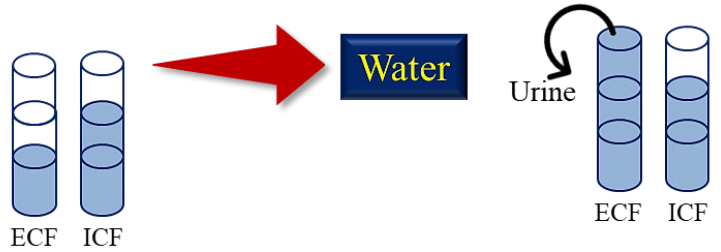
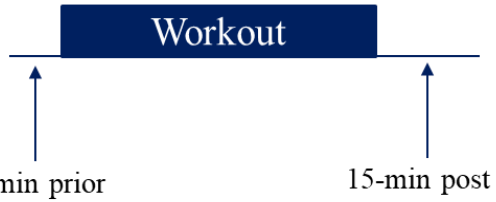
High Octane Fueling

Pre- and Post-exercise Nutrient Timing





Developed by:

Fabio Comana, MA., MS.
NASM CPT, CES, PES, CNC, & CSNC; ACE CPT & HC; ACSM EP; CSCS; CISSN

Agenda …

110-minutes:

1. Protein Quality, DIAAS and importance of leucine for muscle protein synthesis (MPS).
2. Protein needs for exercising individuals.
3. Fluid and hydration.
4. Pre-exercise strategies – protein and hydration.
5. Peri-exercise strategies – protein and hydration.
6. Post-exercise strategies – protein and hydration.

Unfortunately, carbohydrate, fat, and supplement discussion will be omitted due to time constraints.

Introduction …

A Food-first Approach:

- Nutritional strategy utilizing whole foods to 1st address poor nutritional intake before dietary supplementation.
  - Protein powders are complementary (v. supplementary) – example of kcal
  - Safety LGC and NSF

Food Source	Pro (g)	Kcal	Food Source	Pro (g)	Kcal
Dairy – skim (2 x 8 oz.)	16	180	Dairy – skim (2 x 8 oz.)	16	180
Chicken breast (2 x 3oz.)	48	350	Chicken breast (1 x 3oz.)	24	175
Fish (salmon) (1 x 3oz.)	20	200	Fish (salmon) (1 x 3oz.)	20	200
Quinoa (1 cup)	22	640	Quinoa (½ cup)	11	320
Lentils – boiled (1 cup)	18	230	Grains (2 servings)	6	160
Grains (4 servings)	12	320	Vegetables – raw (2 cups)	6	80
Vegetables – raw (2 cups)	6	80	Good protein powder	59	275
Total:	142g	2,000	Total:	142g	1,390

Informed-Choice (LGC Labs)	National Sanitation Foundation (NSF International)
Quality assurance for sports nutrition products – certify supplements/raw materials are free of banned substances.	Supplement testing, inspection, and certification – ensure product/ingredient safety (GMP) and test for banned substances.

Protein Quality …

Protein Quality

- Never limit protein selection to food labels alone – no insight of AA absorbability.
- Digestible Indispensable Amino Acid Score (DIAAS)

Protein Source	DIAAS	Protein Source	DIAAS
Whole milk (and powders)	1.14-to-1.43	Pea concentrate	0.82
Whey protein isolates	1.09-to-1.25	Sunflower seeds	0.67
Whey protein concentrates	1.10-to-1.22	Peas (cooked)	0.58-to-0.64
Whole egg / Pork	1.13-to-1.18	Rice (cooked)	0.37-to-0.59
Beef	1.11	Tofu	0.52
Casein	1.09	Kidney beans / Black beans	0.51
Chicken	1.08	Barley	0.47-to-0.51
Fish (Tilapia)	1.00	Peanut butter / Corn	0.46-to-0.47
Soy isolate	0.90-to-1.00	Wheat / Rye / Peanuts	0.40-to-0.43
Pea isolate	0.95	Almonds / Rice protein concentrate	0.37-to-0.40
Oatmeal / rolled oats	0.84	Corn-based cereal	0.01
Chickpea	0.84	Hydrolyzed collagen*	0.00

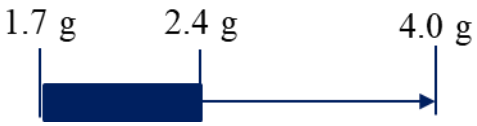
*Hydrolyzed collagen = 0.00 because it contains no Tryptophan and is very low in methionine.

Reference: Phillips SM, (2017). Current concepts and unresolved questions in dietary protein requirements and supplements in adults. *Frontiers in Nutrition*, 4:13.

Protein Quality …

Leucine Threshold (LT) and MPS

- Evidence indicates leucine triggers MPS following consumption – activation of mTOR (mammalian target of rapamycin).
  - mTOR = enzyme regulating cellular processes – in muscle fibers, it coordinates chemical signals initiating exercise-induced MPS.
  - mTOR = critical for early post-exercise phase of MPS (~6 hours).
- For optimal MPS, intracellular levels of leucine (Leu) need to reach threshold.
  - Leucine in isolation ≠ build muscle
- LT influencers:
  - Lowered with resistance training.
  - Elevated with aging and inactivity.



References:

1. Goodman C A, Mayhew D L, and Hornberger TA, (2011). Recent progress toward understanding the molecular mechanisms that regulate skeletal muscle mass. *Cellular Signaling*, 23(12):1896-1906.
2. Pasiakos SM, (2012). Exercise and amino acid anabolic cell signaling and the regulation of skeletal muscle mass. *Nutrients:* 4(7):740-758.
3. Atherton P J, Kumar V, Selby A L, et al., (2017). Enriching a protein drink with leucine augments muscle protein synthesis after resistance exercise in young and older men. *Clinical Nutrition*, 36(3):888-895.
4. Devries MC, McGlory C, Bolster DR, et al., (2018). Leucine, Not Total Protein, Content of a Supplement Is the Primary Determinant of Muscle Protein Anabolic Responses in Healthy Older Women. *Journal of Nutrition*, 148(7):1088-1095.

Protein Quality …

Genesis Wellness Group

Leucine Levels (per 100g serving)

AA (g/100g Protein)	Whey Isolate	Milk (skim)	Egg White	Pea Isolate	Egg	Soy Isolate	Fish (Salmon)	Brown Rice
Leucine – BCAA	**10.23**	**9.80**	**8.37**	**10.42**	**8.53**	**8.11**	**8.40**	**8.29**
Isoleucine – BCAA	6.67	6.06	6.00	4.70	5.43	4.84	4.76	4.24
Valine – BCAA	5.68	6.71	6.31	4.96	6.10	5.07	5.32	5.88
Total:	**22.58**	**22.57**	**20.36**	**20.08**	**20.06**	**18.02**	**18.48**	**18.41**

AA (g/100g Protein)	Beef	Chicken	Amaranth	Quinoa	Potato	Chia	Hemp
Leucine – BCAA	**8.25**	**8.02**	**6.08**	**6.00**	**6.16**	**3.20**	**3.25**
Isoleucine – BCAA	4.72	4.80	4.03	3.61	4.23	4.17	2.69
Valine – BCAA	5.17	5.17	4.70	4.51	3.25	5.30	2.36
Total:	**18.14**	**17.99**	**14.81**	**14.12**	**13.64**	**12.67**	**8.30**

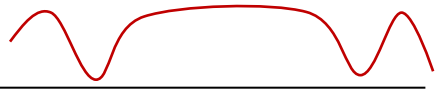
Protein Quantity …

Do Athletes/Athletic Individuals More Protein?

Position Statements – Quantity (Complied from AND, JDC, ACSM, NSCA, ISSN):

Activity Level	Type of Exercise	Protein Needs (g/kg BW)	Protein Needs (g/lb. BW)
None	N/A	RDA (0.8g/kg)	RDA (0.36g/lb.)
Light-to-moderate	Cardiopulmonary Training	1.2-to-1.4g/Kg	0.55-to-0.64g/lb.
Light-to-moderate	Resistance Training	1.5-to-2.0g/Kg	0.68-to-0.91g/lb.
Moderate-to-vigorous	Endurance Training*	1.5-to-2.0g/Kg	0.68-to-0.91g/lb.
Moderate-to-vigorous	Resistance Training	1.7-to-2.2g/Kg	0.77-to-1.00g/lb.
Upper Tolerance believed to be approximately 2.0-to-2.2 g/Kg (0.91-to-1.00 g/lb.) **			

* Sport-specific training or > 10 hours of vigorous weekly exercise.
** Belief that excesses cannot be utilized by body – converted to glucose or fats.

Undulate between training/non-training days 

Men	Women
Range = 25-to-30g per meal	Range = 15-to-20g per meal
Upper threshold: ~50g	Upper threshold: ~30g

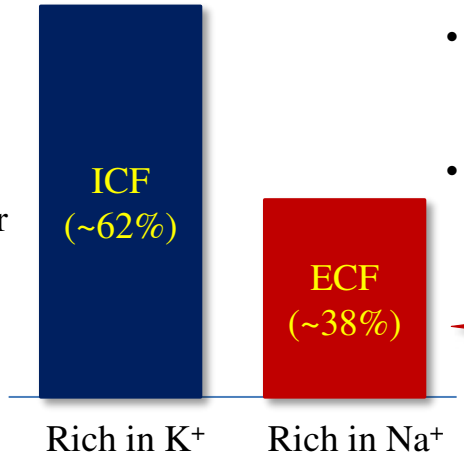
Reference: Pencharz PB, Elango R, and Wolfe RR, (2016). Recent developments in understanding protein needs - How much and what kind should we eat? *Applied Physiology, Nutrition, and Metabolism*, 41(5):577-580. doi:10.1139/apnm-2015-0549.

Hydration …

Fluid and Hydration

- Total body water averages approximately 45-to-75% of a person's body weight.

- Gives shape (cells, tissues, organs).
- Sustains cell integrity / function.
- Tissue comparison:
  - Muscle tissue up to ~75% water
  - Adipose tissue ~10-to-15% water



- Located in ISF, blood, lymphatic system, GI tract, saliva, spinal cord, eyes, tears, synovium, etc.
- Blood (plasma) = ~20% of ECF volume (~5% of body weight).

Sweat originates from ECF

Initial Fluid Losses
Originate within extracellular fluid compartment (ECF)

Reduced Blood Volume
Increases solute load in blood and within interstitial fluid (ISF)

ISF solute concentration increases (increased osmotic pressure)

Fluid movement from ICF (responds to ISF osmotic pressure)

Osmolar threshold

Intracellular dehydration activates osmoreceptors to stimulate hypothalamus (production of ADH)

Activates thirst sensation and water reabsorption from kidneys

Re-establishes euhydration levels in ECF and ICF

Hydration …

Fluid and Hydration

Dehydration: Concern with exercise – most people don't strategize to maintain hydration levels during prolonged/vigorous exercise or fail to rehydrate adequately post-exercise.

General Day-to-day Hydration Recommendations

- U.S. National Academies of Sciences and World Health Organization:
  - 3,700 mL/day total for males.
  - 2,700mL/day total for females.
    - Deduct 20% for food sources.
    - More for active individuals/hot environments.
  - Drink fluids in an obligatory fashion = Euhydration (optimal body water).

- Other Recommendations:
  - American College of Sports Medicine: 30-to-40 mL/kg or approximately 0.50-to-0.60 oz./lb.
  - 50% of bodyweight in oz. + 16 oz./hour of exercise.

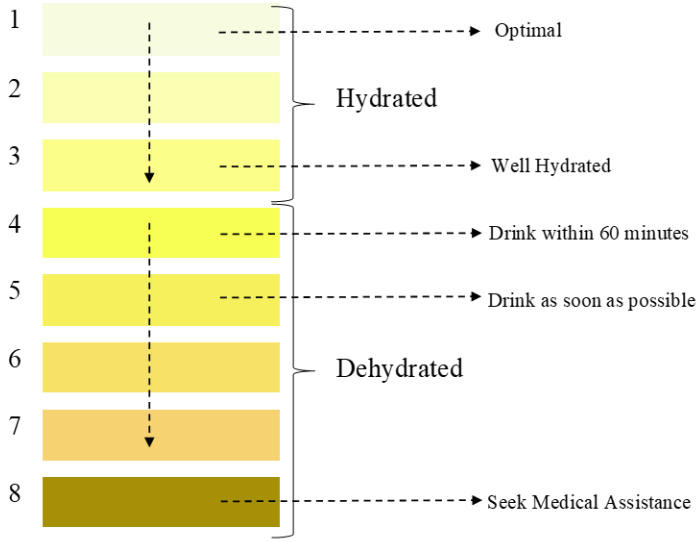
Guideline	Method
30-to-40 mL/kg	Example: A 150 lb. (68.2 Kg) = 2,046-to-2,728 mL (approx. 70-to-90 oz.) of fluid daily.
Fluid (oz.) = BW ÷ 2	Example: A 150 lb. (68.2 Kg) person should ingest 2,218 mL (75 oz.) of fluid daily.

Hydration …

Monitoring Hydration – General (day-to-day)

Urine Specific Gravity (USG)	Consistent Urine Color* (and volume)
Measures solute concentration in urine in 1st morning urine sample via light refraction v. light refraction through water Normal range: < 1.024 with higher values used as a dehydration marker.	Consistent, larger volumes during first morning void with lemonade color = euhydration Consistent, smaller volumes excreted during first morning void with apple juice/iced tea color = dehydration Similar application throughout the day

Armstrong Urine Color Chart



Score	Dehydration Level
1-to-2	Well-hydrated – equivalent to < 1% loss in BW.
3-to-4	Minimal dehydration – equivalent to 1-to-3% loss in BW.
5-to-6	Significant dehydration – equal to 3-to-5% loss in BW.
> 6	Severe dehydration – equivalent to > 5% loss in BW.

- Chart has higher correlation to USG and urine osmolality in younger adults.
- Lacks validity in older adults.

* Exceptions:

- B-vitamins, betacyanins (dark red vegetables pigments – beets), high protein intakes and artificial food color discolor urine (7-day wash-out, normal fluid intake, observe urine color).
- Medications (e.g., diuretics) consistently increase urine volume – lighten urine color.

Hydration …

Monitoring Hydration – General (day-to-day)

- To detect baseline hydration status, record morning body weight after making voids over a 3-day period
  - Use a change exceeding a 1% decrease from the 3-day body-mass average as a marker of hypohydration*.
  - Urinating ~3-hours during day = good general indicator of hydration.

* Strategy only applies to those not trying to lose or gain weight.

Reference: Cheuvront SN, Carter R, Montain SJ, and Sawka MN, (2004). Daily body mass variability and stability in active men undergoing exercise-heat stress. *International Journal of Sport Nutrition and Exercise Metabolism*, 14(5):532-540.

Energy Balance …

Low Energy Availability In Athletes

Energy availability (EA): Amount of dietary energy available to sustain physiological function after subtracting the energy cost of exercise.

- Insufficient EA, often attributed to increased exercise, reduced energy intake, or some combination = physiological disruptions
- Often evident in female athlete triad and RED-S.

$$\frac{\text{Total Energy Intake} - \text{Exercise Energy Expenditure}}{\text{Fat-free Mass (kg)}}$$

Score	Male	Female	Notes
High	> 40	> 45	Maintenance or weight gain
Optimal	40	45	Maintenance and normal physiological function
Sub-optimal	30-to-40	30-to-45	Suggested for short-term weight loss
Clinical	< 30	< 30	Unhealthy – potential physiological impairments

References:

- Logue D, Madigan SM, Delahunt E, et al., (2018). Low energy availability in athletes: A review of prevalence, dietary patterns, physiological health, and sports performance. *Sports Medicine*, 48(1):73-96.
- Areta JL, Taylor HL, and Koehler K, (2021). Low energy availability: history, definition and evidence of its endocrine, metabolic and physiological effects in prospective studies in females and males. *European Journal of Applied Physiology*, 121(1):1-21.

Energy Balance …

Energy Balance

- 20% energy deficit can reduce MPS rates by 20% v. to caloric maintenance
  - Energy deficit of 500 calories/day can reduce MPS rates by 27%.
  - Negative effects exacerbated by increased protein use for energy production with hypocaloric diets.
- Higher protein intakes (with hypocaloric diets) help preserve muscle mass.
  - 1.6-to-2.2g/Kg (0.73-to-1.0g/lb.) for sedentary and recreational exercisers.
  - 2.2-to-3.4g/kg (1.0-to-1.5g/lb.) for experienced exercisers and athletes.

References:

1. Pasiakos, SM, Vislocky LM, Carbone JW, et al., (2010). Acute energy deprivation affects skeletal muscle protein synthesis and associated intracellular signaling proteins in physically active adults. *The Journal of Nutrition*, 140(4):745-751.
2. Areta JL, Burke LM, Camera DM, et al., (2014). Reduced resting skeletal muscle protein synthesis is rescued by resistance exercise and protein ingestion following short-term energy deficit. *American Journal of Physiology. Endocrinology and Metabolism*, 306(8):E989-997.
3. Simmons E, Fluckey JD, and Riechman SE, (2016). Cumulative muscle protein synthesis and protein intake requirements. *Annual Review of Nutrition*, 36:17-43.
4. Cava E, Yeat NC, and Mittendorfer B, (2017). Preserving Healthy Muscle during Weight Loss. *Advanced Nutrients*, 8(3):511-519.
5. Stuart CA, Shangraw RE, Peters EJ, and Wolfe RR, (1990). Effect of dietary protein on bed-rest-related changes in whole-body-protein synthesis. *American Journal of Clinical Nutrition*, 52:509-514.
6. Weinheimer EM, Sands LP, and Campbell WW, (2010). A systematic review of the separate and combined effects of energy restriction and exercise on fat-free mass in middle-aged and older adults: implications for sarcopenic obesity. *Nutrition Reviews*, 68:375-388.
7. Mettler S, Mitchell N, and Tipton KD, (2010). Increased protein intake reduces lean body mass loss during weight loss in athletes. *Medicine and Science in Sports and Exercise*, 42(2):326-37.
8. Pasiakos SM, Cao JJ, Margolis LM, et. al., (2013). Effects of high-protein diets on fat-free mass and muscle protein synthesis following weight loss: A randomized controlled trial. *The FASEB Journal*, 27(9):3413-3885.

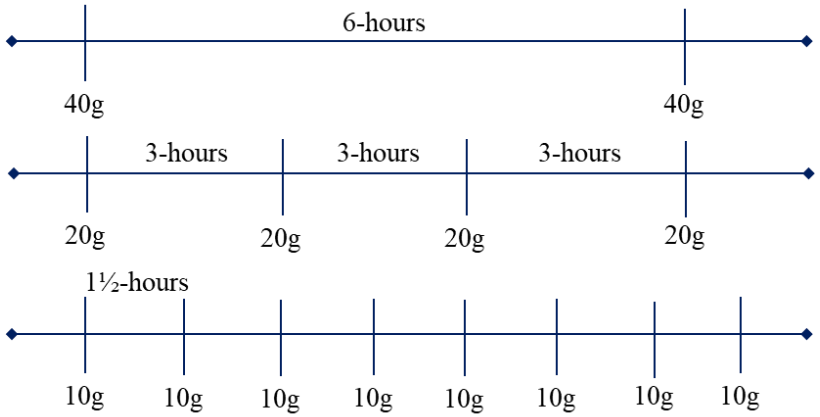

Pre-Exercise
Strategies

Nutrient Timing …

Nutrient Timing: Protein

Compare muscle protein rates over a 12-hour period with whey protein:

- 4x20g servings was superior v. 2x40g or 8x10g spread evenly over day.
  - Results:
    - 10g servings failed to reach LT (threshold) – did not stimulate MPS optimally.
    - 20g and 40g reached threshold, but 4-servings did so more frequently (i.e., every 3 hours v. every 6 hours).



References:

1. Areta JL, Burke LM, Ross ML, et al., (2013). Timing and distribution of protein ingestion during prolonged recovery from resistance exercise alters myofibrillar protein synthesis. *The Journal of Physiology*, 591(Pt 9):2319-2331. doi:10.1113/jphysiol.2012.244897.
2. Schoenfeld BJ, Aragon AA, and Krieger JW, (2013). The effect of protein timing on muscle strength and hypertrophy: a meta-analysis. *Journal of the International Society of Sports Nutrition*, 10(1):53. doi:10.1186/1550-2783-10-53.
3. Mamerow MM, Mettler JA, English KL, et al., (2014). Dietary protein distribution positively influences 24-h muscle protein synthesis in healthy adults. *Journal of Nutrition*, 144(6): 876-880.

Pre-exercise Strategies …

Nutrient Timing: Protein

Consuming protein before exercise can attenuate muscle catabolism during exercise and promote protein synthesis after exercise:

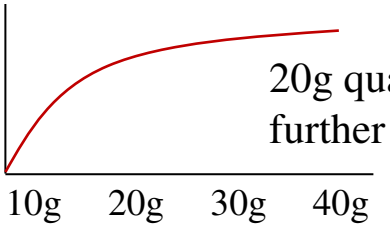
- Study Design: 1st visit – 1RM testing (squat) on strength/power athletes (n=15).
  - 2nd-through-4th visits: Training (4 sets x 10 POF) for deadlifts, squats, lunges with 24-hour recovery periods.
  - Whey protein (42 g) administered 10-min prior or 15-min post-exercise v. placebo.
  - Results:
    - No differences in 1RM performances between pre- and post-feeding.
    - Both showed equal recovery rates 24- and 48-hour post-exercise.

References: Hoffman J, Ratamess N, Tranchina C, et al., (2008). Effects of a pre- and post-exercise whey protein supplement on recovery from an acute resistance training session. *Journal of the International Society of Sports Nutrition*, 5(P6).

Pre-exercise Strategies …

Nutrient Intake – Protein Recommendations

- Consensus:
  - Target 0.25-to-0.4 g/Kg (0.11-to-0.18g/lb.) per feeding = 20-to-40g.



20g quality protein = optimal MPS; increasing to 40g = 10-to-20% further increase in MPS.

  - Consume good quality protein every 3-to-4 hours when awake = ≥ 4 meals/day.
    - Protein distributed throughout day = 25% greater MPS v. back-ended or front-ended (e.g., think 16-8 fasting-type programs).
  - Pre-, intra-, and post-workout protein consumption not needed if adequate protein ingested 1-to-3 hours prior to training.
  - Consume slow protein (~30-to-40 g) before sleep – acutely increase MPS and metabolic rates throughout night without influencing lipolysis.

References:

1. Aragon A, and Schoenfeld BJ, (2020). How much protein can the body use in a single meal for muscle building? Implications for total protein distribution. *Journal of the International Society of Sports Nutrition*, 15(1).
2. Kerksick CM, Arent S, Schoenfeld BJ, et al., (2017). International Society of Sports Nutrition position stand: nutrient timing. *Journal of the International Society of Sports Nutrition,* 14:33.
3. Moore DR, Churchward-Venne TA, Witard O, et al., (2015). Protein ingestion to stimulate myofibrillar protein synthesis requires greater relative protein intakes in healthy older versus younger men. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, 70(1):57-62.

Pre-exercise Strategies …

General Fluid Guidelines (NATA, ACSM, AND)

1. An important goal is to establish normal sweat-loss volumes for the individual during a typical workout – helps strategize to avoid dehydration.
   - Protocol: Measure pre- and post-exercise weights (dry-naked, voided) + the volume consumed during the workout to determine total water losses (sweat rate).
   - *Example:* Pre-exercise weight = 145 lbs. and post-exercise weight = 142 lbs.
     - Weight loss = 3 lbs. or 2.1% of body weight and ingested fluid in workout = 16 oz.
     - Total fluid lost per hour = 3 lbs. (48 oz.) + 16 oz. ingested = total of 60 oz. (1.77 L).
2. General guideline (essential if projected weight loss > 2-to-3%):
   - Consume an extra 500 mL of water 2-to-3 hours before bedtime – allows time for urine removal (average adult kidney filtration rate = 0.5-to-1.5 mL/kg/hour).
   - Consume 500 mL 2-to-3 hours before exercise.

References:

1. Sawka MN, Burke LM, Eichner ER, et al., (2007). American College of Sports Medicine position stand. Exercise and fluid replacement. *Medicine and Science in Sports and Exercise,* 39(2):377-390. doi:10.1249/mss.0b013e31802ca597.
2. Sawka MN, and Noakes TD, (2007). Does dehydration impair exercise performance? *Medicine and Science in Sports and Exercise*, 39(8):1209-1217. doi:10.1249/mss.0b013e318124a66400005768-200708000-00001 [pii].
3. Academy of Nutrition and Dietetics, (2016). Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *Journal of the Academy of Nutrition and Dietetics*, 116(3):501-528.

Pre-exercise Strategies …

Genesis Wellness Group

General Fluid Guidelines (NATA, ACSM, AND)

3. Avoid having individuals engage in any exercise if they experience extreme thirst or have extremely dark urine (urine color 4+).
4. Recognize that water is NOT the only beverage to improves hydration.
   - Any beverage, excluding those with alcohol percentages > 4% can increase total body water.
   - Caffeine is also miscast as a diuretic, but habitual consumption of caffeine and exercise negate its diuretic effect.

Sequence	Strategies (takeaway)
Step One	• Drink water in an obligatory fashion beginning 24-hours prior to training. • Unless on medications, vitamins or high protein intakes – use urine color.
Step Two	Follow previous recommendations: • 500 mL 2-to-3 hours before exercise. • 5-to-10 mL/kg BW (~3-to-5 mL/lb.) 2-to-4 hours before exercise. National Athletic Trainers Association (NATA): • Consume 17-to-20 oz. (500-to-600 ml) of water or sports drink 2-to-3 hours pre-exercise.


Peri-exercise
Strategies

Peri-exercise Strategies …

Protein Intake

- Protein consumption during exercise is generally advised for endurance-type events > 2 hours (i.e., moving towards glycogen depletion).
  - Consuming small quantities of protein/amino acids can limit muscle breakdown as it serves as a fuel substrate.
  - Can also reduce muscle soreness and accelerate muscle recovery.
  - Can provide some psychological benefits (i.e., central theory of fatigue).

Central Theory of Fatigue (CTF):

- Serotonin linked with fatigue* (role in sleep, lethargy, drowsiness + motivation losses) through conversion to 5-hydxoytryptophan (5-HT) and melatonin.
  - During exercise / prolonged fasting, CNS uptake of tryptophan increases.
  - Tyrosine (dopamine precursor) and BCAAs use same transporter mechanism to pass through blood-brain barrier (BBB)
  - Plasma concentration ratios of these amino acids are therefore important markers of neurotransmitter synthesis.

* Increased levels of dopamine and norepinephrine favor motivation, arousal, and reward. 5-HT remains high at fatigue v. dopamine falls at exhaustion.

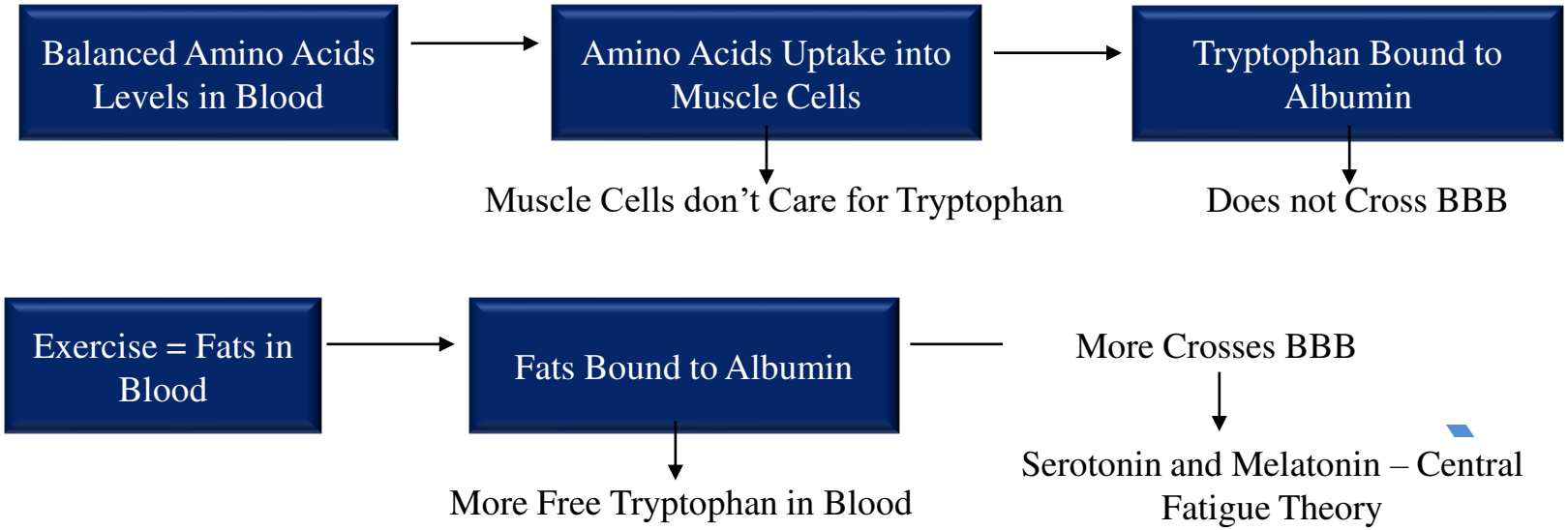
Peri-exercise Strategies …

Protein Intake and Fatigue

Updated premise to CTF*:

- Increased serotonin-to-dopamine ratio = causes tiredness and lethargy.
- Decreased ratios favor improved performance – preserve motivation and arousal.
  - Adding BCAAs (and tyrosine) elevate dopamine and norepinephrine levels – may also help reduce 5-HT synthesis.
  - Both may positively influence perceived exertion and measures of mental performance.

Also:



* Fatigue also directly influenced by other parameters (e.g., glycogen depletion,, elevated core temperature, and elevated circulating free fatty acids.

Peri-exercise Strategies …

Protein Intake – BCAAs During Exercise

	Endurance Athlete	Resistance Athlete
Physical Performance	Possibly – lacking strong evidence	Some evidence of faster recovery and less muscle soreness – potentially improved performance.
Psychological Performance	Lower RPE and mental fatigue	No significant evidence

- Intakes:
  - 1-to-2% protein is adequate for intra-workout endurance purposes.
    - 5 grams of protein/BCAA in an 8 oz. serving (240 mL) = (5 ÷ 240) x 100 = 2.1%.
  - Resistance Training: BCAA dosages range between 3½-to-6g per serving
  - Up to 2-to-4 servings per hour = ~7-to-25g per hour.
  - Usually mixed with carbohydrates (provides palatability, some improved uptake into cells for fuel): 2:1 to 4:1 CHO-pro ratios.

1 oz. = 29.57 ml

References:

1. Bird SP, Tarpenning KM, and Marino FE, (2006). Liquid carbohydrate/essential amino acid ingestion during a short-term bout of resistance exercise suppresses myofibrillar protein degradation. *Metabolism*, 55(5):570-577.
2. Greer BK, Woodard JL, White JP, et al., (2007). Branched-chain amino acid supplementation and indicators of muscle damage after endurance exercise. *International Journal of Sport Nutrition and Exercise Metabolism*, 17(6):595-607.
3. Koopman R, Pannemans DL, Jeukendrup AE, et al., (2004). Combined ingestion of protein and carbohydrate improves protein balance during ultra-endurance exercise. American Journal of Physiology-Endocrinology and Metabolism, 287(4):E712-E720.
4. Saunders MJ, (2007). Coingestion of carbohydrate-protein during endurance exercise: influence on performance and recovery. *International Journal of Sport Nutrition and Exercise Metabolism*, 17(Supplement 1), S87-S103.

Peri-exercise Strategies …

General Hydration Strategies During Exercise

Exercise Duration	Strategies
Events ≤ 60 minutes	Water is all that is needed (assuming a balanced diet and pre-exercise euhydration) unless: • High-intensity exercise. • Extreme environments / profuse sweating. • Dehydrated and fasted (improper preparation).
Events 60-to-90 minutes	• Fluid and electrolyte replacement are most important with carbohydrate replacement needed to a lesser extent.
Events 90-to-120 minutes	• Require fluid, electrolyte and carbohydrate replacement.
Events ≥ 120 minutes	• Require fluid, electrolyte, more complex-carbohydrate replacement. • Consideration inclusion of BCAA (Branched Chain Amino Acids) as glycogen stores become depleted.

Sweat rates vary during exercise (0.3-to-2.4 L/hour).

- Make fluids freely accessible if sweat losses reach 2-to-3% BW – under this level, no formal hydration strategy is really needed.
- How much fluid is needed?
  - Recommendation of 7-to-10 oz. (200-to-300 ml) of fluid 10-to-20 min.

Reference: Academy of Nutrition and Dietetics, (2016). Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *Journal of the Academy of Nutrition and Dietetics*, 116(3):501-528.

Peri-exercise Strategies …

Hydration During Exercise

- What kind of fluid is needed?
  - Carbohydrate concentration is important with any beverage
  - Needs to ≤ 6-to-8% carbohydrate solution – why?
  - Higher concentrations impede gastric emptying rates and absorption.

Carbohydrate	Fluid volume	Concentration
14 grams	8 oz. serving (240 ml)	14g ÷ 240 = 0.058 (x100) = 5.8%
Brand	**Ingredients**	**Concentration**
Power Gel	63% maltodextrin, 27% fructose	27g per 40g (1.4 oz.) package (67.5%)
Hammer Gel	90% maltodextrin, 10% sugars	21g per 33g (1.2 oz.) package (63.5%)

Example of managing fluid needs:

Male Exerciser (2 hours of exercise)	
Pre – Post-exercise Weight: = 5 lbs. (2.3 Kg)	Say % body weight loss is 2.6%
Fluid Consumed During Exercise: 8 oz. (240 mL) every 15 minutes = 32 oz. per hour or 64 oz. total.	
How do we correct this problem if the goal is to maintain dehydration under 2%?	
• Need to reduce overall fluid loss to < 2% – for example, this might change weight loss to 3.9 lbs. (1.8 Kg). • Differential of 1.1 lbs. (18 oz.) = current fluid intake of 32 oz./hr. + additional 9 oz./hr. = 41 oz./hr. (1,212 mL/hr.)	


Post-exercise
Strategies

Post-exercise Strategies …

Protein Intake Following Exercise

- Protein included with carbohydrates (3:1-to-4:1 carbohydrate-protein ratio) can accelerate muscle glycogen replenishment.
  - Relevant for endurance athletes and individuals training with high frequency.
- Resistance meta-analysis = no statistically significant effects of post-workout protein v. frequent protein feedings throughout day (if total intake is equal).
  - Exceptions:
    - If post-workout protein consumption increases total daily protein intake – MPS can be enhanced.
    - In resistance-trained individuals – post-workout protein further elevates MPS.

References:

1. Aragon AA, and Schoenfeld BD, (2013). Nutrient timing revisited: is there a post-exercise anabolic window? *Journal of the International Society of Sports Nutrition*, https://doi.org/10.1186/1550-2783-10-5.
2. Schoenfeld BD, Aragon AA, and Krieger JW, (2013). The effect of protein timing on muscle strength and hypertrophy: a meta-analysis. *Journal of the International Society of Sports Nutrition,* https://doi.org/10.1186/1550-2783-10-53.

Post-exercise Strategies …

Protein Intake Following Exercise

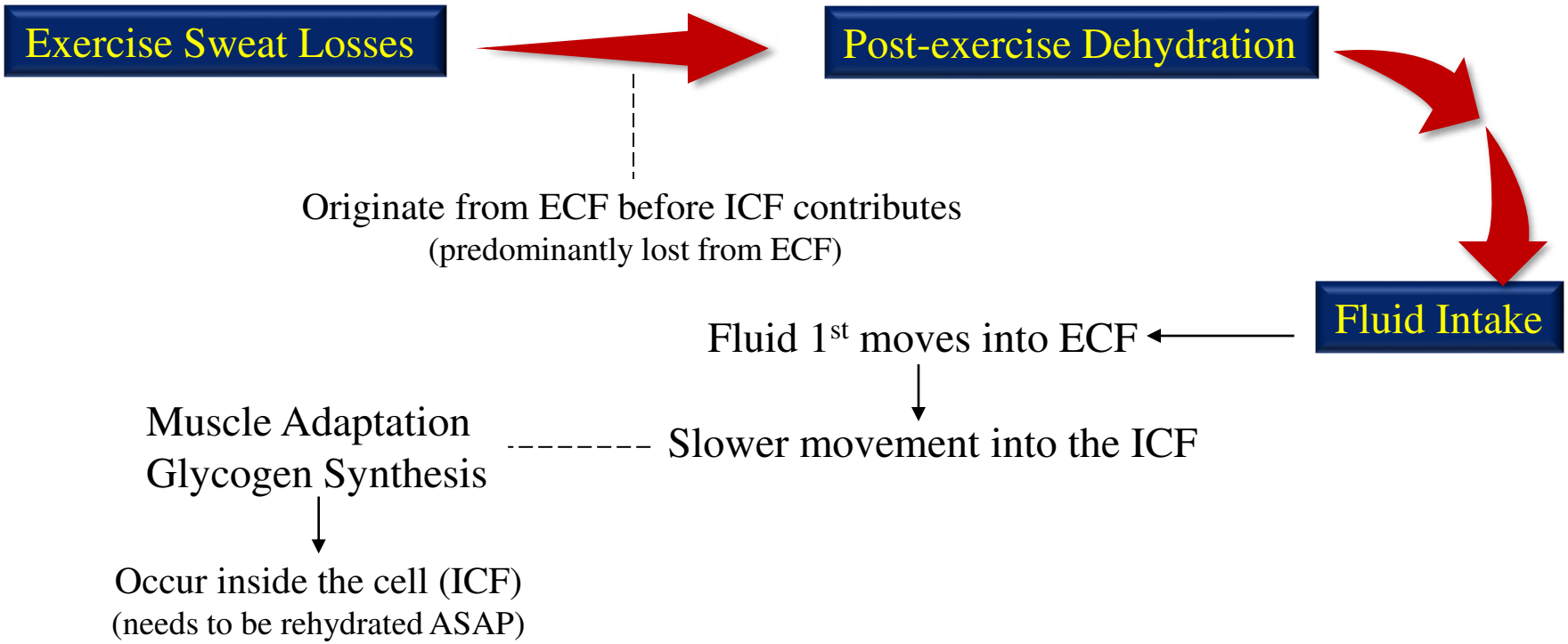
- Post-exercise Goal:
  - Ingest quality protein within 1st hour post-exercise – best accomplished via fast protein (e.g., whey isolate).
  - Dosage: 0.25-0.40 g/Kg of BM (0.11-to-0.18g/lb.)
    - *Example:* 176-pound (80 Kg) person = 32 grams.
- Daily Strategy:
  - Aim for ≥ 4 protein feedings throughout day.

Six Feeding Interval Example (165 lb. or 75 Kg)	
Protein Needs for Day = 150g (2.0g/Kg body weight)	
• Morning (breakfast)	10g
• Pre-workout	0.25-0.40g/Kg = 30g (fast protein)
• During 90-min workout	10g/hour BCAA = 15g
• Post-workout	0.25-0.40g/Kg = 30g (fast protein)
• 3-to-4 hours post-ex	0.25-0.40g/Kg = 30g (meal)
• Before bed	20g (slow protein)
Subtotal = 135g (balance = additional 15g)	

Event	Amount	Balance
Total Daily Requirement:	____ g	
Morning:	____ g	____ g
Pre-workout:	____ g	____ g
During Workout:	____ g	____ g
Immediate Recovery:	____ g	____ g
3-4 hours Later:	____ g	____ g
Late Night:	____g	____ g
Remaining Balance: ____ g		
Meal/snack allocation	____ g	

Post-exercise Strategies …

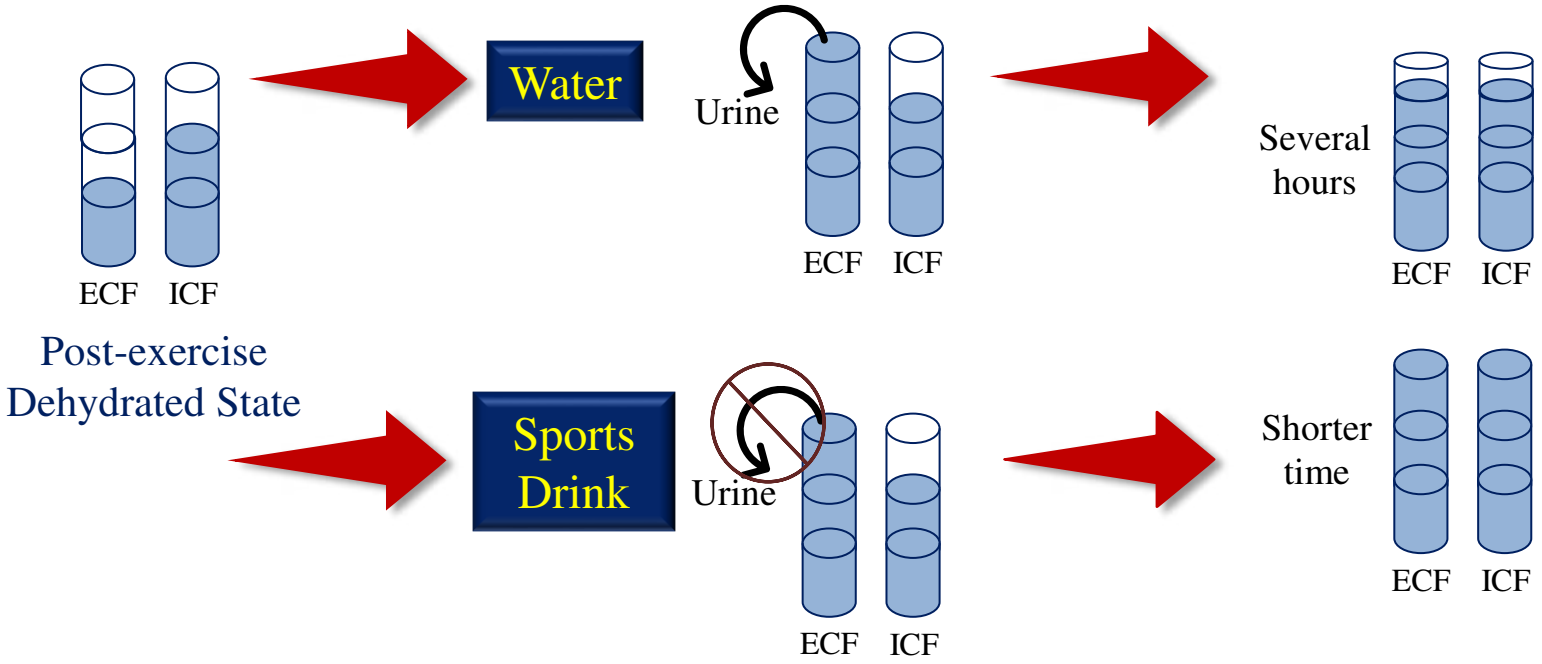
Post-exercise Rehydration



Post-exercise Rehydration Strategy:

- How to BEST expedite ICF rehydration – water or sports drink (electrolyte solution)?
- Water = slower (passive) rehydration response v. electrolyte solutions = more rapid (active) rehydration response.

Post-exercise Strategies …



Water	Electrolyte Solution
• Fluid 1st replenishes ECF (blood volume) – this produces a blood-dilution effect. • Replenished blood volume (BV) activates volume (pressure) receptors = shut-off thirst sensation. • Excess fluids pass to urine (clear-to-lemonade color). • What follows is a passive fluid shift to replace lost ICF volume which lowers BV and re-stimulates thirst. • Thirst-urination cycle can continue up to 6-to-10 hours.	• Same process activating volume receptors. • Beverage concentration maintains or increases osmotic pressure (blood concentration). • Volume receptors attempt to shut down thirst, but the osmoreceptors override (inhibitory effect). • This stimulates water retention, maintains the thirst drive and lowers urine production. • Rehydration is more rapid (within a few hours).

Post-exercise Strategies …

Post-exercise Rehydration Guidelines

Relevant to:

- Individuals losing ≥ 2-to-3% weight loss.
- Individuals who need to rehydrate rapidly due to training frequency (e.g., < 12-hours).
- Individuals exercising in hot, humid environments.
- Individual seeking to optimize training adaptations (e.g., MPS).

Which Solution?

- With water – rehydrate with volumes equal to 120-to-150% of lost body weight.
- With electrolyte solutions – rehydrate with volumes equal to 100-to-125% of lost body weight.

Water

↓

Replace at 120-to-150% of lost body weight
(16 oz. = 19-to-24 oz.)

Sports-type Drink

↓

Replace at 100-to-125% of lost body weight
(16 oz. = 16-to-20 oz.)

Thank You..!!

For Your Commitment to Excellence

Name: Fabio Comana, MA., MS.

Credentials: NASM CPT, CES, PES, CNC & CSNC; ACE CPT & HC; ACSM EP; NSCA CSCS; CISSN.

Email: comana.fabio@gmail.com