SECTION 1

LACROSSE BACKGROUND, SIX PHYSICAL PERFORMANCE QUALITIES, & TRAINING CONSIDERATIONS

1.1 Lacrosse Background

Lacrosse has been referred to as the “fastest sport on two feet” due to the physical and technical skill set required in competition. Lacrosse is an explosive, violent, full-contact, team sport and is one of the oldest sports in North America.

The sport was originally created and played by Native Americans, with fields being miles in length and competition lasting multiple days in some cases. The play of lacrosse has become much more regulated to date, with a regulation time of sixty minutes, divided into four, fifteen-minute quarters. In the occurrence of a tie game at the finish of those sixty minutes, a four-minute, sudden death overtime period is completed and repeated until a team scores.

The field dimensions, shown below in Figure 1.1, is 110 yards in length and a width of 60 yards. The field is then separated into three sections by two restraining lines, the midfield (middle 40 yards of the field), the attack zone (35 yards), and the defensive zone (35 yards). With teams scoring on opposite goals, one team’s attack zone is their opponent’s defensive zone.

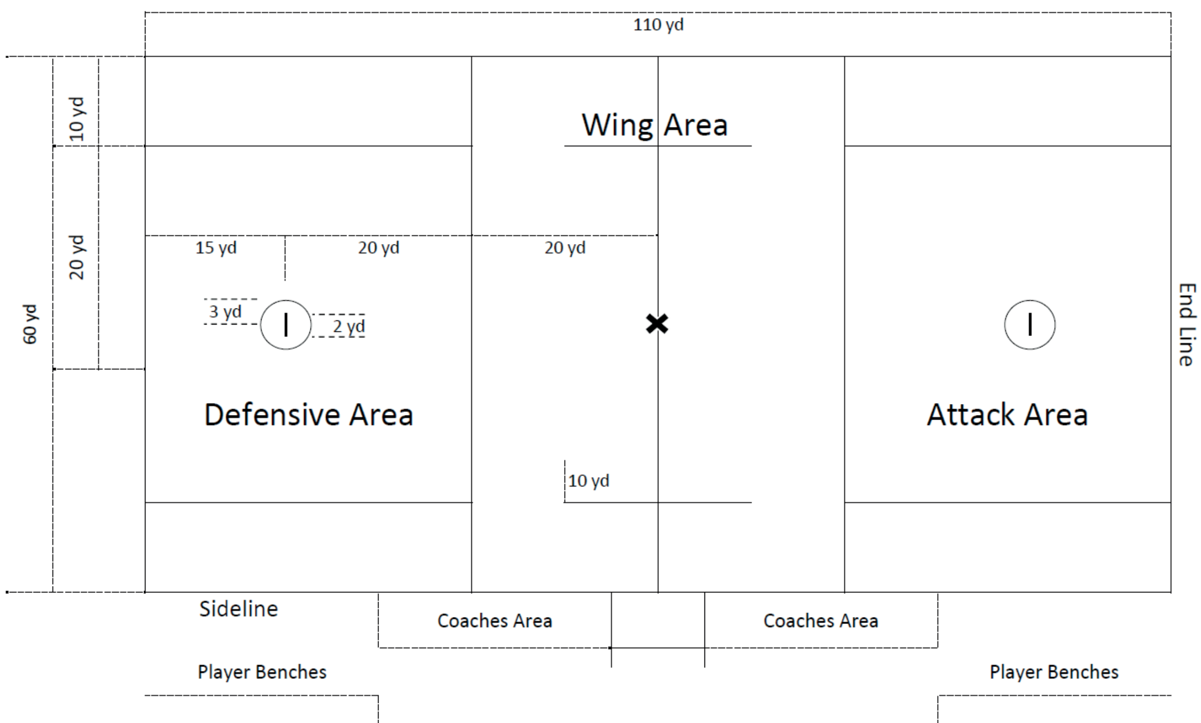

Figure 1.1 - The Dimensions of a Men’s Lacrosse Playing Field

This separation of the field creates position-specific responsibilities and the unique requirements of those individuals in each zone. At any one time there are ten athletes per team allowed on the playing field. These ten players are broken up into the following four positional groups:

- 3 Attackmen
- 3 Midfielders

- 3 Defensemen
- 1 Goaltender

The goaltender is responsible for preventing the opposition from scoring. He does this by defending the goal. The defensemen assist the goaltender in preventing the opposition from scoring. These players typically remain in the defensive zone and compete for the entire sixty minutes. Midfielders play both defense and offense and typically cover the most distance throughout a game. Attackmen are responsible for the offensive production and scoring throughout the game. Clearly, each of these positions utilize a somewhat different skill set. Performance training should be completed specifically for each of these position's requirements. The specific considerations for each position's physical requirements will be covered in greater detail in an upcoming section.

In addition to being the "fastest sport on two feet," lacrosse is also the fastest growing sport in the United States [(1)]. In recent years, participation has spiked and continues to increase, with more than 400,000 youth athletes competing and multiple NCAA programs being added every year. Even with this exponential growth, few studies have been completed on lacrosse athletes and there is limited data available on the specific requirements of the sport. However, performance in this sport can ultimately be broken down into six physical performance qualities. When these qualities are well understood, they are able to be implemented within a system that reduces injury likelihood while also optimizing performance at specific times of the year, which is vital for playoff appearances.

1.2 Six Physical Performance Qualities

When considering the speed and full-contact nature of the game, as well as the game length and the size of the field, it becomes clear there are multiple aspects within the sport of lacrosse for which athletes must be specifically trained [(2)]. In order to compete at the highest levels of lacrosse every athlete requires each of the six physical performance qualities to be in a highly trained level. As described above, each individual position within the sport of lacrosse requires a slightly different set of skills. Nevertheless, every position will require the six physical performance qualities. These six physical performance qualities are implemented throughout the Triphasic Lacrosse Training Model described throughout this manual. To the majority of performance coaches, the training of these qualities are not new concepts by any means; however, their importance cannot be overlooked in training.

When broken down scientifically, the six physical performance qualities include the three energy systems (Oxidative, Glycolytic, and ATP/Cr-P), Strength, Repeat-Power, and Speed. Each of these physical performance qualities are shown, along with a brief description, in Figure 1.2. Now, many performance, as well as lacrosse, coaches may look at this and say, "of course there are more physical qualities that are required in lacrosse than just these six." Yes, there are many more performance factors and skills that must be considered and trained in the sport of lacrosse; however, each of those skills fits into one of the six physical performance qualities. The ability to repeatedly sprint for the entire sixty minutes of a game is determined upon the training and conditioning of the three energy systems as well as the repeat-power quality. Skills such as change of direction and agility fall within the strength and speed physical performance qualities. The more force an athlete is able to absorb and re-direct, or "load and explode," the quicker they will be able to change direction on the playing field. Each of these skills will be explained to a greater extent in later sections, but ultimately it is important every coach understands the importance of these six physical performance qualities and the effects they have on lacrosse performance. Figure 1.3 below is a visual representation of the six physical performance qualities for an elite level lacrosse athlete to reach optimal performance.

6 Physical Performance Qualities of Lacrosse	
Physical Performance Quality	**Functions During Performance**
ATP/Cr-P Energy System	Short burst, high-intensity activities of less than 10 seconds in duration
	Sprinting towards the goal, dodging a defender, face-off wing play
Glycolytic Energy System	High-intensity activities that occur for greater than 10 seconds
	Extended shift on either offense or defense, longer sprint series in competition, running out the clock at the end of a game
Oxidative Energy System	Allows long distances to be covered, improves recovery ability when properly trained, forms foundation of all other qualities trainability
	Sometimes multiple miles covered in a game, ability to recover and play at high speeds even at the end of a game, recovery between competitions
Speed	The ability to move at a high velocity, usually for a brief amount of time
	Sprinting towards the goal, dodging a defender, getting back on defense after a turnover, clearing the ball
Repeat-Power	Increases ability to produce high forces for extended amounts of time
	Sprinting at high speeds even at the end of a long game, playing at a high level with multiple games per weekend, face-off athletes
Strength	Increases force production, basis of repeat-power and speed qualitites
	Body checking and other body contact, picking up a ground ball in a scrum, face-off athletes, dodging with pressure, play near the crease

Figure 1.2 - The Six Physical Performance Qualities of Lacrosse

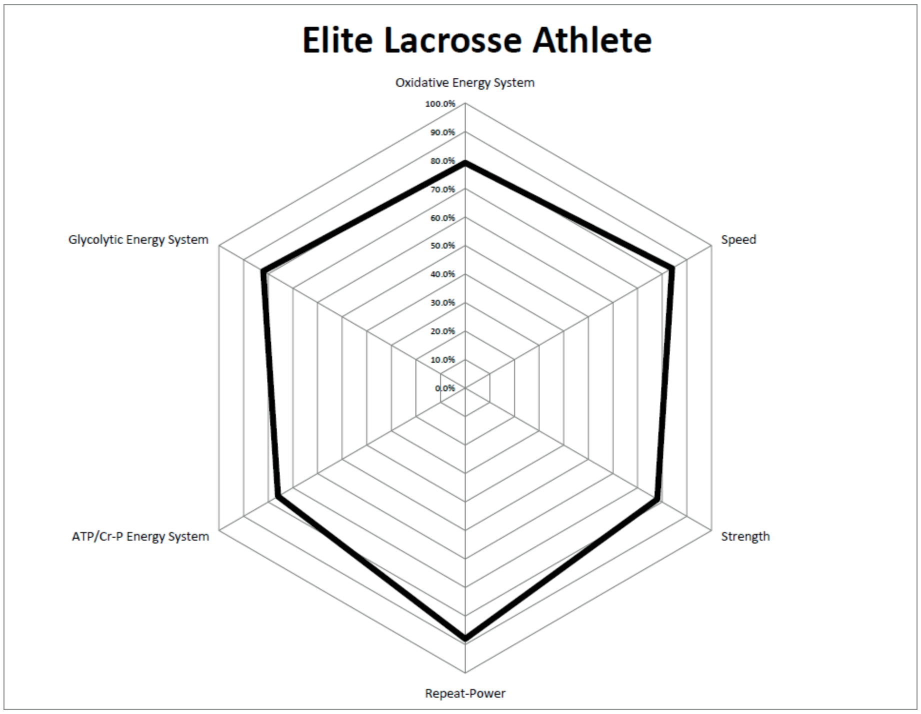

Figure 1.3 - Six Physical Performance Qualities of an Elite Lacrosse Athlete

Ultimately, the foundations of all performance abilities are built upon the oxidative and strength performance qualities. Through the improvement of these two qualities, the other four performance qualities are able to be developed to a greater extent. Without a solid foundation created by these two, oxidative and strength, a lacrosse athlete will not be capable of recovering throughout the course of a game appropriately. This leads to an inefficient athlete that will not be capable of optimal performance late in a competition. The two pyramids created by these two qualities are shown below in Figure 1.4, these are important to remember later on when the order of training each quality is demonstrated. Simply put, without a solid foundation of the oxidative and strength qualities, the ability of other performance qualities to be improved is drastically reduced.

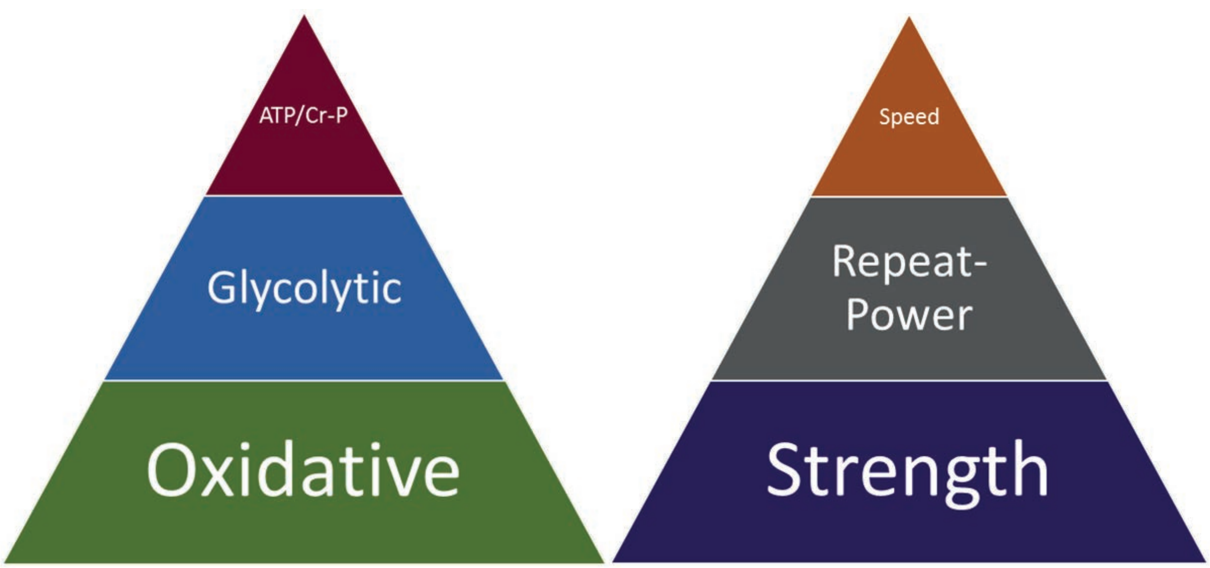

Figure 1.4 - Energy System and Strength Pyramids of the Physical Performance Qualities

The three energy system performance qualities include the oxidative, glycolytic, and ATP/Cr-P energy systems. As shown above in Figure 1.2, the oxidative energy system functions at lower intensities to allow longer distances to be covered at a slower pace. This quality is also vital for recovery from high-intensity activity, such as sprinting in lacrosse, and serves as the foundation for the other two energy systems required in competition. Training adaptations realized with the improvement of the oxidative energy system range from increased oxygen availability to improved fat metabolism within the body, which makes training and performing less fatiguing on the body. The importance of the oxidative energy system becomes clear when comparing an athlete's ability to control his heart rate. An athlete with a highly trained oxidative system can complete tasks at a much lower heart rate than an athlete not trained in this performance quality. This means athletes trained in this quality can function at much higher intensities while maintaining an extremely high level of efficiency, ultimately meaning they can do more work while expending less energy. Clearly the oxidative energy system functions as the support system for all other physical performance qualities. However, simply training this zone only will not optimize performance in all other qualities. Examples of the oxidative energy system in both competition and training are shown below in Figure 1.5.

Oxidative Energy System
Functions During Performance
Allows long distances to be covered, improves recovery ability when properly trained, forms foundation of all other qualities
Oxidative Energy System in Lacrosse
Cumulative long distances covered during a game
Ability to recover rapidly after a long shift
Playing at high-intensities through the 4th quarter
Recovery between competitions such as two game weekends
Oxidative Energy System in Training
Biking
Jogging
Aerobic interval training
Weight lifting circuit

Figure 1.5 - The Oxidative Energy System and its use in both Competition and Training

The glycolytic energy system is utilized within the body to complete high-intensity activities of greater than ten seconds, up to two minutes. Although technically the glycolytic energy system becomes the primary source of energy utilized in high-intensity efforts greater than ten seconds, training time must reach a minimum of twenty seconds in order for maximal effects to be realized in the improvement of this system. It is for that reason, even with high-quality training, the minimal training time for the glycolytic energy system is twenty seconds. This performance quality is necessary in lacrosse as sprinting is a vital part of the game, especially for the midfielder experiencing a longer shift. Figure 1.6 below gives examples of competition and training examples of the glycolytic energy system.

Glycolytic Energy System
Functions During Performance
High-intensity activities that occur for greater than 10 seconds
Glycolytic Energy System in Lacrosse
Extended shift for either offensive or definsive athletes
Running out the clock at the end of a game
Sprinting the field during a transition from defense to offense
Glycolytic Energy System in Training
Running a 300 yard shuttle
Pushing a heavy sled for greater than 15 seconds
Completing a lift to failure (greater than 8 reps) or 15 plus seconds

Figure 1.6 - The Glycolytic Energy System and its use in both Competition and Training

Finally, the ATP/Cr-P energy system works within the body to allow the highest intensities to be reached for short bursts of less than ten seconds.

This energy system is highly utilized in the sport of lacrosse as sprinting and change of direction over short distances is relied on heavily for success. The ATP/Cr-P energy system examples for both competition and training are listed in Figure 1.7. In order to train the ATP/Cr-P energy system, training at maximal intensities for short duration must be executed. These maximal intensities can only be reached so often though, meaning longer rest times are required to maximally train this performance quality. Specific guidelines for the training each of these energy systems will be given later on in this section.

ATP/Cr-P Energy System
Functions During Performance
Short burst, high-intensity activities of less than 10 seconds in duration
ATP/Cr-P Energy System in Lacrosse
Sprinting towards the goal
Dodging a defender
Face-off wing play
Fast break occurrences
ATP/Cr-P Energy System in Training
Running full speed for a short amount of time
Lifting explosively or heavy for a set of 10 seconds or less
Short burst agility training

Figure 1.7 - The ATP/Cr-P Energy System and its use in both Competition and Training

The combination and appropriate training of all three performance zones plays a pivotal role in improving and maintaining the necessary optimal performance needed by every lacrosse athlete. The training requirements of each performance zone are woven into the structure of the Triphasic Lacrosse Training Model, which will be described throughout this manual. Without the appropriate training of the oxidative energy system, no other qualities are capable of being improved to their maximal extent. When this training model is followed, the performance zones build upon each other to allow optimal performance.

The three energy systems described each play a role in the optimal performance of every athlete and allow the qualities of strength, repeat-power, and speed to be realized to their fullest extent. In other words, the training of these three energy systems allows the body to remain functioning in a high-quality state throughout the stressful training or competition experienced.

It is no surprise that strength is a key physical performance quality as every coach understands the importance of strength in the sport of lacrosse. Through specific training, strength improves force production and increases muscle size, which are both crucial for athletes. Due to the high forces needed to improve strength, loads of greater than 80% of an athlete's 1-rep max are used in training. Without a basic level of strength, the ability to produce high levels of force consecutively, for repeat-power, or at a high rate, as needed for speed, is reduced. Once again, it the main concept that strength lays the foundation for the other two qualities, repeat-power and speed, to be maximized. The importance of the strength quality is currently well understood by coaches. Examples of strength for both competition and training are shown in Figure 1.8.

Strength
Functions During Performance
Increases force production, basis of repeat-power and speed qualities
Strength in Lacrosse
Body checking and other body contact
Picking up a ground ball in a scrum
Dodging with pressure
Play near the crease
Strength in Training
Training with a heavy implement
Pushing a heavy sled
Lifting heavy weight

Figure 1.8 - The Strength Performance Quality and its use in both Competition and Training

The repeat-power performance quality is the ability to execute high force movements repeatedly and relies on the foundation created by the strength performance quality. Repeat-Power is only capable of being maximized when all three energy systems are also trained to the highest extent. These energy systems provide fuel for high-intensity situations and allow an athlete to train harder for longer simultaneously. This quality is crucial for a lacrosse athlete as they must not only be able to create force, but must do so continuously for the entire duration of the game. Training of this quality leads to reduced fatigue levels, allowing a highly-focused mental state to be maintained. Examples of the Repeat-Power performance quality are shown below in Figure 1.9.

Repeat-Power
Functions During Performance
Increases ability to produce high forces for extended periods of time
Repeat-Strength in Lacrosse
Sprinting at high speeds at the end of the 4th quarter
Playing at a high level with multiple games per weekend
Face-off athletes
Repeat-Strength in Training
Running a 300 yard shuttle
Pushing a heavy sled for greater than 20 yards
Completing a heavy training lift to failure (greater than 8 reps) or 15 plus seconds per set

Figure 1.9 - The Repeat-Power Performance Quality and its use in both Competition and Training

Finally, the speed performance quality is the ability to move at a high velocity. Speed, much like the repeat-power performance quality, is built upon the foundation of strength, while also being closely related to the ability of the ATP/Cr-P energy system. The stronger an athlete is, the more force-producing capabilities his muscles possess during sprinting actions. Speed must be trained at the highest possible intensity for every repetition completed if an improvement is to be realized. If an athlete does not complete the required movement at the highest velocity possible, speed will never be trained. That being said, full recovery is required between each repetition when training for speed. It is also important to note training with exercises at high velocities, in addition to sprinting, can also improve this performance quality.

Exercises can be completed with the intent to maximally accelerate the object being used in training. Methods of training can range from heavy exercises like a back squat, but can also include light weight, high-velocity exercises or even unloaded body weight training exercises. Maximal acceleration throughout whatever exercise is utilized must remain a training goal if speed is to be improved. Remember to allow appropriate recovery to ensure high-quality, and not capacity training is achieved. Figure 1.10 gives examples of the speed quality in competition as well as training.

Speed
Functions During Performance
The ability to move at a high velocity, usually for a brief amount of time
Speed in Lacrosse
Sprinting towards the goal
Dodging a defender
Clearing the ball after a defensive stop
Fast break occurrences
Speed in Training
Sprint training
Lifting explosively for a short set
Short burst agility training
Lifting light weight extremely fast

Figure 1.10 - The Speed Performance Quality and its use in both Competition and Training

These six qualities lay the foundation for many of the skills developed and required by all lacrosse athletes; without them the specific skills are not able to be maximally developed on the field. Each performance quality must be considered and trained specifically throughout training and approached with an organized, systematic, methodical program in order for optimal performance to be achieved. Each of these six physical performance qualities training methods will be expanded upon to a great extent in the sections to follow, but it is critical all coaches understand how each of these qualities are required for optimal and elite level lacrosse performance. It is important to note that although these qualities are broken up individually in training, they are all intertwined and are all utilized as one within the athlete's body in training and game situations.

This manual will show the appropriate ordering and combination of these six qualities which creates the unique system that is the Triphasic Lacrosse Training Model. This model continues to allow optimal performance for all athletes as each of the six physical performance qualities are considered. Once again, it is important to note other skills, such as agility and proprioception, will also be improved through the specific enhancement of these six physical performance qualities improved within the Triphasic Lacrosse Training Model.

The amount of training, or stress, applied to each specific performance quality should be determined based on these pre-determined needs of each position. However, based on the parameter graphic shown earlier in Figure 1.2, each of the six physical performance qualities are required to a high extent in the sport of lacrosse for all positions. None of this should be new information to a performance coach. However, this basic idea must be kept in mind at all times throughout the training process. A coach must always consider the requirements of the competitive event in the creation and implementation of a training program.

With the understanding that these six qualities are crucial for elite performance in lacrosse, it is even more vital each of these qualities adaptations are understood and can be implemented in a training setting. Keeping these qualities in mind, it must be realized there will be times when an athlete will not be training in a "sport-specific manner." At different times throughout the year, particularly in the off-season, methods used may actually decrease performance in one parameter due to the improvement of another physical quality to the highest extent possible. In the Block Periodization Model, which is described in Section 2, performance qualities are improved on an individual basis, which may lead to the slight decrease of other parameters. However, when this system is used appropriately and with the correct timing, optimal performance becomes possible for each and every athlete.

High-level coaches must also understand the physiological adaptations required to achieve the sport skills demonstrated on the playing field and what training methods lead to said adaptations. The systematic annual plan leading to peaking, or optimal performance, laid out in this book considers each adaptation, or performance quality, required in order to be successful in the sport of lacrosse and trains in a manner to maximize each performance quality individually.

The training model laid out in this manual accomplishes this goal of specific training based on the requirements of the sport of lacrosse. The Triphasic Lacrosse Training Model aims to prepare each individual lacrosse athlete with the physical capabilities required for his specific skills needed to perform at the highest level possible. Only when this training model is followed is the likelihood of optimal performance maximized. This is due to both the specific programming applied and the efficiency of the training utilized within this systematic training model.

The Triphasic Lacrosse Training Model is a methodical, well-thought-out, systematic method of training which ultimately leads to the optimal performance potential for all individuals. Required, sustainable adaptations, such as structural and metabolic enhancements to the six physical performance qualities, occur due to the implementation of the specific stress applied within each training block. It is in this training model that long-term training adaptations are aptly realized leading to optimal performance and a successful outcome. The methods to achieve each of these adaptations will continue to be expanded and built upon throughout the programs provided within this manual, ultimately leading each athlete to achieve success to the highest level possible.

This is not a system based on making an individual tired or fatigued, and it is not mindless work; it is an all-encompassing system designed to maximize performance during the high-stressors experienced in competition. The Triphasic Lacrosse Training Model is not based on the idea of implementing neat or new exercises or the newest fads in training, it is based on the body's specific response to training qualities.

1.3 High-Quality and Work Capacity Training

Each of the six physical performance qualities can be further broken down into two components, *high-quality* and *work capacity*. When these two components are accounted for in training appropriately, optimal results are seen in each performance quality [3-5]. High-quality training improves the ability of the performance quality to function at the highest intensities possible. Work capacity training, on the other hand, focuses on improving the performance quality's ability to be used for an extended period of time. By training these components at specific times within a workout and/or training block, the greatest improvements possible to each performance quality have the potential to occur.

High-quality training requires greater rest times since maximal intensities are required to improve this aspect of a performance quality. Work capacity is increased when shorter rest times are used in training, as the goal of training becomes improving the length of time the physical performance quality can continue to be used by an athlete [3-5].

An example of this work capacity training in lacrosse is the ability to run repeated sprints in a specific amount of time with little to no rest time in between. Most coaches, in general, tend to excel in work capacity training, or the ability to continue to push their athletes to the brink of exhaustion. Most athletes would agree they have endured grueling conditioning drills where, by the end, there is nothing left in the tank. It is important to note this manual is not stating difficult training sessions, aimed at improving work capacity, are not vital for lacrosse performance. However, these workouts should not be the only method implemented in a program, as the glycolytic energy system becomes disproportionately elevated. The importance of each of the energy systems and the high-quality training required to specifically improve them cannot be overlooked. Figure 1.11 below depicts the work and rest durations for both the high-quality and work capacity component of all three energy systems.

Comparing High-Quality and Work Capacity Energy System Training				
ATP/Cr-P Energy System				
High-Quality Training			Work Capacity Training	
Work Duration	Rest Duration		Work Duration	Rest Duration
3-10 sec.	1:30-5:00 min.		3-10 sec.	30-45 sec.
Glycolytic Energy System				
High-Quality Training			Work Capacity Training	
Work Duration	Rest Duration		Work Duration	Rest Duration
20-30 sec.	2:30-8:00 min.		40 sec.-1:30 min.	2:00-6:00 min.
Oxidative Energy System				
High-Quality Training			Work Capacity Training	
Work Duration	Rest Duration		Work Duration	Rest Duration
1:30-6:00 min.	1:00-3:00 min.		3:00-8:00 min.	1:00 min. and below
			20-120 min.	Continuous

Figure 1.11 - Comparing High-Quality versus Working Capacity Training

An example of this can be seen in the movie *Miracle* when Coach Brooks lines the team up and has them skate repeat sprints on the ice after tying a game he felt they should have won. By the end of this the players were doubled over in exhaustion and completely drained from the high-intensity skating. The majority of us have experienced a coach that approached training with this mentality, to simply push their athletes to the edge with every training session. In this example, because Coach Brooks did not allow rest time for the team, only the work capacity glycolytic energy system was trained.

Consequently, the aerobic and ATP/Cr-P energy systems are neglected. Every performance coach must understand there is a time and place for each component, high-quality and work capacity, to be executed within a training program. True optimal performance may only be achieved when all training factors are accounted for and completed appropriately. Figure 1.12 shows the advanced programming requirements of the three energy systems to meet either the high-quality or work capacity component in training. The Triphasic Lacrosse Training Model takes each of these components into account throughout the annual, block, weekly, and daily training schedules completed.

Advanced High-Quality and Work Capacity Energy System Training Comparison								
ATP/Cr-P Energy System								
High-Quality Training					Work Capacity Training			
Work Duration	Rest Duration	Total Volume	HR Range		Work Duration	Rest Duration	Total Volume	HR Range
3-10 sec.	1:30-5:00 min.	4 to 8 repetitions	N/A		3-10 sec.	30-45 sec.	8 to 16 repetitions	N/A
Glycolytic Energy System								
High-Quality Training					Work Capacity Training			
Work Duration	Rest Duration	Total Volume	HR Range		Work Duration	Rest Duration	Total Volume	HR Range
20-30 sec.	2:30-8:00 min.	3 to 4 repitítions	170+ bpm		40 sec.-1:30 min.	2:00-6:00 min.	4 to 12 repetitions	170+ bpm
Oxidative Energy System								
High-Quality Training					Work Capacity Training			
Work Duration	Rest Duration	Total Volume	HR Range		Work Duration	Rest Duration	Total Volume	HR Range
1:30-6:00 min.	1:00-3:00 min.	6 to 12 repetitions	155-170 bpm		3:00-8:00 min.	1:00 min. and below	10 to 24 repititions	140-155 bpm
					20-120 min.	Continuous	1 repetition	140-155 bpm

Figure 1.12 - Advanced High-Quality versus Work Capacity Training

A simple example of high-quality versus work capacity training is the difference between training for maximal speed versus conditioning. Maximal speed training is a high-quality component, and thus requires increased recovery times as the athlete must truly run at maximal speeds in order to improve this physical performance quality. Athletes are only capable of running at maximal speeds if they are fully recovered between sprints. If a coach reduces the recovery time between repetitions, training shifts to a work capacity, rather than a high-quality, training session, just like the skating example above. This returns to the simple idea that specific improvements in each performance quality must remain the goal of training. Every coach must understand the high-quality and work capacity components must be specifically stressed in training at certain times within the annual cycle.

Examples for high-quality, work capacity, and combination training are given below for each energy system in Figures 1.13-1.15. It is important to note that although multiple methods (running, biking, sled pushes, swimming, etc.) are capable of adapting these systems, the most transferrable to sport will be running. This is the case because the body continues to adapt to the stressor method presented in training. As seen in the examples provided in Figures 1.13-1.15 below, the recovery period between each repetition ultimately determines whether high-quality or work capacity training is completed. By training each of these components (high-quality and work capacity), the athlete will have an improved ability to produce high-intensity efforts, while also increasing the length of time each energy system is capable of remaining activated. Every lacrosse athlete must train both of these components at the appropriate times within the daily, weekly, and annual blocks to achieve optimal results.

Comparing High-Quality and Work Capacity Oxidative Energy System Training		
Oxidative Energy System in The Triphasic Lacrosse Training Model		
High-Quality Training	Work Capacity Training	Combination Quality/Capacity Training
Biking (1:30-6:00 min. on 1:00-3:00 min. off for 6-12 reps)	Biking (3:00-8:00 min. on 1:00 min. and below off for 10-24 reps) or Continuous Biking (HR 140-155)	Biking (1:30-6:00 min. on 1:00-3:00 min. off for 6-12 reps) Followed By: Biking (3:00-8:00 min. on 1:00 min. and below off for 10-24 reps) or Continuous Biking (HR 140-155)
Jogging (1:30-6:00 min. on 1:00-3:00 min. off for 6-12 reps)	Jogging (3:00-8:00 min. on 1:00 min. and below off for 10-24 reps) or Continuous Jogging (HR 140-155)	Jogging (1:30-6:00 min. on 1:00-3:00 min. off for 6-12 reps) Followed By: Jogging (3:00-8:00 min. on 1:00 min. and below off for 10-24 reps) or Continuous Jogging (HR 140-155)

Figure 1.13 - Oxidative Energy System High-Quality, Work Capacity, and Combination Training

Comparing High-Quality and Work Capacity Glycolytic Energy System Training		
Glycolytic Energy System in The Triphasic Lacrosse Training Model		
High-Quality Training	Work Capacity Training	Combination Quality/Capacity Training
Bike Sprints (20-30 sec. on 2:30-8:00 min. off for 3-4 reps)	Bike Sprints (40 sec.-1:30 min. on 2:00-6:00 min. off for 4-12 reps)	Bike Sprints (20-30 sec. on 2:30-8:00 min. off for 3-4 reps) Followed By: Bike Sprints (40 sec.-1:30 min. on 2:00-6:00 min. off for 4-12 reps)
Shuttle Running (20-30 sec. on 2:30-8:00 min. off for 3-4 reps)	Shuttle Running (40 sec.-1:30 min. on 2:00-6:00 min. off for 4-12 reps)	Shuttle Running (20-30 sec. on 2:30-8:00 min. off for 3-4 reps) Followed By: Shuttle Running (40 sec.-1:30 min. on 2:00-6:00 min. off for 4-12 reps)

Figure 1.14 - Glycolytic Energy System High-Quality, Work Capacity, and Combination Training

Comparing High-Quality and Work Capacity ATP/Cr-P Energy System Training		
ATP/Cr-P Energy System in The Triphasic Lacrosse Training Model		
High-Quality Training	Work Capacity Training	Combination Quality/Capacity Training
Short, Heavy Sled Pushes (10 sec. on 2:30-5:00 min. off for 4-8 reps)	Short, Heavy Sled Pushes (10 sec. on 30-45 sec. off for 8-16 reps)	Short, Heavy Sled Pushes (10 sec. on 2:30-5:00 min. off for 4-8 reps) Followed By: Short, Heavy Sled Pushes (10 sec. on 30-45 sec. off for 8-16 reps)
Short Burst, Agility Training or Running (10 sec. on 2:30-5:00 min. off for 4-8 reps)	Short Burst, Agility Training or Running (10 sec. on 30-45 sec. off for 8-16 reps)	Short Burst, Agility Training or Running (10 sec. on 2:30-5:00 min. off for 4-8 reps) Followed By: Short Burst, Agility Training (10 sec. on 30-45 sec. off for 8-16 reps)

Figure 1.15 - ATP/Cr-P Energy System High-Quality, Work Capacity, and Combination Training

1.4 Training Considerations

Specific training principles and ideas involved in the training programs laid out in the chapters to come are laid out and described throughout this section. These training principles include stressing the athlete optimally, prevention of injury in training and reduction of injury on the field of play, and transfer of training. Each of these ideas presented in this section serve as the foundation from which all training programs presented in later chapters will be created. By the end of this chapter every coach should have a firm understanding of the basic principles that should be considered when planning and implementing every training session completed by an athlete. Only when these training principles are effectively implemented with appropriate timing within the annual cycle is optimal performance possible.

1.41 Optimal Stress Application & General Adaptation Syndrome

The first training consideration, which is vital prior to any understanding of the sport of lacrosse or other knowledge, is the complete understanding of optimal stress application and the general adaptation syndrome (GAS) [6]. Even before a coach considers the amount each physical performance quality is required in performance, it is vital every coach understand the stress and adaptation response the body encounters in order to maximize the effects of training.

Transfer of training, whether it be a technical skill, the ability of the body to mobilize energy stores through the use of the three energy systems, or the ability to produce high levels of force within a movement, is ultimately determined by one aspect, STRESS. Simply put, in order to improve any skill or performance quality, an athlete must be exposed to that stimulus, or stressor. Only when the concept of stress and its specific application in the adaptation process is well understood can training be implemented appropriately within a systematic program to achieve optimal performance. The Triphasic Lacrosse Training Model has been created and programmed in a manner that utilizes the body's stress response and induce specific desired adaptations according to the requirements in the sport of lacrosse, ultimately leading to optimal performance.

The goal of the human body is to always remain in a homeostatic state, or a state of comfort. Stress, in a general sense, occurs on a daily basis, to all people, with no prejudice. It can be largely accumulated through training, although one's family, money, psychological state, school and performance issues may all play a role in the athlete's response to stress and must be constantly considered. A disturbance in homeostasis, or any stressor, leads to some level of adaptation within the organism. When stress is applied and the body experiences this disruption of homeostasis, whether in training or everyday life, the body has one goal: survival.

An athlete's body will increase its odds of survival through any means necessary, even when that means functioning in an inefficient manner. Only after the stressor has subsided and the body has guaranteed survival, does the adaptation process occur. This process ensures the organism is well-equipped, should that stressor present itself again. Performance coaches must work to improve the efficiency of the body in regards to the specific stressors it experiences in training and/or competition. As a performance coach, the approach in training must be to put the body outside of its comfort zone to cause a specific change in the athlete. Only when this approach is applied in the systematic, properly organized fashion seen in the Triphasic Lacrosse Training Model is optimal performance achievable.

The highly organized and systematic Triphasic Lacrosse Training Model presented in this manual requires the understanding of the concept of balance. A performance coach is ultimately a stress manager and must realize that balance is crucial in order for optimal performance to be achieved by any athlete. A simple way to view the stress being applied in training is to consider training on a continuum. If stress is applied at an extreme amount with limited recovery, the athlete will be unable to cope with the excessive levels of stress and begin to respond poorly. At the opposite end of the continuum, if not enough stress is applied during training, the desired training adaptations will not occur and optimal performance will never be reached.

In either case, too much or too little stress in the training process will hinder the improvement of the desired performance qualities and limit the transfer of the skills to the competitive event. This less than optimal stress application, either too much or too little, will hinder an athlete's development over the course of time and ultimately lead to detrimental effects on their performance. Managing and balancing stress is a crucial aspect of every performance quality required in competition.

All performance coaches must keep this stress continuum in mind and maintain the appropriate levels of stress required of each athlete to achieve success. Figure 1.16 below displays the continuum used for appropriate training. Throughout this manual, the Triphasic Lacrosse Training Model will present the specific adaptations that occur with each training block, but without the general, appropriate understanding of stress and how to implement it with balance those specific adaptations will be useless knowledge.

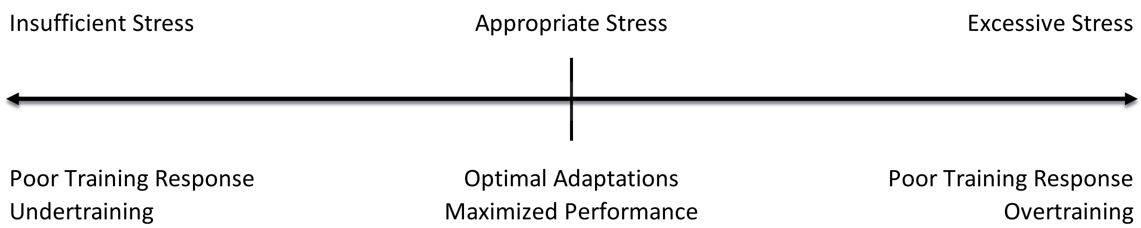

Figure 1.16 - Determining appropriate training stress

As an athlete trains, adapts, and progresses through the development process, the line dictating "Appropriate Stress" for each athlete in Figure 1.16 shifts further to the right side of the continuum. This is due to the fact as the body accumulates stress and then adapts to that training stress, increased amounts of stress are required to achieve continued adaptations in that specific quality.

Every athlete's body prepares and adapts to the specific stress experienced in training. After training the body should view that stressor experienced as simple and easy to overcome. An elite athlete has a high capability to adapt to whatever stimulus is provided them, this is the fundamental idea behind long-term athletic development. If this is not well understood, inappropriate stress will be applied at the incorrect times and an athlete will not adapt to their highest capabilities and optimal performance will not be achieved. An example of this can be seen in many Division I football athletes. After their freshman year, which is typically aimed at development, athletes fail to see continued improvements in performance. This is due to the increased requirements of both the amount and specificity of stress required in training to continue the realization of transfer of training, which will be discussed thoroughly in the upcoming section.

The Autonomic system plays the determining role of the appropriate stress application for each athlete. The "ANS" controls the majority of the responses that occur throughout the body when a stressful event, such as training, is experienced by an athlete. This portion of the nervous system is divided into two components, the sympathetic and parasympathetic nervous systems. Each of these components of the ANS play a vital role in the stress application and recovery processes every athlete requires.

When an athlete experiences any stressor, whether that be in training, an issue in their family or with a significant other, the parasympathetic nervous system becomes downregulated by an increased response by the sympathetic nervous system. Basically, when as the body encounters any stressor, it prepares itself to maximize the completion of the required action. This includes the increased blood flow, mobilization of resources within the body, and a heightened ability to produce force by the muscles. It is for this reason the sympathetic nervous system has been termed the "fight or flight" aspect of the ANS, as it enhances the odds of surviving, or overcoming, the applied stressor.

Although this is an important and necessary process in improving performance in stressful situations, it is imperative to realize that an increased sympathetic drive can also lead to performance decreases. At first glance, we can view extreme feats of the sympathetic nervous system as desirable, such as a mother lifting a car off of their young child. However, when these situations are examined more closely it becomes clear many cognitive abilities, which are absolutely vital for performance in the sport of lacrosse, are diminished to a great extent. Ultimately, as extreme stressors are experienced in competition, an athlete will commonly begin to lose technical performance skills they are otherwise proficient in. As the body encounters extreme sympathetic arousal, the likelihood of inefficient functioning increases dramatically and performance decreases occurs.

A simple example of this extreme sympathetic drive is a highly experienced and accurate lacrosse shooter is unable to control the location of his shots. If, for whatever reason, his sympathetic nervous system has increased his output, his learned technical skills that he has repeated thousands of times will become useless and he will lose control of his cognitive functioning. As seen in this shooting example, the sympathetic system can function to heighten awareness in a high stress situation, but it can also lead to the breakdown of skill ability, such as accuracy of a shot, if the sympathetic system becomes too activated. Every athlete will have a specific heart rate range in which they are able to perform, and maintain, at an optimal level.

The parasympathetic nervous system works in the opposite manner of the sympathetic nervous system and leads to the body returning to a normal homeostatic state. For this reason, the parasympathetic nervous system has been termed the "rest and digest" phase, as it leads to the calming of the body after a stressor has been experienced. It is during this post-stressed state that adaptation occurs and the body can begin to adapt and prepare for that specific stressor, should it occur again.

It is vital performance coaches prepare their athletes in an appropriate manner based on each of the stressors required in the competitive event to guarantee optimal performance as a possibility. Ultimately, the ability of the athlete to control his heart rate during the specific requirements of competition must remain of upmost importance to every coach. The high response rate and functioning of each energy system as well as the proper breathing pattern determines the abilities of each athlete to quickly transfer from one branch of the ANS to the other. This becomes especially important in repeat sprint sport events.

Learning appropriate breathing, termed *belly breathing,* is essential to controlling the balance between the sympathetic and parasympathetic nervous systems and ultimately the heart rate during both training and performance. This breathing technique is executed by inhaling through the nose and exhaling through the mouth. Throughout this process it is vital that the lower abdomen initiates the movement rather than the chest. The chest will, and should, eventually expand, just after the abdomen does. Shallow chest breathing releases stress hormones that lead to an increase in sympathetic arousal, which are counterproductive to the end goal of maintaining an appropriate heart rate during competition, leading to a less efficient athlete.

This breathing technique should be used at all times to help control heart rate and keep every athlete within his appropriate range for optimal performance. Belly breathing can be trained to improve efficiency through specific practice in training sessions. For example, if belly breathing is made a focal point of recovery between every set completed, the athlete is much more likely to utilize this method in performance. By practicing this breathing technique during training and for other relaxation purposes, an athlete will improve his ability to keep heart rate lowered consistently or lower it rapidly when an extreme stress level occurs. This training can be instrumental for controlling the stress response during high-intensity situations commonly experienced in performance and can lead to increased durations of both focus and optimal performance.

Applying appropriate levels of stress, of both magnitude and the timing, is the foundation upon which all peaking abilities are based. Once again, be a stress manager! This Triphasic Lacrosse Training Model will provide the resources to not only manage stress for each athlete, but will also demonstrate the requirements to achieve optimal stress response and adaptations in every athlete encountered.

The application of appropriate stress is only the first aspect of performance enhancement. As mentioned previously, without the necessary recovery the body will not adapt to its maximal ability. This process of improving performance occurs due to the general adaptation syndrome (GAS), which is shown below in Figure 1.17. The goal of training in the Triphasic Lacrosse Training Model becomes stressing a specific performance quality beyond its level of “comfort” and then allowing the body to recover, improve, and gain the desired results from training. This process of adaptation followed by supercompensation should be well understood by all coaches.

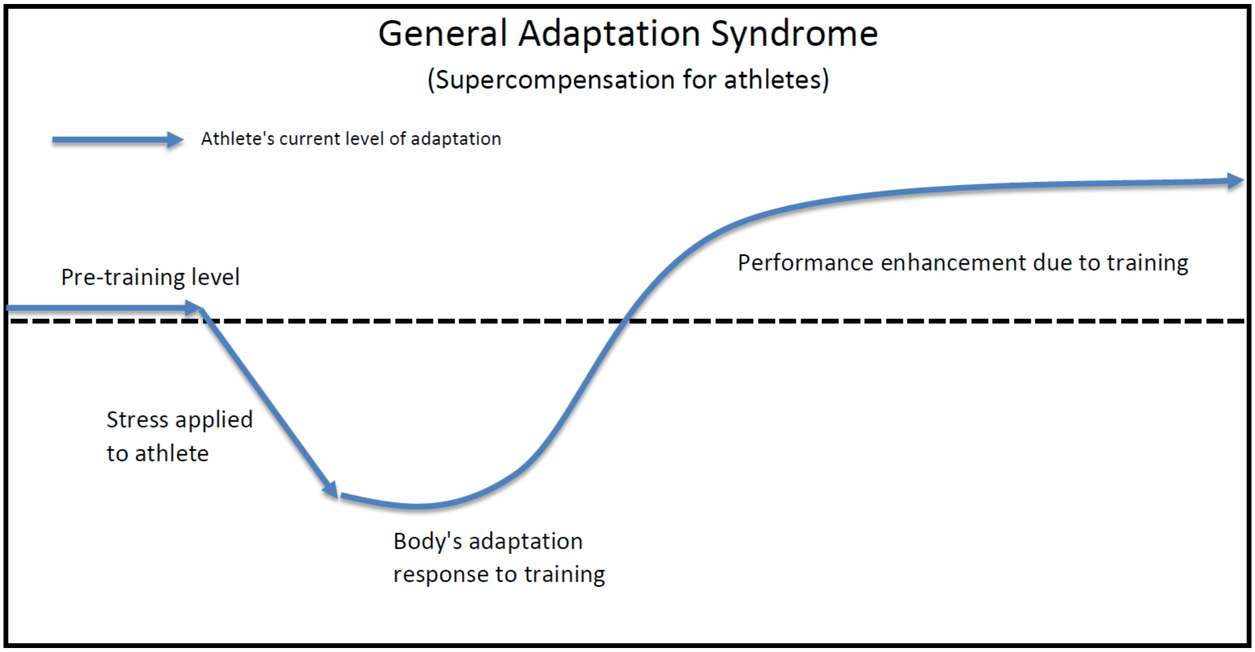

Figure 1.17 - General Adaptation Response (GAS) [6]

Discomfort is a necessary and expected aspect of the adaptation process as the body must experience a large enough stressor to cause adaptation to that specific stressor. However, based on the understanding of the stress continuum shown earlier in Figure 1.16, a logical and systematic approach to training must be implemented at all times to ensure appropriate stress is applied. After the initial stressor has subsided, as long as the intensity of the stressor was not too extreme, the body will enhance its ability to complete that trained skill or quality in the most efficient, specific way possible. This enhancement prepares the body for that stressor, should it occur again in the future. This is why training must be completed systematically and specifically to the competition event being trained for, to ensure the body adapts and is prepared for the stressors experienced in the athletic event.

It is through the constant process of stressing, adapting (or recovering), and improving of an athlete, that all training should be based [7]. Simply put, stress or train the body in a similar manner to the requirements of the task at hand, if you want to improve a skill, you must practice or train it specifically. This basic idea of the general adaptation syndrome can and must be applied in extremely specific manners if transfer of training is to be maximized and optimal performance is to be reached. Only when stress is understood can the specific training presented within the Triphasic Lacrosse Training Model be applied to each athlete's required performance qualities.

Figures 1.18-1.20 below represent the three possible outcomes of stress application in training. Each of these three results are determined based on the stress continuum shown above in Figure 1.16. The first figure, Figure 1.18, displays the improvements possible when stress is applied in an appropriate amount for the desired adaptation, which leads to improved performance to the fullest extent. The second figure, Figure 1.19, shows the results of an athlete that is stressed using insufficient means in training. This training method results in a poor training response and no performance gains due to the training applied. The final figure, Figure 1.20, represents the results of an over-trained athlete, or one that has experienced excessive levels of stress. When this approach is implemented in training, the athlete's body does not have the resources or capabilities to adapt to the demands being placed upon it in training. Thus, a negative, or poor, training response occurs and an athlete will end in a worse performance state than pre-training levels.

The final two examples (Figures 1.19 and 1.20) must be avoided by performance coaches at all costs. If either of these two occur at any time within the training cycle, a desired skill or performance quality will be left either undertrained or with a negative adaptation, leading to an athlete to a less than optimal state of performance. It is vital performance coaches understand stress and manage it appropriately based on the guidelines laid out. This is the only systematic method created that considers each of the models presented simultaneously, which is truly the only option if optimal performance is to be reached in lacrosse performance.

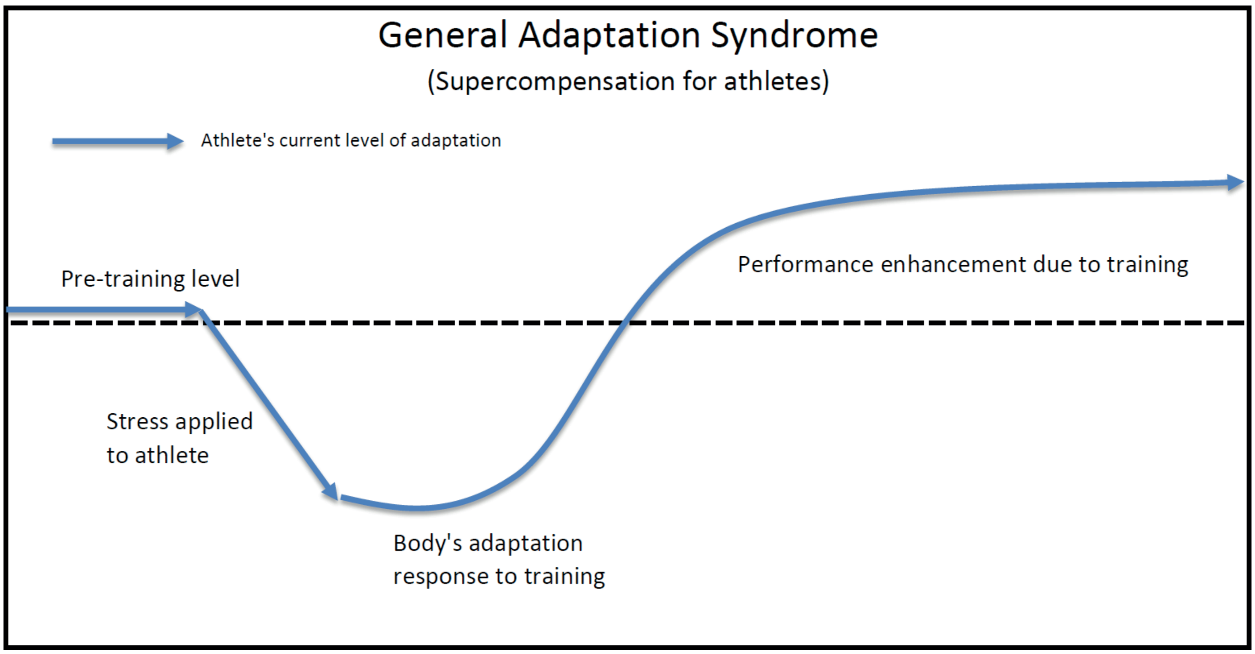

Figure 1.18 - Adaptation Response with Appropriate Stress in Training (Desired Adaptation)

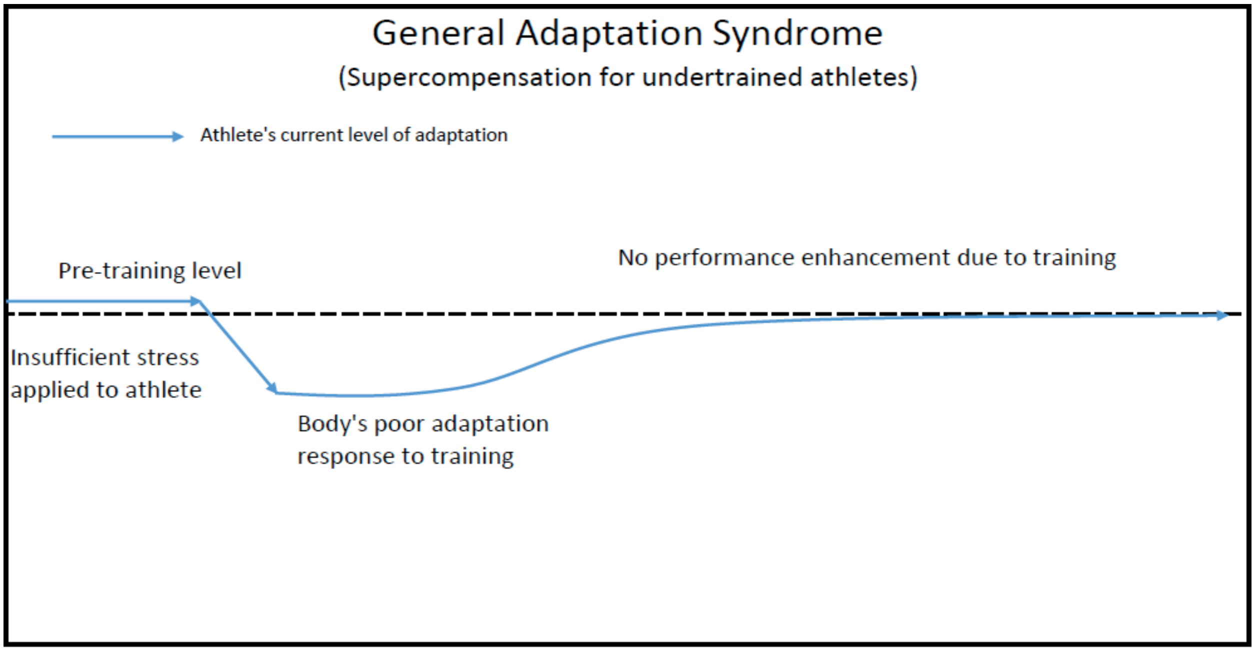

Figure 1.19 - Adaptation Response with Insufficient Stress in Training (No Response)

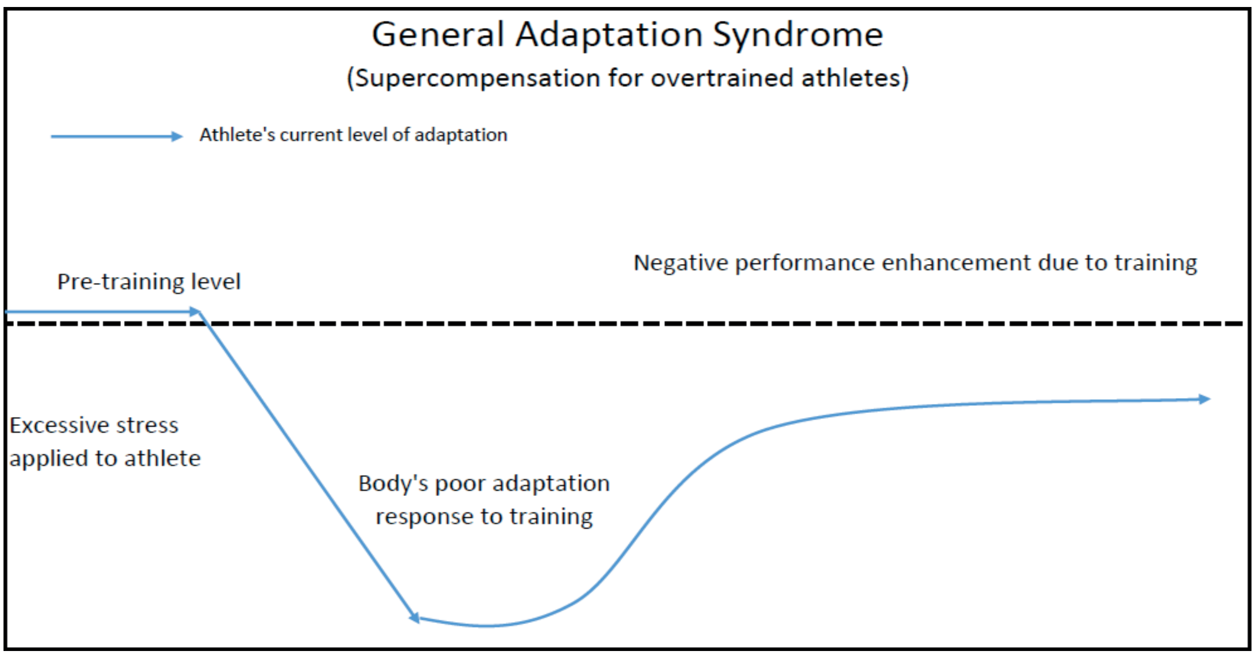

Figure 1.20 - Adaptation Response with Excessive Stress in Training (Decreased Performance)

Every performance coach must view the training process of each athlete in two individual phases. Both the training session, or stressor, and the recovery phase. These two phases give an in-depth view of the athlete's bodily response to the stressor applied and must be carefully considered in training to ensure the desired adaptation(s) occur. Both the training and recovery balance will vary depending on the time of the year. However, the overall concept remains that too much or too little stress leads to less than ideal adaptations and creates an impossible situation for optimal performance to occur.

Based on Figures 1.18-1.20 above, stress and the body's response can be thought of as a wave. As stress is applied, the wave, or readiness of the athlete, drops below the pre-training level. It is at this time homeostasis has been disrupted due to the completed training. Once the stressor has subsided, the upswing of the wave occurs with adaptation and recovery beginning. The importance of recovery cannot be overstated as this phase allows supercompensation of the trained performance quality. It is at this high point of the wave that optimal performance of the trained skill is possible.

It must be realized that nowhere is it ever stated that full recovery and supercompensation must occur between every training session. If full recovery were to be allowed, results will be minimal as truly high levels of stress are never accumulated. In this instance the training response will resemble Figure 1.19 and ultimately no, or extremely minimal, performance gains will be realized by the athlete. Once again, Figure 1.17 above demonstrates the proper implementation of a training stressor and the body's response. When the process of stress and adaptation are well understood, these principles can be applied specifically to the six performance qualities required for elite performance in lacrosse. This creates the systematic, proven Triphasic Lacrosse Training Model.

1.42 Injury Prevention and Reduction

Injury prevention in training and reduction on the field is the second training consideration presented in this manual. This consideration is presented second in this manual only due to the fact that without the appropriate implementation of stress in training can the prevention and reduction of injury be accomplished. As coaches, it must be understood that every aspect of an athlete's life contributes to his stress levels described in the previous section. Competition, practice, and training are commonly considered as stressors; however, travel, family life, significant other issues, even exams contribute to the accumulated stress experienced by an athlete [(9)]. Studies have now shown football athletes are more likely to be injured during finals week than during training camp. These are stressors that must be accounted for at all times, especially during the competitive season.

There is a clear distinction between prevention and reduction of injury for both training and play due to the uncontrollable nature of lacrosse. The most commonly experienced injuries include lower extremity injuries (ankle and knee issues are experience most commonly), as well as concussions [(1, 10-13)]. The knowledge and understanding of each injury's mechanism continues to increase, leading to improved training and reduced injury likelihood during gameplay.

Once again, there is no method that can entirely prevent injuries during competition. However, there are specific methods laid out throughout this manual to ensure athletes experience the most efficient training possible. A few of these methods are described in this section and include the incorporation of specific motor learning, the training of appropriate glute functioning, activation techniques, multi-dimensional training, rate of force acceptance training, and neck training. Each of these training methods are implemented at specific times throughout the year in order to prepare every athlete for the high stressors experienced in competition.

The body continues to learn in the manner it is trained; this forms the foundation of motor learning. The specifics of this learning process will be provided in the transfer of training section to follow. However, it is important coaches realize appropriate motor learning plays a role in reducing injury likelihood in lacrosse. Methods for increased motor learning will be described in the training sections of this manual. However, one important aspect of injury reduction and improved performance is the appropriate functioning of the glutes. We have developed a specific layered system to increase the ability of these vital muscles in athletics.

The gluteus maximus, or glute, is likely the most discussed muscle in the body, particularly in the world of athletics. As a performance coach or any other professional that works to understand the human body, this is likely one of the most fascinating muscles as it is also the most commonly dysfunctional muscle found in athletes. There have been many methods and techniques introduced to assist with dysfunctional glutes, ranging from hip bridge to banded clamshell and other exercises to increase the glute firing. These are all useful exercises to some extent, but they do not apply the required stress to increase glute activation to the highest extent. Before these specific methods to maximize glute activation and function in dynamic movements are utilized, the basics of the glute muscles must be entirely understood.

The glute muscles are primarily responsible for hip extension, which as we know is crucial for all athletic events and movements. However, this muscle is also responsible for concentric movements in other planes, including abduction and external rotation. That being said, the glute is also responsible for the important role of eccentrically decelerating the hip in the opposite movements (hip flexion, adduction, and internal rotation), which are all mechanisms of ACL tears, FAI, and other issues athletes experience. For this reason, the firing of the glutes appropriately is critical for reducing injury likelihood, particularly at the knee, as, once again, the mechanism of knee injuries commonly occurs due to excessive adduction and internal rotation. As the glutes become inhibited, for whatever reason, the ability to control the hip and knee become greatly reduced. This leads to an increase in traumatic injury likelihood, which we as coaches must be working to prevent at all times.

As the primary driver of the hip into extension and the critical deceleration of the body safely in various positions and angles, the glutes, and surrounding musculature should fire in a specific pattern with every movement. Whether it is running, cutting, walking, throwing a football, shooting in lacrosse, etc., the glutes should be utilized as the primary driver in EVERY movement. In hip extension, the glute should be the first muscle to fire, followed by the hamstring and contralateral quadratus lumborum (QL), which is shown below in Figure 1.21. This should not be new information to those dealing with the human body and elite level performers on a regular basis. However, the fact of the matter is almost every athlete we have tested does not utilize this optimal pattern. Many athletes fire from their hamstring first, leaving their primary muscles, the glutes, inactive. This pattern leads to a change in gait and likely a pulled hamstring in high-speed running scenarios.

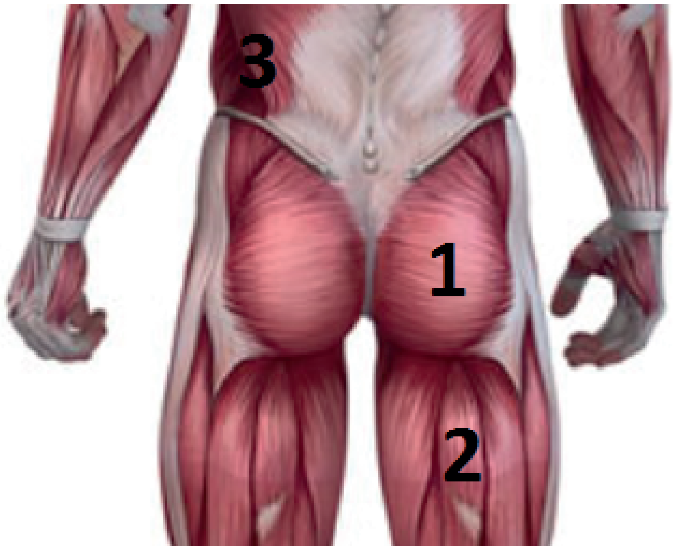

Figure 1.21 - Appropriate firing of the hip extension musculature firing

There are multiple reasons why these changes in firing patterns occur. These reasons include an athlete that is structurally “off,” has learned compensation patterns, or is in a chronically sympathetic state. Ultimately your glutes function by the “use it or lose it” mentality. Unfortunately, and amazingly, your body is so efficient, intelligent, and aware of its need for hip extension in movement that it will find other ways to complete this required hip action. These compensation patterns, such as the hamstring being recruited as the primary mover rather than the glute, occur due to the vast musculature surrounding the hips. Once again the “use it or lose it” approach is taken. If for some reason the body cannot fire the glute, it will find a secondary, although sub-optimal, firing pattern for hip extension.

Regardless of the reasoning it is vital a coach is capable of creating optimal, functional firing patterns within the hip with the glute as the primary mover. This will reduce injury likelihood and also improve power output from an athlete. The following will provide, a scientific, research-based, layered system to “reset” your athletes per se into their appropriate, optimal hip extension firing pattern. These methods will be laid out in a pyramid fashion ranging from pure volume with correct coaching and cueing, isometric activation protocols, manual activation techniques, up to structural adjustment principles to ensure appropriate patterning. The glute layering pyramid is demonstrated below in Figure 1.22. This layered system begins with a foundation that all coaches should be capable of providing their athletes, and then progresses to other methods that become more selective in their utilization. At the very least coaches should be providing glute isometric work and then the 3-D contralateral circuit. Ultimately, this system is based on availability, with the most readily available systems forming the foundation of performance.

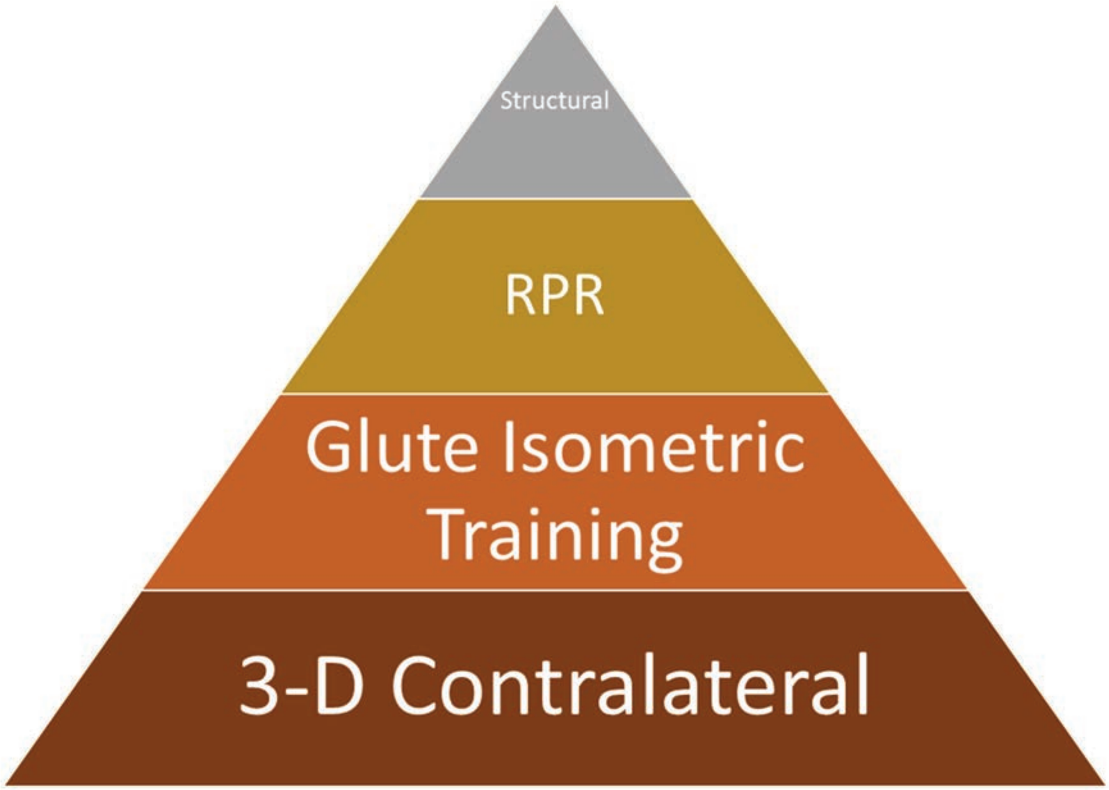

Figure 1.22 - The Glute Layered Pyramid

After seeing this figure, some coaches may feel they already incorporate the majority of these, and it is entirely possible that components of this protocol are implemented. However, as each layer is explained on a deeper level, every coach will begin to realize the physiological importance of the individual components involved in this glute training process.

In order to ensure glute function to the highest extent, a coach must first ensure every athlete is in structural alignment. Many athletes have structural issues that may go unnoticed that are limiting performance. Without structural alignment, an athlete will become inhibited in specific muscle groups, particularly the glutes. If this structure is left in a misaligned position, the athlete will forever be in a reduced state of functioning. This returns to the concept of "don't add load to dysfunction." It is important to note structural issues can occur in multiple places, particularly the hips and the feet. The feet are commonly overlooked in this process. In many actions, the feet are the only contact point an athlete has with the ground, thus they are responsible for relaying the ground forces experienced up to the hips, ultimately leading to an eccentric loading of the glutes. However, the foot commonly does not have the appropriate mobility at specific joints, which means the information is never relayed up to the glutes. Therefore, appropriate foot function, as well as other potential structural alignment issues, must be considered as dysfunction can ultimately lead to glute inhibition.

Many coaches are fortunate enough to work with extremely skilled chiropractors who can greatly assist with the glute functioning process. If a coach has this resource, physical therapists, or even an athletic training staff they trust, it is important to develop a relationship with them as their knowledge will be invaluable to the progression and safety of an athlete. However, it is understood that not all coaches have this valuable resource available to them. It must be noted that we are in no way suggesting you take chiropractic or other structural adjustments into your own hands if you are not certified to do so. If you do not have this skill set personally, or do not have a chiropractor available to you, then this layer is simply unavailable to you and your athletes. It is for this lack of availability to some coaches that this layer forms the peak of the pyramid and not the foundation.

When the structural inhibitions of the body have been resolved, the Reflexive Performance Reset/RPR™ method is able to be implemented with the highest level of success. For those unfamiliar with this technique, it is a form of reflexive therapy that considers neurolymphatic, neurovascular, acupuncture, and many other techniques. When combined, this activation leads to an immediate change in muscle function and compensation patterns within every athlete.

Compensation patterns have been referred to multiple times already, but what leads to these patterns being developed? Factors including stress, such as past trauma, home and work life, and other general stressors experienced, repetitive exposure to a specific movement pattern, as well as posture all play a role in the sequencing pattern of the body and can all lead to compensation.

As compensation patterns are engrained through motor learning, reciprocal inhibition, synergistic dominance and neuromuscular efficiency can all be affected. Reciprocal inhibition occurs when one dysfunctioning muscle leads to a decreased neural drive in its antagonist muscle. An example of reciprocal inhibition occurs when the psoas becomes shortened and leads to a decrease in force producing capabilities in the gluteus maximus, as they are antagonist muscles. Ultimately this inhibition leads to reduced force production by the prime mover and places stress and compensation patterning in a synergist muscle. Synergistic dominance is the outcome of the reduced or inhibited functioning of the primary mover in the kinetic chain or sequence. In this pattern a synergist acts to take over for a major muscle, or primary mover, in an attempt to maintain force production. An example of synergistic dominance would be the hamstrings taking over for the dysfunctional glutes in hip extension. Ultimately synergistic dominance will lead to altered movement patterns, decreased neuromuscular efficiency and control, and increased injury likelihood.

The glute commonly experiences a compensation pattern due to the many number of muscles surrounding the hip. The body can find other ways to complete hip extension. The hamstrings are commonly the group to take over the skill of hip extension, leading to the inappropriate pattern described in the opening section (hamstring, to glute, to contralateral QL). However, when this occurs the body functions inefficiently and is at an increased risk of injury.

RPR™ techniques consider the appropriate sequencing of the muscular system, or kinetic chain sequencing, in every movement completed in life. Everyone should fire in the 1-2-3 pattern, or from the inside-out with explosion, not implosion [15]. This pattern is shown below in Figure 1.23. When a compensation pattern occurs and the 1-2-3 firing order does not occur an athlete experiences implosion, or he drives forces inwards back toward his zone 1. Basically, as the body finds new patterns to complete a task, or compensation patterns, the capability to produce power is lost as the body functions inefficiently. As performance coaches our goal should always be to create explosion, or the 1-2-3 pattern. When the body is executing movements in the correct sequence, the right structures complete the right job at the right time. Notice in Figure 1.23 below, the glutes are found in zone 1 and the hamstrings and QL's are found in zone 2. This ensures the appropriate firing pattern of glute, to hamstring, and finally contralateral QL. As soon as compensations occur and zone 1 (the glute) is no longer used as the primary driver, implosion of the body occurs as synergistic, zone 2 muscles (the hamstrings) are required to take over the job of the primary driver. Once zone 1, ultimately the gluteus maximus, is altered, the entire sequencing of the body is altered with increased injury likelihood and reduced performance.

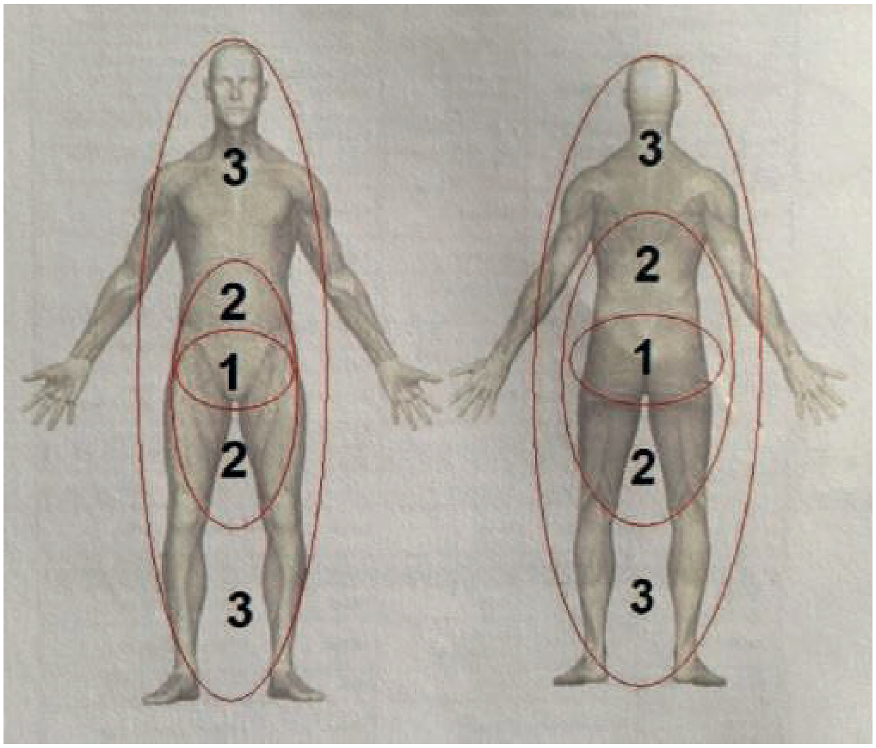

Figure 1.23 - The 1-2-3 sequencing found within the body when correctly functioning

Diaphragmatic or "belly" breathing in the appropriate manner is one method to maintain the appropriate 1-2-3 patterning. This sounds oversimplified, but anatomy shows the direct connection between the diaphragm and the psoas, which is a primary mover in zone 1. For this reason, the importance of this breathing technique cannot be overlooked. Many coaches may already apply this method of breathing in an attempt to reduce the stress response of the body. Anytime the chest is used in breathing, the body is forced to act as if it is encountering a stressful situation. An athlete that breathes through his chest, rather than using the diaphragm, chronically will cause a much greater compensation pattern to occur than a "belly breathing" athlete. This should make perfect sense as stress is one of the factors leading to the patterns other than the 1-2-3 sequence.

A second reason the use of diaphragmatic breathing is useful in athletics is the change in pressure throughout the lungs. When using "belly breathing," the inhaled oxygen is pulled deep into the lungs, where the partial pressure is less than at the top of the lungs. This allows greater amounts of oxygen to be pulled from the lungs at a higher rate, leading to an improved aerobic and cognitive functioning.

Through the utilization of the reflexive reset, RPR™ is applied to ensure the optimal hip firing pattern (glute, hamstring, and finally contralateral QL) of the body is functioning at the highest level. In lacrosse, the muscles within the body do not function as individual pieces, but rather as entire chains. The synchronization realized due to the implementation of RPR™ allows the appropriate use of each muscle group within the kinetic chain at the correct time. When the body is activated through this technique and is properly utilizing the 1-2-3 sequencing pattern, the ability to learn and apply skills that maximize coordination and synchronization required for success in any athletic competition is improved.

This method leads to immediate increases in neural drive to the muscles "activated" and can be seen in isolated muscle testing. Through the implementation of RPR™ an athlete has an increased ability to fire his hips in the appropriate sequence. This access to the glute plays a crucial role in creating sustainable, long-lasting changes to hip firing patterns, which are now understood to be vital to performance.

For more information on RPR, click here.

The previous two layers described, structural and RPR™ require previous training and a specific skill set prior to their implementation. Although they each play critical roles in the activation of the glutes, it is understood that not all coaches are equipped with, or have, these skills available to them. These next two methods are readily available to every performance coach. For that reason, they form the base of the glute layering pyramid due to their accessibility.

The glute isometric protocols are designed to regain the ability to fire the glutes in all three planes of motion. This training method has been developed due to evidence of increased corticomotor excitability through transcranial magnetic stimulation due to isometric glute training [(14)]. Put simply, the motor cortex area of the brain specific to the glute muscle fires at a greater amplitude post-glute isometric training, or an athlete has an increased ability to learn to utilize their glutes in the appropriate firing pattern of hip extension after this training method is implemented.

Time under tension and athlete tolerance become the two primary factors in this training method. Examples for each of these progressions are provided in section four of this manual. Based on research, the goal time under tension to optimally "prime" the motor cortex for the glutes seems to be around twenty minutes. For that reason, these three progressions all require around that time. However, as an athlete adapts and is able to progress, the amount of time spent in isometric positions increases. For example, in progression 1, of the eighteen-minute training protocol six of the minutes are spent in unilateral, constant movement patterns (Forward Cross Crawl, Cross-Under Lunge, and Cross-Under Lunge Crawl). These patterns are implemented as they continue to stimulate the motor cortex while also allowing an untrained athlete to recover from the isometric work. As an athlete progresses and is able to handle greater isometric training, a higher percentage of the twenty minutes consists of isometric work. A coach can also increase the intensity of an isometric by adding a focal point for the athlete; simply have them focus on one single point as they complete the isometric exercise. An electric muscle stimulation machine can also be utilized on the gluteus maximus to increase intensity even further. However, a coach should use extreme caution with this method as extreme levels of soreness are seen after its implementation.

Simply based on the examples provided in section four, it is common for coaches to add extra work or utilize a higher tension band. However, this must be completed with extreme caution. The primary goal of this training is to ensure the glutes are utilized in the firing pattern. If excessive load or exercises are implemented, an athlete will find ways to cheat, or compensate. Some of our strongest athletes experience EXTREME levels of soreness with the level 1 progression and a yellow mini-band. This is due to their compensation patterns and the lack of glute firing in every movement they complete. These high-level athletes are exceptional cheaters, and thus are commonly the sorest in their glutes the day after this program.

The glute isometric progressions are implemented at a high level during the aerobic GPP phase, due to the increased volume seen in this training block. By priming the glutes through this readily available method, an athlete can then fire appropriately through a high volume of different exercises and movement planes to “cement” this optimal hip firing pattern.

Once the glutes have been primed through the use of the isometric protocols, along with RPR, and structural layers, if available to you as a coach, the next step is to add a higher level of volume in full movement while utilizing the appropriate hip firing pattern. As stated above, this protocol is implemented within the aerobic GPP phase as its volume and intensity also lead to aerobic adaptations within the body. Typically, this exercise method is prescribed to be completed with a maximal number of repetitions within a specific time frame. For example, an athlete completes repetitions for thirty seconds, followed by a ten-second rest prior to the start of the next exercise. This program is provided in section four with all other training protocols.

The 3-D contralateral program is completed after the glute isometric protocol as it adds repetition to the now available correct glute firing pattern in all three planes of motion. As referred to in the opening paragraphs, the glute has functions in all three planes of motion. Only when these are incorporated into training appropriately can the highest level of function be achieved. Previous layers function to improve the ability to utilize the optimal hip extension pattern, however, they are all completed in an isolated fashion. The 3-D contralateral program is the first layer to utilize the appropriate glute firing pattern in full, complex, multi-planar movements. As almost every athlete has been using an incorrect firing pattern, this exercise method requires heavy coaching. Without appropriate cueing, an athlete will simply revert to his old methods of firing from his hamstring first and all progress from previous layers will be lost. This is the most critical time for changes to be made in actual function through real-life, or athletic, movements. At the initiation of every movement, the athlete should feel the glute contract to some extent. This returns to the idea of creating an “explosive” rather than “implosive” athlete. We want all forces to be generated from zone 1, or the glutes, and then transferred to the extremities of the body. By reinforcing this appropriate hip extension firing pattern, optimal movements are able to be executed.

The glutes are clearly the most important muscle group in the human anatomy. They play a critical role in every aspect of locomotion as they function as the primary movers to extend the hips, particularly the eccentric deceleration of the body. When the glute activation process is set up in a layered system it allows coaches to emphasize certain aspects over others. In the layered example given here the foundation is formed by an activity that every coach should have prepared in their tool box, simply the ability to coach and cue an athlete. For that reason, the 3-D contralateral forms this foundation of optimal glute firing. Through high volume training of the glutes and good coaching the body will begin to utilize the glutes appropriately to a greater extent.

The isometric glute protocols increase the motor cortex firing of the brain. Although this training is applicable to any muscle, such as a quadriceps muscle firing post ACL, the glutes represent the most common dysfunctional major muscle in the human body. By incorporating isometric training to achieve the around twenty-minute threshold, an athlete’s ability to fire the glutes in movement are increased. The equipment required for this is minimal, thus the implementation of this training method will assist with the motor learning involved in the 3-D contralateral training to follow.

The RPR™ method described in this section may not be available to everyone. However, if you have the opportunity to attend this course I would highly recommend it as immediate, lasting changes in glute function are capable in minimal time (less than twenty seconds). This method increases neural drive to the glutes prior to the glute isometric program, leading to increased intensity and greater response within the motor cortex. As it is not readily available for all coaches it has been placed above the isometric program.

Finally, the structure and/or chiropractic aspect of glute function must be addressed. We are aware that this technique is not always available for all coaches as it requires outside assistance for the majority of its implementation. For that reason, it creates the very top portion of the glute layering pyramid. This should not diminish the importance of this method as without it optimal function will not ever be possible.

To create a simple analogy for this glute layering process, we can treat the glutes like a circuit breaker. If an athlete's structure, hip or foot function is off, it's as if the power to the breaker is off. Regardless of how well the circuits function there is no change as there is no power input to the breaker. Once the power is on, or the athlete's structure is appropriate, RPR™ methods can be applied to ensure the circuit to the glutes is closed, or able to conduct electricity. If this activation technique is not applied, an athlete will lack neural drive to the glutes, as a result the circuit will be left open, or be "switched off." Once the circuit breaker has been closed or "flipped on" through RPR, the glute isometric training protocols are implemented to increase the strength and capacity of the "glute circuit." Finally, the 3-D contralateral is implemented to repetitively send the stronger signal to the glutes, which increases the body's ability to function at the highest possible level and begin to add strength appropriately.

Every one of these layers within the functioning of the glute revealed in this section play a specific role. At the very least coaches must be capable of completing the basics prior to completing any others. Once again, when viewing the pyramid presented in Figure 1.22, a coach should begin from the highest level they are capable of completing all layers below. For example, if a coach is not trained in RPR™ techniques, the glute isometric and 3-D contralateral protocols would be implemented. A chiropractor that has been trained in RPR™ would be capable of utilizing all four methods of the layered glute protocol provided. Only when each of these layers of the glute are considered and implemented appropriately will the glute regain its full function as a primary mover. Once this has been completed the body will utilize the appropriate, optimal pattern of glute, hamstring, and opposite QL, leading to vastly reduced injury likelihood and increased performance and power output.

The 3-D contralateral program described above for glute functioning represents one method in which multi-dimensional training can be implemented to continue to reduce injury likelihood. Multi-dimensional training can be applied throughout the entire body to ensure optimal functioning and performance to occur. The methods of multi-dimensional training and the potential benefits will be demonstrated throughout the following section.

From the very beginning of a performance coach's career, the three planes of motion (sagittal, frontal, and transverse) are taught in basic anatomy classes. Figure 1.24 below shows these three planes of motion. However, as coaches progress into full-time work, many programs implement exercises which utilize primarily the sagittal plane (step ups, forward lunges, back squats, bench press), while commonly neglecting both the frontal and transverse planes of motion. Many coaches may argue that the majority of movements in athletic competition occur in the sagittal plane, or that strength is generally transferrable to all planes of motion. These arguments lead to the primarily sagittal based training programs regularly implemented. However, the movement in all three planes of motion places significantly different biomechanical and kinetic chain reaction demands upon the body. As the understanding of movement through each joint of the body is improved, the importance of each plane of motion becomes apparent in all movement patterns executed.

Before the methods of multi-dimensional (3-D) training are described, the basic concepts of the three planes of motion must be well understood by all performance coaches. Figure 1 below displays each of the planes of motion (sagittal, frontal, and transverse) in respect to their application within the body.

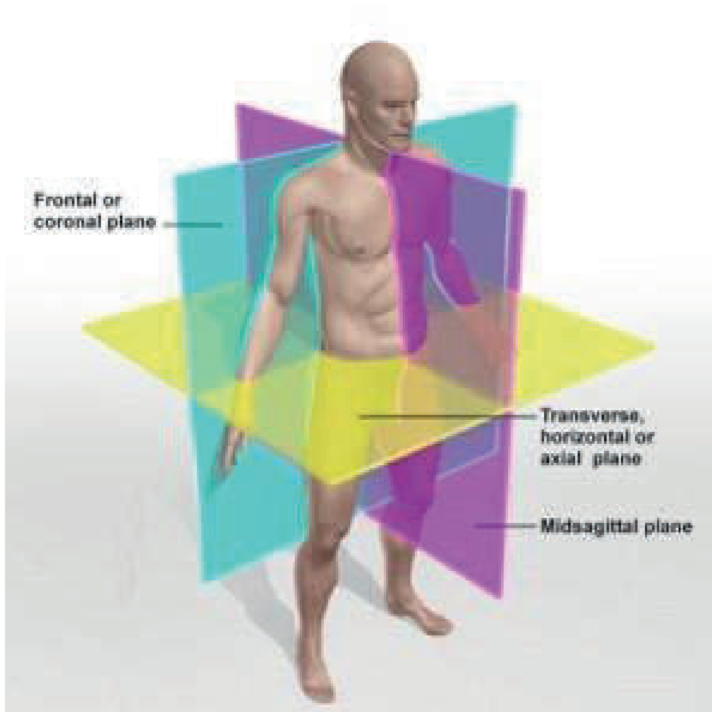

Figure 1.24 - The Three Planes of Motion found within the Body

Sagittal Plane: Separates the body into a left and right section. Any type of flexion and extension movements require the utilization of the sagittal plane of motion.

Frontal Plane: Separates the body into the anterior and posterior sections. Lateral movements require the use of the frontal plane of motion.

Transverse Plane: Separates the body into the upper and lower sections. Anytime rotation is completed within a movement the transverse plane of motion is used.

This is not new information to many coaches. At some point each of these planes was likely even memorized for some type of certification test. However, the implementation of exercises to each of the planes of motion can become difficult and sometimes complex. This does not have to be the case though, as there are simple strategies that can be applied to maximize the ability of each joint to function appropriately in its primary plane of motion.

Before these strategies are covered in greater detail, it is necessary every coach understands the value of all three planes of motion in even basic movements. A skill as simple as walking or running straight ahead is viewed as a primarily sagittal movement by many. However, upon closer look, the application of a joint by joint approach reveals the importance of 3-D training in even the most “sagittal” of movements completed. The task of walking or running is completed by nearly every person/athlete on a daily basis. During normal gait, all three planes of motion are present and are required for efficient movement. As the foot strikes the ground, the subtalar joint experiences eversion, which leads to a pronation at the foot. This pronation of the ankle leads to tibial medial rotation, femur medial rotation, and eventually hip internal rotation. Finally, ankle dorsiflexion is required throughout gait to achieve appropriate toe-off through the big toe. These movements are all required and summate to create eccentric loading of the glute, which should be the primary driver of all hip extension.

Each of these joints is required to function to a high-extent if appropriate movement is to occur. This mechanism, termed tri-planar loading, clearly demonstrates the importance of all three planes of motion in everyday tasks. The subtalar joint experiences a frontal plane of motion change (eversion), the tibia experiences transverse plane of motion change (medial rotation), and the ankle experiences sagittal plane change (dorsiflexion). Figure 1.25 below depicts this tri-planar loading, which should occur in every stride taken. As this loading pattern occurs the glute is able to experience eccentric loading and an athlete experiences efficient movement.

It is important to note this pronation and tibial rotation occurring with every step. Although extremely important for appropriate and efficient movement, they do not function on the “more is better” approach. Every athlete must attain the proprioceptive control over his arch to ensure excessive pronation and tibial medial rotation do not occur, as this will lead to valgus stress placed upon the knee. In fact, many professionals measure this “medial-drift” occurring at the foot to determine potential pathologies.

Figure 1.25 - Tri-planar loading within the foot and lower leg in gait

Besides the improved efficiency of movement through appropriate joint articulation and tri-planar loading, 3-D training also leads to a reduction in the likelihood of injury. 3-D training, when programmed appropriately, leads to improved motor patterning, a reduction in biomechanical deficiencies, increased range of motion, the creation of tissue tolerance, force absorption capabilities, and improved strength in extreme or abnormally utilized tissue lengths. Ultimately, the implementation of 3-D training leads to the ability of an athlete to create proprioceptive control and strategies to move in and out of disadvantageous positions which occur in athletics.

The benefits and adaptations listed above are just a few of the many improvements seen with the implementation of 3-D training methods. However, these methods must be implemented with a careful coach’s eye. When movements are completed in multiple planes, tissue lengths can extend far beyond an athlete’s active range of motion and into their passive length capacities. A lateral lunge is a simple example of this passive range of motion. As an athlete loads the leg reaching laterally, the leg stays in a relative neutral position to the pelvis as it remains directly below the hips. This is not the case for the trail leg, which is locked out and experiencing relative abduction when compared to the pelvis. Examples of this relative motion are demonstrated in Figures 1.26 and 1.27 below. It is the trail leg that experiences passive range and does not have a significant amount of neuromuscular loading. Therefore, exercises must be carefully implemented and managed to create specific outcomes that are actually seen in sport, not passive loading which many exercises create.

Figure 1.26 - Lateral Lunge, the left hip experiences relative hip abduction and ankle inversion

Figure 1.27 - Cross-Under Lunge, the left hip now experiences relative hip external rotation, adduction, and ankle eversion

Every coach must continue to decrease an athlete's active to passive range of motion deficit, as this deficit is the most common place an injury is likely to occur. If an athlete lacks active, neuromuscular control over a range of motion, they will not have the ability to maintain appropriate position as they are passively experiencing the movement. It is this ability to control tissue in greater ranges of motion that must be actively sought after by all coaches and athletes. By placing the body into appropriate positions that are not normally experienced in training, the athlete learns to control their joint in these extreme ranges of motion. As athletes adapt to any stimulus provided, each individual becomes accustomed to these ranges of motion, ultimately leading to motor learning and tissue strength and tolerance.

Motor patterning is defined roughly as the recruitment of a muscle in a coordinated fashion in an attempt to accomplish a desired task. When the body is completing a novel task the motor pattern functions inefficiently, but as an athlete experiences repetition at a specific joint angle and tissue length the movement is executed at higher efficiency, or co-ordination levels. Ultimately, every movement completed is a learned skill, with each requiring specific training in order for maximal efficiency to be achieved in performance. 3-D training methods aim to enhance the skill learning of athletes in planes as well as ranges of motion commonly overlooked in training. Through correct coaching of these multi-planar exercises, many biomechanical issues are also addressed as joints experience appropriate articulation in these ranges of motion.

By creating variability within movement, positions and demand coaches can drive neuromuscular stress and orthopedic articulation to create appropriate kinetic chains reactions and efficient biomechanics within their athletes. For instance, a coach can drive subtalar joint articulation and hip internal rotation by creating a rotational reach pattern. This is only created when movement from the hip and ankle are encouraged and taught as part of a kinetic chain reaction. Otherwise, many athletes may just reach or drive motion rotationally from their arms, shoulders, and/or T-spine. Many isolated mobilization exercises can improve articulation at a singular joint, but recreating the demand across the entirety of the kinetic chain teaches movement from appropriate zones. This leads to a reduction in dysfunctional movement patterns, or compensation patterns, commonly displayed by athletes.

In addition to the motor and movement pattern improvements, multi-plane training contributes to improved strength, particularly in the extreme ranges of motion. This enhanced strength is in part due to the increased neural drive and co-ordination in these positions (motor patterning described above), but is also due to improved tissue tolerance at these new lengths. Figure 1.28 below demonstrates the length-tension relationship experienced at the individual muscle fiber. The majority of movements in athletics are completed within the "Normal Tissue Length", however there are times, particularly when an injury occurs, that tissue enters the "Extreme ROM" (range of motion) lengths. With appropriate multi-dimensional training, the ability of an athlete to accept and produce high-levels of force is improved at these different tissue lengths. These training adaptations are demonstrated in Figure 1.29 below.

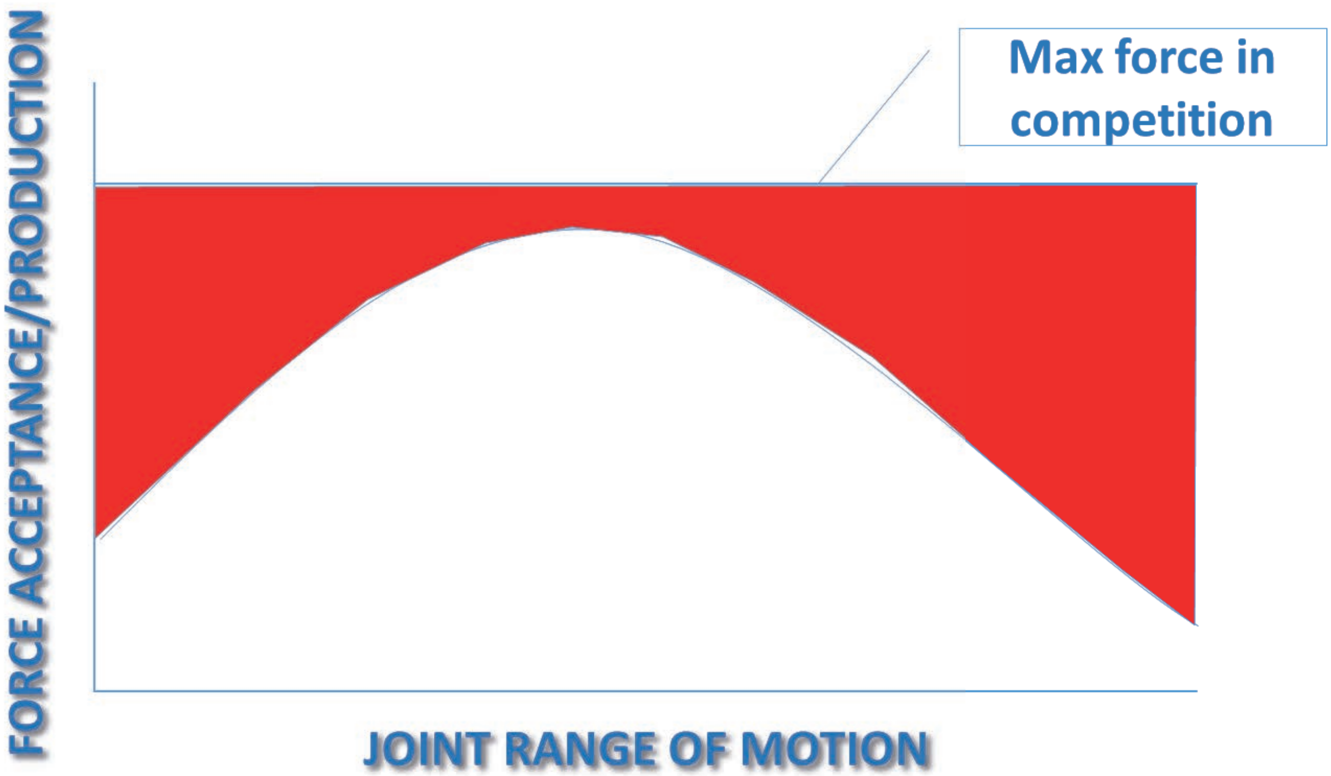

Figure 1.28 - 3-D Pre-Training Levels at Different Tissue Lengths

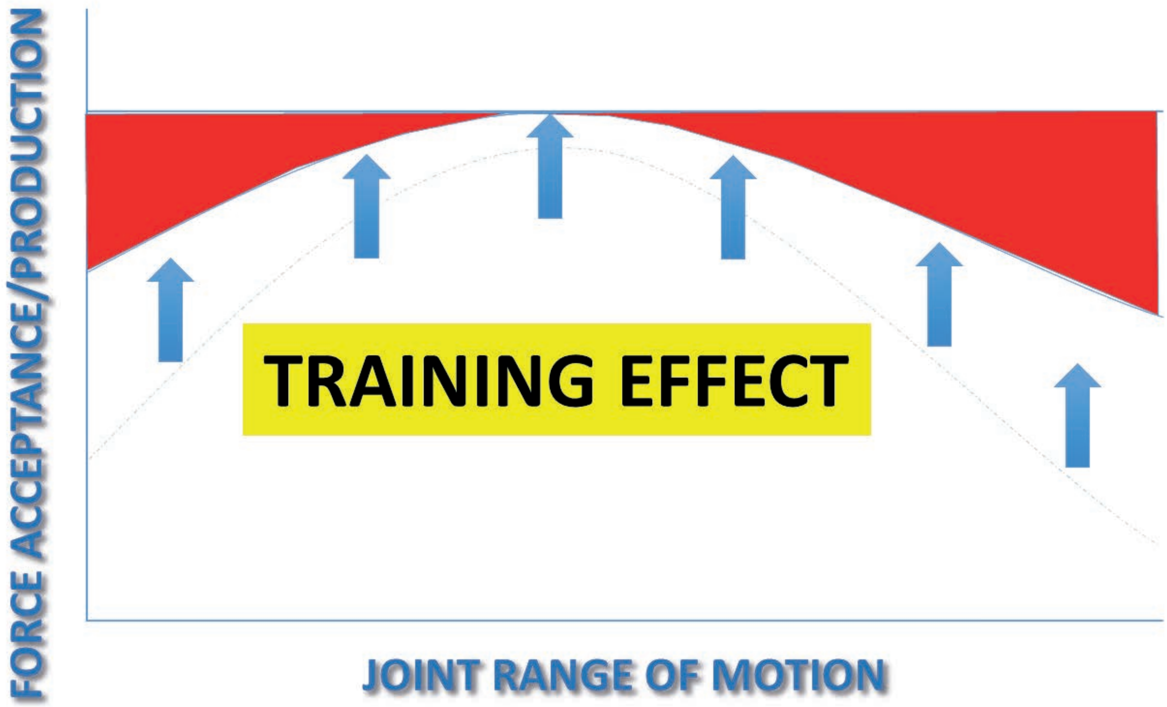

Figure 1.29 - Training Adaptations Experienced at Different Tissue Lengths

The understanding that the majority of athletic movements are completed within a normal range has led to the emphasized training of maximizing force absorption and production within those “Normal” ranges. However, this method of thinking leaves the “Extreme ROM” zones, or the lengths experienced when an injury is sustained, in a weak and undertrained state. Multi-plane training, when implemented in a way that drives new tissue lengths, creates strength, and thus stability, at these uncommonly experienced tissue lengths or joint positions. This increased exposure, and resulting strength, leads to an even greater ability of the tissue to absorb and tolerate high force levels when extreme lengths are experienced. This returns to the concept of active to passive control. As an athlete experiences range of motion in new tissue lengths, they are capable of improving their neuromuscular control throughout the movement to a greater extent, ultimately leading to a reduction in injury likelihood. As explained above, a primary goal of the 3-D training methodology is to improve the functioning of both the joint and the tissue to optimally articulate and tolerate loads at the “Extreme ROM” zones.

Just as performance coaches implement stress to cause a specific adaptation, disadvantageous positions can be applied in training in order to further reduce injury likelihood. By placing an athlete in these positions, the ability to develop proprioceptive control is provided. This ultimately gives an athlete a strategy to maneuver in and out of disadvantageous positions experienced during competition and reduces the likelihood of sustaining an injury.

Figure 1.30 - Disadvantageous Positions Experienced in Competition

Figure 1.30 demonstrates an example of an “awkward position” commonly experienced in a lacrosse game. As the player plants his foot to execute a roll-back dodge, adduction or valgus at the knee occurs. This is a position most performance coaches avoid entirely in the weight room. However, if an athlete is never given a strategy to move in and out of this position in training, motor patterning and tissue tolerance will never be learned.

Due to the highly reactive nature of athletics it becomes clear the body must respond in a rapid manner, leading to awkward positions, such as the one displayed in Figure 1.30. By providing an athlete these proprioceptive abilities and strategies in the awkward positions experienced, an athlete’s injury likelihood is greatly reduced. Ultimately multi-plane training methods aim to improve the athlete’s ability to decelerate, stabilize successfully, and attain proprioceptive control in awkward ranges of motion experienced in athletics.

Every performance coach has learned the three planes of motion that are present in every athlete. However, the implementation of these different planes can become more difficult in a practical training setting. Coaches must understand the application of each plane of motion, even in what appears to be primarily single plane movements such as walking or running. By providing appropriate stimulus and training to all three planes of motion and applying a joint-by-joint approach an athlete will improve motor patterning, his neuromuscular control in different positions, and his ability to get in and out of disadvantageous positions safely. Each of these adaptations leads to a greater ability to perform effectively while reducing the risk of injury, which should remain top priorities for all coaches. Through the better understanding of the spectrum of tissue lengths an athlete is exposed to consistently in specific sports, coaches can better prepare and condition athletes. This leads to a decreased injury risk and better reconditioning methods for athletes during return to play protocols.

Once the glutes are functioning to a high level and an athlete has increased control at different tissue lengths, it is important to train an athlete to absorb high forces at high velocities. The ability of the athlete's body, specifically muscles, to receive and overcome high levels of force plays a critical role in reducing injury likelihood. The ability to rapidly create high levels of force, termed rate of force development or "RFD," has long been shown to be a primary determinant of athletic performance. The specific training and adaptations that occur to RFD within the Triphasic Lacrosse Training Manual will be covered in great detail in later sections. However, with RFD playing such a vital role in performance, the ability to absorb high levels of force is often overlooked. This ability is termed the rate of force acceptance or "RFA." RFA is crucial for performance because lacrosse requires athletes to constantly absorb and overcome forces.

Anytime a lacrosse player dodges, cuts, plays defense, or moves dynamically in any fashion there is a constant undulation between producing and absorbing force. On the field, every athlete with every movement is constantly speeding up or slowing down. As an athlete speeds up, RFD plays a major role in acceleration; however, as he slows down, or decelerate, his RFA ability plays the biggest role. RFA is particularly important as an athlete's inability to tolerate high forces in a rapid fashion, or reduced RFA, is a common mechanism of injury.

As an athlete decelerates his body experiences a high-eccentric load all at one time, as shown in Figure 1.31 below. If an athlete has a poorly trained RFA, he does not have the ability to appropriately decelerate, or eccentrically load his musculature, and injury likelihood is increased dramatically [16]. Through specific eccentric training, for both strength and at high velocities, the RFA for an athlete can be improved dramatically. Methods of this training will be provided in later sections of this manual, but it is critical coaches understand the importance of training lacrosse athletes to absorb high levels of force. Every athlete must be capable of matching the speed at which contact is made, while also applying high enough force levels to not only meet but overcome the immediate force levels required.

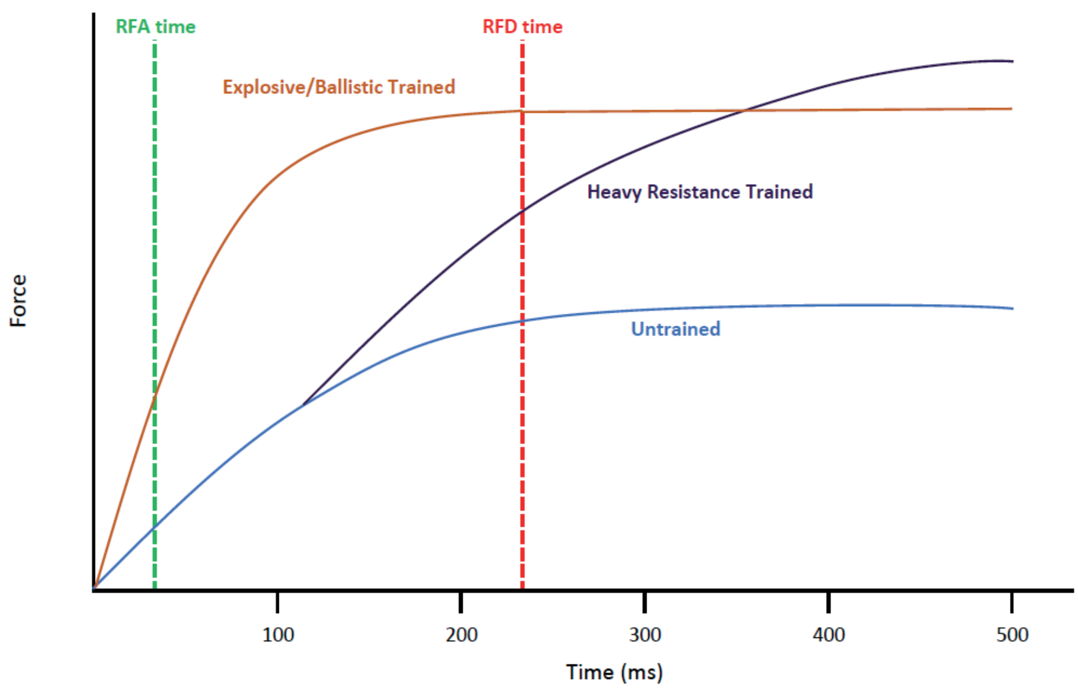

Figure 1.31 - RFD vs. RFA in a high-velocity athletic movement

Another injury common in lacrosse that deals with the ability to decelerate a body part is a concussion. With the increasing concern around the incidence of concussions in lacrosse, which is third in occurrences only behind football and ice hockey, specific training methods must be implemented to reduce the likelihood of sustaining one of the debilitating injuries. Appropriate use of activation methods to create explosion within the body, along with neck training can be implemented to drastically reduce the likelihood of this traumatic brain injury.

Elite level lacrosse players excel primarily due to their ability to cognitively function at a high level during game-play. A lacrosse player must be capable of thinking at extremely high rates while also executing athletic movements. Clearly the brain plays an important role in this ability to think, process, and react appropriately in competition. That being said, coaches must ensure the safety of this vital asset at all times. Due to the physical nature of lacrosse, training must be completed to ensure an athlete is equipped with the appropriate neck, jaw, mandible, and shoulder girdle strength needed to protect his most important performance factor, his brain (17).

Think of the head, neck, trap, and shoulder girdle as a tree. A tree has strong roots holding the trunk and branches in place so it can withstand nature. If a tree does not have strong roots and a strong trunk, the tree will break and/or collapse. Just as a tree has roots, so does the neck. The trapezius, upper back muscles, and entire shoulder girdle act as the roots to the neck, head, and brain. The neck and jaw musculature is the trunk of the tree. The head is the most important branch bearing fruit, in this case cognitive thinking. We must have strong and stable roots (traps, upper back, shoulder girdle) to ensure we have a stable foundation. We also must have a strong trunk (neck, jaw musculature) to help absorb and the outside physical forces. Having these critical pieces will help stabilize and anchor the head and brain, ultimately decreasing the concussion/neck injury likelihood (17).

To read more on neck training, click here.

Each of these considerations plays a vital role in preventing and/or reducing injury likelihood in the sport of lacrosse and are implemented specifically within the Triphasic Lacrosse Training Model. Whether the goal of training is to teach and allow appropriate patterns through motor pattern, activation, or three-dimensional methods; to improve tissue tolerance and the ability to overcome high forces through RFA or three-dimensional method; or to reduce concussions through the use of neck training every coach should utilize training methods to diminish injuries. Ultimately, an effective performance program, such as the Triphasic Lacrosse Training Model, can have a dramatic impact on a team's success simply by keeping all athletes healthy and prepared to compete at the highest level.

1.43 Transfer of Training

Transfer of training is crucial and the ultimate goal for any training program implemented. Every coach has one concept in mind: to improve the performance of an athlete on the lacrosse field. An example skill required in performance is the specific amount of force produced with every stride while sprinting or executing a dodge. This idea can be lost occasionally as too many coaches get caught up in using specific exercises, rather than applying the knowledge of the six physical performance qualities simultaneously with appropriate stress. It is always important to remember to not get caught up in numbers or the completion of a certain lift. Coaches are training lacrosse athletes, not power or Olympic lifters. Once again, the specific improvement of the six physical performance qualities according to their needs in lacrosse are much more important than just strength. Training programs must match this thinking if transfer of training, or performance on the field, is to be maximized [18].

Every action completed by the body is a learned skill. To repeat that again, EVERY ACTION COMPLETED BY THE BODY IS A LEARNED SKILL. Every step, movement, change of direction executed in everyday life or on the lacrosse field is completed based on the foundation and accumulation of previously experienced actions by the body. It is absolutely imperative coaches understand this principle and its application in preparing an athlete for performance. This is where the idea of "use it or lose it" comes from. Every coach must implement the specific requirements of lacrosse at the appropriate time of year to maximize specific skill learning and performance.

With the understanding that every action is a learned skill there are clearly many skills that must transfer from training into competition. However, the majority of these can be boiled down to three abilities. These three skills include the enhancement of the required motor patterns, an improvement of the energy systems in both their output and efficiency, and finally the ability to produce force rapidly in the competitive movements. Each of these skills requires a high output from the nervous system in a specific pattern and will be covered in great detail throughout this manual as they form the foundation of sport perfection, and thus optimal performance.

Optimal performance is a term that will be consistently used throughout this manual, as it should ultimately be the goal of all training. Its continued use should display the importance of achieving optimal performance at the appropriate and desired times within the competition calendar. It is important for all performance coaches and athletes alike to understand the meaning of this term and how it can be applied to the specific skill set needs of the event. Optimal performance can only be achieved when each of the skills required in the competitive event is improved, or peaked, to the fullest extent possible, at the desired time. This peaking of each skill required is only possible when training methods that maximize the transfer of the specific skills needed in competition are implemented [18].

When subjects are introduced to a new and relatively complicated task, such as those found in lacrosse, the body will function in an inefficient manner. This is due to the reduced motor learning, myelination, and the other adaptations that occur in the skill-learning process. It is important all coaches understand there is NO WAY to mimic the exact required movements of lacrosse outside of actual practice. The speed required to complete these skills CANNOT be matched, and thus should not be attempted to be attained in training. An example of attempting to improve transfer of training is comparing a heavy set bench press at 80% of an athlete's 1 repetition max (1RM) compared to a medicine ball chest pass. The medicine ball exercise is much closer to the speed and rate of force development required during an athletic movement, thus it will have a higher transfer of training than the 80% 1RM bench press.

It is more important athletes learn to absorb and generate high levels of forces at high velocities for the duration of the competition in training and practice. The requirement for increasing transfer of training from the weight room to the competitive event must be realized in order to optimize performance. For this reason, it is necessary to train using specific exercises that utilize the similar muscle activation patterns and ATTEMPT to mimic the high velocities realized in sport. Implementing training with these ideas in mind will improve the efficiency the body functions during lacrosse movements in both practice and competition.

It is unlikely that training improvements in one movement will correlate to other movements, even within the same muscle. An example of this can be seen in the quadriceps muscles. Although quadriceps contraction is common for many movements in athletics such as jumping, cycling, and/or sprinting, the sequence of muscle activation for each of these movements differ so that a set of neural connections established as a result of quadriceps training is unlikely to help with multiple movement patterns. For this reason, it is vital to train lacrosse athletes in patterns similar to the movements seen in competition, such as sprinting and agility methods.

Motor learning forms the foundation of the skill-learning process. Skill development, at the most basic level, is the ability of the body to adapt to a stimulus and adjust its response in order to achieve optimal results for that one specific task. The accomplishment of any task, especially athletic skills that require high forces and velocities, require proper coordination and rely on previous experiences and the motor learning ability of the athlete. This coordination of movement can be improved through the proper training stimulus.

Motor learning increases the efficiency of movements, such as muscular contraction patterns utilized in lacrosse. In novel or complex tasks, co-activation by antagonist muscles is often excessive, but has been shown to decrease with practice (19-22). However, after four weeks of resistance training a smaller input from the central nervous system is required to achieve the same muscle activation post-training (23). The development of a specific skill, once again, leads back to the importance of training programs having a high transfer of training, allowing the learned skills, ranging from nervous system adaptations to increased force output, to be transferred from the weight room to the lacrosse field (18, 23).

The 10,000 hour rule is a perfect example of this skill-learning process in action. It has been shown that 10,000 hours is about the time it takes to truly become an “expert” at a certain skill. It does not matter what the end goal is, whether it is sprinting, golfing, change of direction, etc., as long as 10,000 hours of high-quality learning are completed. This number is not exact and will change based on each individual. However, the ability of the body to learn and recall specific skills is extremely useful in the world of athletics and lacrosse performance. The learning of skills is all due to myelination that occurs with every movement completed in life.

Myelin is a white, fatty substance that coats axons throughout the brain and human body. Axons act as wires, carrying electrical signals along billions of chains of nerve fibers, relaying messages from the CNS to the peripheral nervous system and then back again (24). As the amount of myelin increases, the proficiency of the skill correlating with that specific neural circuit is increased as well.

Myelination of axons is increased with the development of skill (23). Skill development leading to an increase in myelination is the result of motor learning, which forces the brain to fire the electrical impulses through specific neural circuits to the motor units of the muscles (23). The increased number of signals continuously sent through a specific group of neural circuits leads to an increase in myelin, which wraps the axon of nerves and acts to speed up conduction velocity (23).

Studies have shown that a physiological adaptation of the brain to learning a new skill is the addition of myelin around the neural circuits responsible for that specific skill (23). A second study showed that myelination could be inhibited by blocking of specific neural circuits. These two studies show stimulation of neural circuits, such as those observed in thoughts and movements, is a requirement to increase myelination (23).

Again, every task, thought, and action that the human body and brain perform is a learned skill or reflex circuit (23). The basic ideas regarding neural transmission can be broken into three points. The first is that every movement, thought, or feeling is a precisely timed electrical signal traveling through a chain of neurons, otherwise known as a circuit of nerve fibers allocated together to perform a task. Second, myelin is the insulation that wraps many of those nerve fibers and increases the signal strength, speed, and accuracy. Finally, myelination is important for skill development. The more a particular neuronal circuit is fired, the more myelin insulates that circuit. These stronger, faster signals lead to more fluidity throughout an athlete's thoughts and movements [(23)].

Increasing myelination due to a specific movement calls for better methods to determine how athletes should train and practice. The next step is to find ways to maximize the amount of neural input each athlete processes while competing in his specific event. If this feat is achieved, coaches would have the ability to speed up the development and learning process, which would ensure athletes reach their full potentials [(24)]. There are many theories considered valid that may be responsible for the increase in myelination as this research is still in its infancy and is highly theoretical [(23)].

Every coach must use motor learning to maximize skill development and transfer of training of the specific requirements of lacrosse. Like every aspect of coaching, motor learning is a delicate balance between both art and science. The principles of high-quality versus capacity training continue to apply to motor learning. For optimal skill learning to take place, a specific window of time must be utilized. This window occurs when an athlete is warmed up, but not yet physically tired, or when his nervous system is in a high-quality state. A coach that simply focuses on making athletes "tired" each day at practice will never optimize this learning process. Put simply, a tired athlete is no better than an old dog when it comes to learning new tricks. It is not that the desire is not there, but rather his physiology limits the ability to learn new skills and achieve higher performance levels when fatigued.

The considerations for appropriate transfer of training must be applied to the each of the six physical performance qualities of lacrosse. The metabolic systems, three energy systems, along with the muscular system must be carefully trained in order to teach the required skills of the game. Each of the specific training aspects will be covered thoroughly throughout each phase of the Triphasic Lacrosse Training Manual program.

1.44 Peaking Athletes Optimally

The final aspect to consider for lacrosse athletes is the peaking of the six physical performance qualities at specific, desired times throughout the annual calendar. In the world of athletics, before the focus of a specific stressor or physical performance quality can be chosen within the training cycle, the competition dates must first be determined. The knowledge of when athletes must be peaked will allow a coach to set up a plan that will complete all phases of training within the allotted time frame. When an athlete approaches a game or match, he has prepared for competition knowing the date and exact specifications of the event. This allows a systematic training protocol to be implemented with the end date and objective to be known long before the competition occurs. Ideally athletes should be physically prepared just prior to beginning pre-season camp, as these camps primarily focus on technique, skills, and tactics rather than physical performance quality development.

Ultimately, the goal of every lacrosse team should be ending the season as a championship program. It is critical all coaches understand how each of the six physical performance qualities must be trained and peaked for optimal lacrosse performance. The Triphasic Lacrosse Training Manual demonstrates the program implemented that guarantees this occurrence and leads to maximized athletic performance as shown below in Figure 1.32. The training methods utilized to optimally peak each individual athlete will be explained in great detail throughout the remainder of this training manual.

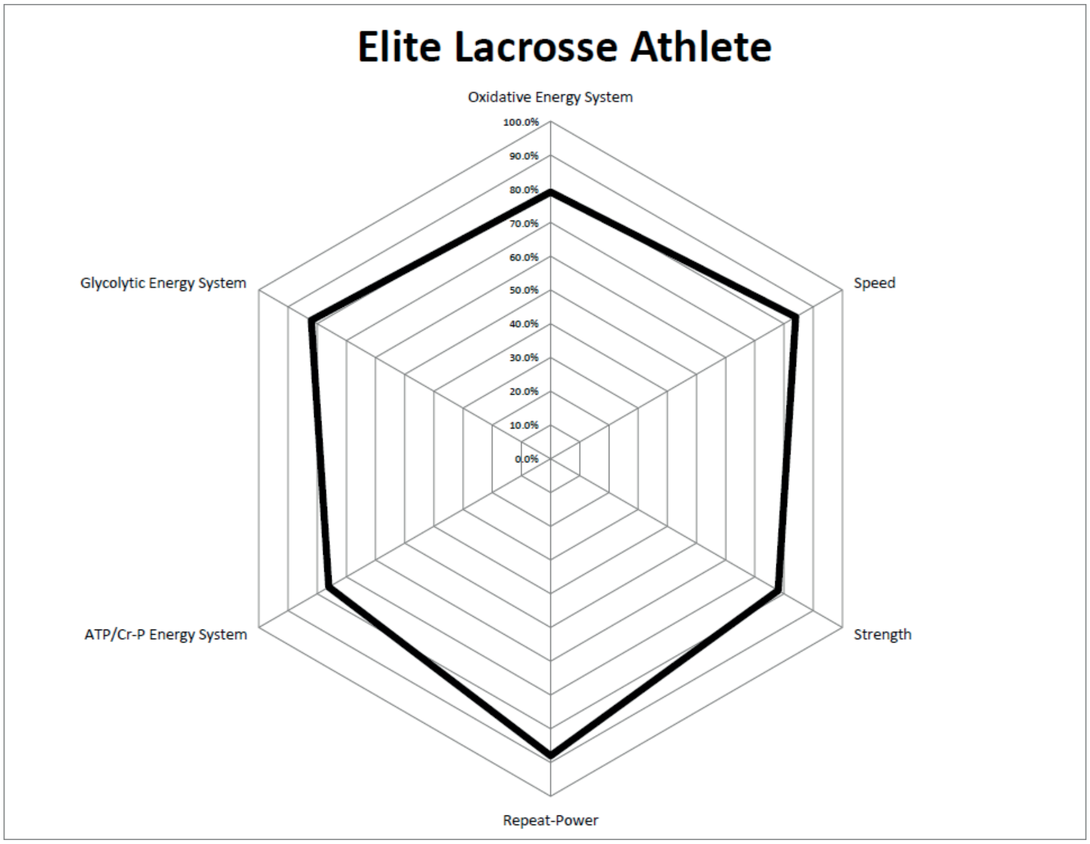

Figure 1.32 - Six Physical Performance Qualities of an Elite Lacrosse Athlete