Fueling for Performance

Nutrition Strategies for Training and Competition

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"After exercise, the dietary goal is to provide adequate energy and carbohydrates to replace muscle glycogen and to ensure rapid recovery. If an athlete is glycogen-depleted after exercise, a carbohydrate intake of 1.5 g/kg body weight during the first 30 min and again every 2h for 4 to 6h will be adequate to replace glycogen stores. Protein consumed after exercise will provide amino acids for the building and repair of muscle tissue. Therefore, athletes should consume a mixed meal providing carbohydrates, protein, and fat soon after a strenuous competition or training session."

(ACSM, ADA, Dietitians of Canada Joint Position Statement on Nutrition and Athletic Performance, 2000, p 2131)

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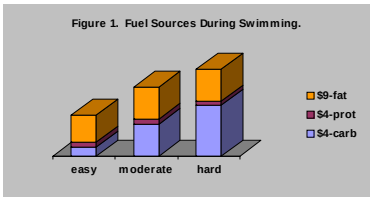
The Power of Nutritional Recovery

How well a swimmer recovers from a workout can affect the quality of their next practice.

A quality workout depends on the replenishment of fuel sources used/spent during previous sessions. Here's why:



For starters, the total amount of energy required to perform an activity increases with exercise intensity. We also know that carbohydrate and fat tend to be the body's fuels of choice during any variety of exercise intensities (the body will tap into protein as a fuel source only when carbohydrate and fat are not readily available) (see Figure 1.).

Because less oxygen is required to access a molecule of carbohydrate compared to a molecule of fat (i.e. carbohydrate "costs" less), carbohydrate is metabolically easier to access than fat. For this reason, carbohydrate becomes the primary contributor to the total amount of energy required as training sets toughen.

For us, this means that swimmers (sprinters, in particular) rely heavily on carbohydrate as their primary fuel source during most workouts. Much of this carbohydrate comes from the storage form, glycogen.

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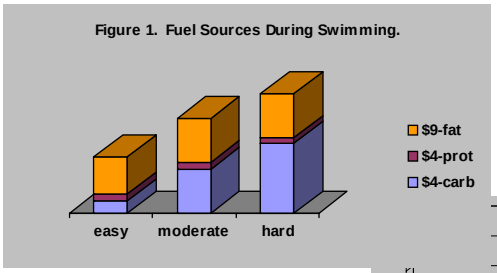
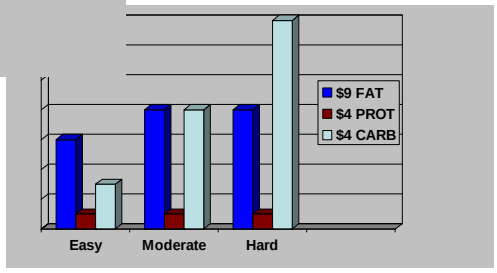
The Energy "CO$T" of Swimming





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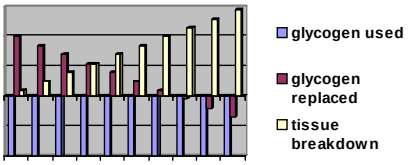
There is a direct link between fatigue and muscle glycogen depletion.

Over time, if the glycogen spent during one workout is not replenished prior to the next, the net effect is a reduction in the amount of glycogen available to fuel the tough sets. Should the intensity of the work remain too high for the body to rely on fat as the primary fuel source (which it will!), the body will turn to protein. Generally this translates into tissue breakdown or damage.

Although some tissue damage is normal with training, this series of events demonstrates the importance of replenishing glycogen stores *after every workout*.

Figure 2. Long-term failure to replace glycogen leads to tissue breakdown.



Replenishing stores after every workout, not only maintains energy reserves from workout to workout, but also limits the amount of tissue damage per workout and over time (see Figure 2 above).

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Glycogen and Recovery

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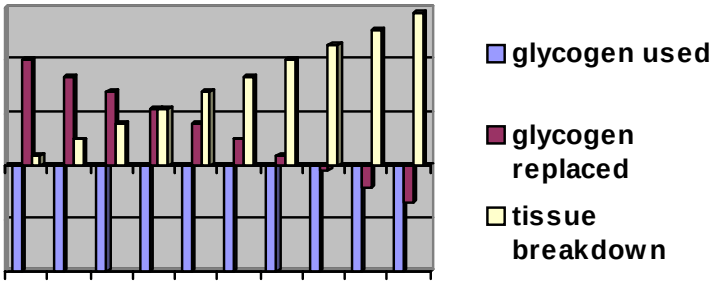
Figure 2. Long-term failure to replace glycogen leads to tissue breakdown.



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The first two hours post-workout are the most critical.

Depending on the extent of depletion, it can take as long as 24 hours to fully replenish glycogen stores, but the first two hours post-workout are the most critical. Given the right fuel, glycogen synthesis during this time can occur as much as *2-3 times faster* than normal.

This is due to the increased sensitivity of muscle cells to the hormone insulin, which rises in response to an increase in blood sugar (i.e. after eating carbohydrate). It is insulin's job to remove sugar from the blood and store it, preferably as glycogen. At most times during the day, there is a limit to the amount of glycogen that can be stored at one time, and once that limit has been reached, the remaining blood sugar may be stored as fat. A good reason to eat smaller amounts of carbohydrate at more frequent intervals during the course of a day, or to eat high-carbohydrate foods that also contain some protein, fat and/or fiber (each of these lessens the glycemic response). Thanks to the body's enhanced sensitivity to insulin right after exercise, the exception to this storage limitation is the two hours immediately following a tough workout.

The general idea is to take advantage of the body's natural post-exercise sensitivity to insulin by providing it with food that will (1) raise insulin levels, (2) put glucose in the bloodstream quickly and (3) enhance the conversion of glucose to glycogen.

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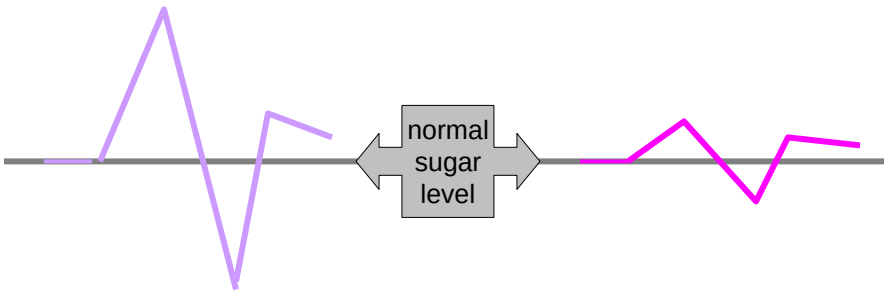
Eat Early and Often



Bigger Meals
(3 per day)
Insulin Spikes

OK post-workout

Smaller Meals
(5-6 per day)
Insulin Steady

Preferable during day

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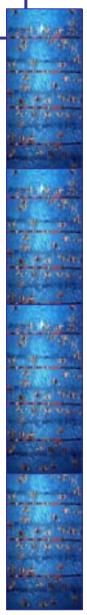
Remember…



- There is a limit to the amount of glycogen that can be stored at one time.
- Remaining blood sugar may be stored as fat.
- A good reason to eat smaller amounts of carbohydrate at more frequent intervals.
- A good reason to eat high-carbohydrate foods that also contain some protein, fat and/or fiber (each of these lessens the glycemic response).
- The exception to this storage limitation is the two hours immediately following a tough workout.

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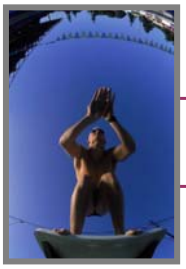

S&S of Poor Nutritional Recovery

Training (chronic/long-term)

- "lead legs"
- "can't keep up"
- elevated resting HR
- elevated HR on typical sets

Racing (acute/immediate)
(usually on back end of meet)

- lower post-race peak lactate
- diminished recovery
- feelings of fatigue
- elevated resting HR
- longer post-race HR recovery

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Experience the Power of Good Nutritional Recovery!

Experts suggest that eating carbohydrate in the amount of 1.2-1.5 g/kg/hr for up to 5 hrs post-workout is optimal for glycogen re-synthesis. There is also strong evidence indicating that adding protein to the post-workout snack enhances the insulin response, resulting in more glycogen storage. Some experts suggest that adding protein simply creates a more anabolic (muscle-building) state during recovery. Also not a bad idea.

Regardless, while carbohydrate is the body's top preferred nutrient for the post-workout snack, including protein (1 gram for every 4 grams of carbohydrate) is likely to enhance recovery by enhancing glycogen storage or preventing post-workout tissue breakdown or both.

It's a win-win situation.

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Good Nutritional Recovery

Maintains energy. ~ Limits tissue breakdown.
Especially during periods of high volume/high intensity.

Training

Start the replenishment process IMMEDIATELY! The "window of opportunity" for maximizing glycogen repletion starts to close as soon as exercise stops…it lasts for about 2 hours.

1.2-1.5 g/kg/hr for up to 5 hrs post-workout

Racing

Eat a high-carb/moderate-protein snack IMMEDIATELY after your PRELIMS race and immediately after your FINALS race, then again after warm-down.

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Recovery Nutrition Tips & Reminders

- Adjust post-exercise fuel intakes accordingly. Focus on maximizing glycogen repletion when practices are exhaustive. You might not need to replenish as long when workouts are not as intense.
- Most replenishment periods should continue for at least 2 hours, but may last as long as 5 hours if the workout was completely exhaustive.
- Something is better than nothing. If you just can't meet the 1.0 g/kg/hr for at least two hours recommendation, consuming *some* carbohydrate fuel immediately after workout will do more to help prevent chronic or long-term glycogen depletion than consuming nothing at all.

Maximize Nutritional Recovery

•Start the replenishment process IMMEDIATELY! The "window of opportunity" for maximizing glycogen repletion starts to close as soon as exercise stops…it lasts for about 2 hours.

•Pulse the system. Try to eat something substantial *every hour* versus waiting for the large meal or eating only every 3-4 hours.

•Something is better than nothing. If a swimmer just can't meet the 1.2-1.5 g/kg/hr for at least two hours recommendation, consuming *some* carbohydrate fuel immediately after workout will do more to help prevent chronic or long-term glycogen depletion than consuming nothing at all.

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Recovery Nutrition Q&A

How much is enough?

Consuming carbohydrate in the amount of 1.0-1.2 g/kg/hr (73-87 grams/hr for a 160 lb male) every hour for 4 hours is enough to maximize glycogen repletion following a tough workout.

What about added protein?

If a swimmer is consuming adequate amounts of carbohydrate (1.0 g/kg/hr, or 73 grams/hr for a 160 lb male) after an exhaustive dryland workout, adding protein or amino acid mixtures to the post-exercise fuel is not likely to enhance muscle glycogen replenishment. As far as its effect on protein synthesis, it doesn't seem to matter whether a recovery fuel is carbohydrate alone or carbohydrate combined with protein, as long as it provides at least 1.0 g CHO/kg/hr or fits the 1.0 g/kg/hr formula (4 kcal/kg/hr). Consuming carbohydrate in the amount of 1.0 g/kg/hr for 4 hours appears to be as effective in replenishing glycogen stores as combining that same amount of carbohydrate with arginine. For highly trained athletes, it seems that the insulin response is more important to post-exercise protein synthesis than increasing the amount of circulating amino acids. The added insulin response caused by the addition of protein to a carbohydrate-only drink can be achieved just as effectively by adding the same amount of extra carbohydrate. With a post-exercise carbohydrate intake of 1.2 g/kg/hr or more, insulin loses its effect after 2 hours. After this point, the rate at which glycogen is made is more dependent on other factors, such as digestion and absorption rates.

Does gender make a difference?

The amount of recovery fuel needed after a tough workout depends on a swimmer's body weight, not their gender. Recognize that many male swimmers weigh more than female swimmer, but not always.

Why water is *not* enough.

Water alone will not replenish glycogen stores that have been spent during practice. A fuel containing 1.0 grams of carbohydrate per kg of body weight every hour is far superior. For the 160 lb swimmer, that equates to about 73 grams of carbohydrate every hour.

What else?

- Eating nothing at all will only allow muscle glycogen stores to remain low and reduces the potential for complete replenishment.
- It's ok to consume recovery fuel that contains a small amount of fat.
- To maintain an elevated insulin level, it may be beneficial to divide fuel intake into more frequent "doses," such as every 15-20 minutes versus every hour.

The Final Word

- Recovering from one practice is just as important as fueling for the next. Changing workout intensity and/or duration can affect an athlete's nutritional needs during recovery. Keep these points in mind:
- Start the replenishment process **IMMEDIATELY**! The window for maximizing glycogen repletion starts to close as soon as exercise stops.
- Beyond the 1.0 g/kg/hr, it doesn't really matter whether it's extra protein or extra carbohydrate, as long as the caloric intake is sufficient (1.0 g or 4 kcal per kg per hour). For a 160 lb swimmer, that's at least 290 kcal/hr from carbohydrate, or that minimum plus some combination of carbohydrate and protein. Use the following tables for reference.

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Consider ONE of the following immediately after workout or racing, then another item an hour later:

Body Weight (lbs)	Carbohydrate Required to meet 1.2 g/kg	DRINK Examples (good anytime, but particularly for race days)	BAR Examples (good anytime, but particularly for race days)	OTHER Food Examples (good anytime, but particularly for home training days)
120-150	65-85 grams	35-50 oz Gatorade®* OR 35-50 oz Powerade®* OR 2 cans Carnation Instant Breakfast ™ OR 1.5 cans Boost ® OR 1.5 cans Ensure™	1.5 PowerBars® OR 1.5 PowerBar Harvest® bars OR 1.5 Clif® bars OR 2 50g pkgs PowerBar® Bites	2 cups apple juice* or cranberry cocktail* OR 2 servings of low-fat yogurt OR 1 cup dried apricots OR 1.5 PBJ sandwich
160-200	85-110 grams	50-65 oz Gatorade®* OR 50-65 oz Powerade®* OR 2.5 cans Carnation Instant Breakfast ™ OR 2.5 cans Boost ® OR 2.5 cans Ensure™	2 PowerBars® OR 2 PowerBar Harvest® bars OR 2 Clif® bars OR 3 50g pkgs PowerBar® Bites	2/3 cup raisins* OR 4 cups grapefruit juice* or orange juice* OR 2 medium bagels OR 4 slices watermelon* OR 1 bagel with peanut butter OR 2.5 cans Ensure™
>200	115+ grams	65+ oz Gatorade®* OR 65+ oz Powerade®* OR 3 cans Carnation Instant Breakfast ™ OR 3 cans Boost ® OR 3 cans Ensure™	2.5 PowerBars® OR 2.5 PowerBar Harvest® bars OR 2.5 Clif® bars OR 3.5 50g pkgs PowerBar® Bites	8 kiwi fruits* OR 2 cups canned fruit salad* OR 2 PBJ sandwich plus 1 serving yogurt

*(*indicates carb-only food)*

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Reminder: The values in this table are presented as guidelines only. While replenishing in 30-minute intervals may be a little better in terms of keeping insulin levels elevated, a swimmer will still benefit from taking a “full dose” every hour instead.

Body Weight in lbs (kg)	Carbohydrate Required (g) to meet Intake of 1.2 g/kg	Amount of Common Commercially-Available 6% Carbohydrate Bottled Sports Drink	Food Examples (for every 30 minutes)
120 (54.5)	65 (33 g/30min)	37 oz/hr	1 cup apple juice
130 (59.1)	71 (36 g/30min)	41 oz/hr	1 serving low-fat yogurt
140 (63.6)	76 (38 g/30min)	44 oz/hr	½ cup dried apricots
150 (68.2)	82 (41 g/30min)	47 oz/hr	1 cup cranberry cocktail
160 (72.7)	87 (44 g/30min)	50 oz/hr	1/3 cup raisins
170 (77.3)	93 (47 g/30min)	53 oz/hr	2 cups grapefruit juice
180 (81.8)	98 (49 g/30min)	56 oz/hr	1 medium bagel
190 (86.4)	104 (52 g/30min)	60 oz/hr	2 slices watermelon
200 (90.9)	109 (55 g/30 min)	62 oz/hr	2 cups orange juice
210 (95.5)	115 (58 g/30min)	66 oz/hr	4 kiwi fruits
220 (100.0)	120 (60 g/30 min)	69 oz/hr	1 cup canned fruit salad

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Body Weight	Carbohydrate Required to meet Intake of 1.2 g/kg	Amount of Common Commercially-Available 6% Carbohydrate Bottled Sports Drink	Food Examples (per hour)
120-150 lbs	65-85 grams	35-50 oz/hr	2 cups apple juice or cranberry cocktail OR 2 servings of low-fat yogurt OR 1 cup dried apricots OR 2 cans Carnation Instant Breakfast
160-200 lbs	85-110 grams	50-65 oz/hr	2/3 cup raisins OR 4 cups grapefruit juice or orange juice OR 2 medium bagels OR 4 slices watermelon OR 1 bagel with peanut butter
+200 lbs	115+ grams	65+ oz/hr	8 kiwi fruits OR 2 cups canned fruit salad OR 3 cans SlimFast

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Recovery Foods Comparison Chart

	Food Item	Amount	Carbohydrate (g)	Protein (g)	Ratio CHO:Prot	Fat (g)	Calories (Kcal)	Vit A (ugRE)	Vit C (mg)	Vit E (mg aTE)	Sodium (mg)	Potassium (mg)			
Solid Foods	Bagel w / Peanut butter	1w / 2 tbsp	49	16	3.1	17	399	0	0	3	558	345			
	Yogurt w / Grapenuts	8oz w / 1/2 cup	58	13	4.5	4	309	0	2	0	242	556			
	PBJ (white bread)	1 sandwich	44	12	3.7	18	375	0	1.5	3	415	287			
	PBJ (wheat bread)	1 sandwich	46	13	3.5	18	384	0	1.5	3.5	451	370			
	PowerBar (basic)	1 bar (65 g)	45	10	4.5	2	230	0	60	9	90	150			
	PowerBar Bites	1 bag (50 g)	32	8	4.0	5	200	0	54	9	190	160			
	Clif Bar (non-iced)	1 bar (68 g)	48	8	6.0	3.5	230	333	60	10	110	210			
Liquid Nutrition	Milk (2%)	8oz	12	8	1.5	5	122	0	2.4	0.2	122	376	Milk-based	lactose	casein
	Milk w / Chocolate Syrup	8oz w / 2 tbsp	24	9	2.7	5	172	0	2.4	0.2	170	407	Milk-based	lactose, sucrose	casein
	Carnation Instant Breakfast	1 can (10 fl oz)	37	12	3.1	2.5	220	450	30	2.5	230	610	Milk-based	lactose, sucrose	milk
	Boost	1 can (8 fl oz)	41	10	4.1	4	240	250	60	10	130	400	Lactose-free	sucrose,fructose	milk
	Ensure	1 can (8 fl oz)	40	9	4.4	6	250	250	30	2.5	200	370	Lactose-free	sucrose,fructose	soy,whey,milk
	SlimFast	1 can (11 fl oz)	40	10	4.0	3	220	350	60	10	220	600	Milk-based	sucrose,fructose	milk
	Gatorade Nutrition Shake	1 can (11 fl oz)	54	20	2.7	8	370	?	?	?	280	560	?	??	??
	VitA, VitC, VitE values based on 1997-1998 Dietary Reference Intakes (DRI) for Adult Males														
	(Vit A 1000 ug RE, Vit C 60 mg, Vit E 10 mg aTE)														

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Individual Requirements

First, covert your weight to kg: _____ lbs / 2.2 = _____ kg

	Low 6 g/kg-carb 1.4 g/kg-prot	High 10 g/kg-carb 1.8 g.kg-prot	Recovery 1.0 g/kg-carb for up to 3 hrs	Foods:
Carb total			---	
Carb recovery	---	---		
Carb remainder			---	
Protein total			---	

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Example:

<u>140</u> lbs / 2.2 = <u>63.6</u> kg

	Low 6 g/kg-carb 1.4 g/kg-prot	High 10 g/kg-carb 1.8 g.kg-prot	Recovery 1.0 g/kg/hr-carb for up to 3 hrs	Foods:
Carb total	382	636	---	
Carb recovery	---	---	64	
Carb remainder	318 (382 – 64)	508 (636 – 128)	---	
Protein total	89	114	---	

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USA Swimming's Position on Dietary Supplements

In an effort to maintain the integrity of our sport and the safety of our athletes, USA Swimming has taken a proactive role in making athletes and coaches more aware of the risks involved in the use of commercially available dietary supplements that have been linked to enhancing performance. Along with the US Anti-Doping Agency (USADA), USA Swimming considers dietary supplements "take at your own risk," placing full responsibility for any effects and repercussions on the athlete.

It is the role of USA Swimming to educate swimmers, coaches and parents on the issues of dietary supplements, including general and specific risks, normal values and toxicity, drug testing and drug interactions, stacking, and conventional dietary alternatives. It is also the role of USA Swimming to validate or repudiate via research review or sanctioned research the answers to the many questions that surround scientific and anecdotal evidence versus actual application. Any recommendations or opinions offered by USA Swimming regarding the use of dietary supplements are based on a yellow-orange-red light continuum Health & Contamination Risk Chart for Dietary Supplements and the most current publicly available scientific and consumer-specific information.

Claims made by the manufacturers/ distributors of dietary supplements regarding the effectiveness of their products are not stictly regulated by the US Food and Drug Administration. Any commercial dietary supplement is susceptible to containing substances that may appear on the Prohibited Substance list(s) of FINA and/or the IOC. The potential exists for commercial supplements to contain substances that do not appear on the product's list of ingredients (see Dietary Supplement Health and Education Act for more information). Statistics indicate that in some cases, the use of legal dietary supplements has been linked to positive test results for prohibited substances in athletics.

The choice to use a dietary supplement is the sole responsibility of the athlete and one that should not be made in haste. An athlete is advised to weigh the options heavily, consider the consequences, and take responsibility for his/her actions.

July 2003

Health & Contamination Risk Chart for Dietary Supplements

WARNING: *Lack of regulation in the supplement industry opens the door for supplement contamination that may result in adverse health effects and/or positive drug tests. Athletes are subject to sanctions even if a positive test is the result of a contaminated supplement.*

*Lower risk of adverse health effects and/or contamination.**	*Increased risk of adverse health effects and/or contamination.*	*High risk of adverse health effects and/or contamination.*
Major Brands** of Basic Multi-vitamins or Iron pills or carbohydrate-electrolyte drinks or nutritional bars ****"Major Brands" means reputable well-established companies that do not also make products containing prohibited substances.**	-Mega-dose pills (more than 300% of daily requirement) -Herbal products and products containing herbal additives (not listed as RED) -Protein powders/shakes -Creatine -Amino Acid mixtures -"Proprietary" ingredients -YELLOW risk products made by companies that manufacture any RED risk products.	Anything with the words: -"Andro-" or "Nor" **(Prohibited!)** -Ephedrine or Ma Huang or Guaranna - **(Prohibited!)** -"Anabol" or "Diol"*** or "Test"*** -"Reduces water retention"*** -"Energizer" or "Energy"*** -"Weight Loss"*** -"Muscle Builder" or "Stack" or "Stak" *** ****Likely to be or contain prohibited substances.** Avoid products from companies that manufacture any of the above or any other prohibited substances.

*Lower risk does not equal "zero" risk. There is evidence linking various YELLOW and ORANGE risk products to positive doping results.

Along with the US Anti-Doping Agency (USADA), USA Swimming considers dietary supplements "take at your own risk," placing full responsibility for any effects and repercussions on the athlete. The ultimate decision to use a dietary supplement is the sole responsibility of the athlete and one that should not be made in haste. All athletes are advised that the use of dietary/nutritional supplements is completely at the athlete's own risk, even if the supplements are "approved" or "verified." If you take dietary/nutritional supplements you may test positive for a prohibited substance, which is not disclosed on the product label. This would result in a doping violation. Please visit www.usa-swimming.org and www.usantidoping.org for important information regarding the risks of taking dietary supplements and the regulation of supplements in the United States. This chart was prepared by USA Swimming, 1 Olympic Plaza, Colorado Springs, CO (719) 866-4578.

For health reasons, athletes who have not completed puberty should not use any product with an ORANGE or RED risk.

Believe in the power of recovery!

Bring your post-workout snack to the pool every day. If you have a significant drive home, you should be eating it in the car and then having a decent meal when you get home. If you live close to the pool, you should have it ready right after practice to eat on the way home or as soon as you walk in the door. Solid foods are great, but oftentimes liquid nutrition (ex. Instant Breakfast, homemade smoothies) is more tolerable after heavy exercise. Individual preference will play a role, but the end result will be positive for you and your performance.

Go USA!

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To inspire and enable our members to achieve excellence in the sport of swimming and in life.

Good Luck!

Swim Fast!