MI SPORTS
PERFORMANCE MADE SIMPLE

ENDURANCE NUTRITION

A GUIDE TO GETTING STARTED

TABLE OF CONTENTS

REVIEW OF MACRONUTRIENTS

Food consists of one or more of three macronutrients, or macros; protein, carbohydrates and fat. The amount of calories a food contains depends on its macronutrients. Protein and carbohydrates both have 4 calories per gram while fat has 9 calories per gram.

Protein

Protein is made up of compounds called amino acids; some are essential (we need to get them from our food) and others are non-essential (can produce them in our bodies).

It provides the building blocks for many bodily structures and tissues as well as molecules such as enzymes, hormones, neurotransmitters, and antibodies. Proteins also transport various substances throughout the body and aid in growth and repair.

Complete proteins contain all the essential & non-essential amino acids e.g. meats, fish, poultry, seafood.

Incomplete proteins are missing one or more essential amino acids e.g. most plants.

Carbohydrates

Carbohydrates, or carbs, are a major source of energy for the body and the brain. They are made up of chains of sugars molecules that can be short or long.

Short-chained carbs are called simple carbohydrates while long-chained carbs are called complex carbohydrates. Simple carbs are foods like sugars and syrups, juices, cereals and candy. Complex carbs are found in whole grains, fruits, vegetables and legumes.

Regardless of the type of carbohydrate, once eaten all carbs are broken down into one type of simple sugar; glucose, fructose or galactose. Simple carbs are quickly absorbed into the body while complex carbs take longer to digest.

Fat

Fats, like protein, are an essential macronutrient meaning they must be consumed from food to get enough for your body to function.

They are an important energy source and also used for manufacturing hormones, protecting the cardiovascular system and helping the absorption of certain vitamins. There are three types of fats. The difference between these fats is how the carbon atoms are linked together.

1. Saturated fats are solid at room temperature. All of their carbon atoms are linked to a hydrogen atom. These types of fats are found in animal fats, butter and coconut oil.

2. Monounsaturated fats are liquid at room temp. They have one empty carbon atom that is not linked to a hydrogen atom. They can be found in olive oil, avocados, peanuts, pecans and almonds.

3. Polyunsaturated fats are also liquid at room temperature and have two or more empty carbon atoms. Foods such flax, hemp, fish, canola and safflower oils contain polyunsaturated fats.

ENDURANCE NUTRITION

Endurance sports can last anywhere from a few minutes to a day or longer. In the context of this guide when we talk about endurance sports we're referring to activities as short as a 5km run to ultramarathons or Ironman triathlons.

When you engage in endurance sports your body uses energy from two primary sources, carbohydrates or fats. The body can only store about 1500 – 2000 calories coming from carbohydrates. Fat stores can provide 50,000 or more calories.

Carbohydrates that are converted to glucose are stored in your body in the form of glycogen. The average person can store about 600 grams of glycogen with approximately 500 grams stored in muscle tissue and 100 grams stored in the liver. There is considerable individual variation in glycogen storage, ranging from 300 – 700 grams found in muscle and 0 - 160 grams in the liver depending on a person's body size and lean muscle mass.

Fats are stored in your body in the form of triglycerides and are found within your muscle cells or adipose tissue (your body fat). Fat found in your muscles is called intramuscular triglyceride, which contains about 2000 to 3000 of the total fat stores. Most of the fat found in your body is stored as body fat.

Energy Metabolism During Exercise

While fat stores can provide much more energy than carbohydrates, it is a much slower and more inefficient process than using carbs. If your body needs to fuel activity quickly it will use carbohydrates. When it doesn't need to produce energy quickly it will rely more on its fat sources.

The Crossover Concept

Lower intensity exercise relies more on fat as a fuel source while higher intensity exercise relies more on carbohydrates for fuel. The graph below demonstrates the concept as exercise intensity increases energy contribution shifts from fat to carbs.

The point where carbs become the major contributor to energy production is called the crossover concept or crossover point.

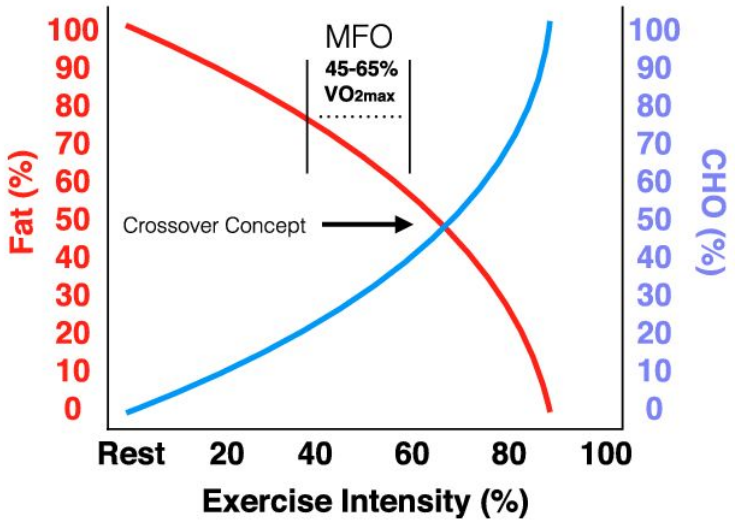


Figure 1: Crossover Concept. *Source* Purdom, T., Kravitz, L., Dokladny, K. *et al.* Understanding the factors that affect maximal fat oxidation. *J Int Soc Sports Nutr* **15,** 3 (2018).

Figure 2 below shows the different exercise intensities of various running races.

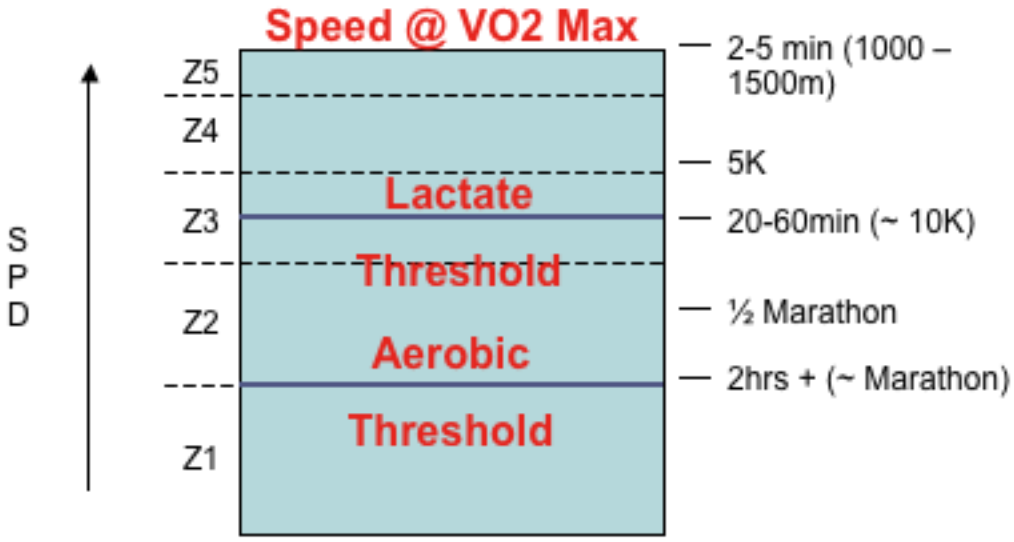


Figure 2: Intensity of Different Races. *Source: Peak Centre Vancouver*

The top of the chart is the highest intensity and speed where energy production relies solely on carb sources. At the bottom of the graph in Zone 1, fat sources provide most of the energy.

But even when fats provide the major fuel source, carbs are still important for endurance athletes to consume. As your glycogen levels fall during prolonged exercise you get more fatigued as your brain and nervous system can only use

glucose for energy.

If you've ever "bonked" during a race you know how it feels when your glucose levels drop. You get dizzy, have trouble thinking, feel weak and may have troubles controlling your movement in extreme cases.

Generally speaking, above your lactate threshold you will be using mostly carbohydrates. Below your aerobic threshold you're using mostly fat. Between those two zones is where you will hit the crossover point.

It is important to come into events and important training sessions with your glycogen stores topped up and to consume carbohydrates during exercise to replenish those stores. This helps you delay fatigue and allows you to maintain the intensity you need to perform your best.

Adequate carbohydrate intake will also help your recovery process. Studies have shown more muscle damage from lower carb intake during exercise than in people who took in higher amounts of carbs.

In the next section we'll look at practical recommendations for the amounts of protein, fat and carbohydrates you should eat daily and during workouts or races.

DAILY RECOMMENDATIONS FOR MACRONUTRIENT INTAKE

You'll need to calculate how much you should be eating each day and how much of each macronutrient to include in your total calories.

Setting Daily Calorie Target

The Mifflin St. Jeor is a good formula to calculate your Basal Metabolic Rate (BMR) and then we can use a multiplier that takes into account your activity levels to calculate a fairly accurate estimate of your overall caloric needs.

Use one of the following formulae, metric or imperial, to determine your daily calories.

Metric formula for women

BMR = 655.1 + (9.563 × weight in kg) + (1.85 × height in cm) − (4.676 × age in years)

Metric formula for men

BMR = 66.47 + (13.75 × weight in kg) + (5.003 × height in cm) − (6.755 × age in years)

Imperial formula for women

BMR = 655.1 + (4.35 × weight in pounds) + (4.7 × height in inches) − (4.7 × age in years)

Imperial formula for men

BMR = 66.47 + (6.24 × weight in pounds) + (12.7 × height in inches) − (6.755 × age in years)

Once you have your BMR then multiply this by an Activity Factor listed below.

Multiplier	Example	Calculation
1.2	If you are sedentary (little or no exercise)	BMR x 1.2
1.375	If you are lightly active (light exercise/sports 1-3 days/week) i.e. 30 – 60 min of easy exercise	BMR x 1.375
1.55	If you are moderately active (moderate exercise/sports 3-5 days/week) i.e. 60 – 90 min of easy to moderate exercise	BMR x 1.55
1.725	If you are very active (hard exercise/sports 6-7 days a week) i.e. 60 min of moderate to hard exercise	BMR x 1.725
1.9	If you are extra active (very hard exercise/sports & physical job or 2x training) i.e. 90 min of moderate to hard exercise	BMR x 1.9

Example: Calorie calculations for a 50 year old runner who's 185 cm tall, weighs 80 kg and trains 5 days per week.

BMR = 66.47 + (13.75 × 80 kg) + (5.003 × 185 cm) − (6.755 × 50 years) = 1754.275

Activity Multiplier = 1.55

Daily Calorie Requirement = 1754.275 x 1.55 = 2719To properly prepare for, fuel and recover from endurance exercise requires all the macronutrients. In this section we'll provide recommendations for how much protein, carbohydrates and fat you should eat each day for endurance sports.

Protein Recommendations

It's commonly assumed endurance athletes don't need much protein. In reality they still need adequate protein to help repair all the muscle damage done by exercise as well as maintaining good hormonal levels.

During different phases of your training you will need different amounts of protein.

Daily Protein Requirements	
Training Cycle	**Recommended Range**
Off-season	**1.2 - 1.8 g/kg BW**
Pre-season (weight loss goal)	**1.5 - 2.3 g/kg BW**
Pre-season (no weight loss)	**1.2 - 2 g/kg BW**
Competition	**1.2 - 2 g/kg BW**

Note: BW = bodyweight.

If you're doing more intense or very long endurance sessions consume near the higher end of the range. This applies to ultra runners and triathletes training for half-Ironman and Ironman distances. The long training sessions break down a lot of muscle tissue as well as lowers your immune system. So it's a good idea to consume a bit more protein after these workouts or races.

If you're also doing some resistance training (and you should be), it's a good idea to

consume more protein on those days as well.

Using the example of a runner weighs 80 kg, they should consume between 96 grams and 160 grams of protein per day during their competitive season. They should consume on the higher end on long training days or days they lift weights.

Carbohydrate Recommendations

Much like protein, carbohydrate requirements will vary depending on your goal and where you are in your training cycle.

You should base your carb intake on your activity level and body weight.

Carbohydrate Seasonal Requirements	
Training Cycle	**Recommended Range**
Off-season	**3 - 10 g/kg BW**
Pre-season (weight loss goal)	**2 - 7 g/kg BW**
Pre-season (no weight loss)	**3 - 10 g/kg BW**
Competition	**4 - 12 g/kg BW**

Use the following guidelines to calculate how many carbs to eat a daily basis based on your training duration.

Carbohydrate Daily Requirements	
Average Daily Training Time	**Recommended Range**
30 - 45 minutes	**3 - 4 g/kg BW**
45 - 60 minutes	**4 - 5 g/kg BW**
60 - 75 minutes	**5 - 6 g/kg BW**
75 - 90 minutes	**6 - 7 g/kg BW**
90 - 120 minutes	**7 - 8 g/kg BW**
120 - 180 minutes	**8 - 10 g/kg BW**
180+ minutes	**11 - 12 g/kg BW**

Going back to our example of an 80 kg runner. Let's assume they're training for 45 to 90 minutes six days per week. They would need to consume 320 - 560 grams of carbohydrates per day. This amount would provide approximately 1,280 to 2,240 calories. The higher amount would be on days they train harder or longer and the lower amount on rest day or lower volume days.

Fat Recommendations

Unlike recommendations for carbohydrates and protein, there is no specific range of fat intake for endurance athletes.

First, aim to meet your carbohydrate and protein requirements. Then take in the remainder of your daily calories from fat.

Aim to get all different types of fats including polyunsaturated, monounsaturated and even some saturated fats in your diet. After meeting your carb and protein needs, your fat intake will be around 10 - 30% of total calories.

Fat Requirements
Approximately 0.6-1.5 g/kg of fat, depending on individual preference, tolerance and goal.

HOW MUCH TO EAT IN DIFFERENT SITUATIONS

This section describes the recommendations of how much to eat in various situations, before exercise, during exercise and after exercise.

Eating Before Training

How much you eat before training or racing will depend on a number of factors.

- How much time you have before your workout or race.
- How your body handles different amounts of food. Some people can eat a lot before training or racing, others cannot.
- How long your workout will be.
- What time of day you're training or racing.
- Whether you're prone to stomach issues during racing or training.

You will want to eat primarily carbohydrates before long or intense workouts. Avoid foods that are too high in fiber or eating too much fat. Some protein can be helpful but focus mostly on carbohydrates.

Aim to consume 1 to 4 grams of carbs per kilogram of body weight in the 1 to 4 hours prior to exercise (1-4 g/kg bodyweight). Generally the higher amount is best eaten with more time before you train or compete. But this can vary by individual tolerances.

If you're prone to gastrointestinal distress in races or training you will want to have as much time as possible after eating before you start your exercise.

But if you're training or racing in the morning you still want to make sure you get adequate sleep so you're not waking up too early to eat.

If your exercise is 45 minutes or shorter in duration and isn't going to be too intense you could forgo eating anything. You will have to make sure you stay well in your aerobic zone if you do this.

An option for people who do have GI issues during exercise is to eat a small amount of food immediately before your training session or race. Consume about 100 – 150 calories of mostly carbs 5 – 10 minutes before you start (25 – 37 grams of carbs). Eat something that is easily digestible like a banana, energy gel or half an energy bar. Then during your workout or race follow the guidelines for eating during training below.

Example of Pre-race Foods

- Bread or toast (choose white bread if the higher fiber content of whole grains causes GI issues).

- Toppings like jam, honey, peanut butter (small amount).
- Oatmeal or other oat preparations such as overnight oats.
- Cereals.
- Energy bars or gels.
- Fruit.
- Pancakes with syrup.
- Fruit smoothies.

It will take some experimentation in training to find the amount and types of food you do well with during racing. The key is to practice all this in your training so you know what works for you as we are all individual. All the information in this ebook are guidelines based on the latest science but it's up to you to figure out your individual tolerances and preferences.

Eating During Exercise

What you eat during racing and training depends on the duration and intensity of your event or workout.

Use the chart below to help you determine how much to consume during events of different lengths and intensities. For a mouth rinse you can simply take some of your preferred energy drink in your mouth and swirl it around a few times then spit it out.

This technique in effect "tricks" your body into thinking it's consumed fuel. Your mouth has sensors that detect if you've eaten carbohydrates. Even if you don't swallow them your body will think it has and you will still benefit.

Your body uses different transport mechanisms to absorb glucose and fructose. In the chart when a single source for carbs is recommended you can use a food that only has one of these carbohydrate types (usually glucose or a variant of it).

When multiple carb sources are recommended for extremely long races or training sessions you should consume both glucose and fructose.

Refer to the Macros Inc Guide to Fueling Products which describes popular energy drinks, powders, bars and gels. It breaks down the macros in each product as well as how many carb sources they have and what those sources are.

Carb Intake During Exercise			
Exercise Intensity	**Exercise Duration**	**Amount of carbs** (Grams)	**# Carb Sources**
Low to moderate	45 min or less	None or mouth rinse	-
Sustained high intensity	45 - 75 min	None or mouth rinse	-
Low to high	1 hr	20 - 30 g	Single source
Low to moderate	1.5 hrs	30 g/hr	Single or multiple source
Low to moderate	2 hrs	40 - 50 g/hr	Single or multiple source
Low to moderate	2.5 hrs	50 - 60 g/hr	Single or multiple source
Low to moderate	3 hrs	60 g/hr	Single or multiple source
Low to moderate	2.5 hrs +	60 - 90 g/hr	Multiple source

Adapted from: Jeukendrup, A. (2014). A step towards personalized sports nutrition: carbohydrate intake during exercise. Sports Med 44 Suppl 1: 25-33, 2014.

Eating After Training

How much you should eat after you're done your exercise or race depends on factors such as what you ate beforehand, what you ate during your event, duration of event, intensity of your session and when you have your next workout or race planned.

The goal of post exercise nutrition is to replenish fuel stores, to repair damage caused by exercise and to re-hydrate. In some cases you will want to begin eating and drinking soon after you stop your exercise; in other situations you can simply wait to eat and drink at your next regular meal.

Post-exercise feeding is less important if you've eaten well before and during your training session.

But if you have another workout or event planned the same day then post-exercise nutrition becomes very important and you should take in food and fluids within an hour of completing your workout or race. In some cases, the sooner you do this the better so your body can begin the process of refilling your glycogen stores and repairing tissues.

If you are doing two training sessions in one day ideally aim to have 6 - 8 hours between them. Several options are outlined below on what and how much to eat after exercise depending on your situation.

Option #1

If exercise duration was easy to moderate and lasted 45 min. or less simply stick to a regular meal schedule.

Option #2

If exercise was high intensity and lasted an hour or it was low to moderate intensity but lasted 90 minutes or longer, consume 30 – 60 g carbs (any kind) + 10 – 20 g protein within 1 – 2 hours of training.

Consume a liquid meal (i.e. a shake) if you can't eat solids otherwise solid is fine.

Eat a regular meal schedule rest of day.

Option #3

If you have a second event or training session scheduled that day consume 30 – 60 g carbs (any kind) + 10 – 20 g protein within 1 – 2 hours of training.

After this eat 1.0 g/kg of bodyweight of carbs + 0.25 g/kg of protein every 15 – 60 minutes for up to 5 hours.

Fats can provide additional calories but meet the above requirements first.

You can spread calories out or eat fewer, bigger feeds depending on what works better for your schedule and individual tolerances.

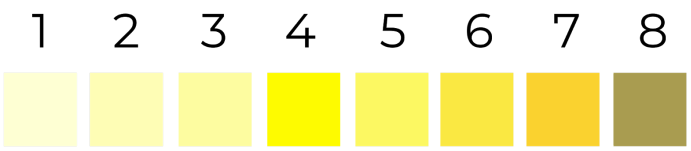
Liquid meals may be better than solids if your second workout is less than 4 hours later.

HYDRATION FOR ENDURANCE SPORTS

Adequate hydration is important to perform well and recover from endurance sports. In this section you'll learn how much water to drink every day and during races or workouts.

Daily Hydration

You can use urine color to customize your individual fluid needs on a daily basis. Aim to have clear or light colored urinations according to the scale below. Keep in mind that some vitamin supplements such as vitamin C will affect urine color.



Urine color scale

If your urine color falls within 1-3 you are well hydrated, but if it is 7 or higher you are likely dehydrated and should consume fluid.

Water, coffee, tea, diet soda, soda, juice, milk, etc., and the fluid in fruits and vegetables all count towards fluid intake. Alcohol however, does not count and does have a dehydrating effect.

Alternatively you can use the following guidelines:

- Imperial Body Weight 2/3 of your body weight (lbs) in fluid ounces
- Metric Body Weight 1L of fluids for every 23 kg of your body weight

Glycogen Storage and Fluid Retention

As discussed previously carbohydrates can be stored as glycogen in your body in your muscles and liver. For every gram of glycogen you'll also hold around 3 grams

of water. So if we use the average figure that a typical person can store 600 grams of glycogen that's 1800 grams of water that can be stored. This amounts to almost 4 lbs!

This is basically helping you come into your workout adequately hydrated. However if you don't drink enough water day to day you can still come into the workout slightly dehydrated.

Hydrating During Training

During races and workouts you will sweat and lose body fluids. You shouldn't try to replace all those fluid losses. While you can certainly become dehydrated during endurance sports, the dangers of over-drinking water can also lead to severe consequences so you need to drink enough but not too much.

In general the fastest athletes who finish at the front of the pack tend to be dehydrated while those at the back of the pack tend to be overhydrated.

Follow these guidelines to help you optimize your hydration for racing and training.

- Stop drinking fluids about 30 minutes prior to the event.
- Drink according to thirst if the event is 90 minutes or less.
- For events longer than 90 minutes drink 4 – 8 oz. (100 – 250 ml) every 15 – 20 minutes.
- Do not consume more than 1L per hour for events lasting 2 hours or more to avoid the risk of over drinking water.
- Gulping may be better than sipping.
- Colder water may be absorbed quicker than warmer water.

For events under 90 minutes duration plain water is good enough to drink.

For longer events of 3 hours or more, you might be better off using an electrolyte supplement along with your water. In ultra endurance events using electrolytes is highly recommended.

Electrolytes are important minerals that help our muscle function. Sodium is the most important electrolyte to replace. Potassium, calcium, chloride and magnesium are other electrolytes that are added to many products but they are not as vital as sodium.

How much sodium you should consume depends on many factors such as environmental conditions, air temperature, individual sweat rate and how much sodium you eat daily.

As a guideline for long events or when exercising in hot, humid conditions, take 500mg or more of sodium per hour.

The Macros Inc Guide to Fueling Products lists the amounts of sodium in various popular electrolyte drinks. Try different ones to find which flavors and brands work best for you.

Post Exercise Hydration

Immediately after training or racing, drink 500 ml to 1 litre (16 to 34 oz) of water within the hour of finishing your workout. How much will depend on how much you've sweated out, temperature, humidity, etc. If you're extremely thirsty and need more by all means listen to your body and drink until your thirst is satisfied.

During the rest of the day after a hard or long training session, make sure to keep drinking water according to your thirst. Often this ends up being 1 - 2 cups (250 ml) of water per hour, though as noted above this can be higher in hot and/or humid conditions.

REFERENCES

Burke, L. M., Jeukendrup, A. E., Jones, A. M., & Mooses, M. (2019). Contemporary Nutrition Strategies to Optimize Performance in Distance Runners and Race Walkers, *International Journal of Sport Nutrition and Exercise Metabolism*, 29(2), 117-129.

Hew-Butler,T., Verbalis, J.G., Noakes, T.D. (2016). Updated Fluid Recommendation: Position Statement From the International Marathon Medical Directors Association (IMMDA), *Clinical Journal of Sport Medicine* 16(4), 283-292

Jeukendrup, A. (2014). A Step Towards Personalized Sports Nutrition: Carbohydrate Intake During Exercise. *Sports Medicine*. 44(Suppl 1), 25–33.

Jeukendrup, A. (Ed.). (2010). *Sports Nutrition - From Lab to Kitchen*. Maidenhead, UK: Meyer & Meyer Sport (UK) Ltd.

Murray, B., & Rosenbloom, C. (2018). Fundamentals of glycogen metabolism for coaches and athletes. *Nutrition reviews*, *76*(4), 243–259.

Purdom, T., Kravitz, L., Dokladny, K. *et al.* (2018). Understanding the factors that effect maximal fat oxidation. *J Int Soc Sports Nutr* 15**,** 3.

Thomas DT, Erdman KA, Burke LM. (2016). Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *J Acad Nutr Diet*, b116(3):501–28.