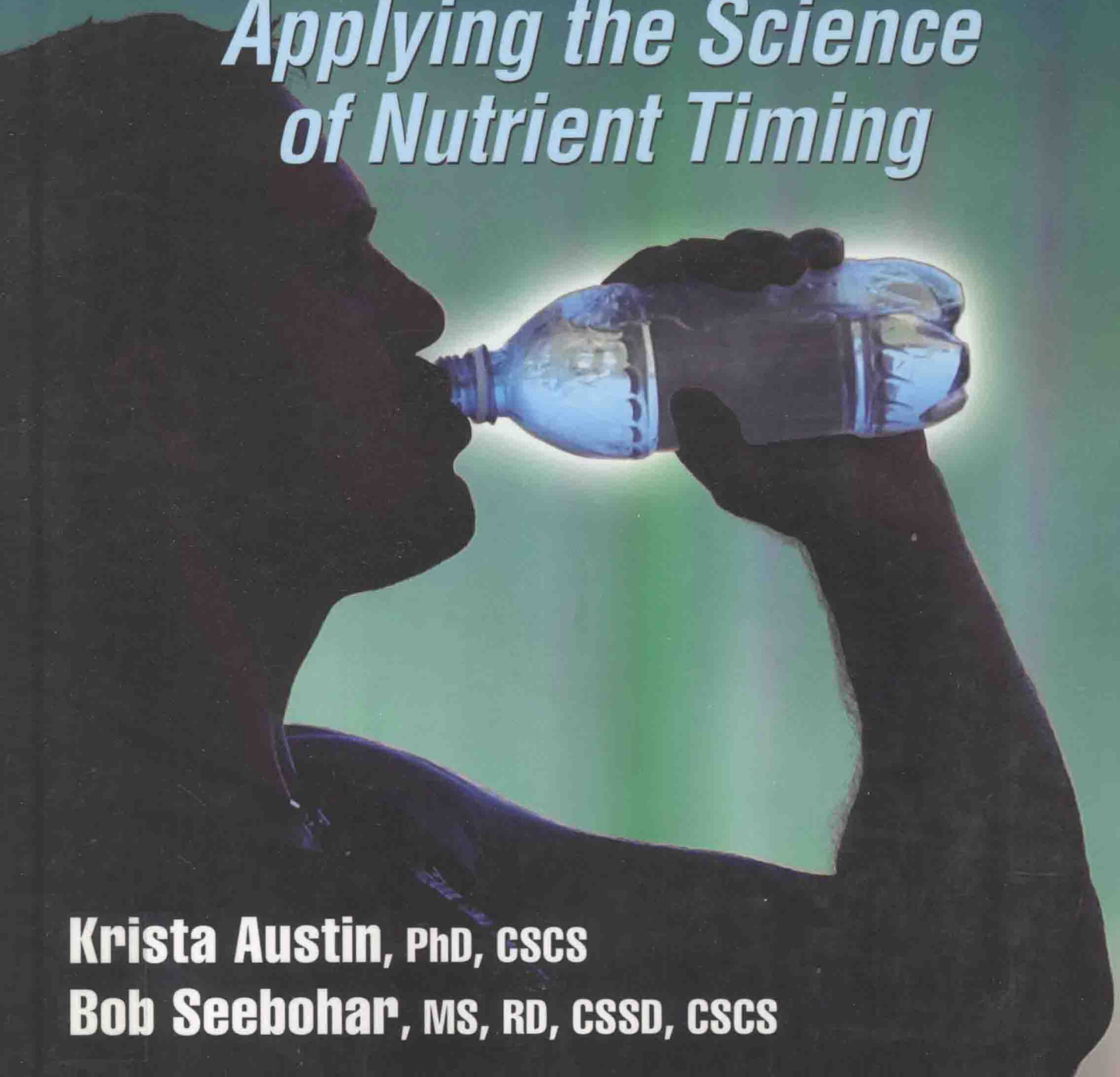
Performance Nutrition

Applying the Science of Nutrient Timing



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Performance Nutrition

APPLYING THE SCIENCE OF NUTRIENT TIMING

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Performance and Nutrition Coaching

Bob Seebohar, MS, RD, CSSD, CSCS
Fuel4mance

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To all the athletes who have taught us so much over the years.

FOREWORDS

In 2009, I had the great opportunity to run personal bests in the marathon (2:09:15) and the half marathon (1:01:00). My personal best in the marathon came at the 2009 New York City Marathon, where I was the first American to win the race since Alberto Salazar in 1982. Such performances are welcome news not only because I am running my best times well into my professional career, which consists of an Olympic medal, American records, and 18 USA Track and Field championships, but also because they are coming after the worst injury I have ever had. In November 2007, I suffered a pelvis fracture during the U.S. Olympic Marathon Trials. Although this injury most likely occurred during the race, I continued to run and finished the marathon. Despite the extreme pain and discomfort, I initially didn't recognize that the injury was as severe as it was. I knew I had pushed my body and overcompensated for my cramped calves in order to finish the race. As a result I didn't get an MRI immediately, and it was Dr. Lewis Maharam who insisted on a very specific MRI in order to diagnose the problem. Once the correct diagnosis was made, my rehabilitation process was structured and focused. The road back from that potentially career-ending injury to running personal bests has been a tremendous test of my faith and determination. Many people deserve credit for helping me make this comeback, and it would take some time to explain all of the people involved. But without a doubt, one of the key contributors to my comeback has been Dr. Krista Austin.

Interestingly, I first met Krista while taking an ice bath at the San Diego Olympic Training Center in 1999. At that time, I was a recently turned professional athlete, and Krista was a master's student at San Diego State University and an intern at the Olympic Training Center. We struck up a conversation, and 10 years later not only are we good friends but I consider Krista a key component of Team Meb as well. I truly believe that everything happens for a reason and that God puts people in our lives for a reason. When I first met Krista in San Diego, I could not imagine the impact she would have on my life.

For years I have consulted with Krista about my athletic potential and how to go about realizing it. Krista's scientific knowledge and expertise allow her to analyze what a specific athlete's body can and cannot do and how an athlete can maximize his or her athletic potential. I cannot begin to convey just how highly I respect Krista for her superior knowledge in the fields of exercise physiology and nutrition. Krista communicates information directly to me and also shares her insight with my long-time coach Bob Larsen. Krista also advises my wife, Yordanos Asgedom, on the best type of meals for me based on type of training and competition schedule. Finally, in this day and age of drug cheats, I trust Krista to recommend vitamins to supplement my diet. I do not take any supplement without the prior consent and consultation of Dr. Krista Austin. I hope it is sufficient to say that Krista knows her stuff, and I trust her with this very important component of my athletic career.

Krista has earned my trust not only through the expertise in her field but also because of her unique ability and desire to help me and other world-class athletes be the best we can be. Krista has supported me through the ups and downs of my athletic career. She would come visit me and my family in Mammoth and has opened her home in Colorado Springs to me and my family. Krista is such an important person in my life that my three-year-old daughter calls her "Auntie Krista."

After my injury during the U.S. Olympic Marathon Trials, I worked with many doctors throughout the different stages of my rehabilitation. Throughout every step of the way, Krista was there to consult with me and refer me to different specialists. In September 2008, almost one year after my injury, Krista helped coordinate the most intensive part of my rehabilitation. She invited me to the Olympic Training Center in Colorado Springs in order to continue my altitude training and simultaneously rehab to get my body stronger. What was meant to be a one-week visit turned out to be a two-month intensive rehabilitation and training period.

I learned many things during the almost year-long rehabilitation process. First, an athlete must work harder and must be more dedicated when injured than when healthy. Second, having a strong support group during this time is more important than having unlimited supporters when all is going well. During my recovery process, Krista exemplified the meaning of a friend and professional. As a friend, Krista hosted me in her home and then opened her home to my wife and two kids so I could continue with the productive process and not have to be separated from my beloved family for so long. As a professional, Krista helped arrange for me to take advantage of all the resources available through the U.S. Olympic Committee. During this time, Krista's consultation about the recovery process and my future outlook played a key role in preparing my mind and body for what it is doing today—running better than ever. I am very fortunate to count Dr. Krista Austin as a good friend and key advisor. I am also very glad she is able to share her amazing insight with you. Pay attention; Dr. Austin knows her stuff!

Mebrahtom "Meb" Keflezighi
Olympic silver medalist

I first met Bob in 2002. We were at an open-water swim lake in Colorado, just chatting about triathlon, and I discovered he was a sports nutritionist. I was attempting my first Ironman that year and needed some guidance on the nutrition for that event, and Bob offered to help me out. It turns out that Bob not only is an expert in this field but also has a wealth of knowledge in many other areas of endurance training. I enjoyed all our conversations, learning so much and wanting to talk for hours.

Although my humbling results at Hawaii Ironman (19th overall) led me back to the path of my Olympic Team pursuit, my nutrition there was perfect. I continued working with Bob on other aspects of my training through 2003 in my preparation for the 2004 Olympic Triathlon Trials. His guidance and advice contributed greatly to my ultimate success in that venture and beyond. In 2008, Bob helped me prepare for a winning performance at the Leadville 100-mile (160 km) mountain bike race. And in 2009 we joined coaching forces to create Elite Multisport Coaching, a triathlon community that works with youth and elite athletes of all disciplines and abilities.

Bob's first book, *Nutrition Periodization for Endurance Athletes*, really led athletes, coaches, and sports nutritionists to think outside the box. And since that book was published, Bob continues to push the envelope of sports nutrition, going beyond the traditional views of what to eat to focus on how to use our diets to optimize our performance and our well-being throughout the year. I think athletes of all abilities will benefit greatly from reading this new book.

Susan Williams
2004 Olympic triathlon bronze medalist

PREFACE

The first question we often ask athletes when they enter our office is out of 100 percent, how much does nutrition affect their performance? Typically, most athletes are kind enough to give nutrition about 10 to 15 percent and attribute the rest to training and recovery. This response tells us a great deal about how these athletes are viewing their food. When we point out that an athlete's nutrition should be designed to support training and enhance recovery, athletes realize that nutrition can affect performance 100 percent.

Timing nutrient ingestion is a concept that has become increasingly popular in the world of sport performance. When the primary goal between training sessions is to recover, nutrition becomes a key component that will allow the body to adapt to the imposed training demand; thus nutrition to support the recovery process and adaptations to training must start before training even begins. This concept might best be understood by viewing the body as a furnace and its energy supply as the fuel for the furnace. The furnace in a house functions best when we ensure that enough fuel is readily available, and a steady supply of fuel to the furnace keeps it functioning most efficiently. The furnace also runs best when we consider the type of fuel we use to maintain the fire. A high-quality fuel will ensure that the furnace runs most effectively, whereas low-quality fuel can lead to eventual breakdown of the system. In the same sense, if an athlete does not fuel the body at regular intervals throughout the day and provides the body with poor food choices for the energy demand it is under (i.e., training load), then recovery from training cannot occur and adaptation cannot take place. The furnace is equal to the engine of the human body, which is also known as metabolism. The rate of metabolism is dependent on consistently needing to operate the body within an optimal range. If the body is deprived of food, metabolism is reduced to compensate, and over time the body will operate continuously under this reduced rate. When quality food such as whole grains, fruits, and protein is provided steadily throughout the day, metabolism increases and thus helps minimize fat stores while improving muscle mass.

The timing, type, and volume of carbohydrate, protein, and fat consumed throughout the day are critical for restoring overall muscle function and body homeostasis. Several decades of scientific research has shown us that centering an athlete's food and fluid consumption around exercise (before, during, and after) can significantly help support the demands of sport training. The greatest evidence for timing nutrient ingestion initially came from studies examining the effects of timing carbohydrate ingestion. These studies showed that muscle glycogen (carbohydrate stored within the muscle) was restored faster when athletes were fed carbohydrate within the first hour after exercise than when the intake was delayed. Since this time, a number of studies have emerged to show that timing nutrient ingestion can promote enhanced recovery from training, create positive training adaptations, improve body composition, support immune health, and thus enhance performance.

Athletes come in all body shapes and sizes, and all have personal sport performance goals. However, with these goals come a variety of different genetics, training backgrounds, eating habits, and personal histories that make each athlete's needs unique—even within the same sport or family. As a result, timing nutrient ingestion must take into account the athlete's own instinctive eating, environment, food prefer-

ences, and psychological view of food. To properly apply the concept of timing nutrient ingestion, it must be realized that *we eat to train rather than train so we can eat*. For many, this may be a new way of thinking about nutrition, and an open mind-set that is ready to consider new ideas is necessary in order to adopt the principles that are presented. Our goal in this book is to provide the athlete, coach, and support staff a knowledge base and toolbox that will allow them to develop their own nutrition programs that are geared to optimize adaptations to training and enhance recovery from training.

In the first chapter, we familiarize you with the basis and background we believe is necessary to lay the foundation for timing nutrient ingestion. From there, we give you the knowledge behind the methods so that you have a full understanding of how and why timing nutrient ingestion works. Toward the end of the book, we combine that knowledge and personal preferences to bring all of this together for an optimal performance nutrition plan.

Note for Weight-Classified Athletes

Over the years, my focus on how to work with athletes in weight-classified sports has significantly changed. I used to frown upon athletes who appeared to cut large amounts of weight going into competition (yet won). Instead, I followed the conservative approach to getting an athlete to make weight, allowing only a 2 to 3 percent body-weight cut in the days leading up to competition. Losing weight through a breakdown in muscle mass was taboo, and the thought of even assisting in a sauna-based weight cut was never even a question. I was mainly influenced by a lack of knowledge regarding the sport and the science.

The change in my mentality happened over the past several years. I met brothers who shared the goal to become world and Olympic champions, and based on height and body size they should have competed in the same weight category. The option to go up an additional weight class and gain mass was not there, nor was it healthy for them to sit 2 to 3 percent out from their weight class—they most likely would never have been successful. In the end, one sibling would have to sacrifice for the other if they were both to compete, and they would do it—with or without me. Today, they stand and compete as world champions, and Olympic medals hang around their necks, and I have become a better scientist and practitioner for it.

Throughout this book, I have intentionally addressed weight-classified sports and the upper limits of weight cutting. It is important that athletes, parents, and coaches consider the age and stage of development; any form of weight cutting should be minimized in young athletes who are still growing. Every athlete is different, and the goal is to achieve the best performance in the safest manner possible. Although guidelines are provided in this book, I hope that you seek assistance in working with a physiologist who knows your sport and can help optimize this lifelong process.

Please be safe,

Krista Austin

ACKNOWLEDGMENTS

I would like to thank some of the many mentors, coaches, and other influential people who helped make this book a unique combination of science and real-life experience. Thanks to my mentors Michael Buono, Fred Kolkhorst, Mike Shannon, and Emily Haymes for giving me the freedom to experiment and learn in an open environment while at the same time challenging me to become the scientist and practitioner that I am today. Many thanks also to Melinda Manore for her energy, openness, and insight into the field of sports nutrition.

An enormous thanks to the elite coaches who have influenced and believed in me over the years: George Dallam, JJ Clark, Blackman Ihem, Joe Vigil, Paul Ratcliffe, Jean Lopez, Bill Sweetenham, Kevin Renshaw, Jorg Gotz, Per Nilsson, and Zeke Jones. My work with these coaches' athletes has made this book possible. Thanks to all the athletes who were willing to try a new point of view and have kept the fire burning by giving me new challenges at every turn.

Finally, thanks to my parents, Steve and Gail, and to my friends and colleagues Bo, Mike, Jon, Meredith, Keri, Sunde, and William for always supporting me. Last and definitely not least, thanks to Auntie's little angel, Sara, who sat by my side on many nights as I wrote this book and reminded me of what is important in life.

Krista Austin

Many people throughout my career have been influential, but most notable is my first graduate advisor, Dr. Matt Hickey, who taught me not only how to review research with a critical eye but also to have an open mind when approaching research and its application to sport. This has allowed me to blend science into real-life application, which is seen throughout this book. Both critical thinking and outside-the-box thinking have enabled me to apply complex principles of sports nutrition to athletes and coaches in a user-friendly manner.

Additionally, I would like to extend thanks to my family for all of their support throughout the countless hours of "research" I spent in my own physical training, which allowed me to put my tough questions to the test in real-life training situations. Being in the trenches as an athlete allows me to fine-tune the nutrition concepts that science provides.

Bob Seebohar

CONTENTS

ONE

Principles of Nutrient Timing

Performance nutrition is about strategically utilizing the food an athlete consumes to gain an advantage in training adaptations and performance. Through the use of nutrient timing, food can be used to enhance the energy systems, improve body composition, and increase stamina for improved performance. Nutrient timing is designed to use physiological principles to drive what type of foods athletes eat and when they eat them. Using these principles puts the body in an optimal state for training and competition.

Physiological Basis for Nutrient Timing

Several lines of scientific evidence provide the basis for timing nutrient ingestion. The body's response to exercise in terms of hormone control and muscle function and its response to different types of carbohydrate and protein create the foundation for understanding how timing nutrition specifically to the muscles' functional needs is optimal for an athlete. Together, these responses produce the greatest evidence, which is the effect on body composition, glycogen stores, protein balance, and rehydration.

Hormonal Control

Hormonal responses to exercise are dependent on training intensity, training duration, training volume, and the fitness level of the person. The key **hormones** involved in the regulation of muscle function are epinephrine, norepinephrine, insulin, cortisol, and glucagon. Figure 1.1 shows how these hormone levels change with increasing exercise duration. The hormones epinephrine and norepinephrine are called **neurotransmitters** and are responsible for stimulating the breakdown of stored fat and **glycogen** for use as energy during exercise. With the onset of exercise, epinephrine and norepinephrine rapidly increase.

Insulin is the hormone responsible for the integration of fuel metabolism at rest and during exercise. The levels of insulin determine how much of the body's needed energy will be derived from the breakdown of fat, carbohydrate, and protein. When an athlete is in a fasted state, less insulin is produced, and fats and proteins are recruited to provide fuel for the body. With food consumption, insulin levels increase so that consumed carbohydrate, fat, and protein can be utilized for fuel or stored by

hormone – A substance that is produced in one of the body's tissues and transported through the blood to a target tissue, where it acts to produce a specific response.

neurotransmitter – A chemical substance that provides a signal to receptors located throughout the body.

glycogen – The form of glucose that is stored in the muscle and liver.

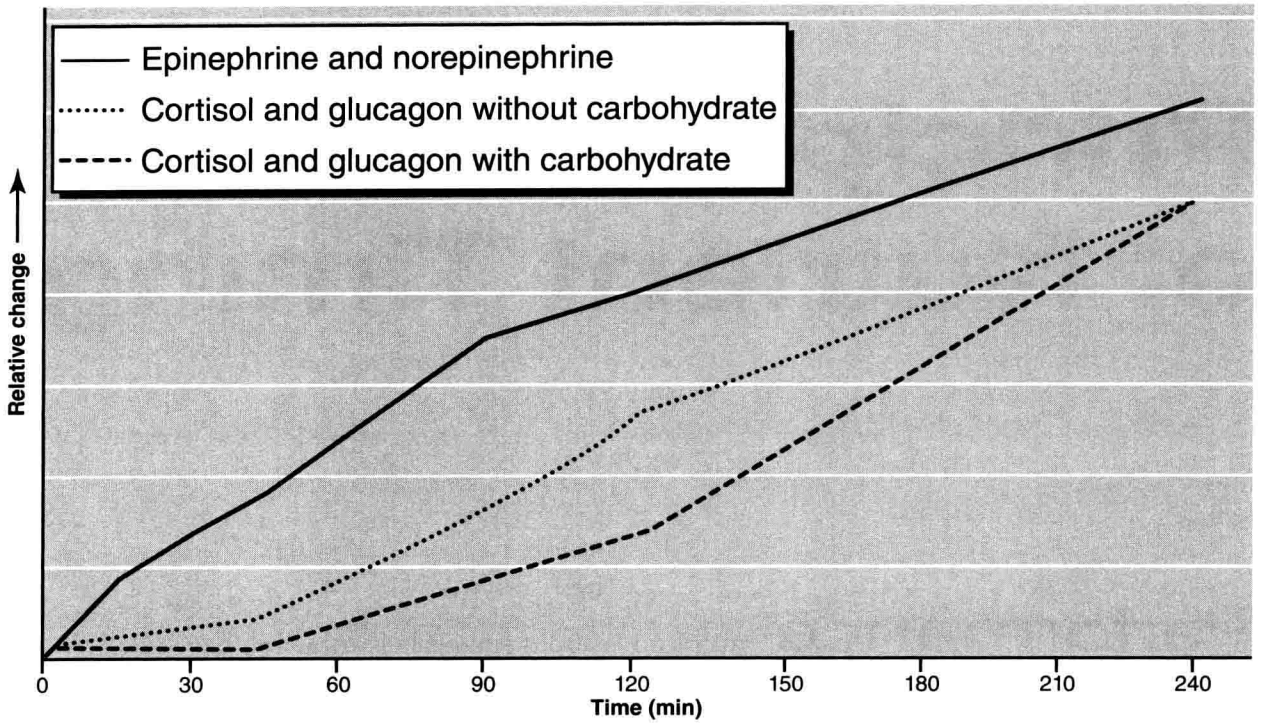


Figure 1.1 Responses of epinephrine, norepinephrine, cortisol, and glucagon to exercise. Note that cortisol and glucagon levels increase during exercise. In the absence of carbohydrate, the increase in these hormones is sharp, but with carbohydrate ingestion, the increases in the levels of cortisol and glucagon are slower and more moderate.

the body's tissues. During exercise, insulin allows glucose to be readily used by the body's working tissues. The sensitivity of the muscle cells to insulin increases when exercise is stopped.

The actions of cortisol and glucagon are dependent on the amount of glucose in the blood and on energy availability in the body. Glucagon is increased in response to low blood glucose levels; it is responsible for breaking down carbohydrate stored as glycogen in the liver and facilitating the conversion of amino acids to glucose. Cortisol is the hormone that facilitates the synthesis of glucose from the breakdown of protein and fat in times of a reduced energy state. When blood glucose levels drop too low during exercise, glucagon is increased to promote glycogen release from the liver and, if necessary, works with cortisol to promote the synthesis of glucose from free fatty acids and amino acids.

Muscle Regeneration

A number of factors—from enzymes, to blood flow, to receptors on the muscle cell, to hormone action—are elevated to the greatest extent in the first 45 minutes after exercise stops. Over the next several hours, these factors slowly return to resting levels; thus, the 45 minutes after exercise is considered a window of opportunity for the ingestion of foods that will promote muscle recovery through glycogen replenishment and rehydration.

This response is highly facilitated by the enzyme glycogen synthase and a transporter known as **GLUT4**, both of which are responsive to insulin and are significantly elevated after exercise. Together glycogen synthase and GLUT4 enhance the uptake of carbohydrate and improve glycogen storage. These actions are further facilitated through insulin, which facilitates carbohydrate uptake and increases the rate of muscle blood flow. This not only helps deliver nutrients to the muscles but also aids in the elimination of metabolic waste that was produced during exercise. In the 45 minutes immediately after exercise, the activity of GLUT4 receptors and levels of glycogen synthase are maximally elevated, allowing insulin to facilitate carbohydrate restoration to the muscle cells and improve recovery from training (figure 1.2).

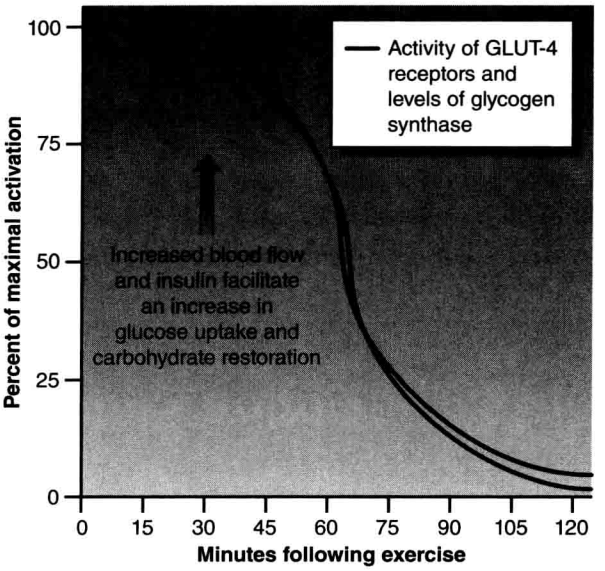


Figure 1.2 The activity of GLUT4 receptors and levels of the enzyme glycogen synthase are significantly elevated in the first 45 minutes after exercise, then begin to decline rapidly.

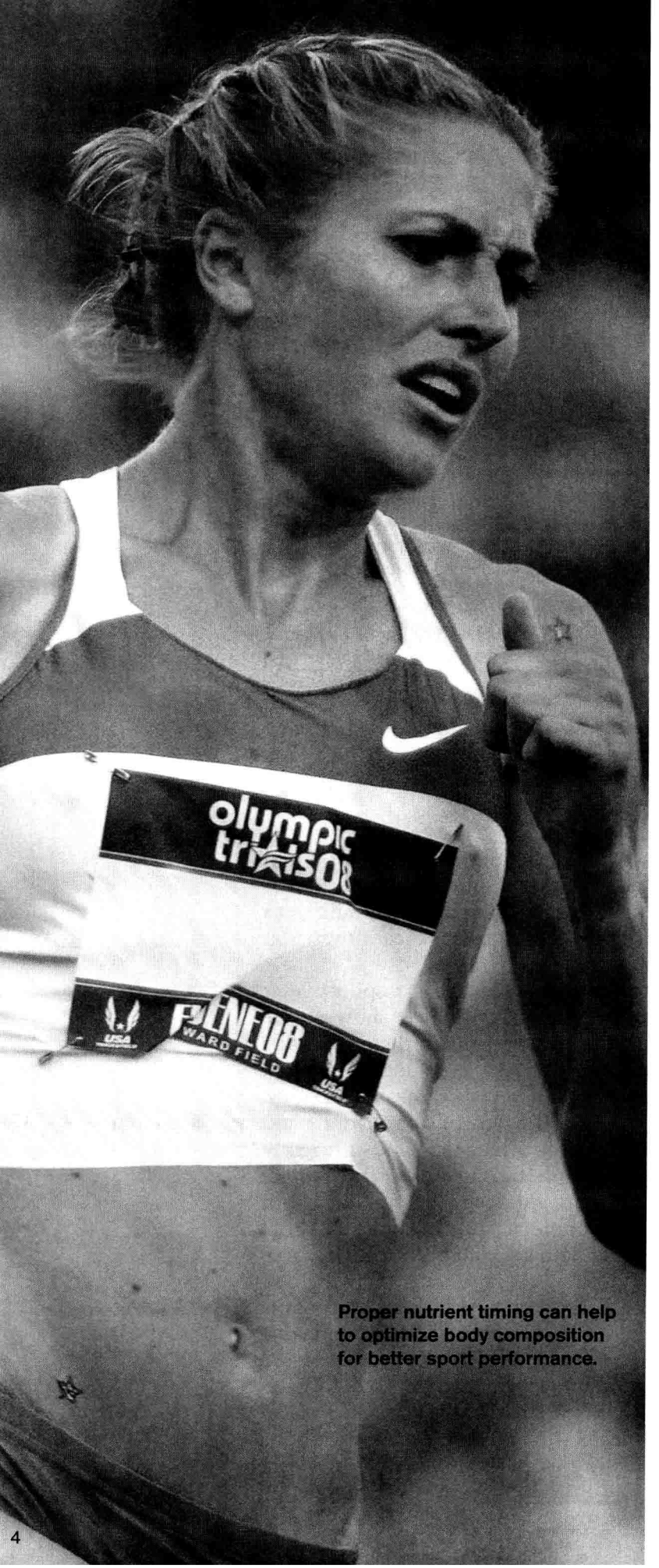
GLUT4 – A receptor that is located in skeletal muscle, the heart, and fat and is highly regulated by insulin. It is responsible for the uptake of glucose.

Types of Carbohydrate and Protein

The functionality of foods is covered in greater detail in chapter 4, but it is important to note here that intake of the right type of carbohydrate is significant evidence for timing nutrient ingestion. In addition, the timing of protein and the type available to the muscle are critical for optimizing adaptations from resistance and cardiovascular training.

As mentioned, insulin is an important hormone in the muscle response after exercise. The rate of posttraining muscle glycogen synthesis has been shown to be proportional to the increase in blood insulin levels. Athletes should therefore select the type of carbohydrate they consume based on how quickly glycogen stores must be replenished, which depends on the amount of time between training sessions. When the next training session will begin determines the type of carbohydrate and insulin response that is desired. For most athletes, muscle glycogen can be sufficiently restored through the use of low to moderate glycemic carbohydrates that do not require a significant spike in insulin and will steadily restore glycogen. This approach will also help to minimize gains in body weight. An example of a postexercise snack that would provide this response is whole wheat bread with almond butter and banana. When glycogen restoration must happen quickly, the best types of carbohydrate to stimulate an increase in blood insulin levels are those that evoke a high **glycemic response** because of their rapid conversion to glucose in the blood. An example of a postexercise snack that would provide this response is white bread with banana and honey. All are made of simple sugars and have minimal fiber content so that digestion and absorption by the body can be done quickly. The more readily glucose can become available to the working muscles, the faster the rate of glycogen resynthesis can occur and recovery can begin. This is frequently the case for athletes who perform

glycemic response – A measure of a food's ability to raise blood glucose.



Proper nutrient timing can help to optimize body composition for better sport performance.

multiple prolonged training bouts within a day or, in the case of a weight-classified sport, athletes who must replenish glycogen stores from having cut weight.

Glycogen restoration may be further enhanced through the ingestion of protein with carbohydrate. This is attributed to the optimization of the insulin response and the suppression of cortisol, which speeds the muscle's recovery process. The availability of essential amino acids (such as those found in dairy and meat products) before and after training is also an important factor in maintaining or increasing muscle protein synthesis. Thus, it is important that the protein source used contain all the essential amino acids. Depending on an athlete's food preferences, this can be accomplished by consistently consuming foods in the daily diet that contain all the essential amino acids or by ensuring that the pre- and posttraining snack contains foods that are a good source of essential amino acids.

Body Composition

Most athletes seek to optimize the ratio of muscle and fat mass in the body because of the positive relationship this has with performance. Studies assessing the patterns of food intake by athletes have shown that eating meals at regular intervals is most optimal for maintaining a high level of muscle mass and a lower level of body fat. These same studies show that most athletes eat infrequently and consume a majority of their calories in a large meal at the end of the day. This leads to large rises in blood glucose that in turn encourage the storage of fat mass. Furthermore, this eating pattern delays energy restoration, and so the body utilizes muscle proteins to make and maintain blood glucose levels, leading to a decrease in muscle mass. For the body to optimize its composition, blood glucose needs to stay stable. When an athlete consumes the energy expended in a training session through frequent eating that revolves around training, the muscles are functionally available and ready to absorb the nutrients ingested, thus helping to

maintain stable levels of glucose in the body. Timing nutrient ingestion revolves around the supply and demand for energy production by the working body, which enhance body composition. Improvements in body composition result in an improved ratio of muscle mass to fat mass and in turn directly result in an improved work capacity.

Nutrient Timing, Training, and Performance

Now that we have established the basis for timing nutrient ingestion, it is important to understand the physiological principles that support its use. This means understanding how the body regulates food intake, what limits performance, the goal of training, and how to use the principles of recovery and adaptation as the foundation for improving sport performance.

Using Nutrient Timing to Optimize Training Adaptations

Human work capacity is considered to be limited primarily by the muscles' capacity to do work. Improvements in performance come as a result of progressive overload, which can be imposed through increases in the volume, frequency, intensity, or perception of work. The body is stressed by a training load (and other life stressors such as work, school, friendships, and relationships), and the work undertaken results in a degree of fatigue or depletion of the physical or psychological systems involved. Performance gains are accelerated when fatigue is reduced as soon as possible after training and the challenged systems are restored to normal levels. Learning to accommodate a training stressor (i.e., load) can eventually lead to successful adaptation. An athlete's nutrition must be seen as a tool in this process. By understanding the principles of recovery and adaptation, and how food or the lack thereof can be a performance-limiting factor in these processes, you can begin to understand the positive role food can play in the training program.

Recovery and Adaptation

The primary goal of recovery is to overcome muscle fatigue and establish a greater ability to generate power. The principle of recovery can be defined as the part of training where the benefits of the work done are maximized through practices that reduce fatigue and enable the athlete to cope with the training load more effectively. Recovery is about encouraging adaptive processes after the presentation of a training load. If there is sufficient recovery before the next workload, the underlying system or fuel store stressed during training can improve its capacity to cope with the next stressor. To maximize an athlete's potential to learn, adapt, and improve, it is important to start training and competition in a relatively nonfatigued state. This becomes more challenging for coaches and athletes when athletes are required to complete more than one training session per day, often over several days, and when combined with a range of additional lifestyle stressors such as education, work, and so on.

Adaptation can be defined as the body's response to a stressor that has thrown the body out of homeostasis (i.e., balance). The body's response to a stressor can be positive or negative adaptation, and this adaptation can be short term (minutes to hours) or long term (days to weeks). A positive adaptation will result in an improved function by the body (e.g., increased sweat rate during exercise in the heat), and a negative adaptation is seen as a plateau or reduced capacity of the body (e.g., reduced

sweat rate after heat stress). It is thought that the cumulative effects of multiple short-term adaptations will result in a long-term adaptation.

By thinking of food in the context of creating short- and long-term training adaptations, you can begin to understand the interrelation of training and nutrition with performance. Food is a key part of sufficient recovery before the next training session; food restores the energy system that was stressed during training so it can improve its capacity to cope with the next stressor. Ensuring restoration of fuel stores facilitates adaptation to an imposed stressor. When this is done appropriately, an athlete can begin the next training session in a state of energy regeneration, and an additional stressor can then be imposed. The overall effect is to improve training and cause faster adaptation (figure 1.3).

Monitoring Training

Assessing the progression of an athlete's adaptation to an imposed training stressor is important because it provides a measurable outcome that indicates whether or not the body is adapting favorably to training. A training stressor or nutrition intervention is valuable only if the outcome is an improvement in work capacity or some other measure of performance. These assessments can be objective (physiological tests designed to evaluate the effects of an intervention) or subjective (feedback from the athlete). Ideally they are used in combination to measure the progression of adaptation to training. Most frequently, recovery and adaptation are assessed through blood markers that measure energy use; cardiovascular capacity; and immune, hormone, and enzyme function along with the athlete's feeling of perceived exertion and total body recovery (psychological, physiological, and muscular).

How might this relate to timing nutrient ingestion? Often an athlete can perceive the benefits of a nutrition program only when it is compared with training under less than ideal nutrition practices; thus, monitoring training allows an athlete to evaluate the benefits of an intervention. The examples of hydration and recovery nutrition are probably the simplest and best ones we have found to date. In the case of hydration,

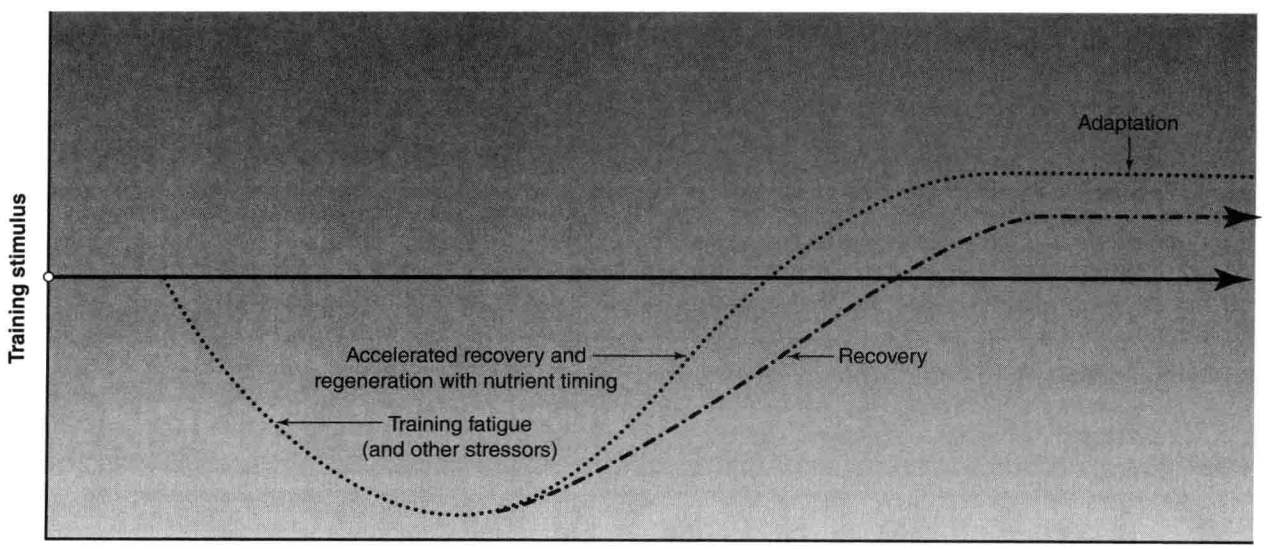


Figure 1.3 With proper nutrient timing, accelerated recovery from each training session leads to more effective adaptation to the stress of training.