of overtraining is performance. Feeling excessively tired and unable to perform, even after a day or 2 of reduced work, are signals to consider a "mini-taper" period to allow the body's systems a chance to revitalize. Although this might seem counterintuitive since athletes commonly train in a "more is better" and "work through the pain" environment, the consequence of following these philosophies are an inability to perform and a high probability of injury.

Continued on page 8...

Overtraining warning signs

Strength or speed athlete	Endurance athlete
• Increased perceived exertion during a lifting or sprinting set	• Reduced VO2max
• Increased resting heart rate	• Reduced HRmax and HR response at any level of exercise
• Decreased muscular strength of movement speed	• Elevated resting heart rate
• Reduced coordination and increased performance errors	• Reduced neuromuscular excitability
• Reduced rate of lactic acid produced (suppressed anaerobic energy production)	• Reduced rate of glycogen (stored sugar) and fat utilization
• Reduced ability to perform a workout	• Reduced rate of lactic acid produced (suppressed anaerobic energy production)
• Reduce immune system response	• Reduced immune system response
• Disrupted sleep	• Disrupted sleep
	• Amenorrhea (premenopausal female)

Continued from page 7

Other markers, which are very simple to use and highly effective, are a person's mood or attitude toward training. A number of studies have shown a strong association between changes in mood state and overtraining (15, 16). The major markers you should look for are a decrease in vigor and an increase in tension and depression. If your client mentions feeling more tired, tense and depressed than usual, consider that mini-taper.

There are a number of classic markers used to detect overtraining in endurance and strength athletes, which are presented in "Overtraining warning signs" on page 7. However, many of the symptoms listed in this table also occur at different points in the regular training cycle; therefore, you should use them in combination with performance decrements and mood changes for an accurate evaluation.

Periodization is worth the planning

Periodization of training has been shown to be more effective in improving performance, reducing the incidence of overtraining and decreasing the potential for overuse injuries than standard programs using progressive increases.

While this article offers you a template that you can use to design programs, it is by no means a complete review of the topic. I suggest that you examine other resources, such as those included at the end of this article, for a more comprehensive picture of the topic.

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References are on page 13

Sample periodization programs

On the following pages, sample periodization programs for the marathoner (an example of the endurance athlete) and the tennis player (an example of a power/speed athlete) show how the training cycles can be used to schedules changes in the training variables.

Please recognize that these training programs are offered as examples and may vary in effectiveness from person to person. Second, the cycling only refers to the specific fitness factors directly associated with the sport-specific performance. Clearly other factors—especially flexibility, which shows considerable decline with age—must be addressed during the training cycles.

Continued on page 9...

Resources

Periodization (article)
Sara Quan
United States Masters Swimming
www.usms.org/fitness/articleofthemonth.php?a=24

Periodization (article)
YPI Training Planner
www.aball-ypi.com/periodization.htm

Periodization - Theory and Methodology of Training, 4th Edition (1999)
Tudor Bompa
Human Kinetics Publishers
www.humankinetics.com

Periodization Training for Sports
2nd Edition (2005)
Tudor Bompa and Michael Carrera
www.humankinetics.com

Science and Practice of Strength Training
2nd Edition (2006)
Vladimir Zatsiorsky and William Kraemer
www.humankinetics.com

Strength Training for Tennis (NTSC) (video, 1993)
United States Tennis Association
www.humankinetics.com

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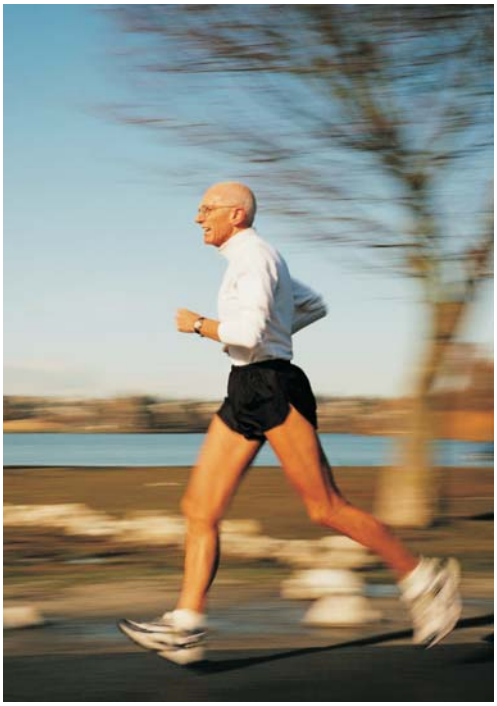
The marathoner

(intermediate to advanced)

The majority of the work should be interval in nature since intervals have been shown to have a superior impact on improving aerobic power.



Preparation (General) – 6 weeks

Distance and pace: Progress from about 12 to 18 miles with the majority of the work (approximately 75%) being slow, controlled runs. The remaining 25% should be work at approximately the current race pace.

Frequency: Approximately 3 to 4 days per week, with one distance day progressing from approximately 7 to 12 miles.

Strength training: On days when running is not performed, hypertrophy resistance training concentrating on lower body muscle and connective tissue strength is appropriate.

Preparation (Specific) – 4 weeks

Distance and pace: Concentrate on distance and increased work pace with the inclusion of long intervals and some Fartlek (short speed intervals) training. Low-intensity work will average between 18 and 25 miles. Faster speed work is incorporated. This speed work will comprise about 30% to 40% of the cycle with the percentage increasing throughout the cycle in an undulating pattern.

Frequency: 3-4 days/week

Strength training: Decrease resistance training from 2 to one day a week to allow tissue strength maintenance while reducing stresses on the musculo-skeletal and energy systems.

Pre-competition – 4 weeks

Distance and pace: This cycle becomes much more race-specific. The mileage for this phase fluctuates by week between 10 and 24 miles. Race pace and interval work now makes up approximately 50% to 65% of the work.

Continued on page 10...

Continued from page 9

Pre-competition – 4 weeks (continued)

Frequency: 3-4 days/week

Strength training: Reduce resistance training to a maintenance program of one short workout per week.

Competition – 2 weeks

Distance and pace: This phase is highly sport-specific. Mileage will be approximately 30 miles for week one and 23 miles for week 2. The long run for week one will be approximately 20 miles, while the one for week 2 will dramatically decrease to 10 miles.

Given the increase in distance during the first week and the approach of the taper during the second week, high-intensity work will now make up about 40% and 60% of the training for each week, respectively.

Frequency: 3-4 days/week

Taper: During the taper, volume, intensity and frequency of training all drop exponentially. Mileages will be 10 and 8 miles, respectively, for the final 2 weeks, with no light runs occurring during the last week and no runs during the final 2 to 3 days before the race.

Recovery

This is the phase to reduce specific training; add cross-training and recreational activities in lieu of formalized training.

Sample periodization plan for a marathoner

Phase	PREPARATION		COMPETITION			EVENT	TRANSITION	
Specific phase	General Preparation	Specific Preparation	Pre-competition	Competition			Recovery	Off-season
Mesocyle	6 weeks	4 weeks	4 weeks	2 weeks				
Microcycle				1 week	1 week			
	Base: Long runs, low to moderate intensity	Increased speed: Moderate to high intensity; Fartlek	Long interval: Submaximal intensity, long recovery	Short interval: Maximal to supra-maximal intensity, short recovery	Taper: Fun runs		Recovery	Competition break

Continued on page11...

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The tennis player

(intermediate to advanced)

Since many tennis players compete year-round, this program targets a club or league championship within the context of a season of league play. The periodization plan is designed for an all-court player.

A service-volley player needs a greater concentration on speed work, shorter intervals and explosive movements. For the baseliner, greater concentration on repeated sets of short (10 to 15 seconds) intervals with a limited rest (5 to 10 seconds) may best suit the game.

Preparation (General) – 3 weeks

Conditioning: This phase is designed to develop the physiological qualities required for high-level competition. Plan a gradually increasing program of interval work, gradually increasing from an average of 25 to 60 minutes, 3 days per week. Remember to vary the volume/intensity patterns throughout the training week.

Strength training: Tennis-specific resistance training occurs 2 to 3 days per week. As with the interval aerobic training, incorporate an increase across the time period. Once again, the pattern should vary across each week. Attempt to follow heavy aerobic days with lower resistance training days to allow optimal energy utilization.

Sport specific: Tennis training should be non-competitive drills.

Preparation (Specific) – 3 weeks

Conditioning: This phase continues with the background work designed to make the physiological changes associated with the high-intensity interval nature of the game of tennis. Since most points in tennis last about 6 to 10 seconds, this sport-specific phase begins to incorporate high-speed intervals to train the body to adapt to the waste product build-up and high-energy use patterns associated with game situations.

Perform interval runs (forward, backward and side-to-side) 3 days a week. Duration starts at 5 minutes and progresses to 20 minutes by the end of the 3-week phase. In addition, the work:recovery duty cycle starts at 1:3 and progresses to 2:1 (for example 10s work: 30s recovery progressing to 10s work: 5s recovery).

Speed and plyometric drills can be added with proportional reductions in aerobically-based intervals.

Strength training: Continue resistance training twice per week, concentrating on sport-specific higher velocity lifts.

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Sport specific: Play during this phase will most likely include some competitive matches, but concentrate on drills to address specific weaknesses in the client's game.

Pre-competition – 2 weeks

Conditioning: This phase features only speed and agility drills that are specific to on-court performance.

Strength training: Resistance training declines from 2 to one day per week and is explosive in nature. Medicine ball and rubber tubing drills are good choices for biomechanically-specific speed/resistance work.

Sport specific: On-court work concentrates on strategy and execution, as well as play at a more competitive level.

Taper: Slowly increase recovery periods and decrease volume of work across this 2-week cycle.

Competition – 2 weeks

Conditioning: Speed, agility and quickness drills dominate fitness training and are limited to 15 to 20 minutes per day.

Strength training: Weight training volume continues to decline, dropping to a single day of lightweight, explosive lifts. On-court points should concentrate on high-intensity points with limited formal play.

Taper: All resistance training ends at this point. Only light on-court work and limited points to hone skills are used. The end of this week will be the competitive event.

Recovery

A day or 2 of full recovery may be advisable if the athlete is feeling any residual fatigue toward the end of the taper. At most, light recreational work should be used during these final days of taper. Remember, mental imaging of points and play strategy is a strong tool during this period of reduced work.

Sample periodization plan for a tennis player

Phase	PREPARATION		COMPETITION			EVENT	TRANSITION	
Specific phase	General Preparation	Specific Preparation	Pre-competition	Competition			Recovery	Off-season
Mesocyle	3 weeks	3 weeks	2 weeks	2 weeks				
	Base strength and mechanics (skill)	Maximum strength and mechanics (application)	Power, strategy and tactics	Speed and plyometrics; Match play	Taper: points and imaging		Recovery	Competition break

Continued from page 8

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ICAA Functional Levels

Athlete

Exercises or participates in sports activity almost every day or works at a physically demanding job. Activity goals are to maintain or improve fitness level and succeed in sports.

Active now

Exercises at least twice a week and engages in physical activity most days of the week for health and enjoyment. Needs exercise that maintains the level of fitness to live an active, independent lifestyle and to manage weight.

Getting started

Engages in some physical activity and can perform activities of daily living, but may have functional limitations. Needs activity that helps improve physical function and develops physical reserve to prevent decline.

Needs a little help

Engages in limited physical activity. May have medical conditions and movement limitations. Goals are to regain strength and balance, improve function and mobility and improve medical conditions.

Needs on-going assistance

Does not engage in physical activity and needs to improve the ability to perform activities of daily living and manage illness.

ICAA Functional Levels are adapted from the work of Waneen Spirduso, EdD (Physical Dimensions of Aging)