



Nutritional Science Primer

In order to discuss the complex nutritional needs of cyclists we first must define a few key metrics.

Osmolality

One of the most important nutritional metrics that cyclists should understand is Osmolality. Osmolality simply is the measure of solids in solution (mOsm/Kg). Why is osmolality a key metric for cyclists? Well, it answers the question of how much drink mix should go in your water bottle depending upon the type carbohydrate you choose. It also helps define the point of optimal uptake of calories. In addition, if your drink is hyper-osmolar you will find that gastrointestinal distress can be caused by the overloaded concentration of your drink mix.

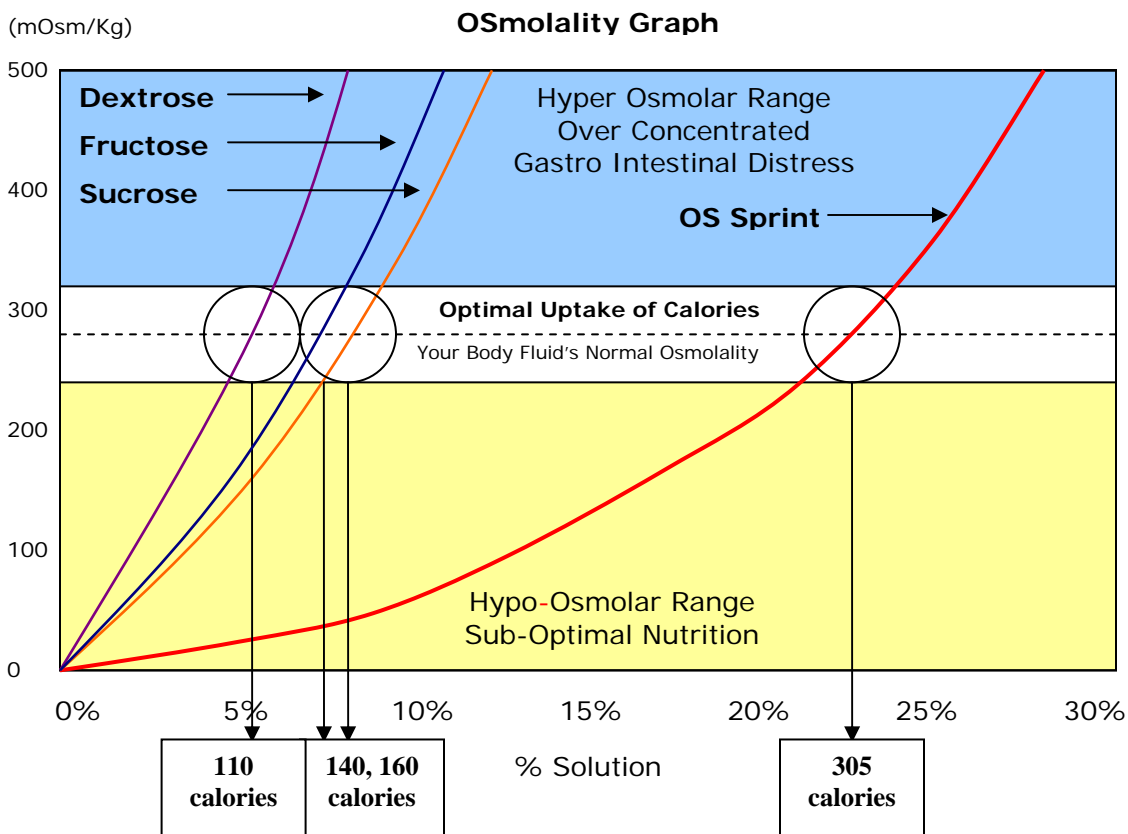


Figure 1. Osmolality, calories per 16oz serving mixed with water.

Your body's fluids maintain a normal osmolality of around 280 to 300 mOsm/kg. If you drink something that has a higher osmolality than your body's normal range, the drink solution is hyper-osmolar and can cause dehydration and gastrointestinal distress. Your body continuously tries to maintain its fluid osmolality and if you ingest something that is above its normal range, then your body will try to pull water from other parts of your body to balance the osmolality. A cyclist's performance will fall if over-concentrating the drink solution. This is contrary to your normal way of thinking that more must be better. In this case, overloading your sports drink will actually harm your performance and possibly cause gastrointestinal distress.

You would be surprised if you knew the osmolality of other commonly consumed sports drinks. These products can range in osmolality from 380 mOsm/Kg up to 570 mOsm/Kg, and more. 100% fruit juice has an osmolality of 690 mOsm/Kg. All of these commonly consumed products are hyper-osmolar, well over your body's normal osmolality of 280 to 300 mOsm/Kg. The same is true with bars and jells. These products are by definition over-concentrated sources of energy and require a significant amount of water to process the calories efficiently. To say the least, cyclists should not consume much of these products prior to riding and definitely not while on the bike. (Unless you plan to consume significant amounts of water to balance the osmolality.) If you do plan to consume these products, how much water would you need to drink? The bottom line is that these products simply were not designed for optimal nutritional performance.

Under-concentrated, hypo-osmolar, sports drinks, on the other hand, will not cause any problems other than providing a lower level of calories than what your body is capable of digesting. Since your body can function at a high level on stored glycogen for up to approximately 45 minutes of moderately high pace cycling, low caloric uptake is not an issue until glycogen stores start to become depleted 30 to 40 minutes into the ride. At this point caloric uptake becomes very important to performance and drinking under-concentrated sports drinks is simply not efficient.

Another important point about osmolality is that different drink mixes have different osmolality curves. We have defined the osmolality curves for dextrose, sucrose, fructose and OS Sprint. From the graph, figure 1, it is easy to see that simple sugars such as sucrose, fructose and dextrose have lower osmolality concentration curves indicating that your body can only tolerate low concentrations of these carbohydrates. Drink mixes that are based on simple sugars have a low caloric uptake. The average recommended concentration of these drink mixes are from 5% to 7% solutions when mixed with water yielding 110 to 160 calories per 16 ounce water bottle.

OS Sprint has a significantly longer concentration curve since it consists primarily of complex carbohydrates – pentasaccharides and other long chain carbohydrates. Your body is capable of digesting higher concentrations of complex carbohydrates than simple sugars. This allows OS Sprint to provide twice the calories at the same 280 to 300 mOsm/Kg, "optimal uptake" osmolality band. Twice the calories is a huge difference in a time trial or other sprint distance event.

Glycogen Depletion

The next metric that we need to explain is how your body manages glycogen, which is the stored fuel of your muscles. If you are eating a healthy diet prior to getting on the bike, then we can assume that your body has a 100% store of glycogen. As you exercise your body burns the stored glycogen. The graph below shows how your body depletes glycogen stores as you ride.

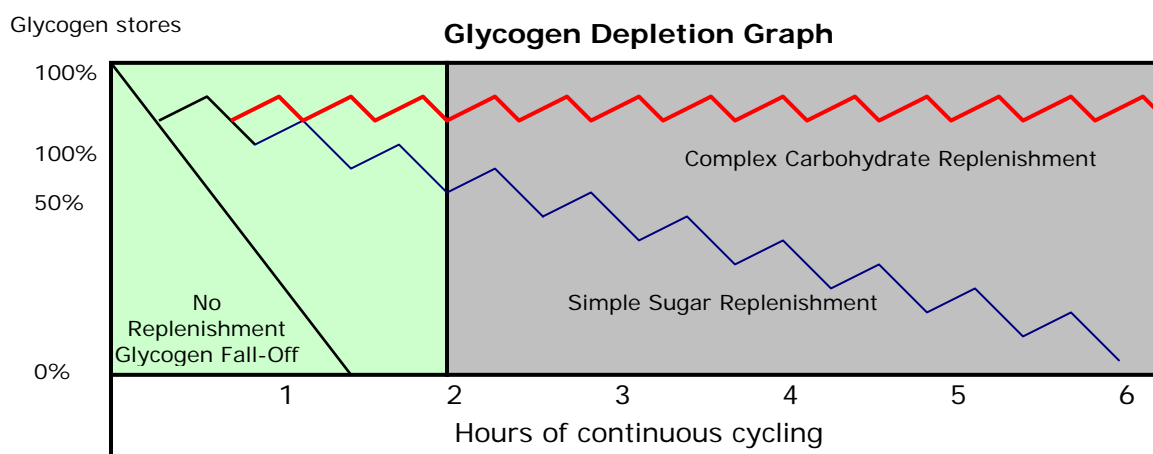


Figure 2. Glycogen Depletion.

Glycogen depletion is the normal process of your muscles burning stored glycogen. In general, we assume a cyclist with no caloric replenishment can ride for just over an hour before hitting the wall and "bonk" at 0% glycogen stores (longer if you are riding at a slow pace).

If you drink an osmotic solution, within the optimal uptake band of 280-300 mOsm/Kg, then you will be able to maintain an optimal level of glycogen replenishment. However, even with the optimal concentration of carbohydrates your body will not be able to sustain the same output for endurance events as it can for sprint events. In general, your body will automatically reduce output to the level of caloric input, which is why optimal caloric uptake is so important to cyclists.

For example, if you replenish your body with simple sugars while you ride, then your body will not be able to replace the calories that you are burning even if it is an osmotic solution and over time you will deplete your body's stored glycogen due to the net deficit of calories.

Complex carbohydrate loading is the most effective way to stay cycling longer and at a higher pace. Complex carbohydrate replenishment will allow for a significantly higher caloric uptake as compared to simple sugars. If you ride too fast in an endurance event, you will exceed the level of caloric uptake of even complex carbohydrates and potentially deplete glycogen stores. Therefore, finding your endurance pace that balances the level of glycogen burn with caloric uptake is the key to ultra-endurance cycling.

Your body will let you know when you are getting low on glycogen. You will feel fatigued and pedaling will become more difficult as stored glycogen levels go below 50%. Experienced cyclists will plan for the proper replenishment and at the proper pace for the duration of the event. (The irregular lines in Figure 2 represent caloric loading every 20 minutes.)

Natration

Now that we have explained osmolality and glycogen depletion, we need to discuss natration, the function of maintaining adequate sodium levels in your body. Your body loses sodium as you sweat and urinate. If you do not replace the sodium lost while cycling, then there is a chance you can suffer from hyponatremia. Before getting into the details, see the graph below to explain the issue.

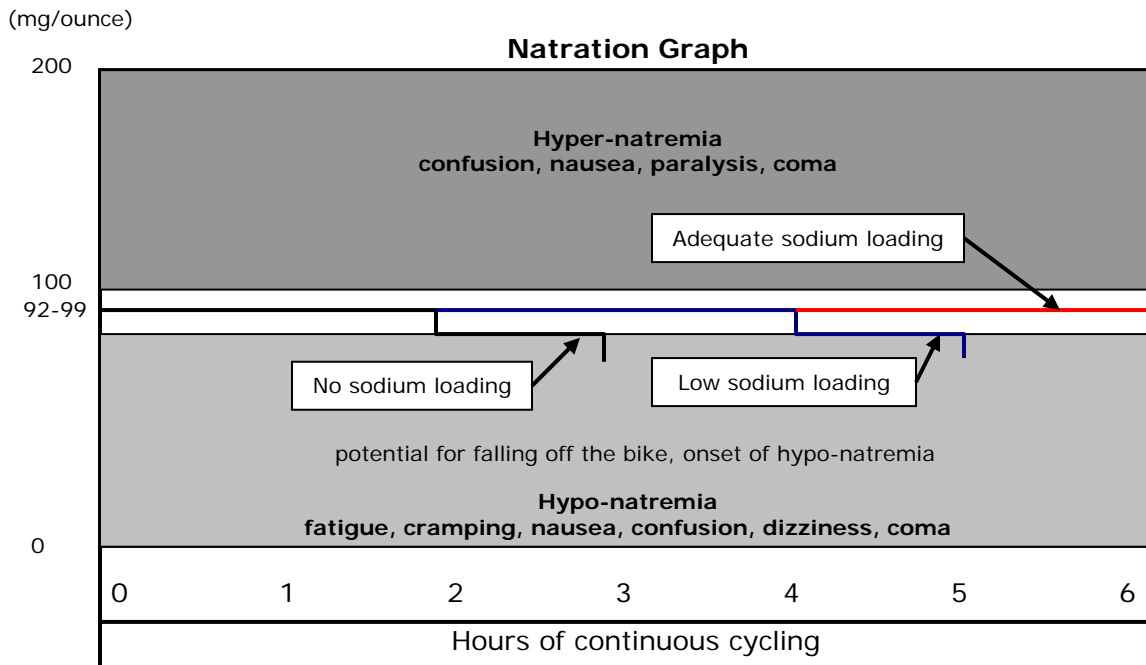


Figure 3. Blood Sodium Concentration.

Natration is important if you want to stay on the bike for a long period of time, especially if the conditions are hot and your sweat rate is high. Sodium is lost through sweating at approximately 34 mg per ounce of sweat. (However, every individual sweats at different rates based on fitness level and the prevailing conditions of temperature and humidity.) The reason that the sodium fall-

off line is not linear is that your body has a natural mechanism to maintain the blood sodium level within the 92 to 99 mg/fluid ounce range. Your kidneys have an ability to send less sodium out of your body as urine if your blood sodium starts running low. If you are dehydrated and your blood sodium level is too high, your kidneys will try to increase the sodium concentration in your urine.

It is roughly after two hours of continuous cycling during relatively hot conditions without sodium intake that you may start feeling dizzy. If this is the case, you are possibly seeing early signs of hypo-natremia. Even if you are using a sports drink with sodium, if it has lower sodium content than you are losing through sweat, then you will risk hypo-natremia if you ride much longer than 2 hours. The only way to maintain sodium levels in your blood while riding over 2 hours continuously is to intake sodium at a similar rate to your loss rate, approximately 500 mg per hour, however, loss rates vary based on an athlete's conditioning, pace and environmental conditions of temperature and humidity.

OS Endurance is designed to meet the needs of endurance cyclists by providing a balance of high quality calories and optimal electrolytes. OS Endurance has 327 mg of sodium per 24 ounce serving size. If you are cycling a 2 hour or longer ride and conditions are prime for sweating, then OS Endurance is the appropriate product for you.

Glycemic Index

One final nutritional metric that cyclists need to understand is the glycemic index. The glycemic index is a ranking of carbohydrates based on their effect on blood glucose levels. Carbohydrates that breakdown quickly during digestion have a high glycemic index. Carbohydrates that break down slowly have low glycemic indexes. The table below shows a list of commonly used carbohydrates and the corresponding glycemic index.

Carbohydrates/Sugars

Maltodextrin.....	105
Glucose.....	100
Sucrose.....	64
High fructose corn syrup.....	62
Honey.....	58
Lactose.....	46
Fructose.....	21
Artificial sweeteners.....	<5
Stevia Liquid Extract.....	0

People that are on a serious weight-loss diet may want to maintain a low glycemic diet; however, cyclists when on the bike need to consume high glycemic carbohydrates. The carbohydrate of choice is maltodextrin. The high glycemic index of maltodextrin is similar to blood glucose and is converted to glycogen faster than any other carbohydrate. Faster conversion or uptake is important for cyclists in that it helps to quickly replace burned glycogen far better than simple sugars such as fructose.

Note that cyclists that are diabetic need to be careful about using maltodextrin and make sure that insulin levels are capable of managing efficient conversion of maltodextrin into glycogen. The lack of sufficient insulin will cause elevated blood sugar levels.

Maltodextrin is the "gold standard" carbohydrate for cyclists since it has such a high glycemic index causing it to be quickly converted to glycogen, which is exactly what your body needs when you are riding hard. There is no other carbohydrate that can replenish your caloric loss faster.

Now that we have defined key metrics such as osmolality, glycogen depletion, natration and glycemic index, we can talk about what a cyclist's nutritional needs are and when those needs change.

Segregated Diet

Nutrition is a complex subject. Cyclists should try not to rely on one solution to fit all situations. In reality, your body needs certain nutritional replenishment at certain times and these needs vary with the situation. With this premise we propose that you think about nutrition in four distinct areas:

1. **Off the bike during the day;**
2. **Off the bike pre-event;**
3. **On the bike;**
4. **Off the bike post-event.**

Off the Bike During the Day Nutrition

Cyclists, on days which they are not on the bike, should simply eat a healthy, well balanced diet and get plenty of rest. I am sure that you have heard this before, so rather than getting into specific dietary recommendations, just eat smart, try not to drink too much alcohol during your training period and especially limit the alcohol before race day due to the dehydrating effect of alcohol on your body.

Carbo-loading, also called glycogen loading, during the days leading up to an event can be of benefit to a cyclist, however, let your body indicate when you have had enough and do not gorge your body with calories the day before an event. This will only increase the potential for gastrointestinal stress that could last well into your ride.

Glycogen loading is a specified regime of glycogen use through heavy exercise followed by reduced activity combined with a high carbohydrate diet. The glycogen use phase of the regimen typically takes two to three days of endurance exercise to deplete the body's stored glycogen and is followed by two to three days of rest and high carbohydrate loading prior to the targeted event.

Hydration is of equal importance. You should increase your intake of water at a minimum the day before the event until the color of your urine is nearly clear. This is a sign that you are fully hydrated.

Pre-Event

The hours before a race or training ride are critical. Your goal should be to top-off your muscle glycogen stores and start the event well hydrated. The process of carbo-loading should be avoided during the day of the event. It is too late and counterproductive to try to load your muscles with a big heavy meal a few hours prior to an event. Your stomach likely will take the next two hours or more working to digest the meal and if your event starts while you are still digesting, then your performance will suffer.

Prior to the event, a cyclist should keep a two-hour window free of solid foods. This is to ensure complete digestion of the calories that you ingest prior to riding.

A pre-race diet should contain water-soluble mix of carbohydrates and protein to top off your muscle stores for glycogen lost during sleep and or during the waiting period prior to the race.

OS Pre-Load

We created OS Pre-Load precisely for this purpose. OS Pre-load is a scientifically balanced 4 to 1 carbohydrate to protein mixture that when mixed with water provides a quickly metabolized source of pre-race fuel. For more information on OS Pre-Load go to the "Product Info" section of our website at www.OScycling.com.

Note that protein takes longer to fully digest than carbohydrates, so it is important not to overload on protein prior to the race, especially big greasy sausages, bacon, steak or ham. OS Pre-Load contains fast absorbing whey protein in an amount that is just enough to promote enhanced glycogen stores.

Also, foods such as bananas, bagels, cereals, and other carbs are fine to eat within the two-hour window but leave at least one hour for digestion prior to getting on the bike.

On The Bike

Now that you are on the bike, your body should have plenty of stored glycogen in your muscles and you should be well hydrated. The only thing that you will need to worry about during the first hour of riding is maintaining hydration.

However, some elite time trial racers do not even carry a water bottle. This is because those athletes understand that if you have prepared well by getting on your bike fully hydrated, then your body can perform at a high level for upwards of an hour before dehydration will start affecting performance. Since many time trial events do not last more than an hour this is a reasonable strategy and can have added benefits of lower aerodynamic drag and lower total weight due to not carrying a water bottle.

Understand that conditions will vary based on temperature, humidity and your general fitness level and will cause you to sweat at varying rates. Your sweat is exactly what you are trying to replace to maintain hydration. Therefore, your hydration strategy should be adjusted with the conditions.

After one hour of hard riding your body will start to become depleted of stored glycogen. If you do not replace the stored energy, then your performance will fall.

OS Sprint

We have created OS Sprint to restore your energy while on the bike. OS Sprint is a complex carbohydrate mix that is soluble in water, quickly metabolized by the body to replenish muscle glycogen, and on top of that it tastes great. For more information on OS Sprint go to the "Product Info" section of our website at www.OScycling.com.

What About Electrolytes

What about electrolytes? Why didn't we talk about having electrolytes in OS Sprint? All of the other sports drinks and supplements have electrolytes. Well, our nutritional philosophy is that if your body doesn't need it then don't put it in there. Electrolytes are a very important part of a long-distance cyclists' nutritional needs, however, sprint cyclists generally do not need added electrolytes. Your body's store of sodium, potassium, chloride and magnesium are not significantly depleted if your cycling event is under two hours in duration. Therefore, we do not need to load OS Sprint with electrolytes. We give your body exactly what it needs and that is pure energy in the form of long chain, complex carbohydrates.

However, if the event day is particularly hot, over 75 degrees Fahrenheit, then you need to consider adding electrolytes to your nutritional needs on the bike. The more you sweat the more electrolytes become an important part of your diet. We created OS Endurance precisely for this situation. OS Endurance has the same high quality source of long-chain, complex carbohydrates as OS Sprint combined with electrolytes to meet your needs on a hot day of riding.

OS Endurance

We have created OS Endurance to restore your energy while on the bike. OS Endurance is a complex carbohydrate and electrolyte mix that is soluble in water, is quickly metabolized by the body to replenish muscle glycogen and maintains the body's essential electrolytes lost through sweat. For more information on OS Endurance go to the "Product Info" section of our website at www.OScycling.com.

Protein Pros and Cons

What about protein? Why didn't we talk about having protein in OS Sprint or OS Endurance? Many other sports supplements talk of the virtues of protein. Well, the issue is optimal uptake of calories. Protein is a valued source of calories, but it is not as efficiently digested and converted to energy as carbohydrates.

When protein is supplemented into your diet a portion of protein goes to rebuilding muscle tissue and a portion gets converted into glucose for energy. The portion that gets converted into glucose

has a by-product called urea, which is created by the liver when it processes the nitrogen contained in the protein's amino acids. The kidneys excrete the urea, which requires water for processing the by-product.

Carbohydrates on the other hand are very similar to blood glucose and are converted to energy with no by-products other than carbon dioxide creating a highly efficient source of calories.

Therefore, protein is less efficient as fuel for energy and generally is not needed by most cyclist while you are on your bike, since muscle degradation is minimal. There is no question that your body is capable of processing the protein. The body is a superb machine and can process a large dose of protein. This issue at hand is optimal efficiency. If you are racing or simply trying to set a personal record you need to understand nutritional efficiency as much as you understand pedaling efficiency. Complex carbohydrates are the optimal fuel of choice when on the bike.

There is one caveat to the protein debate. If you are an ultra distance cyclist, riding over ten hours per day, then you need to consider adding protein to your on-the-bike diet. Protein supplementation can be of benefit to ultra distance cyclists due to normal muscle degradation that occurs during extremely long rides. Muscle degradation can be reduced and glycogen conversion can be enhanced for ultra distance cyclists by supplementing with protein. A suggested ratio would be 2 to 1 carbohydrates to protein. This is an easily digestible level of protein that will help ultra distance cyclists maintain a high caloric uptake while on the bike. Protein supplementation for ultra distance cyclists becomes more and more important the longer that you ride.

For most cyclists, protein supplementation is more important immediately after a ride, when digestive efficiency is not an issue and your body needs replenishment and recovery.

Off The Bike Post Event

After the race or training ride, your body needs protein, carbohydrates and electrolytes to replenish the body's depleted stores. This is especially important within the first hour after the ride. Drinking a balanced protein carbohydrate mix just after your ride will improve your recovery time and prepare you for riding again the next day.

OS Re-Load

We created OS Re-Load precisely for this purpose. OS Re-Load is a balanced high protein, complex carbohydrate and electrolyte mix that is soluble in water or milk depending on your taste. OS Re-Load should be taken within the first hour after getting off of your bike for maximum benefit and fastest recovery. For more information on OS Re-Load go to the "Product Info" section of our website at www.OScycling.com.

OS Re-Load should not be considered a meal substitute. Your body needs far more calories to fully replenish the calories lost during the ride, especially if you rode long and hard. You should eat a full, healthy meal as soon as it is convenient after getting off your bike.

Now that you have completed the race or training ride and have taken care of your body's nutritional needs, what do you do? That is an easy question to answer ... Sleep.

Life does not get much better than riding hard and sleeping well, except for the celebration at the end of your event when you have exceeded your expectations.

So get on your bike. Ride hard! Replenish well! Drink OS!

OS Pre-Load

OS Sprint

OS Endurance

OS Re-Load