
Calculating Carbohydrate Needs

Carbohydrate is the main source of energy for high-intensity events lasting for less than 60 seconds (for example, a break-away goal on a power play, a slam dunk, or the long jump) and for high-intensity aerobic events lasting longer than 1 hour (eg, cycling, triathlons, marathons). Carbohydrate is the only nutrient that can be used without oxygen, which is notable because anaerobic glycolysis for adenosine triphosphate (ATP) generation becomes more important as the duration of a high-intensity activity increases. For example, a 30-second maximal sprint will derive about 80% of ATP from anaerobic glycolysis whereas a 10-second sprint derives about 97% of ATP from this system (1).

Carbohydrate is the most efficient fuel for humans because more oxygen is needed to burn fat than carbohydrate (2). Protein is used as a fuel source in endurance events, but to a much lesser extent than carbohydrate or fat. Oxidation of amino acids accounts for 2% to 6% of total energy expenditure (3).

Key Points About Carbohydrate

- Athletes need carbohydrate and should be discouraged from consuming low-carbohydrate diets.
- The quality of an athlete's workout may be compromised if he or she begins activity with low levels of muscle glycogen. There is a strong relationship between the amount of pre-exercise muscle glycogen and the length of time that a person can perform an activity at 70% of maximum oxygen consumption (VO_{2max}).
- High-intensity activity in a game that involves both anaerobic and aerobic activity (eg, basketball) requires carbohydrate to keep muscle glycogen replenished.
- Athletes who are restricting calories for weight loss need a greater percentage of carbohydrate in their diet than athletes who are not restricting energy intake.
- Carbohydrate consumption before and during endurance exercise improves performance.
- Using a carbohydrate-containing sport drink will help the athlete meet both carbohydrate and fluid goals.

Carbohydrate Intake Recommendations for Selected Situations

Situation	Recommendations	Example for 70-kg (154-lb) Athlete
1-4 hours before event*	1.0-4.0 g/kg†	70-315 g*
General training for endurance events	6.0-7.0 g/kg/day	420-490
Endurance training and competition	7.0-10.0 g/kg/day	490-700 g
During endurance events lasting > 60 minutes	30-60 g/hour	30-60 g/hour
High-intensity events	5.0-8.0 g/kg/day	350-560 g
Recovery for athletes who train or compete hard for > 90 min/day	1.5 g/kg immediately after exercise Additional 1.5 g/kg 2 hours after exercise	105 g
Recreational activities	5.0-6.0 g/kg/day	350-420 g

*An athlete who eats 4 hours before an event may need to eat again 1 hour before event.

†The carbohydrate recommendation will vary depending on the number of hours that pass between the time the athlete eats and the activity. Athletes who eat 4 hours before an event should eat more carbohydrate; athletes who eat 1 hour before activity should eat less carbohydrate.

Carbohydrate Foods*

Grains	Dairy Products and Other Beverages	Beans and Starchy Vegetables
2 slices whole wheat bread	2 cups milk (low-fat or fat-free)	½ cup black beans
½ deli-style bagel	1 cup low-fat chocolate milk	½ cup baked beans
1 2-ounce English muffin	1 4.5-oz container fruit-flavored yogurt	¾ cup kidney beans
1 cup oatmeal	1½ 8-oz cartons sugar-free yogurt	½ cup lima beans
1 cup ready-to-eat breakfast cereal	1 cup vanilla-flavored soy milk	1 cup green peas
1 package snack-type cheese crackers (6 to package)	1 package instant hot chocolate (made with water)	½ cup corn
2 fig cookie bars		¾ cup mashed potatoes
½ cup rice		½ medium baked potato with skin
½ cup cooked pasta		
5 cups popcorn		
½ large soft pretzel		
17 mini-pretzels		
1 12" flour tortilla		
1 oz tortilla chips and ¼ cup salsa		

Carbohydrate Foods*

Energy Drinks, Bars, Gels	Mixed Dishes	Fruit and Juice
2 cups sport drinks (6%-8% carbohydrate-containing sport drinks) 1 energy bar (average of many energy bars) 1 energy gel ½ can Boost or Ensure ½ can Slim Fast	1 slice thin-crust pizza with meat or veggie toppings ½ slice thick crust pizza with meat or veggie toppings 1 small bean and rice burrito ½ cup black beans and rice 1½ cups canned chicken noodle soup ¾ cup tomato soup 1 cup cooked ramen noodles ½ 6" sub sandwich ½ cup macaroni and cheese	2 cups fresh strawberries 1 large orange ¾ cup orange juice ½ cup cranberry-apple juice 1 medium apple

*1 serving (approximate) = 25 g carbohydrate

Tips for Boosting Healthful Carbohydrate Consumption

Breakfast

- Mix a whole-grain, high-fiber cereal with a favorite breakfast cereal.
- Use fruit (fresh, frozen, or canned) as toppings for cereal, pancakes, or waffles.
- Drink a glass of low-fat milk or a glass of 100% fruit juice.
- Mix yogurt with fruit or cereal.

Lunch

- Choose sandwich breads that contain carbohydrate and other nutrients (pumpernickel, cracked wheat, mixed-whole grain bread, bagels, English muffins, pita bread).
- Choose three-bean salad, pasta salad, potato salad, or wild rice salad instead of potato chips or french fries.
- Add carrots, bell peppers, mushrooms, celery, cucumber, and garbanzo beans (chick peas) to greens at the salad bar.
- Select a bean or vegetarian burrito instead of one filled with meat.
- Top a baked potato with salsa.
- Try baked chips (potato or tortilla) for added crunch.

Dinner

- Try different shapes and types of pastas topped with a marinara sauce. Serve with crusty bread or bruschetta.
- Choose thick-crust pizza instead of thin-crust or stuffed-crust pizza.

- Try a vegetarian plate for dinner: a meal of broccoli, black beans, and rice is a carbohydrate-rich alternative to a meat-based meal.
- Eat beans and rice dishes (red beans and rice, black beans and rice).
- Check out the variety of packaged grain mixes on the grocery store shelf for new combinations. Try lentils and rice, couscous with pine nuts, or yellow rice and black beans.
- Wrap strips of chicken in a whole wheat flour tortilla and top with lettuce, tomato, and salsa.
- Combine a prewashed, bagged Asian mixed salad with strips of lean cooked beef, chicken, or fish.

Snacks

- Drink low-fat chocolate or strawberry milk.
- Make a fruit or yogurt smoothie.
- Carry a cereal bar, energy bar, or canned sports shake in a gym bag.
- Choose whichever fresh fruit is in season; it's the original convenience food.

References

1. Walberg Rankin J. Nutrition for very high intensity sports. In: Dunford M, ed. *Sports Nutrition: A Practice Manual for Professionals*. 4th ed. Chicago, Ill: American Dietetic Association; 2006:405-419.
2. Coleman R. Carbohydrate and exercise. In: Dunford M, ed. *Sports Nutrition: A Practice Manual for Professionals*. 4th ed. Chicago, Ill: American Dietetic Association; 2006:14-32.
3. Gibala MJ, Howarth KR. Protein and exercise. Dunford M, ed. *Sports Nutrition: A Practice Manual for Professionals*. 4th ed. Chicago, Ill: American Dietetic Association; 2006:33-49.