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Nutrition for the athlete

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Quick Facts

- Athletes—from fitness runner to competitive sports participant—achieve peak performance by training and eating a variety of foods.
- Athletes gain most from eating carbohydrates.
- Fat also provides body fuel; use of fats as fuel depends on the duration of the exercise and the condition of the athlete.
- Exercise does not generally increase an athlete's need for protein.
- Water is a critical nutrient for athletes, needed for energy production, temperature control and elimination of waste; dehydration can cause muscle cramping and fatigue.
- Cool water is absorbed faster and helps to lower body temperature.
- Eating a variety of foods supplies the athlete with necessary vitamins and minerals.

Becoming an elite athlete requires good genes, good training and conditioning, and a sensible diet. Optimal nutrition is essential for peak performance. Nutritional misinformation can do as much to harm an ambitious athlete as good nutrition can help.

Carbohydrates

Athletes gain most from the amount of carbohydrates available in the body. In the early stages of moderate exercise carbohydrates provide 40-50% of the energy requirement.[1] Carbohydrates yield more energy per unit of oxygen consumed than do fats. Since oxygen is often the limiting factor in long duration events, it is beneficial for the athlete to use the energy source requiring the least amount of oxygen per kilocalorie produced. As work intensity increases, carbohydrate utilization increases.

Complex carbohydrates come from food such

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as spaghetti, potatoes, lasagna, cereals, vegetables and other grain products. Simple carbohydrates are found in fruits, milk, honey and sugar. The body breaks down carbohydrates during digestion to glucose and stores it in the liver and muscles as glycogen.

During exercise, the glycogen goes back to glucose and is used for energy. The ability to sustain prolonged vigorous exercise is directly related to initial levels of muscle glycogen. The body stores a limited amount of carbohydrate in the muscles and liver. If the event lasts for less than 90 minutes, the glycogen stored in the muscle is enough to supply the needed energy, and extra carbohydrate will not help the athlete, just as adding more gas to an automobile at half fuel does not make the car go faster.

For events that require a heavy workload for more than 90 minutes, a high-carbohydrate diet eaten for two to three days prior to the event allows glycogen storage spaces to be filled. Long distance runners, cyclists, cross-country skiers, canoe racers, swimmers and soccer players report benefits from eating a diet containing 70 percent of the calories from carbohydrates before competition.

According to the Olympic Training Center in Colorado Springs, endurance athletes on a high-carbohydrate diet can exercise longer than athletes eating a low-carbohydrate, high-fat diet. Eating a high-carbohydrate diet constantly is not advised since this conditions the body to use only carbohydrates for fuel and not the fatty acids derived from fats.

For continuous activities of 3 to 4 hours, the athlete should ensure that glycogen stores in the muscles and liver are at a maximum. In such cases the athletes should consider ingesting carbohydrates during the event in the form of weak glucose solutions. The American Dietetic Association (ADA) recommends 2.5% glucose solution (2½ grams of sugar in 100 milliliters of water; this is the equivalent of about ½ teaspoon sugar in 3.3 ounces of water).

Eating sugar or honey just before an event does not provide any extra energy for the event. It takes about 30 minutes for the sugar to enter the blood stream. This practice also may lead to dehydration. Water is needed to absorb the sugar into the cells. Furthermore, sugar eaten before an event may hinder performance because it triggers a surge of insulin. The insulin causes a sharp drop in blood sugar level in about 30 minutes. Competing when blood sugar level is low leads to fatigue.

A diet in which at least 70% of calories comes from carbohydrates for three days prior to the event is sometimes helpful for endurance athletes. (See Table 1 for sample menu.) Retention of water has been associated with loading, which may cause stiffness in the muscles as well as sluggishness early in the event. This is minimized when only a 3-day regimen is practiced. The previously suggested practice of 7 days of deprivation/repletion is not recommended due to increased risks of coronary heart disease. In addition, electrocardiograph abnormalities may occur and training during the deprivation phase may be difficult.

Table 1: Sample menu of a high carbohydrate diet.

Food item	Calories	Grams carbohydrate
8 ounces orange juice	120	28
1 cup oatmeal	132	23
1 medium banana	101	26
8 ounces low-fat milk	102	12
1 slice whole wheat toast	60	12
1 tablespoon jelly	57	15
2-ounce slice ham	104	0
1 ounce Swiss cheese	105	1
2 slices whole wheat bread	120	25
1 leaf lettuce	1	0
1 slice tomato	3	1
8 ounces apple juice	116	30
8 ounces skim milk	85	12
2 cookies	96	14
3 cups spaghetti	466	97
1 cup tomato sauce	89	19
with mushrooms	5	1
2 tablespoons Parmesan cheese	45	0
4 slices French bread	406	78
1 slice angel food cake	161	36
¼ cup sliced strawberries	13	3
½ cup ice cream	133	16
16 ounces grape juice	330	83
6 fig cookies	386	81
TOTAL	3236	613
	(75% of total calories)	

Water

Water is a very important nutrient for the athlete. Athletes should start any event hydrated and should attempt to replace as much lost fluid as possible by drinking chilled liquids at frequent intervals during the event. Chilled fluids are absorbed faster and help in lowering body temperature.

Table 2: Recommendations for hydration.

Day before	Drink fluids frequently
Pre-event meal	2-3 cups water
2 hours before	2-2½ cups water
½ hour before	2 cups water
Every 10-15 minutes during	2 cups water ½-¾ cup cool (45-55° F) water
After event	2 cups fluid for each pound lost
Next day	Drink fluids frequently (it may take 36 hours to rehydrate completely)

Fats

Fat also provides body fuel. About half of the total energy expenditure is derived from free fatty acid metabolism when the exercise is moderate. Once an event has lasted longer than an hour, the body may use predominately fats for energy. Use of fat as fuel depends on the duration of the event and the condition of the athlete. The untrained athlete uses fat for energy quicker than the trained athlete.

Fat may contribute as much as 75% of the energy demand during prolonged aerobic work in

the endurance-trained athlete[2]. There is evidence that the rate of fat metabolism may be accelerated by ingesting caffeine prior to and during endurance performance. However, insomnia, restlessness and ringing of the ears can occur. Furthermore, caffeine also acts as a diuretic, and athletes want to avoid the need to urinate during competition.

Protein

In addition to carbohydrates and fats, protein can provide energy for the body. In general, exercise does not increase an athlete's need for protein. Extra protein is stored as fat. In the fully grown athlete it is the training and use of calories that builds muscle, not protein per se. The ADA reports that a protein intake of 10-12% of total calories will be sufficient[3]. Most authorities recommend that athletes eat 1 gram protein/kilogram of bodyweight/day (a kilogram equals 2.2 pounds). For adult athletes, the recommended amount decreases to .8 grams of protein per kilogram of ideal body weight.

Recently, Japanese researchers have demonstrated that "sports anemia" may appear in the early stages of training with intakes of less than 1 gm/kg body weight/day of high quality protein[2].

To calculate, divide your ideal weight by 2.2 pounds, then multiply your weight in kilograms by the grams of protein recommended.

A varied diet will provide more than enough protein as the caloric intake of an athlete increases. Furthermore, Americans tend to eat more than the recommended amounts of protein. Excess protein can deprive the athlete of more efficient fuel and can lead to dehydration as high-protein diets increase the water requirement necessary to eliminate the nitrogen through urine. Also, an increase in metabolic rate can occur and, therefore, increase oxygen consumption. Protein supplements are unnecessary and are not recommended.

Vitamins and Minerals

Increased caloric intake through a varied diet assures a sufficient amount of vitamins and minerals for an athlete. There is no evidence that an increase in vitamins above that obtained from eating a variety of foods will improve performance. Thiamin, riboflavin and niacin (B vitamins) are needed biochemically to produce energy from the fuel sources in the diet. However, more than sufficient amounts of these vitamins are obtained from the foods eaten. Carbohydrate and protein foods are excellent sources of these vitamins. Furthermore, the B vitamins are water soluble, and thus, are not stored in the body. Although some female athletes may lack riboflavin, eating milk products not only increases the riboflavin level but also provides necessary protein and calcium. The body stores excess fat-soluble vitamins A, D, E and K. Excessive amounts of fat-soluble vitamins may produce toxic effects.

Minerals play an important role in performance. Heavy exercise affects the body's supply of sodium, potassium, iron and calcium. To replenish sodium lost through sweating, an athlete should eat normally following competition. Avoid excessive amounts of sodium.

Eating potassium-rich foods such as oranges, bananas and potatoes supplies necessary potassium. Salt tablets or electrolyte drinks are not recommended. Sweating naturally increases the concentration of salt in the body. Also, salt tablets take water from the cells causing weak muscles[4]. Salt tablets also increase potassium losses. Potassium is important to help regulate muscle activity.

Iron is needed to carry oxygen and, therefore, is another important mineral for athletes. Female athletes and athletes between 13 and 19 years old may have inadequate supplies of iron. Female athletes who train heavily have a high incidence of amenorrhea and thus conserve iron stores. Iron supplements may be prescribed by a physician if laboratory tests indicate an iron deficiency. Excess iron can cause constipation. To avoid this problem eat fruits, vegetables and whole grain breads and cereals.

Calcium is an important nutrient for everyone. Female athletes should have an adequate supply of calcium to avoid calcium loss from bones. Calcium loss may lead to osteoporosis later in life. Dairy products, especially lowfat choices, are the best source of calcium.

The Pre-Game Meal

Eating the pre-game meal 3 to 4 hours prior to the event allows for optimal digestion and energy supply. Most authorities recommend small pre-game meals that provide 500 to 1000 calories[5].

The meal should be high in starch, which breaks down more easily than protein and fats. The starch should be in the form of complex carbohydrates (breads, cereal, pasta, fruits and vegetables). They are digested at a rate that provides consistent energy to the body and are emptied from the stomach in 2 to 3 hours.

High-sugar foods lead to a rapid rise in blood sugar, followed by a decline in blood sugar and less energy. In addition, concentrated sweets can draw fluid into the gastrointestinal tract contributing to dehydration, cramping, nausea and diarrhea. No carbohydrate should be taken 1½ to 2 hours before an event as this may lead to premature exhaustion of glycogen stores in endurance events.

A meal high in fats should be avoided as fat takes longer to digest.

The athlete should take in adequate fluids during this pre-game time. Caffeine (cola, coffee, tea) may lead to dehydration by production of increased amounts of urine.

The psychological aspect of eating foods the athlete enjoys and tolerates well before an event should not be disregarded. However, choose wisely (i.e., bake meat instead of frying).

Some athletes may prefer a liquid pre-game meal, especially if the event begins within 2 to 3 hours. A liquid meal will move out of the stomach by the time a meet or match begins. Remember to include water with this meal.

Regardless of age, sex or sport, the pre-game meal recommendations are the same.

Maintain nutritional conditioning not only for athletic events, but all the time. Any pre-game meal or special diet followed for several days prior to competition cannot make up for an inadequate daily food intake eaten in previous months or years.

Pre-Event Meal Plan I
(approximately 500 calories)

Milk, skim	1 cup
Lean meat or equivalent	2 ounces
Fruit	1 serving (1/2 cup)
Bread or substitute	2 servings
Fat spread	1 teaspoon

Pre-Event Meal Plan II
(approximately 900 calories)

Milk, skim	2 cups
Cooked lean meat or equivalent	2 ounces
Fruit	1 serving (1/2 cup)
Pasta or baked potato	1 cup 1 medium
Bread or substitute	2 servings
Vegetable	1 serving (1/2 cup)
Fat spread	1 teaspoon
Dessert: Angel food cake or plain cookies	1 piece 2

Lifelong good nutrition habits must be emphasized. By combining good eating practices, good training and conditioning with good genes, a winning athlete can result!

References

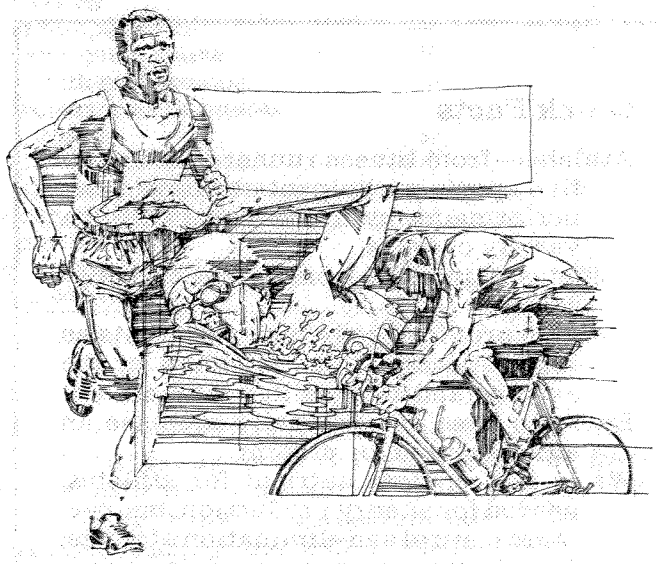
[1]McArdle, W., Katch, F. and Katch, V. *Exercise Physiology: Energy, Nutrition and Human Performance*, Lea and Febiger, Philadelphia, 1981.

[2]"Nutrition for the Athlete Update," *Contemporary Nutrition*, General Mills, April, 1982.

[3]The American Dietetic Association. *A Statement on Nutrition and Physical Fitness*. Journal of American Dietetics Assoc., 1980. 76:437.

[4]*Nutrition and the M.D.*, Vol. IX(10), Oct., 1983.

[5]Grandjean, A.C. "Sportsmedicine: The Pregame Meal," *National Strength and Conditioning Assoc. Journal*, 1980. 2(4):23.



Sources of Information

Request other Service in Action sheets from your local Colorado State University Cooperative Extension office listed under county government in the telephone directory. Single copies are free.

#9.312 Water-soluble vitamins
#9.315 Vitamins A, D, E and K
#9.324 Vegetarian diets
#9.353 Dietary guidelines for Americans
#9.354 Sodium in the diet
#9.355 Potassium and health
#9.356 Iron—an essential nutrient

For more information and recipe suggestions, read *Food for Sport* by Nathan J. Smith, M.D., published by Brill Publishing, Palo Alto, CA, 1976.

Nutrition for Athletes: A Handbook for Coaches produced by the American Alliance for Health, Physical Education and Recreation, 1201 Sixteenth Street, NW, Washington, DC, 20036.

For recipes see *Athlete's Kitchen* by Nancy Clark, published by Bantam Books, 1983.

Order a copy of *You: A Guide to Food, Exercise and Nutrition* from Colorado Dairy Council, Inc., 12450 North Washington Ave., P.O. Box 33120, Thornton, CO, 80233-0120; telephone (303) 451-7711; cost $1.