Recovery Nutrition: Review and Application

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Is Chocolate Milk the answer?

Despite an equivalent carbohydrate content between chocolate milk and CR, and less carbohydrate in FR, subjects cycled 49% and 54% longer following chocolate

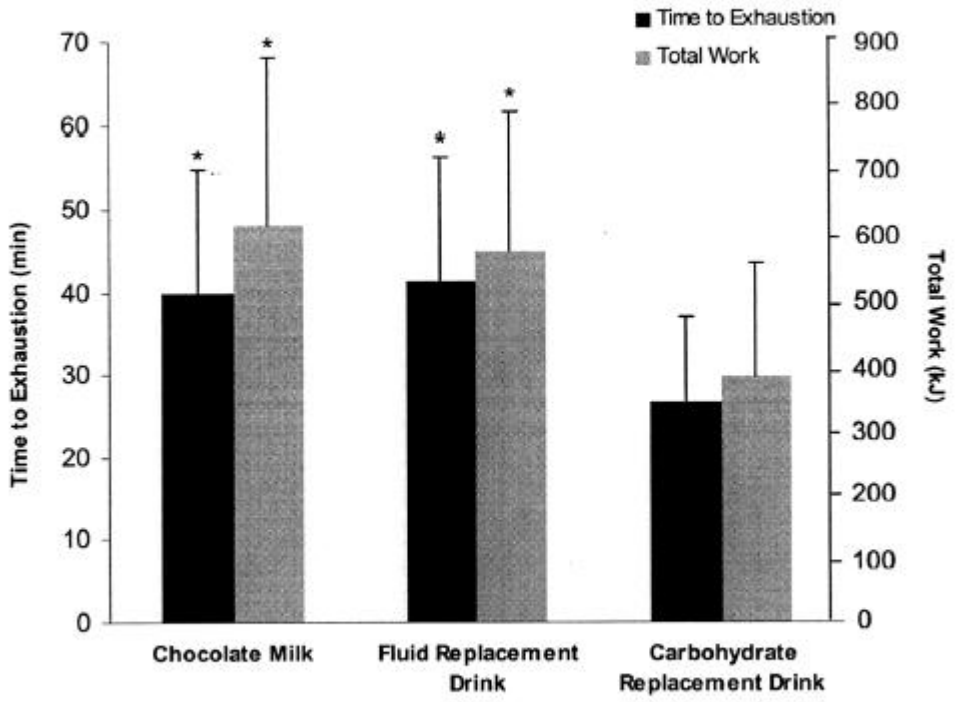


Figure 1—Time to exhaustion and total work performed during the endurance performance trial following ingestion of three different recovery drinks. *Significantly different from carbohydrate replacement drink ($P < 0.05$).

Is Chocolate Milk the answer?

Karp, J.R. et al. Chocolate Milks as a Post-Exercise Recovery Aid, *Int. J of Sports Ntr.* 16:78-91, 2006.

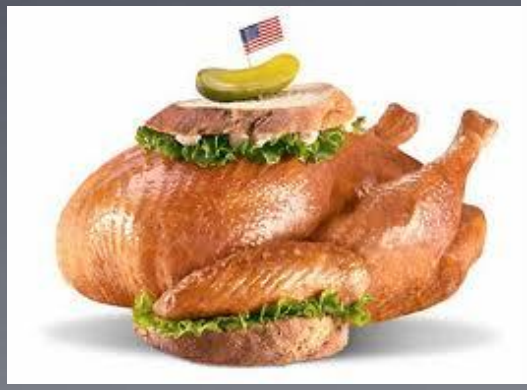
- PROS
  - Study focused on trained athletes (male cyclists)
  - Assessed recovery time with limited amount of recovery time (4 hours)
  - Assessed maximal exertion and time to exhaustion
- CONS
  - Biased funding group: Dairy and Nutrition Council, Inc.
  - Study was not Isocaloric (Recovery solutions yielded different calorie amounts)

Chocolate Milk's vs _____

	Whole Milk (3.25%)	Partly Skimmed (2%)	Partly Skimmed (1%)	Skim Milk (0.1%)	Chocolate Milk, Partly Skimmed* (2%)	Gatorade Thirst Quencher®	Gatorade Endurance Formula®	Accelerade®
Calories	159	128	108	90	189	52	53	85
kJ	663	536	453	380	793	218	221	354
PRO (g)	9	9	9	9	8	0	0	4
FAT (g)	9	5	3	trace	5	0	0	0
CHO (g)	12	12	12	13	27	15	15	16
Na (mg)	126	129	129	133	159	115	211	127

Simple Questions to ask to tailor Recovery Nutrition Needs

- What needs to be recovered after the training session?
- What nutrients will promote this recovery and how much do I need?
- What foods and drinks are suitable to provide these nutrients?



What dictates your recovery nutrition needs?

- Physiological Needs for recovery
  - Fuel store replenishment? CARBOHYDRATE
  - Replace fluid loss? HYDRATION
  - Muscle recovery? PROTEIN
- Performance/Composition Goals
  - Increased muscle growth? Prolonged aerobic activity?
  - Decreased fat mass?
  - Performance expectations with little recovery time?
- Accessibility to food and preparation materials
  - Naturally found foods vs. sports nutrition products

The Car Theory

Gasoline vs. Hardware vs. Oil

Physiological Needs

- Glycogen repletion (Gasoline)
  - The stored form of carbohydrate
  - Carbohydrate equals energy
  - Within the first 30-60 minutes, CHO ingestion recommended to increase resynthesis rate

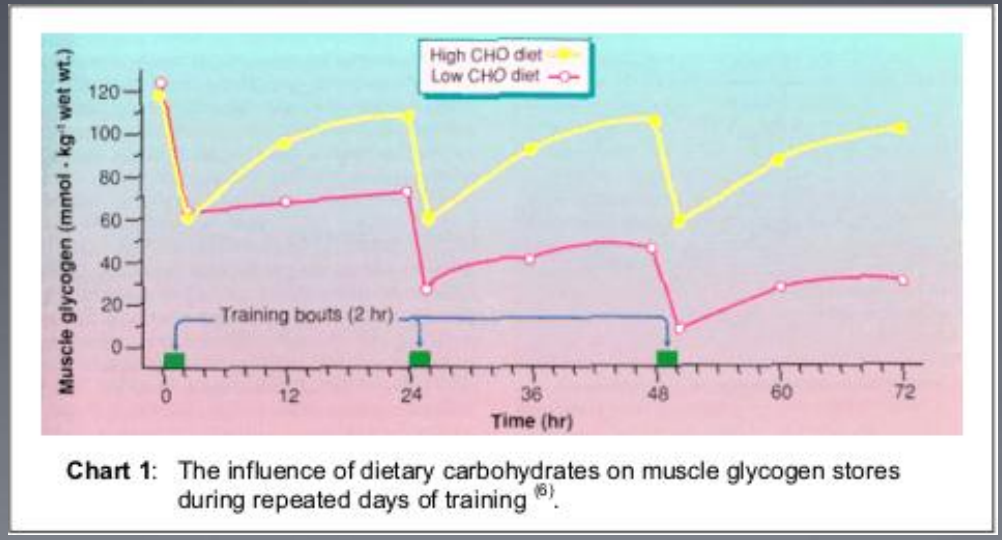


Chart 1: The influence of dietary carbohydrates on muscle glycogen stores during repeated days of training [6].

Review of Medical Physiology, 16th ed. Lange. 1993. Ed. William F Ganong. pp 434.

Effect of Timing on Glycogen Resynthesis

- Ivy, JL., et al. J Appl Physiol. 64: 1988
- The time of ingestion of carbohydrate supplementation was examined.
- After 70 minutes of "intensive" training, a carbohydrate solution was provided either immediately following activity (P-Ex) or 2 hours following activity (2P-Ex). 2g CHO/kg body wt was provided both times
- Results: Rate of glycogen storage was 3x greater immediately after exercise than it was 2 hours after the completion of activity
- Despite elevated plasma glucose and insulin with supplementation 2 hours post activity, a slower rate of glycogen storage was seen when compared to immediate supplementation

Results

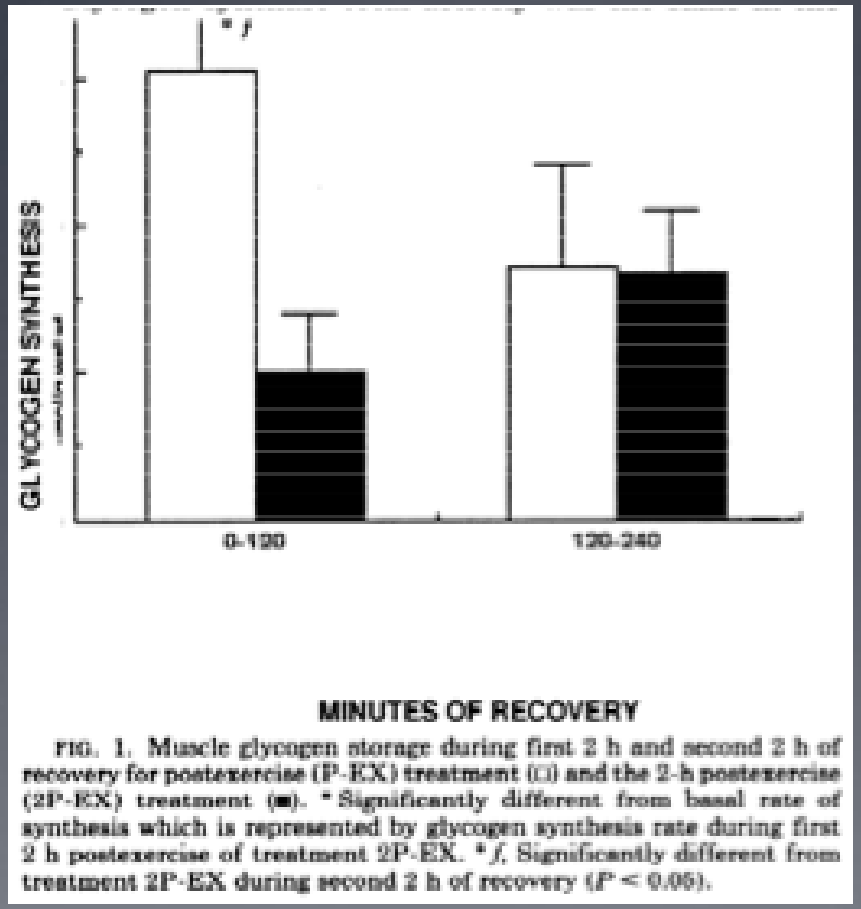


FIG. 1. Muscle glycogen storage during first 2 h and second 2 h of recovery for postexercise (P-EX) treatment (□) and the 2-h postexercise (2P-EX) treatment (■). * Significantly different from basal rate of synthesis which is represented by glycogen synthesis rate during first 2 h postexercise of treatment 2P-EX. *f, Significantly different from treatment 2P-EX during second 2 h of recovery ($P < 0.05$).

Carbohydrate Ingestion for Recovery: Additional thoughts

- Jentgens, R. et al, *Sports Med. 33: 2003*
- Higher glycemic index sugars increase glycogen storage (glucose vs. fructose)
- With shortened time for recovery, how much is needed to maximize glycogen synthesis?

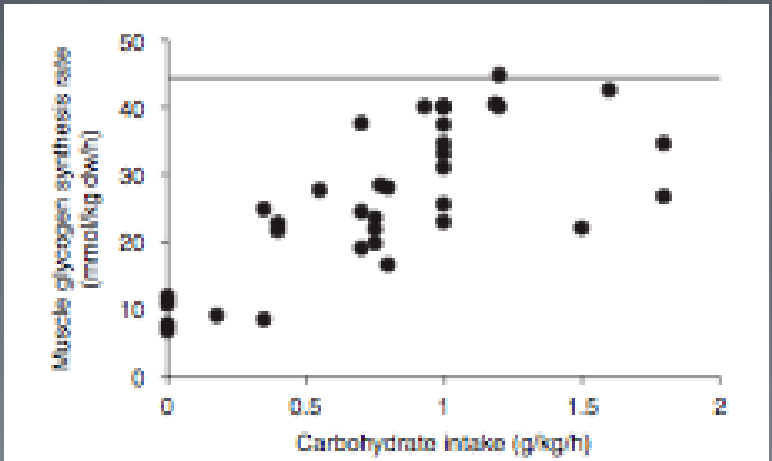


Fig. 2. Muscle glycogen synthesis rates are depicted against the rate of carbohydrate ingestion. The horizontal line depicts the absolute maximum for muscle glycogen synthesis.

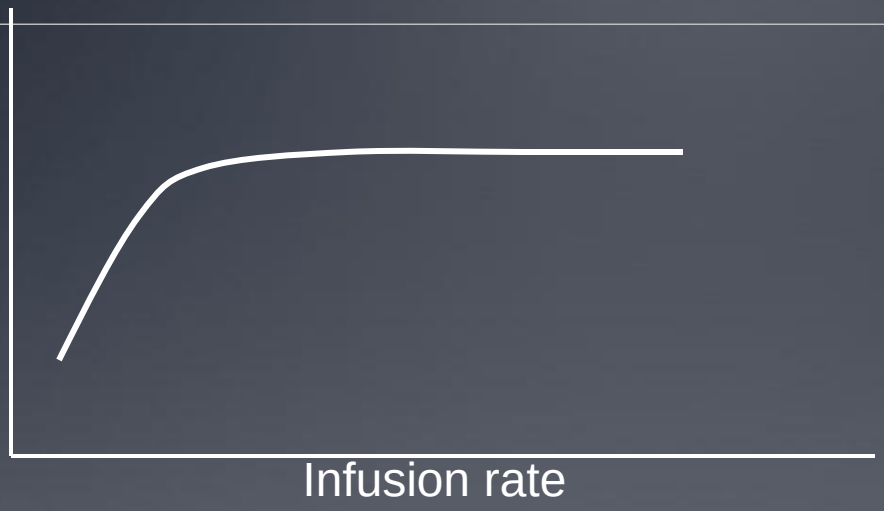
Physiological Needs

- Protein for Maintenance (Car: Gears, Pistons, etc. under the hood)
- High intensity activity breaks down muscle fibers
- Dietary protein provides building blocks for the maintenance, growth and repair of muscle fibers
- Protein with carbohydrate can increase insulin levels and activate further glycogen synthesis
- Intense training periods increase muscle breakdown
  - Ingestion of protein is necessary, but does timing of ingestion increase absorption??

AA Infusion Studies

- Rate of infusion is *saturable* after which a higher rate does not lead to greater synthesis.
  - Surprisingly small doses are effective (~ 6-10 g)
  - Extracellular AA concentration regulates muscle protein synthesis Bohe, 2003
- Infusion of AA has a *transient* response on PRO synthesis after which continued infusion does not lead to continued synthesis.
  - Multiple small feedings probably more effective than large bolus feeding Bohe, 2001

Maximizing Protein Synthesis After Exercise: two important facts



Saturable Response

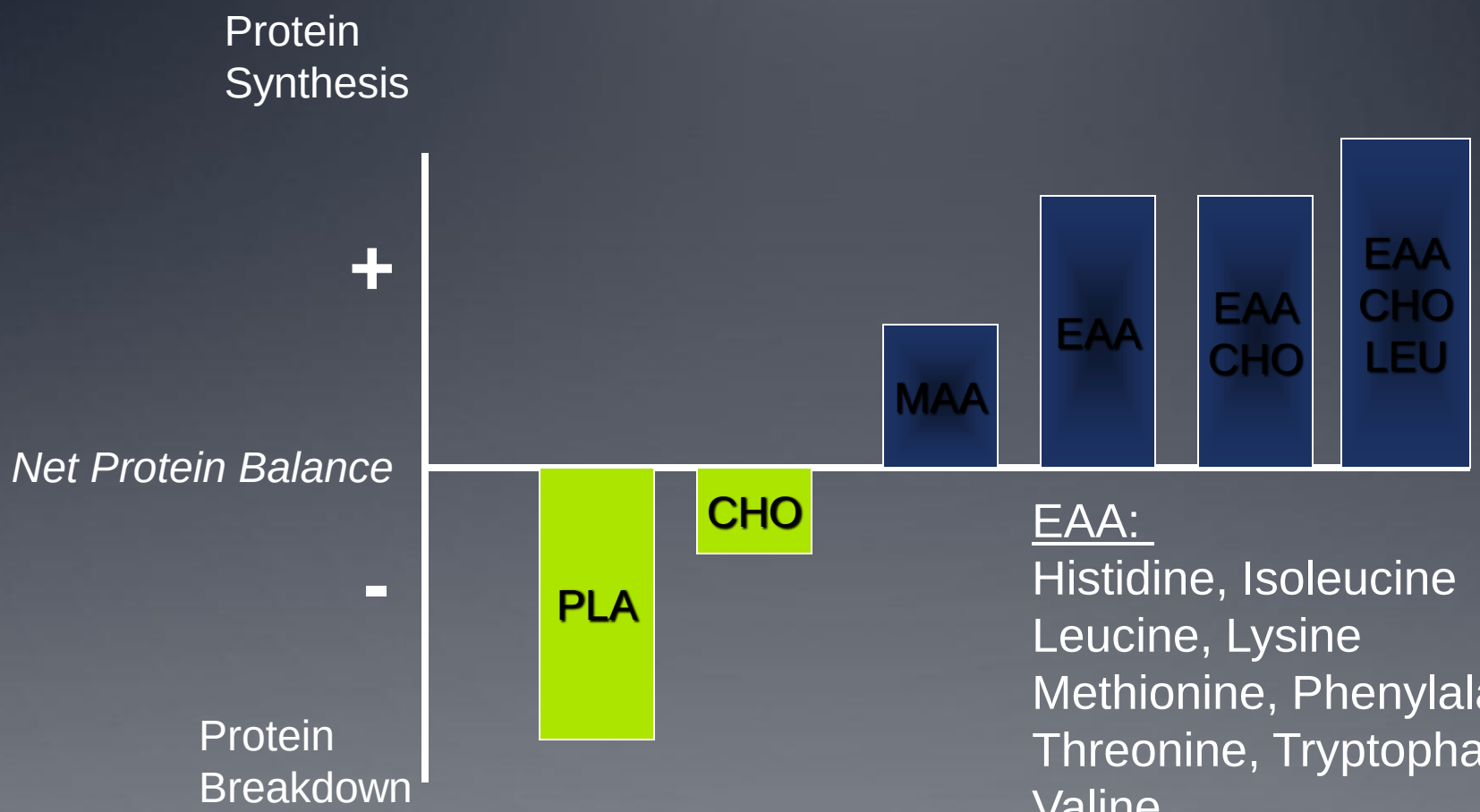
More is not better…

Transient Response

Multiple small servings can stimulate PRO synthesis…

not drawn to scale

Macronutrient Mix and Post-Exercise net Protein Balance



EAA:
Histidine, Isoleucine
Leucine, Lysine
Methionine, Phenylalanine
Threonine, Tryptophan
Valine

Most studies are done with small amounts of PRO & CHO

Coingestion of Protein + Carbohydrate

- Howarth, et al. *J Appl Physiol. 106:* 2009
- Stimulates skeletal muscle protein synthesis in humans and improves whole body nitrogen balance
- Comparison of (3 hours post exercise) :
  - 1.2 g CHO/kg/hr
  - 1.2 g CHO/kg/hr + 0.4 g PRO/kg/hr
  - 1.6 g CHO/kg/hr
- Glycogen resynthesis did not change between trials
- Synthetic rate was significantly higher in CHO+PRO than the other two samples.

Study Results

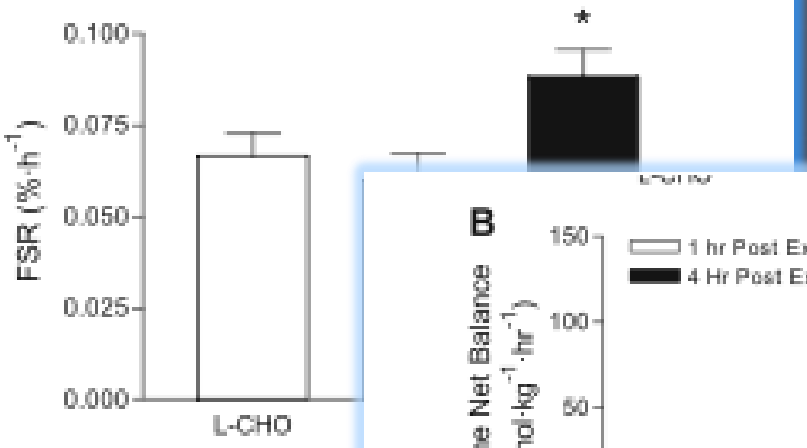


Fig. 4. Mixed muscle protein fractional sy
from prolonged exercise while ingesting eit
CHO·kg^{-1}·h^{-1} (H-CHO), or 1.2 g CHO
Values are means ± SE; n = 6. *P < 0.0

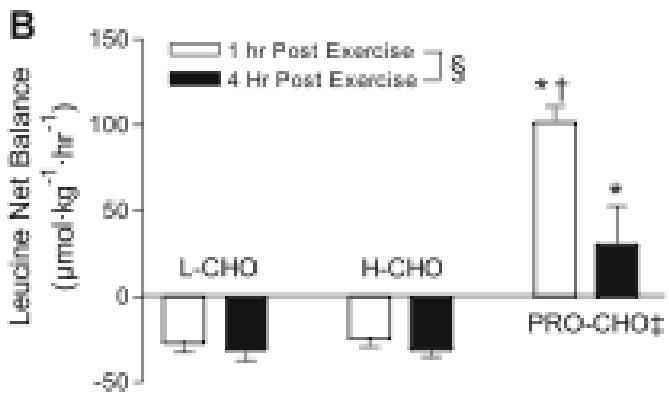


Fig. 3. Whole body leucine oxidation (*A*) and net balance (*B*) during recovery from prolonged exercise while ingesting either 1.2 g CHO·kg^{-1}·h^{-1} (L-CHO), 1.6 g CHO·kg^{-1}·h^{-1} (H-CHO), or 1.2 g CHO + 0.4 g protein·kg^{-1}·h^{-1} (PRO-CHO). Values are means ± SE; n = 6. *P < 0.05 vs. other treatments at the same time point. †P < 0.05 vs. 4 h in the same trial. ‡Main effect for treatment, P < 0.05. §Main effect for time, P < 0.05.

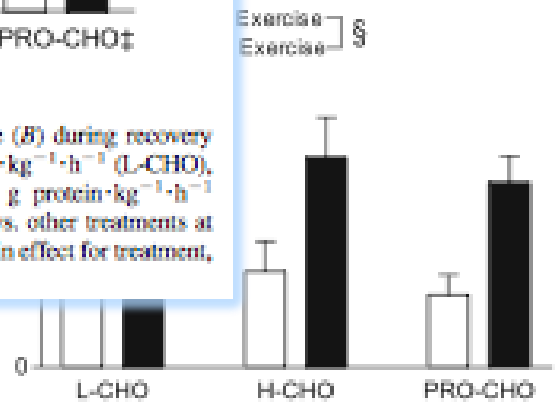


Fig. 5. Muscle glycogen concentration over 4 h of recovery from prolonged exercise while ingesting either 1.2 g CHO·kg^{-1}·h^{-1} (L-CHO), 1.6 g CHO·kg^{-1}·h^{-1} (H-CHO), or 1.2 g CHO + 0.4 g protein·kg^{-1}·h^{-1} (PRO-CHO). Values are means ± SE; n = 6. §Main effect for time, P < 0.05. dw, dry wt.

Physiological Needs

- Rehydration *and* Anti-oxidents (Car: Motor Oil)
- As little as a loss of 2% body weight can lead to:
  - Decreased muscle strength
  - Decreased anaerobic work capacity
  - Decreased aerobic work capacity
  - Decreased alertness
  - Decreased movement acuity
  - Decreased cardiac stroke, and increased heart rate
- Many athletes begin training in a Dehydrated state

Immune Suppression Post-Training

- Training at high intensities and volumes compromises immune system
  - Stress promotes training adaptation
- Carbohydrate depletion and energy depletion increases stress and suppresses immune function
- Choose nutrition-rich foods during this recovery eating time frame
- Fruit and other energy dense foods are optimal for recovery

Physiological Needs

- Rehydration: When body weight is lost in the form of fluid during an intense training session:
  - Replenish by replacing losses 150% (24 fl oz per pound body weight loss)
    - Drinking what is lost is not enough: Continued perspiration and urine production requires overcompensation
  - Monitor urine status to cater to changes of environment, exercise intensity, and prior hydration status before activity
  - Added sodium will aid in retention of fluid
  - Carbohydrate will speed up absorption

Application and Accessibility

- Given all of this information, **what can be done?**
  - Review
    - Carbohydrate as soon as possible post activity to increase rate of recovery
    - ~1.0g CHO/kg/hr to optimize recovery time
    - Include protein to enhance insulin response and increase muscle glycogen and enhance muscle repair (as little as 10g of PRO)
    - Rehydration is just as important and can serve as a shuttle for carbohydrates during recovery
    - Nutrient Dense food choices to boost immune system

Recovery Nutrition Ideas

Natural Foods	Sports Nutrition Products
Low-fat Chocolate Milk	Clif Bar
Half of a bagel with fruit preserves	Powerbar Performance Bar
Low-Fat Yogurt with cereal/fruit	Endurox
Cereal with low-fat milk	PowerBar Recovery Drink
Peanut Butter and Jelly Sandwich	First Endurance Bar
Fruit Smoothie (yogurt, fruit, protein)	Liquid Meal Supplement (Boost, Ensure)
Turkey Sandwhich	

Thank you…

…Questions?