RECOVERY NUTRITION: BEYOND THE POST-EXERCISE WINDOW

GATORADE SPORTS SCIENCE INSTITUTE

OVERVIEW

Adequate recovery has been shown to result in the restoration of physiological and psychological processes so that an athlete can train or perform at the desired level.

This lecture will address recovery related to:

- Energy
- Muscle tissue repair
- Hydration
- Immunity
- Injury prevention
- Inflammation
- Sleep

RECOVERY

What is recovery?

"An inter-individual and intra-individual multi-level (e.g., phycological, physiological, and social) process in time for the re-establishment of performance abilities. Recovery includes an action-oriented component, and those self-initiated activities (proactive recovery) can be systemically used to optimize situational conditions and to build up and refill personal resources and buffers."

Avoiding overtraining and achieving optimal performance can only be realized when athletes are able to balance training stress and recovery.

Long term imbalance of training stress, non-training stress factors, and recovery can lead to a state of overtraining.

Kellmann M. *Scand J Med Sci Sports*. 2010;20(2):95-102
Kellmann M & Kallus KW. Champaign, IL: Human Kinetics, 2001
Lehmann M, Foster C, Gastmann U, et. al. Boston, MA: Springer, 1999

ENERGY: CARBOHYDRATE

CARBOHYDRATE & RECOVERY

A goal during a competitive season is to maintain "full" glycogen stores.

Muscle damage can impair glycogen synthesis after exercise.

Consume 1-1.2 g of CHO/kg post exercise for the first 4-6 hours followed by regular dietary habits.

Carbohydrate intake also support immune function.

Bendiksen M, Bischoff R, Randers MB, et. al. *Med Sci Sports Exerc*. 2012;44(8):1595-1603
Jeukendrup AE. *Biochem Soc Trans*. 2003;31(6):1270-1273
Rollo I. *Sports Science Exchange*. 2014;27(127):1-8

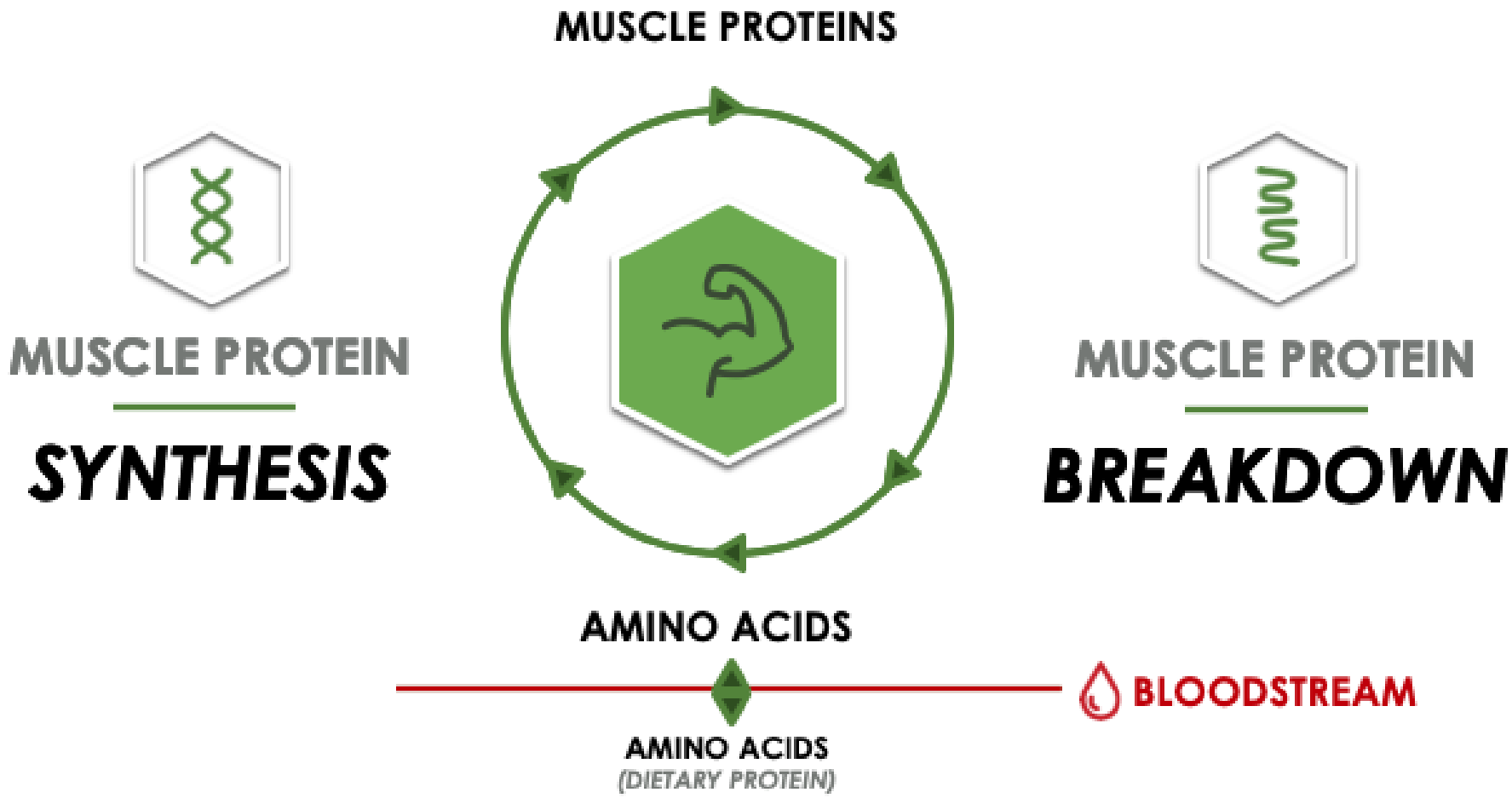
CARBOHYDRATE & RECOVERY

"The restoration of muscle and liver glycogen is a **FUNDAMENTAL GOAL** of recovery between training sessions or competitive events, particularly when the athlete undertakes multiple workouts within a condensed time period."

Burke L, Hawley JA, Stephen H. et. al. *J Sport Sci* 2011;29(1):S17-S27

MUSCLE TISSUE REPAIR: PROTEIN

MUSCLE PROTEIN TURNOVER



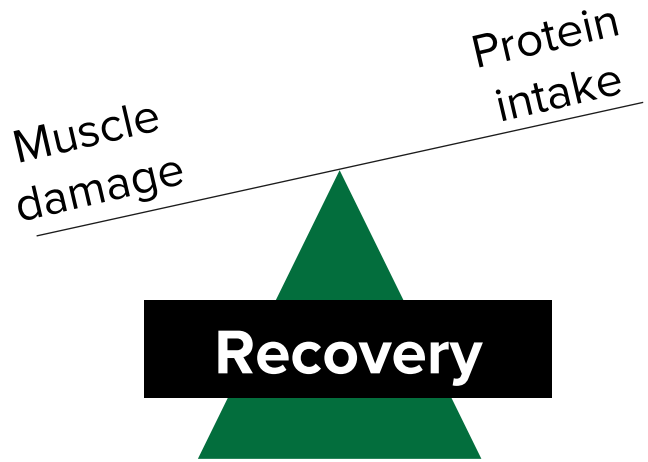
PROTEIN & RECOVERY

Both muscle protein breakdown and muscle protein synthesis are initiated by exercise.

Dietary protein is necessary to keep net protein in balance.

> A negative protein balance will reduce muscle mass, thus negatively impacting performance.

Muscle hypertrophy and repair of exercise induced muscle damage are dependent on positive muscle protein balance.



SSE#129

GATORADE SPORTS SCIENCE INSTITUTE

Dalleck LC. *American Council on Exercise*. 2018:1-14
Res P. *Sports Science Exchange*. 2014;27(129):1-5

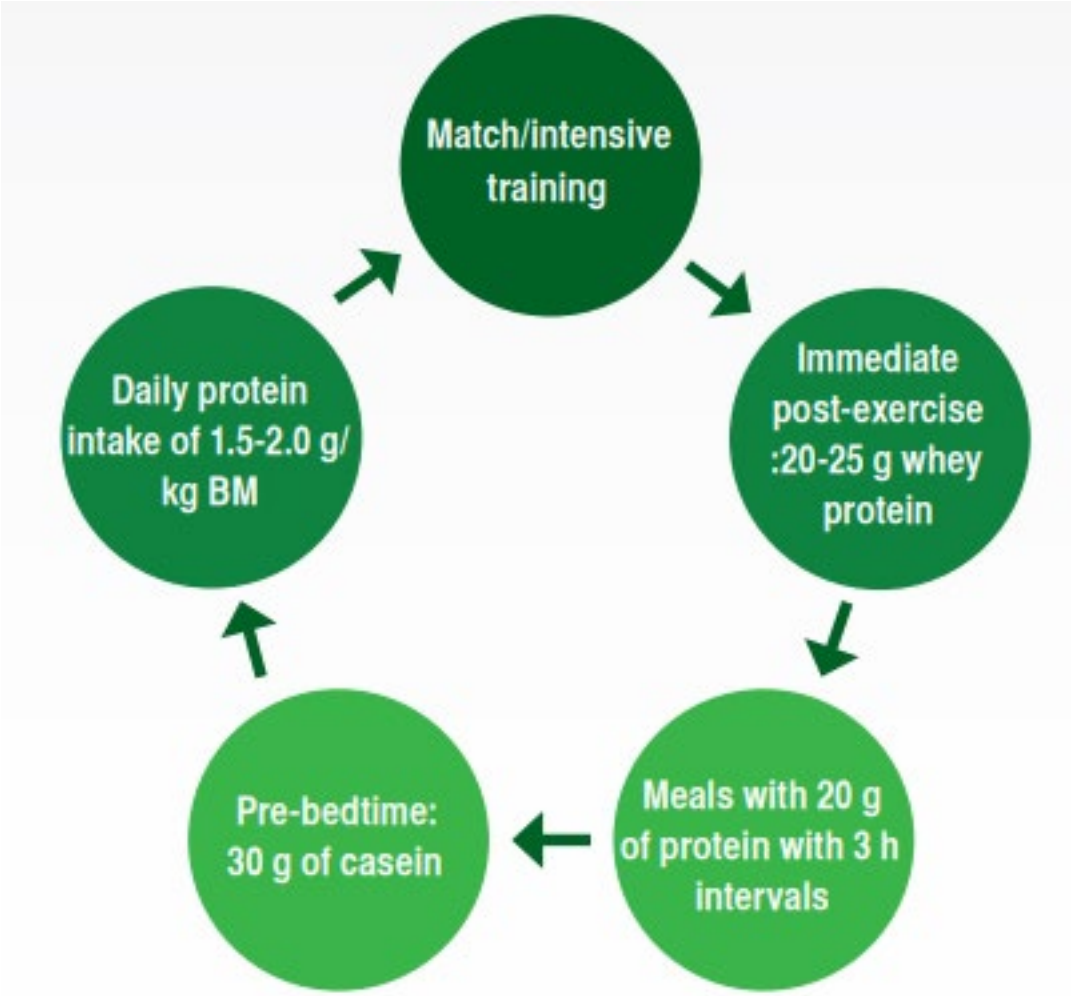
PROTEIN & RECOVERY

Muscle protein synthesis is elevated for up to 24 hours in response to a meal.

Meals that contain protein should be consumed every ~3 hours with a meal containing protein before bed.

SSE#129

GATORADE SPORTS SCIENCE INSTITUTE



Areta JL, Burke LM, Ross ML, et. al. *J Physiol*. 2013;591(9):2319-2331
Burd NA, West DW, Moore DR, et. al. *J Nutr*. 2011;141(4):568-673
Res PT, Groen B, Pennings B, et. al. *Med Sci Sport Exerc*. 2012;44(8):1560-1569
Res P. *Sports Science Exchange*. 2014;27(129):1-5

BRANCHED-CHAIN AMINO ACIDS & RECOVERY

- Branched-chain amino acids (BCAA) are an essential amino acid (EAA) that play an important role in muscle metabolism.
- BCAA, especially leucine are necessary for stimulation of molecular signaling that lead to muscle protein synthesis and breakdown
- BUT ingestion of BCAA without co-ingestion of a source of the other EAA will not stimulate a maximal muscle protein synthesis response.
- BCAA supplements should not be used to reduce exercise-induced muscle damage or stimulate muscle protein synthesis.

SSE#170

GATORADE SPORTS SCIENCE INSTITUTE

Dalleck LC. *American Council on Exercise*. 2018:1-14
Tipton KD. *Sports Science Exchange*. 2017;28(170):1-6

HYDRATION & RECOVERY

HYDRATION & RECOVERY

Athletes should aim to drink fluids throughout the day to recover from a training session and start their next session hydrated.

Foods with high water content (ie: watermelon, soups, etc) contribute to meeting daily hydration needs.

Consuming a beverage with sodium, or eating salty foods, can help retain fluid if athletes have an issue with hydration.

While not a perfect technique, checking urine color can be an indication of hydration (aim for a light, lemonade color).

IMMUNE FUNCTION

IMMUNITY

Adequate recovery won't prevent illness but can help an athlete stay healthy.

Periods of prolonged and strenuous exercise or training can result in depression of white blood cell functions, during which the risk of developing an infection increases.

Psychological stress, lack of sleep, and malnutrition can also depress an athlete’s immunity and increase the risk of infection.

IMMUNITY

Suggestions to maintain immune health during intensified training:

- Get adequate recovery and sleep.
- Consume sufficient amounts of protein and micronutrients.
  - Iron, zinc, Vitamins A, D, E, B6, and B12.
- Consume sufficient amounts of carbohydrates.
- Consume plant-based polyphenols and probiotics.
- Consider Vitamin D supplementation.
  - Many athletes are Vitamin D deficient and are at greater risk during winter months.

SSE#151

GATORADE SPORTS SCIENCE INSTITUTE

IMMUNITY

Nutritional Supplements and Immune Resistance[1]		
Supplement[2]	**Proposed Mechanism**	**Evidence for Efficacy[3]**
Zinc	Zinc is required for DNA synthesis and is an enzyme cofactor for immune cells. RNI is 7 mg/day for women and 9.5 mg/day for men. Zinc deficiency results in impaired immunity (e.g., lymphoid atrophy) and zinc deficiency is not uncommon in athletes. Antiviral effects of zinc lozenges.	**No support** for "preventing URI." Regular, high-dose zinc supplementation can decrease immune function and should be avoided. **Strong support** for "treating URI." Dissolving zinc lozenges in the mouth (75 mg/day elemental zinc) shortens common cold by ~33%; zinc must be taken < 24 h after onset of URI. Optimal lozenge composition and dosage to be determined. Side effects include bad taste and nausea.
Glutamine	Nonessential amino acid that is an important energy substrate for immune cells, particularly lymphocytes. Circulating glutamine is lowered after prolonged exercise and very heavy training.	**Limited support**. Some evidence of a reduction in URI incidence after endurance events in competitors receiving glutamine supplementation (2 x 5 g). Mechanism for therapeutic effect requires investigation. Supplementation before and after exercise does not alter immune function.
Carbohydrates (drinks, gels)	Maintains blood glucose during exercise, lowers stress hormones, and thus counters immune perturbations.	**Limited support.** Ingestion of carbohydrate (30–60 g/h) attenuates stress hormone and some, but not all, immune perturbations during exercise. Very limited evidence that this modifies infection risk in athletes.

SSE#198

GATORADE SPORTS SCIENCE INSTITUTE

IMMUNITY

Bovine colostrum	First milk of the cow that contains antibodies, growth factors and cytokines. Claimed to improve mucosal immunity and increase resistance to infection.	**Limited support** that bovine colostrum blunts the decrease in mucosal immunity and *in-vivo* immunity after heavy exercise. Some evidence in small numbers of participants that bovine colostrum decreases URI incidence. Further support required.
ß-glucans	Polysaccharides derived from the cell walls of yeast, fungi, algae and oats that stimulate innate immunity.	**Limited support**. Effective in mice inoculated with influenza virus; however, studies with athletes show no benefit to immunity and equivocal findings for risk of URI.
Echinacea	Herbal extract claimed to enhance immunity via stimulatory effects on macrophages. There is some *in-vitro* evidence for this.	**Limited support.** Small reduction in URI incidence but no influence on URI duration in general population. Ambiguous findings from small number of studies in athletes. Further support required.
Caffeine	Stimulant found in a variety of foods and drinks (e.g., coffee and sports drinks). Caffeine is an adenosine receptor antagonist and immune cells express adenosine receptors.	**Limited support**. Evidence that caffeine supplementation activates lymphocytes and attenuates the fall in neutrophil function after exercise. Efficacy for altering risk of URI in athletes remains unknown..

SSE#198

GATORADE SPORTS SCIENCE INSTITUTE

INJURY PREVENTION

INJURY PREVENTION

- Soft tissue injuries to the musculoskeletal system are the most common injury for American football athletes.
  - Accounting for ~70% of physical therapy visits.
- Strength, power, and speed are dependent on stiff connective tissues, which results in high rates of injury.
- The stiffness of connective tissue is dependent on the collagen content of the tissue.
- Consuming gelatin and Vitamin C may promote greater collagen production.

SSE#142

GATORADE SPORTS SCIENCE INSTITUTE

INFLAMMATION

INFLAMMATION

Some level of inflammation supports recovery and adaptation.

Chronic inflammation impairs recovery

Consumption of **Tart Cherry Juice**, due to its polyphenol content, may support recovery via decreased inflammation, oxidative stress and pain.

⟹ Aim for ~8-12 oz/d

Some evidence supports **Omega-3** consumption, along with decreased Omega-6.

⟹ Omega 3 from fatty fish or supplements

⟹ Decrease fried foods, saturated fats

Vitale KC, Hueglin S, Broad E. *Curr Sports Med Rep*. 2017;16:230-239
Tipton, K. *Sports Med.* 2015;45:93-104

SLEEP & RECOVERY

SLEEP & RECOVERY

- Sleep plays an important role in an athlete's recovery plan.
- It is essential for both preparing for and recovery from training/competition.
- Restricting an athlete's number of sleep to less than 6 hours for 4 or more consecutive nights:
  - Impairs cognitive performance and mood.
  - Disturbs glucose metabolism, appetite regulation, and immune function.
- It appears that lack of sleeps has more of a negative impact on prolonged, sub-maximal exercise compared to short, maximal efforts.
- Napping can be effective in making up for shortened sleep duration.
- Athletes should focus on good sleep hygiene:
  - Cool, dark, quiet bedroom.
  - Good sleep routine – Going to bed and waking up at the same time.
  - Avoid screens (tv, phone, computer) before going to bed.
  - Avoid caffeine 4-5 hours prior to sleep.
  - Avoid consuming too much fluid prior to sleep as it may result in waking up to use the bathroom.

SSE#172

GATORADE SPORTS SCIENCE INSTITUTE

Halson SL. *Sports Science Exchange*. 2013;26(113):1-4

ENHANCING SLEEP WITH NUTRITION

- Some nutrients may impact neurotransmitters that are involved in the sleep-wake cycle and may enhance sleep.
- Diet may influence the central nervous system and through the production of serotonin and melatonin:
  - High glycemic index (GI) foods sch as white rice, pasta, breads may promote sleep.
  - Diet high in CHO may result in shorter sleep latencies.
  - Diets high in protein may results in better sleep quality.
  - Diets high in fat may negatively influence the total sleep time.
  - Sleep quality may be disturbed if total caloric intake is decreased.
  - 1 g of tryptophan may improve sleep latency and quality.
  - Melatonin may decrease sleep onset time.

SSE#116

GATORADE SPORTS SCIENCE INSTITUTE

Buscemi N, Vandermeer B, Hooton N, et. al. *J Gen Intern Med*. 2005;20:1151-1158
Halson SL. *Sports Science Exchange*. 2013;26(116):1-5
Morin CM & Benca R. *Lancet*. 2012;379:1129-1141

Orr WC, Shadid G, Harnish MJ, et. al. *Physiol Behav*. 1997;62:709-712
Porter JM & Horne JA. *Clin Neurophys*. 1981;51:426-433

PROTEIN & SLEEP

- During sleep, muscle protein synthesis is low, even if dietary protein is consumed after exercise.
- Dietary protein consumed prior to bed is easily digested and absorbed during the night:
  - This increases plasma amino acid availability.
  - Stimulates post-exercise muscle protein accumulation during sleep.
- Consuming dietary protein prior to sleep may be an effective strategy to help the skeletal muscle adaptation to training.
- In addition to consuming sufficient amounts of protein with each meal and consuming ~20 g of protein after exercise/training, athletes should consume **20-40 g** of protein prior to sleep.

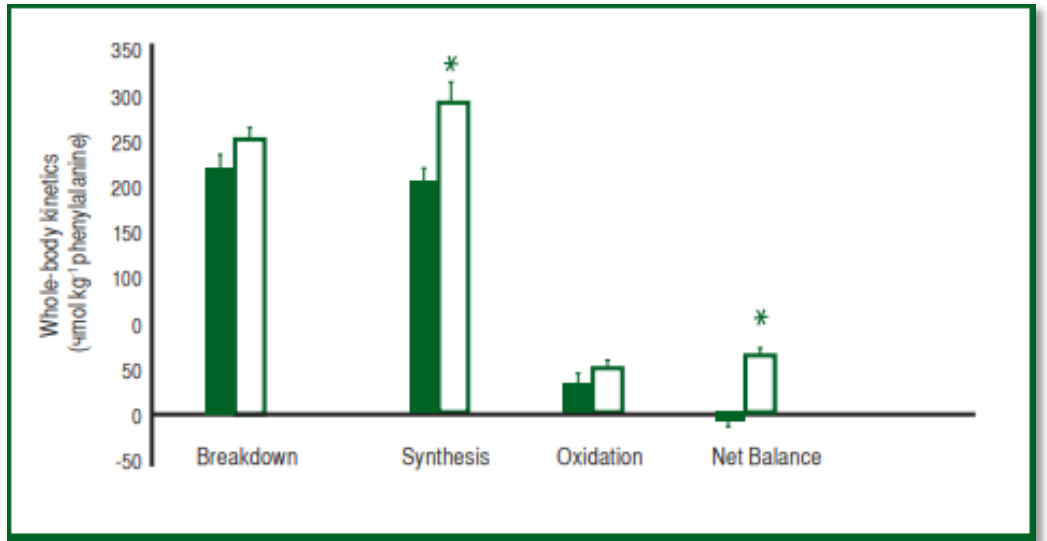


Figure 2. Rates of whole-body protein breakdown and synthesis, protein oxidation rates and net protein balance in the protein (PRO, white bar) and placebo (PLA, black bar) experiments measured during 7.5 h of overnight recovery. Values represent means ± SEM. *Significantly different from PLA ($P<0.05$). Figure redrawn from Res et al. (2012) Med. Sci. Sports Exerc. 44:1560-1569, American College of Sports Medicine.

SSE#117

GATORADE SPORTS SCIENCE INSTITUTE

Res PT, Groen B, Pennings B, et. al. *Med Sci Sports Exerc*. 2012;44:1560-1569
Van Loon LJC. *Sports Science Exchange*. 2013;26(117):1-5

MONITORING FATIGUE & RECOVERY

MONITORING FATIGUE & RECOVERY

Overreaching

- An increase in training load followed by a temporary decrease in performance and with improved performance after rest, is known as **functional overreaching.**
  - Decreased performance for days to weeks.
- Intense training leading to a longer decrease in performance but with full recovery after rest, is known as **non-functional overreaching.**
  - Decreased performance for weeks to months.
  - Often accompanied with increased psychological and/or neuroendocrinological symptoms.

Overtraining

- Consistent with extreme non-functional overreaching.
  - Longer decreases in performance.
  - More severe psychological and physiological symptoms.
  - Additional stressors not explained by other disease.

MONITORING FATIGUE & RECOVERY

- Modifications to an athlete's training load are normal and required to ensure an athlete stays healthy.
- Modifications include frequency, duration, and intensity.
- Monitoring an athlete's training load is important to determine if an athlete is responding to the training program and to avoid and minimizing the risk of non-functional overreaching.

	Internal Load	**External Load**
Definition	Physiological or psychological stressors	Amount of work completed
Methods to Monitor	RPE, heart rate, HR:RPE ratio, TRIMP, lactate, hear rate recovery, sleep, questionnaires	Time motion analysis, GPS, neuromuscular tests (countermovement jump), isokinetic dynamometry

SSE#135

GATORADE SPORTS SCIENCE INSTITUTE

Halson SL. *Sports Science Exchange*. 2014;27(135):1-6
Halson SL & Jeukendrup AE. *Sports Med*. 2004;34:967-981

RECOVERY TECHNIQUES

RECOVERY TECHNIQUES

In addition to diet, rest, sleep, athletes use a variety of other recovery techniques. Research is varied on the physiologic benefits, but athletes often report they help them “feel good”. Newer research is investigating the combination of nutrition + modality post-exercise.

Some common recovery techniques:

Hydrotherapy
Cryotherapy
Pulsed Compression
EMG Muscle Stimulation
Active Recovery
Stretching
Compression Garments
Massage

SSE#120

GATORADE SPORTS SCIENCE INSTITUTE

Barnett A. *Sports Med*. 2006;36:781-796
Halson SL. *Sports Science Exchange*. 2013;26(120):1-6
Weerapong P, Hume PA. Kolt GS. *Sports Med*. 2005;35:235-256

KEY TAKEAWAYS

- ✓ Appropriate recovery is crucial for an athlete's health and performance.
- ✓ Restore glycogen stores by consuming carbohydrates after training or competition.
- ✓ Muscle hypertrophy and repair of exercise-induced muscle damage are dependent on positive muscle protein balance.
- ✓ Consuming a beverage with sodium or salty foods can help the body retain fluids if an athlete is having issues with hydration.
- ✓ Periods of prolonged stress or intense training can suppress an athlete's immunity. Maintaining a balanced diet and adequate sleep can help support an athlete's immunity.
- ✓ Consuming gelatin and Vitamin C may promote greater collagen production.
- ✓ Some level of inflammation supports recovery and adaptation, but chronic inflammation impairs recovery.
- ✓ Sleep is critical to recovery.
- ✓ Several different modalities are available to help enhance recovery.

www.GSSIweb.org