Training and Racing
Optimal Fueling

Let's take a look at the puzzle for optimal fueling. By understanding muscle fatigue you will begin to discern the reasons why you simply get tired during exercise. We all get fatigued at some point. Recognizing the areas of muscle fatigue will help you address fueling during exercise and refueling upon completion. The six causes/symptoms of muscle fatigue are:

1. Dehydration
2. An increase in body temperature
3. Low Blood Sugar
4. Low muscle/liver glycogen
5. Increase in Lactic Acid
6. Central fatigue or mental fatigue

Dehydration:

1. What actually happens to your body when you experience these symptoms? When your body becomes dehydrated, this causes a reduction in your blood volume. The blood helps to not only pump oxygen and nutrients throughout your body but equally, the blood flow helps monitor and regulate the body's cooling mechanism. If you lose even 1-2% of your fluid volume (i.e. 150 pound person with a loss of 2% = 3 pounds) this can cause your body to "rev-up" its cooling mechanism, which causes an increase in your heart rate. Additionally, sweat helps to cool the skin surface which, in turn pumps cooler blood back through your working legs and arms. If the body is dehydrated, this cooling mechanism is compromised.

Prevention:

1. Consume a fluid replacement drink (FRD) 4-12 ounces in extreme heat and humidity and high altitude 6-10 minutes before exercising.
2. Drink a FRD throughout your exercise period (2-5 ounces per 10 minutes during training sessions longer than 45').
3. Weigh yourself pre and post exercise. Replenish fluid loss at 150% beyond the actual weight loss (i.e. If you lose 1 pound of fluid – 16 oz. – then replace with 24 ounces.

Body Temperature:

The body's internal thermostat is directly related to the air temperature, humidity acclimation to the environment and training workload. If your body is unable to keep up with the existing environmental condition then the core temperature can rise dramatically.

Prevention:

1. Follow the same guidelines for dehydration.
2. If possible, avoid mid-day exercise during the hotter months.

3. Allow 10-14 days to acclimate to the environmental conditions – particularly if you have an upcoming race.
4. Wear light but protective clothing during the hotter months.

Low Blood Sugar:
This can be caused by inadequate pre-exercise fueling. Generally, if the activity is 45 minutes or less, the workload is moderate or conversational pace, and the environmental conditions are favorable, fueling is not an issue. However, in longer sessions of 60 minutes or more, you will need to fuel routinely. (See prevention under dehydration). Additionally, if you're an early morning exerciser, to boost your morning blood sugar, you will need to "fuel up" before training. At night, your trained body is a metabolic furnace. Your brain is burning the blood sugar and liver glycogen stores. In the morning, you will need to "top-off" the liver glycogen and boost your blood sugar.

Prevention:
1. *Morning workout – eat 150-250 calories before exercise. (.5 to 1.0 grams/kg of CHO).
2. Preferably, consume a carbohydrate/protein drink of approximately 4 to 1 ratio. The carb/protein combination will improve and lengthen endurance performance by sparing muscle glycogen and limiting muscle damage for repeated training sessions.
3. People that are sensitive to food intake before racing consume 60-120 calories to elevate blood sugar.

Low Muscle and Liver Glycogen:
Muscle glycogen sparing is a factor of these three areas:
1. Fitness level – If you're under-trained, your body will prefer to burn muscle glycogen.
2. *If an inadequate warm-up (to short or too quick) – A faster rate of "burning" will occur.
3. Being repeatedly over zealous on the harder sections (i.e. hills, into the wind and sprinting) will cause a rapid decline in muscle glycogen.
4. **Coaches: 4-6 repeats of 15 to 25" at or near race pace is optimal. For a 1500 or 1km sprint, include 3-6 "build" sprints up to 20 seconds.

Prevention:
1. Pre-drink before exercise – 4 to 12 ounces - 6 to 10 minutes before exercise.
2. Choose a (FRD) with carbohydrates and protein.
3. Get in shape.
4. Don't be the hero on the climb nor the leader in the first 300 meters/exception is the 1500 or 1km races.

Increase in Lactic Acid:
As your intensity increases over the top end of your aerobic exertion, the simple cues are an elevation in heart rate, rapid ventilations (breathing rate), achiness or dullness in the muscles and acute concentration. These cues suggest you are most likely producing lactic acid. Fortunately, this lactic acid is re-synthesized or utilized by your body as fuel. The bad news is, you've got to slow down if the exertion is too high. An increase in lactic acid is commonly felt with an over ambitious start in the swim leg, an aggressive larger gear climb up a hill or a progressive buildup in speed.

Higher intensity exercise produces a hormone called Cortisol. Cortisol adversely affects muscle repair, regeneration and, ultimately, throttles immune function. Due to the

breakdown of muscle protein by this hormone, endurance exercise for long periods, as well as high energy, lactic acid producing intensity can be destructive without proper fueling.

Prevention:

1. Eat protein and carbohydrates at every meal.
2. Include the pre-hydration plan under dehydration.
3. Practice consuming a FRD containing carbohydrate and protein at 10-15 minute intervals during exercise.
4. Monitor training intensity.

Mental Fatigue:

The area of mental fatigue causing a decline in performance is particularly a problem during longer events. The athletes need to "fuel" to prevent mental fatigue. Long duration exercise causes a higher usage of amino acids (protein) and prefers the branched chained amino acids (BCAA) leucine, isoleucine and valine. As the body gobbles these up and if inadequate fueling is taking place, an amino acid called tryptophan enters the brain. Tryptophan causes the sensation of drowsiness and ultimately, the sensation of physical fatigue.

Prevention:

1. Maintain blood sugar during exercise. Consume FRD or supplement with gels or bars for long-term exercise.
2. Providing protein and carbohydrate keeps up blood sugar and spares the muscle glycogen.
3. The carb/protein drink should have 5 to 6 grams of whey protein per serving. This will hold off the BCAA decline and the influx of tryptophan.

In summary, the pre-fueling and maintenance of fuel intake during exercise is vital to your performance. If you are monitoring your intake before and during exercise you will set yourself up for a faster recovery during refueling post-exercise. There are five key points for fueling before and during exercise.

1. Select a FRD that has 130-250 Mg of sodium (Na). The Na helps retain the fluid in the cell. Hydrating just with water flushes the cell and reduces the Na concentration.
2. Drink at regular intervals – every 10-15 minutes is key during longer and harder sessions.
3. Maintaining blood sugar with a FRD will limit your muscle damage post-exercise and "slow down" the immune system attack.
4. Specifics on your drink should be:
    - Na – 130-250 Mg
    - Comprised of maltodextrin, glucose and sucrose. Small amounts of fructose are OK but high concentrate fruit drinks should be avoided.
    - Select a CHO/PRO combined drink of approximately 3.5 to 4 CHO to 1 part PRO. By consuming protein during exercise, the muscle protein breakdown during exercise is reduced and slowed down.
    - Other electrolytes in your FRD should include approximately 80 Mg of Potassium and approximately 100 Mg of Magnesium.
    - Studies have also shown that approximately 80 to 100 Mg Vitamin C and 40 IU of Vitamin E have reduced post exercise muscle damage.

Window of Opportunity:

This term is used by coaches and exercise physiologists to describe the short time period that you must consume calories after exercising. Everyone's physiology

responds differently to workout stress and recovery; however, on average, 15 - 45 minutes post exercise is the key time to have begun to replenish the body. Surprisingly, the fall-off from this short window is quite dramatic. If you waited 60 minutes post exercise to refuel, your body has already gone into a "starvation mode". The carbohydrate receptors, protein synthesis, muscle glycogen replenishment and immune system response are all dramatically affected. In fact, there can be a 40% reduction across the board from 15 minutes to 45 minutes.

In racing, if the body is refueled quickly, the hormone insulin, expedites the recovery process by:

1. Immediately boosting blood sugar which in turn:
2. Restores muscle glycogen levels
3. Accelerates protein enzymes, which help repair muscle tissue
4. Slows down the rapid rise in Cortisol, which catabolizes (breaks down) the muscle.
5. During heavy training and especially racing, fueling is key, particularly for multiple sessions or races on the same day.

We have all experienced huge fatigue and muscle soreness 24 to 48 hours after a strenuous training or racing day. The muscles immediately need the insulin to expedite the recovery and, hopefully, negate some of those extended recovery periods that we have all experienced.

The Window of Opportunity is a tight time frame peaking around 15 minutes and extending to about 45 minutes. After that, the muscles "turn-off" their receptors and insulin's effect is slowed. Consumption of just carbohydrates is good, combined with protein is 25-40% more effective in boosting the factors that I have mentioned. This is particularly important when you are doing multiple workouts or races on the same day.

<u>Specifics of Post Exercise Consumption in a Fluid Replacement Drink (FRD):</u>

1. The concentration of Cho to Pro should still be near 4 to 1.
2. Whey protein concentration of 14-18 grams with 1-2 grams Glutamine
3. Approximately
    - 150 Mg Na
    - 100 Mg K
    - 100 Mg Mg
    - 100 Mg Vit C
    - 150 IU Vit E

In order to calculate your energy costs, an energy factor can be determined based on the intensity of your exercise. The following chart is an approximation for Swim/Bike/Run.

Swim	.10 → 1'10" per 100 yards
Swim	.08 → 1'20" per 100 yards
Swim	.06 → 2' per 100 yards
Cycling	.15 → 23 mph
Cycling	.12 → 20 mph
Cycling	.09 → 17.5 mph
Cycling	.08 → 15 mph
Run	.13 → 6' mile
Run	.10 → 7' mile
Run	.09 → 9' mile
XC Skiing	.16 → 2'40" /km
XC Skiing	.15 → 3'00" /km

XC Skiing .14 → 3'15" /km
XC Skiing .13 → 3'30" /km
XC Skiing .12 → 3'45" /km
XC Skiing .11 → 4'00" /km

An example using the above table:
Calories x minutes x pounds = total calories

Cycling 17.5 mph = .09
Minutes exercise = 90' workout
Weight = 180 pounds
.09 x 90' x 180# = 1458 calories

20 km of XC Ski @3' / km
Minutes of exercise= 60'
Weight= 150 lbs.
Metabolic factor= .15
.15x60'x150lb.= 1,350 cal/hr
Calories consumed during exercise= 200 [1350-200=1150]
50% of 1150= 575 calories consumed in 15-45 post exercise

Athletes' sweat rate during the winter will range from 2-5 ounces of water per 100 calories burned. So, a "normal" SR @ 4 ounces per 100 cal. or 4x1350=approx. 44 ounces of fluid partially lost in an hour of hard exercise.

During exercise, the total calories that need to be replaced are approximately 25-33% of the total caloric expenditure. This range during exercise is 365 to 490 calories.

Estimating the calories consumed post exercise during the window of 15 to 45 minutes is approximately 50% of the net calories. In this example, the athlete consumed approximately 400 calories during exercise with a 1400 calorie workout effort.

1400 – 400 = 1000 calories x 50% = 500 calories.

So, in order for the recovery machinery to maximally rebound, this athlete should take in approximately 500 calories of carb/protein within the mentioned recovery time.

This method of estimating exercise and post exercise calories should be a helpful guideline. Recognize that body size, temperature, humidity, exercise intensity and background all factor into the equation.

Lastly, the principles of training – progression, overload and recovery are all directly related to your diet. Good luck in the next few months of training and racing!