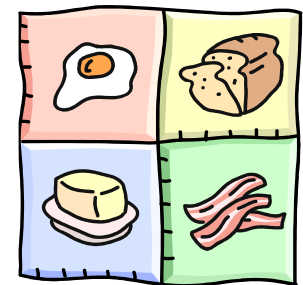
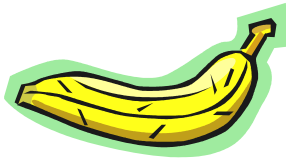
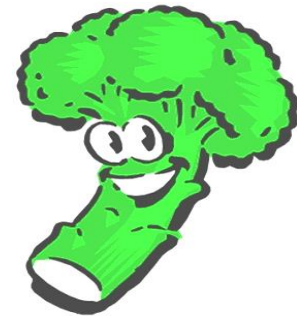




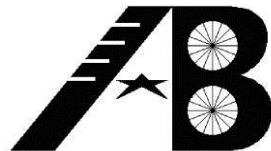
*Essentials of*  
**Nutrition for Sports**

**Arnie Baker, MD**



*Essentials of* *4<sup>th</sup> Edition*  
**Nutrition for Sports**

**Arnie Baker, MD**



<http://arniebakercycling.com>

# Table of Contents

---

**About the Author**..... 6

**Help, But No Guarantees** ..... 7

**Read Me First—Forward**..... 8

**Nutrition Quiz** ..... 9

**Part 1:**

**Workout & Event Nutrition** ... 11

Pre-Exercise Nutrition ..... 13

Nutrition While Exercising ..... 15

Post-Exercise Nutrition..... 19

Sweat Mineral Losses ..... 21

Antioxidants ..... 25

Hydration..... 27

**Part 2:**

**Calories**..... 36

Daily Caloric Needs..... 37

Digestion ..... 40

Energy Sources at Various

    Exercise Levels ..... 45

Carbohydrate Chemistry ..... 47

Why High Carbohydrate? ..... 49

Maltodextrin Nutrition ..... 53

Protein..... 58

Whey Protein..... 67

Soy Protein..... 67

Protein For Recovery? ..... 68

Fats: Types, Structure ..... 76

Dietary Fat..... 79

Omega-3 Fatty Acids..... 83

Heart-Healthy Fat..... 89

Alcohol ..... 95

**Part 3:**

**Sports Foods** ..... 99

Sports Drinks..... 99

Sports Recovery Drinks..... 103

Sports Energy Bars ..... 105

Sports Gels ..... 108

**Part 4:**

**Ergogenics & Ergolytics**..... 111

Ergogenic Products..... 113

Ergolytics..... 126

Vitamin & Mineral

    Supplements ..... 128

Vitamins: Benefit & Harm ..... 132

Minerals: Benefit & Harm..... 133

**Part 5:**

**Promotion & Quackery**..... 134

Athletes Are Targeted ..... 134

Maxxta Makes You Fasta..... 135

What Makes a Good Study?.. 137

Junk Science ..... 141

Product Promotion..... 144

Supplement Hype..... 150

Supplement Problems ..... 152

Herbal Concerns ..... 154

A Look at Endurox R4 ..... 156

**Key Points**..... 170

*A free supplement to this book is available at:*

*[http://arniebakercycling.com/books/b\\_nutrition.htm](http://arniebakercycling.com/books/b_nutrition.htm)*

*It contains the following parts:*

**Body Fat, Weight**

**Healthy Fast Food**

**USDA & FDA Basics**

**Vitamins, Minerals, and Other**

**Nutrients**

## Copyright

The materials available in *Arnie Baker Cycling* and/or *Argo Publishing* products (collectively subsequently referred to as *Arnie Baker Cycling*), both in print and online, are the property of *Arnie Baker* and are protected under United States and international copyright and other laws and conventions.

*Arnie Baker Cycling* grants to you, the customer, a nontransferable, nonexclusive right and revocable license to use this material according to the terms and conditions set forth in this Agreement.

Except as expressly granted by this Agreement, you acquire no right, title, or license to the contents of *Arnie Baker Cycling* products or its website.

Some material is derived from previously published works of Arnie Baker, or includes material previously written and published for or derived from works of the United States Cycling Federation or commercial/trade books.

The information contained herein is for the personal use of the reader, and may not be incorporated into any commercial programs, other books, data bases or any other kind of software without the written consent of the author.

You are granted the right to make a single copy of this electronic publication at a commercial printer such as Kinko's/FedEx. Making additional commercial copies *Arnie Baker Cycling* publications, or any portion, for any purposes other than your own is a violation of United States copyright laws.

The occasional use of trademarked names is for editorial purposes only. There is no intention to infringe upon trademarks. No endorsement or denigration of any product is implied.

Copyright © 1988-2013, by Arnie Baker.

Arnie Baker Cycling <http://arniebakercycling.com/>

Argo Publishing 1820 Washington Place San Diego, CA 92103

## Limitations of Use

All rights reserved.

The contents of *Arnie Baker Cycling* publications may be accessed, viewed or otherwise used only by a registered customer. Customers are permitted to view, browse, download, and/or print for their own personal purposes only. These uses are restricted to noncommercial purposes; all copyright and any other notices must be maintained on all copies.

Any and all materials may have electronic expiration dates. Use of materials beyond their expiration date is prohibited. Using "work-arounds" or programs to defeat electronically set expiration dates is prohibited.

Except as provided by law or by this agreement, the contents of *Arnie Baker Cycling* publications or its website may not be further stored, reproduced, distributed, transmitted, modified, adapted, performed, displayed (including adaptations/displays such as by "framing"), published, printed, or sold in whole or in part without prior written permission from *Arnie Baker Cycling*.

*Arnie Baker Cycling* publications may not be duplicated in any way without the expressed written consent of the author, except in the form of brief excerpts or quotations for the purposes of review.

Sharing a password with a non-customer or otherwise making the contents of *Arnie Baker Cycling* publications available to third parties is strictly prohibited.

Unauthorized use may subject the user to applicable civil or criminal penalties.

## Changes in Terms and Conditions

*Arnie Baker Cycling* reserves the right at its discretion to change, modify, add or remove the Terms and Conditions of this Agreement at any time and post the changes on its website.

Continued use of the website following the posting and such notification of any change to these Terms and Conditions will constitute acceptance by you of the Terms and Conditions as modified.

*Arnie Baker Cycling* reserves the right to change, modify, suspend or discontinue any or all parts of the website or the material available at any time and reserves the right to restrict access to parts or all without notice or liability.

## Disclaimer

The author makes no warranty of any kind, expressed or implied, with regard to the information contained in *Arnie Baker Cycling* publications or its website.

*Arnie Baker Cycling* does not guarantee the accuracy, completeness, currentness, noninfringement, merchantability, or fitness for a particular purpose of information available from its publications or website.

The author shall not be liable in the event of incidental or consequential damages in connection with, or arising out of, the furnishing, performance, or use of information, associated instructions, programs, and/or claims of results or productivity gains.

Generalizations or applicability of information contained in this book may not apply to any specific individual.

The contents of *Arnie Baker Cycling* publications or its website should not be substituted for the advice of a personal physician.

All readers are cautioned to obtain medical consultation in the event of any medical problems. All readers are cautioned to consider obtaining medical consultation before entering into any athletic training program.

*Arnie Baker Cycling* will not be liable for any loss or injury caused by information obtained through its publications or its website.

In no event will *Arnie Baker Cycling* be liable for any decision made or action taken in reliance on such information.

*Arnie Baker Cycling* will not be liable for any damages arising out of any legal claim in any way connected with the information provided in its publications or on its website.

## Acknowledgments

I thank Gero McGuffin for co-authoring Part 7, Healthy Fast Food—as well as doing such a great job of feeding and fueling me for more than two decades of riding and racing.

I thank Barbara Baker and Gero McGuffin for major proofing and other valuable suggestions.

I thank Roger Darley for rousing me to write this book.

I thank Kevin Gilbert, John Jahelka, and John Pingel for help along the way.

## Disclosure

Dr. Baker receives or has received sponsorship or products from: Adams Avenue Bicycles, Bell Sports, Bike USA, Bill Holland Bicycles, Boone Technologies, Cannondale, Chris King, CompuTrainer, Continental, CycleOps, LeMond Fitness, Lew Composites, Mavic USA, Pantour, Polar Electro Oy, PowerFoods, PR Bar, Ralph Ray Engineering, Saris (Power-Tap) Scott USA, Sidi, Specialized, Speedplay, Tailwings, Trek Bicycle Superstores San Diego, Tune (Power-Tap), VeloMax, Vision Tech, Vredestein, WD40, XLM, Xtrem, and Zipp.

Dr. Baker has been a paid consultant for: Colorado Altitude Training, Kirkwood Mountain Resort, PacTour, The International Olympic Committee, The Leukemia & Lymphoma Society, and The United States Cycling Federation.

## Cataloging in Publication Data

Baker, Arnie, 1953-

Essentials of Nutrition for Sports/  
by Arnie Baker.  
—4<sup>th</sup> ed.

Bibliography. Includes index.

1. Nutrition
2. Sports Training
3. Bicycling

I. Title

2013

10 9 8 7 6 5 4

## ***Coach and Author***

# **Arnie Baker, MD**

---

Dr. Arnie Baker has been coaching since 1987. A professional, licensed USA Cycling coach, he has coached racers to several Olympic Games, more than 120 US National Championships, and 35 US records. He is and has been the only National Cycling Coach for Team in Training. This endurance-training program of more than 800 coaches and 30,000 participants raises more than \$80,000,000 each year for the Leukemia & Lymphoma Society.

Arnie held a Category 1 USA Cycling racing license. He has held eight US 40-K time-trial records, has won multiple national championships, and has won more than 200 races. An all-round racer, he was the first to medal in every championship event in his district in a single year.

Dr. Baker is a licensed physician in San Diego, California. He obtained his MD as well as a master's degree in surgery from McGill University, Montreal. He is a board-certified family practitioner. Before retiring to ride, coach, and write, he devoted approximately half of his medical practice to bicyclists. He has served on the fitness board of *Bicycling* magazine as a bicycling-physician consultant. He has been a medical consultant to USA Cycling and the International Olympic Committee.

Arnie has authored or co-authored 17 books and more than 1,000 articles on bicycling and bicycling-related subjects.

## **Also by Arnie Baker, MD:**

- Altitude Climbing Endurance (ACE) Training for Cyclists
- Bicycling Medicine—Cycling Nutrition, Physiology and Injury Prevention, and Treatment
- Bike Fit
- High-Intensity Training (HIT) for Cyclists
- Psyching Psychology: Mind Training for Cyclists
- Skills Training for Cyclists
- Smart Coaching
- Smart Cycling—Successful Training & Racing
- Strategy & Tactics for Cyclists
- The Essential Cyclist

# Help, But No Guarantees

*I used special diets, vegetarian diets with lots of vitamins. Then I'd see the East Germans gorging themselves on greasy French fries and Wiener schnitzel then go out on the track and set world records. It makes you wonder about diet.*

–Mark Gorski. Olympic Gold Medalist, Cycling.



**nu-tri-tion** (nōō-trīsh'ən) *n.*<sup>1</sup>

1. The process by which a living organism assimilates food and uses it for growth, liberation of energy, and replacement of tissues; its successive stages include digestion, absorption, assimilation, and excretion.
2. The science or study that deals with food and nourishment, especially in humans.

Nutrition can help, but it is not everything.

Athletes sometimes ascribe magical powers to nutrition, believing that if they just “get it right,” performance will zoom and fitness will be transformed.

Good nutrition can help performance. Poor nutrition can *worsen* performance. There is no guarantee, either way. Many athletic health gurus have died early.<sup>2</sup>

Just as athletes sometimes have unrealistic expectations about the importance of nutrition, so does the general population. Eating healthily or “health foods” does not result in immortality. It is possible to drink heavily, be morbidly obese and yet live a long life.

It is all about risk and odds. Healthy nutrition does lower the risk of cancer, heart disease, and a host of other diseases. Further, for the years we do have, it helps many of us live stronger.

<sup>1</sup> Stedman's Medical Dictionary, 2002 by Houghton Mifflin Company.

<sup>2</sup> To name just three: runner Jim Fixx, PowerBar founder Brian Maxwell, bicycling nutrition guru Ed Burke.

# Read Me First—Forward

---

There is a lot of information in this book. The first parts provide important information for you to use right away—the next time you exercise. Other parts are best used as reference.

Here are some training essentials:

- Replace fluids.
- Consume calories while exercising.
- If exercising for many hours, pay attention to sodium.
- Avoid multiple or costly supplements.
- Almost always, avoid so-called ergogenics.

Here is what you will find in the different parts of this book:

*Nutrition Quiz.* A fun start. If you get all the questions right, maybe you do not need to read the rest of the book!

*Part 1. Workout & Event Nutrition.* The practical aspects of endurance sports nutrition.

*Part 2. Calories.* A mix of the practical with basic science, helping you understand *why* recommendations are made.

*Part 3. Sports Foods.* Lists of representative sports nutritional products. Once you understand what is in these products, you may be more confident about using “real foods” or other options.

*Part 4. Ergogenics and Ergolytics.* This part is all about the products that are sold to make you go fast—which, most of the time, do not. You will find a review of what is in the marketplace, and explanations about why, generally, it may not be worth spending your money or risking your health.

*Part 5. Nutrition Promotion and Quackery.* Education about how products are marketed, how to be a smart consumer, and about the dangers of nutritional quackery.

*Key Points.* A summary of the key points made throughout the book.

## Nutrition for Sports Supplement

The 250+ page supplement is published separately for ease of electronic transmission and manageable print volumes.

It is available as a free download at:

[http://arniebakercycling.com/books/b\\_nutrition.htm](http://arniebakercycling.com/books/b_nutrition.htm).

The supplement contains the following parts:

*Part 6. Body Fat, Weight.* Many endurance aerobic athletes strive to lose weight. You will find a review, not necessarily glamorous, of how to lose weight. You will also read how basically every diet you have read about as new is really a reincarnation of something previously promoted.

*Part 7. Healthy Fast Food.* Not an oxymoron. Sensible ideas for breakfasts and quick, low-calorie dinners, chock full of nutrients.

*Part 8. USDA & FDA Basics.* What is the food label about? What are the laws for advertising nutrition facts, daily values, nutrient content, and other health claims? What do the claims really mean?

*Part 9: Vitamins, Minerals, and Other Nutrients.* Read this when you have a lot of time, as reference material, or to help you understand the academic underpinnings of the more practical information about vitamins, minerals, and supplements presented throughout this book.

Thank you,

Arnie Baker



# Nutrition Quiz

---

1. **T F** Protein is useful before athletic events. That is why you often hear about athletes having a steak breakfast.
  2. **T F** Everyone needs vitamins. Athletes need so many to perform well that all athletes should take at least several supplemental vitamin pills.
  3. **T F** Protein is important in building muscle. Athletes wanting to increase their strength need protein shakes or supplements.
  4. **T F** Since the body's energy system runs on sugars, soft drinks and candy bars are ideal foods.
  5. **T F** Since being light is so important in getting up hills, it helps to be a little dehydrated before hilly races.
  6. **T F** Athletic drinks are required during all races for their nutritional superiority over plain water.
  7. **T F** Wine or beer with your meal helps digestion.
  8. **T F** If you are training for a long race, it helps to train without drinking. This helps to adapt your body for the effects of dehydration you can expect in the long race.
  9. **T F** No harm comes from taking too many vitamins. It is better to be safe than sorry.
  10. **T F** During heavy hot-weather exercise, do not forget to take extra manganese to prevent muscle cramps.
  11. **T F** Athletes making claims for foods or vitamins usually do so because they believe in the product rather than for financial gain from endorsement.
  12. **T F** If you eat right ("to keep fit") you will not get cancer or heart disease.
  13. **T F** Vegetarians do not get enough protein or iron.
  14. **T F** You should eat extra food at bedtime because your body digests it better when at rest while sleeping.
  15. **T F** Raw unpasteurized milk is a "perfect food." Certainly, it is preferred to watery fat-free milk.
  16. **T F** Your mother was wrong. Colored green and yellow vegetables really are not important. It is a myth that you need them.
  17. **T F** Your mother was right. You should finish everything on your dinner plate.
  18. **T F** Since it is primarily fats that are burned on long rides, fatty foods consumed during rides actually help performance.
  19. **T F** When you are thirsty during a hot race, it is better to drink warm fluids—they are already closer to body temperature.
  20. **T F** Diet pills or prescription diet medicines from a doctor should be used to lose weight.
- Bonus** A Girl Scout cookie has 7 grams of carbohydrate and 3 grams of fat. What percentage of its calories comes from fat?

## Quiz Answers

Probably a lot more is not known about nutrition than is known. This area is subject to much mythology. All of the twenty T F questions are false or mostly false. The Girl Scout cookie in question has 7 grams of carbohydrate, for 28 calories, and 3 grams of fat, for 27 calories. Of a total 55 calories, 27 calories, or 49% come from fat.

## General Nutrition Key Points

- Eat a variety of whole, unprocessed foods in moderation.
- Eat at least half a dozen servings of fruits and vegetables daily.
- Control your weight.
- Limit or avoid alcohol.
- Eat a diet relatively high in fiber.
- Eat fewer simple sugars—candy, table sugar, “sweets.”
- Avoid junk food.
- Avoid high-fat and high-cholesterol foods.
- Avoid salty foods (unless you will be sweating quarts).
- Rely on food, not pills.
- Most people do not need supplements. Consider a multivitamin/multimineral supplement, calcium, or iron supplement if you have special needs.
- There are no absolute rules. Very different diets consumed by different people may have equal nutritional value and result in good nutrition. Occasional dietary indiscretions are not important.

## Part 1:

# Workout & Event Nutrition

---

## Introduction

---

From the athletes' point of view, there is nutrition related to workouts and events, and general nutrition.

Nutrition related to workouts and events refers to nutrition before, during, and after workouts and events. It is about pre-exercise, during exercise, and post-exercise nutrition.

It is mostly about fluids and carbohydrate calories. It is a little about sodium.

The principles of workout and event nutrition are different than those of general nutrition, which must also be kept in mind. Caloric mix and quality, vitamins, minerals, and other nutrients have important roles to play in general or overall nutrition. For example, athletes rarely have vegetables during exercise. Since vegetables are important in a healthy diet, vegetable intake for athletes should be high when not exercising. General nutrition topics are covered throughout this book.

## **Workout Key Points**

### ***Pre Exercise***

- Start exercise well-hydrated.
- Start exercise glycogen-loaded in both muscles and liver.
  - Supper: Pre-event meal high in carbohydrate. If planning to exercise for more than 4 hours, or 2 hours in high heat and humidity, add salt to foods.
  - Breakfast: Cyclists aim for at least 1,000 calories. Runners may not be able to eat as much-perhaps only a few hundred calories. Walkers and triathletes will be in between.
  - Pre-workout calories benefit both endurance and strength athletes, both aerobic and anaerobic work.
- Start prolonged exercise in the heat salt-loaded.
- Be prepared for start delays.
  - At the event: Have easily digestible fluids and calories available in case of a start delay.

### ***During Exercise***

- Hydrate
  - Aim for at least 8 ounces (250 milliliters) of fluids, every 15 to 30 minutes, depending upon the heat.
  - Have carbohydrate-in-water solutions (for example, maltodextrins or sports drinks), rather than plain water.
  - Cyclists: Carry two waterbottles. Or use a hydration system (for example, CamelBak). Walkers: Carry a waterbottle.
- Calories
  - For events longer than one hour, consume at least 300 calories per hour of exercise.
- Salt
  - For multi-hour events in conditions of heat and humidity, consume salty foods, and sodium-rich solutions and gels.

### ***Post Exercise***

- Refueling after exercise is a proven recovery strategy.
- The sooner the better. Refueling during exercise is best.
- Prompt refueling benefits both endurance and strength athletes.
- Prompt refueling benefits aerobic and anaerobic work.
- Aim to ingest at least 50 grams of carbohydrate (200 calories) within the first 30 minutes after exercise and again every hour for the next 3 hours, up to caloric deficit.
- Some fat and some protein with the carbohydrate is no problem.
- “Real food” is probably better than specialty sports products.

# Pre-Exercise Nutrition

---

## Key Points

- Start exercise well-hydrated.
- Start exercise glycogen-loaded in both muscles and liver.
  - Supper: Pre-event meal high in carbohydrate. If planning to exercise for more than 4 hours, or 2 hours in high heat and humidity, add salt to foods.
  - Breakfast: Cyclists aim for at least 1,000 calories. Runners may not be able to eat as much—perhaps only a few hundred calories. Walkers and triathletes will be in between.
  - Pre-workout calories benefit both endurance and strength athletes, both aerobic and anaerobic work.
- Start prolonged exercise in the heat salt-loaded.
- Be prepared for start delays.
  - At the event: Have easily digestible fluids and calories available in case of a start delay.

## Hydration

Exercise can be dehydrating. It is best to start well-hydrated.

As discussed in the section on hydration beginning on page 27, intracellular hydration is different from vascular hydration. Drinking 16 to 32 ounces (500 to 1,000 milliliters) in the hour before a workout or event may improve vascular hydration, but may not improve intracellular hydration.

Intracellular hydration requires adequate hydration in the 24 to 48 hours before exercise.

Although athletes are often advised to drink 16 to 32 ounces in the hour before exercise to assure adequate hydration, this is not always the best strategy.

If you are already well-hydrated, and your workout or event does not allow for easy urination, you may not want to drink that much before exercise and be forced to race with a full bladder.

For example, if you are going to race a 20-kilometer (12.4-mile) bicycle time trial under temperate conditions, dehydration during the roughly 30-minute event is not likely. If you have kept up with losses up to the hour before your race start, drinking a full waterbottle (16 ounces, 500 milliliters) within 30 minutes of your race start is not likely to improve performance, and may worsen it.

On the other hand, keeping up with fluid losses, and drinking a bottle just before the start of a hot 2-hour hilly cycling road race makes sense, especially if fluids on route are limited, you are discrete, and you have the skills to urinate while riding.

## Calories

You need fuel to work.

Starting hungry—calorically deficient—is a bad strategy.

If exercising at high intensity, you'd like your stomach empty. You do not want to have a heavy meal in the minutes before an all-out effort. This is especially true for runners.

On the other hand, if exercising for many hours at moderate or low intensity, solid food near the start time may be fine. This is especially true for cyclists.

Planning to ride a recreational century? The 100 miles will burn about 3,000 calories. By pacing, riding moderately at the start, it may be easy to have a few hundred calories of solid food just before the start.

## *Top Up Blood Sugar and Glycogen*

For basal metabolism and exercise associated with warming up, you may use 250 calories per hour. Ingesting this amount of caloric energy in the hours before your workout or event may allow you to

keep glycogen levels in both liver and muscle high and prevent lowering of blood sugar levels at the start.

The closer to your hard workout or intense event start, the more you will rely on liquids, rather than solids, to provide calories.

Carbohydrate in solution may not be necessary for events as short as 30 minutes, although some studies have shown benefit even for events of this duration.

For workouts or events lasting an hour or longer, topping up energy supplies is important. The longer your event, the more important it is to start with a full tank.

### ***Caloric Mix***

Big meals and fatty meals ingested within an hour of intense exercise can cause performance problems. Fats delay the emptying of the stomach. When blood supplies are diverted to the intestines to aid digestion, less blood is available to go to the working muscles. Intestinal cramps may also result.

If you're entering a road race of 70 miles and it is not going to get "hot and heavy" until two hours or 50 miles into the race, a balanced meal, not based solely on carbohydrate, may stay with you longer, helping to mete out energy over the few hours of your event. Tour de France riders, for example, typically include fats and protein along with their pre-race carbohydrate meals.

Some foods may have the right caloric mix, but be hard to get down. For example, even if comprised mostly of carbohydrate, some energy bars may feel like balls of cardboard in the mouth and stomach.

### ***Insulin and Low Blood Sugar Levels***

When carbohydrate solutions are ingested 30 minutes before exercise, insulin levels may rise and blood sugar levels may fall immediately before exercise starts.

Depending upon type of sugar, formulation, and the exact timing of the sugar load, pre-exercise carbohydrate may also result in higher or lower blood sugar levels during the first 10 minutes of exercise. Even if blood sugar levels fall, studies generally show that performance is the same or improved.

Pre-event feedings have concentrated on carbohydrate calories. Feedings with medium-chain triglycerides have not been shown to improve performance.

### ***Missing Breakfast?***

Runners often race without breakfast; this is not a recommended strategy.

An evening meal with a high fat content may help, because liver glycogen stores may be relatively spared by the slower digestion and metabolism of fats and the resulting longer entry of nutrients from the gastrointestinal tract into the bloodstream.

### ***Salt Loading***

In general, it is probably best for good health to consume a diet relatively low in sodium.

If you are going to work out or race for several hours or more in the heat, it may be difficult to replace sodium during your exercise.

Adding a tablespoon of salt (6,600 mg sodium) to foods over the course of the 24 hours before your exercise may be a good strategy.

The best way to get extra sodium is by eating salty foods. The night before long workouts in the heat add some salt to your pasta meal or have high sodium foods such as pizza, pretzels, or soup. Tomato juice and V-8® are high-sodium fluids.

It is preferable to eat salty foods or drinks rather than ingest salt tablets. Studies have shown that salty foods and drinks appropriately stimulate thirst, and so prevent the unintentional ingestion of dangerously high amounts of sodium.

Read more about sodium, including sweat losses during events, on page 17 and page 21.

Read more about sodium after events on page 20.

Read more about sodium, including the sodium content of selected foods, starting on page 164.

### Keep Pre-Event Supplies Handy

Start delays of several hours or longer may occur because of event permitting problems, weather delays, or roadwork problems. Be prepared to keep fluids, calories, and even salt levels high, with a cooler stocked with solids and liquids. Be prepared for short delays with easily digestible supplies. Be prepared for substantial delays with “real food.”

# Nutrition While Exercising

## Key Points

- Hydrate
  - Aim for at least 8 ounces (250 milliliters) of fluids, every 15 to 30 minutes, depending upon the heat.
  - Have carbohydrate-in-water solutions (for example, maltodextrins or sports drinks), rather than plain water.
  - Cyclists: Carry two waterbottles. Or use a hydration system (for example, CamelBak). Walkers: Carry a waterbottle.
- Calories
  - For events longer than one hour, consume at least 300 calories per hour of exercise.
- Salt
  - For multi-hour events in conditions of heat and humidity, consume salty foods, and sodium-rich solutions and gels.

## Summary Table

	30 Min	60 Min	2 Hr	5 Hr	12 Hr	24 Hr	Multi-day
Fluids		X	XX	XXX	XXX	XXX	XXX
Carb cals/hour		X	300	300	300	300	500
Sodium			X	XX	XXX	XXX	XXX
Vitamins						X	XX
Weigh-in						X	XXX

**Table 1. Nutrition while exercising concerns and calorie goals per hour. X=minor concern. XXX=major concern.**

## What We're Talking About

Consider for a moment a typical American workday: You work three hours in the morning, have a 15-minute coffee break, take 30 to 60 minutes for lunch, and work for four hours in the afternoon, with another 15-minute break. You consume 500 calories for breakfast and 1,000 calories during lunch and work breaks. You drink many glasses of water, coffee, or other fluids.

Doesn't it make sense that when you are exercising, you need even more calories and water? Of course! —Yet so many of us train or race until we drop without drinking enough and fueling our bodies.

The priorities for nutrition during endurance cycling, running, triathlons, or walking are water, calories, and sodium.

For events under an hour, no special nutrition may be needed.

For most events over an hour, concern yourself mainly with fluids and calories.

For long-distance events over most of a day or longer, also consider sodium.

## Nutrition Losses

### *Fluid Loss*

Fluid is lost primarily in the urine and through sweating. The kidneys have a tremendous ability to dilute or concentrate urine. They can rid the body of large excesses of fluids when the need arises. They can also concentrate urine if a person becomes dehydrated.

Sweat rate depends upon work rate and climate (heat and humidity). During hard work in hot desert-like conditions, it is possible to lose more than a couple of quarts (liters) per hour. Sweat rates have been measured up to 3.5 quarts per hour and 17 quarts per day.

For events longer than one hour, or one-half hour in the heat, water replacement is important. Although carbohydrate or electrolytes may not be necessary for energy or balancing mineral losses, they aid hydration by increasing the rate of water uptake by the gastrointestinal tract. They also increase palatability: Fluids that taste better encourage drinking. Chilled fluids also help encourage drinking and are absorbed more quickly.

Aim for 8 ounces of fluids every 15 minutes in the heat. That is about one quart (liter) every hour. Although you may lose more, it is doubtful that drinking more will be helpful because your body probably cannot process more than that. (With nutritional training, athletes learn to tolerate up to 12 ounces every 15 minutes.)

During road racing events, most cyclists and walkers *must* carry waterbottles or hydration systems (for example, CamelBak)—the time distance between aid stations is too great to rely on them for hydration. In addition, walking events often run out of fluids at aid stations. (Runners do not exercise as long, and for them the time distance between aid stations may be short enough so that waterbottles are not required.)

During 40-K cycling time trials, many racers do not bring waterbottles, even in desert events. During races at maximum effort—although dehydration worsens performance slightly—the disruption of rhythm, the time cost of drinking and the aerodynamic cost of water bottles usually justify not drinking.

Read more about hydration in the chapter on hydration starting on page 27.

## Calorie/Energy Loss

### *Calorie/Energy Loss*

It is typical to use 2,500 to 3,000 calories during a cycling century (one-hundred miles); twice as much in a double century or



an ACE event (one-day altitude climbing, endurance events over 100 miles with more than 10,000 feet of climbing).

Runners and walkers use about 80 calories per mile.

Energy loss depends upon work rate. Work rates may be up to 1,200 calories per hour.

In ultra-distance events, work rates are reduced, but duration—the number of hours of work—is increased. It is possible for a 200<sup>+</sup>-pound rider cycling 24 hours in a day to burn 15,000 calories. The typical daily energy requirement of a 150-pound racer cycling 22 hours per day is 10,000 calories. Most multi-day ultra-distance riders become calorically deficient, consuming about 85% of their daily energy expenditure.

For more information about estimating caloric expenditure for basal metabolism and exercise, see page 37.

Some of this energy comes from the body's stores of carbohydrate (glycogen) and fat. Some energy needs can be met by consuming calories while exercising. Depending upon your size, your body can use up to 300 ingested carbohydrate calories per hour (about 1 gram per kilogram per hour). As a rule, try to consume this many calories for every hour you exercise. Multiple studies confirm that athletes perform better when they fuel while exercising. Calories can come from solids, gels, or solutions.

Do you need protein or fat during exercise? Studies have not shown this to be true. (Consume your requirements during the course of the day, not necessarily during exercise.) Read more about protein and recovery on page 68.

The harder you work, the less you are able to tolerate solid food. Cyclists are able to eat solid food while exercising. Most runners cannot.

Although studies show that gels are generally less palatable than carbohydrate solutions, some athletes prefer gels.

Carbohydrate solutions are a convenient way to get calories. Typical sports drinks and diluted fruit juice have 100–125 calories per 16-ounce (500 milliliter) bottle.

More than 400 calories per bottle can be obtained and tolerated with a few specialty sports drinks that contain glucose polymers or maltodextrins. Examples of these products include Extran and Carbo Gain. Read more about maltodextrins on page 53.

Energy bars and gels do work, but after many hours become tiresome for most athletes. If not racing, cyclists do well to stop periodically and eat “real food” —especially early on in a long ride. Leftover breakfast items such as French toast or pancakes, fig bars, bananas, and Pop-Tarts (perfectly packaged for jersey pockets) are favorites for short stops.

Walkers may take short breaks for bananas or other solids.

Runners do not tend to exercise as long and rely more on carbohydrate gels.

### ***Train to Eat***

Although it may not be necessary to consume calories during shorter training sessions, it is crucial in long-distance events. You must practice eating, even in shorter training sessions, to allow your gastrointestinal tract to adapt to the process of eating while exercising.

### **Minerals**

Sodium is the electrolyte priority for the aerobic endurance athlete.

For an analysis of the possible needs of other minerals found in sweat, see page 21.

### ***Sodium***

A low concentration of sodium in the blood is associated with weakness, fatigue, seizures, and occasionally death.

The body loses about one gram of sodium per quart (liter) of sweat. After a gallon (4 quarts, 4 liters) of such loss, the average total daily intake of sodium may be inadequate to meet demands, and the blood sodium may drop.

In temperate weather conditions, this may take 4 or 5 hours. In high heat conditions, sodium depletion can occur in just a couple of hours.

For aerobic-endurance athletes, it is reasonable to plan on an intake of up to a maximum of one gram (1,000 milligrams) of sodium per liter of fluid loss. This is about one-half teaspoon of salt.

Salt in beverages is often unpalatable.

Salty-snacks, including low-fat pretzels, saltines, and pickles are often a good choice for athletes at rest stops.

Carry salt and sprinkle it on oranges or cantaloupe slices.

Read more about sodium before events on page 14.

Read more about sweat losses during events on page 21.

Read more about sodium after events on page 20.

Read more about sodium, including the sodium content of selected foods, starting on page 164.

## **Weigh-In/Diet Diary/Lab Chemistry**

For all-day or multi-day events, repeated, accurate weight measurement can help determine hydration status. Scales accurate to 0.1 pound or kilogram are best.

Some weight loss will reflect glycogen depletion. Read more about acute weight changes in the free supplement to this book available at: [http://arniebakercycling.com/books/b\\_nutrition.htm](http://arniebakercycling.com/books/b_nutrition.htm).

For multi-day events—for example, the Race Across America—a support crew member charged with recording solids and liquids ingested and eliminated can help evaluate caloric, fluid, and mineral balance.

Spot checks of urine electrolytes and specific gravity, or blood biochemistries are occasionally used by sophisticated crews in multi-day events.

## **Keep Event Supplies Handy**

In events over several hours or longer, most athletes do not eat or drink enough. Athlete nutritional intake is heavily dependent upon what the organizer provides at aid stations. Carb, fluid and sodium replacement is often inadequate to keep up with demands. Plan on personal support unless your event is well-provisioned.

# Post-Exercise Nutrition

---

## Key Points

- Refueling after exercise is a proven recovery strategy.
- The sooner the better. Refueling during exercise is best.
- Prompt refueling benefits both endurance and strength athletes.
- Prompt refueling benefits aerobic and anaerobic work.
- Aim to ingest at least 50 grams of carbohydrate (200 calories) within the first 30 minutes after exercise and again every hour for the next 3 hours, up to caloric deficit.
- Some fat and some protein with the carbohydrate is no problem.
- “Real food” is probably better than specialty sports products.

## Hydration

Replace fluids lost during exercise.

Read more about hydration in the chapter on hydration starting on page 27.

## Calories

### *Glycogen Window*

The glycogen window refers to the concept that a post-exercise window of opportunity exists when ingested carbohydrate can be converted to muscle glycogen more readily than at a later time.

Replacing carbohydrate as soon as possible after exercise may reload glycogen to a greater extent than if you travel home, shower, and then sit down to a meal.

On average, the body can incorporate about 50 grams (200 calories) of carbohydrate into glycogen per hour in the first few hours after exercise—if carbohydrate is available.

Despite advertising hype, protein has not been shown to improve glycogen reloading. For more information about protein and recovery, see page 68.

That is not to say that protein is not important in your overall daily program, or that it is bad for recovery. Protein may be helpful for other reasons, discussed below.

### *Caveats*

Dietary patterns (high carbohydrate, low fat vs. lower-carbohydrate, higher-fat) may not degrade training when workout intensity is low to moderate.

If you have 48 hours to recover before your next high-intensity workout—that is, a rest day in between—you have more time to replace glycogen. A lower-carbohydrate, higher-fat diet may not decrease performance.

### *Fat Window*

The glycogen window is relatively well-studied. The fat window is less-well understood. (The glycogen was easier to study and was examined first.)

About 1,500 calories are stored in muscle for energy use as glycogen. About 2,500 calories are stored for energy use as intramuscular lipid.

Fat replacement after exercise has been shown to effectively restore intramuscular lipid using water-suppressed nuclear magnetic resonance spectroscopic imaging.

If you do not get enough fat in your diet, muscle glycogen stores may be great, but muscle fat stores may be deficient. Aerobic endurance exercise demands both to perform well.

How much fat is needed and how quickly is unknown. Whether carbohydrate can be converted to intramuscular fat, or whether adipose stores can be mobilized, and how quickly, is also not known.

Typical of many refueling studies, one study showed that increasing calories from 57% carbohydrate to 68% or 88% carbohydrate results in more muscle glycogen after repeated bouts of exercise, in proportion to the amount of carbohydrate ingested.

Although both the 68% and 88% carbohydrate diets increased intramuscular glycogen, the 88% carbohydrate diet led to decreased muscle triglyceride concentrations.<sup>3</sup>

### ***Even Better: Don't Get Behind***

If you ride a bicycle for 6 hours, why wait to reload when you get home?

Why not stop after a few hours and have a good snack or lunch?

The more you can keep up, the less you are behind, the less you need to replace when you get home.

Up to about 300 calories per hour may be useful during exercise for today's workout.

If you can eat more while you exercise, even though you may not need calories for today's workout, you may improve your ability to ride with intensity again tomorrow.

Tour de France riders, for example, often consume more than 700 calories per hour while riding.

### ***Summary: Overall Caloric Mix***

You need to replace lost carbohydrate and fat stores in muscle.

Adequate carbohydrate and fat calories, rather than percentage guidelines, are what is needed.

At least 200 calories per hour of carbohydrate can be incorporated into muscle glycogen in the first few hours after exercise.

How many calories from fat can be incorporated into muscle per hour is not known. Since there is at least as much intramuscular fat

as intramuscular glycogen, it seems prudent to aim to ingest at least 100 calories of fat per hour for the first few hours after exercise.

There is evidence that post-exercise mood may be better with whole food or mixed-source caloric drinks (carbohydrate, protein, and fat) than with carbohydrate-only fluids.

Although protein has not proved useful in improving glycogen replacement, unless total calories are insufficient, it may be important in rebuilding muscle or for other reasons. Studies are lacking.

My favorite post exercise strategy: Choose "real food," not specialty sports products. Although sports products will be convenient and palatable for some, "real food" is probably better—more complete, balanced, tastier, and less expensive. For example: A quart of fat-free milk, a sandwich, fruit, and a few cookies.

### **Sodium**

Replace sodium lost during exercise, generally with salty foods.

Read more about sodium before events on page 14.

Read more about sodium, including sweat losses during events, starting on page 21.

Read more about sodium, including the sodium content of selected foods, starting on page 164.

### **Keep Recovery Supplies Handy**

It may require planning. Keep a gallon or two of fluids and a cooler in your vehicle if you travel to workouts or events so that you can start the recovery process sooner rather than later.

---

<sup>3</sup> Zderic, T.W., et al. (2000). Effects of 5-day carbohydrate and fat intake on muscle glycogen and triglyceride in cyclists. *Medicine and Science in Sports and Exercise*, 32(5), Supplement abstract 117.