

re·cov·er·y

Recovery is the return to a normal state of health, mind, or strength.

Optimal recovery is best attained through an integrative approach, with the focus on nutrition, sleep and stress management, followed by periodized training, monitoring, treatments and lastly modalities.



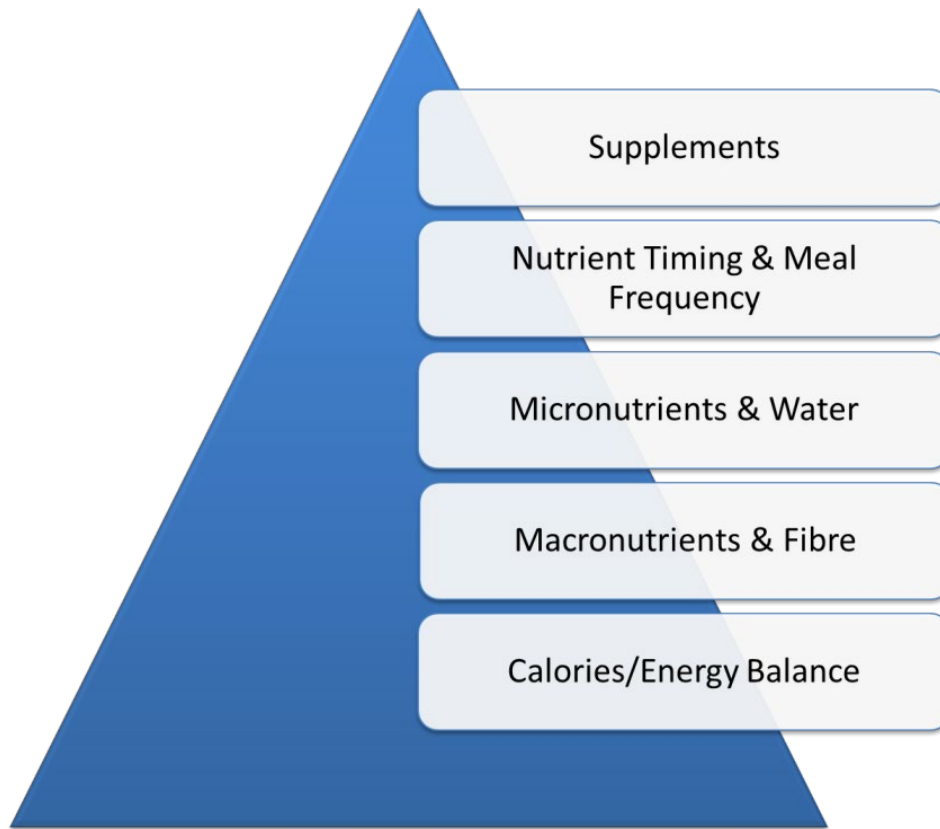
Penfold's Recovery Pyramid

Nutrition- “Refuel, Repair, Rehydrate.”

Nutrition to enhance the recovery process should be prioritized as follows:

1. Energy balance/availability
2. Macronutrients
3. Micronutrients

4. Hydration
5. Nutrient timing
6. Supplements



(Helms)

ENERGY BALANCE & AVAILABILITY

Energy (calories) is the foundation of the repair process. Optimize your energy by focussing on the 3 Ts:

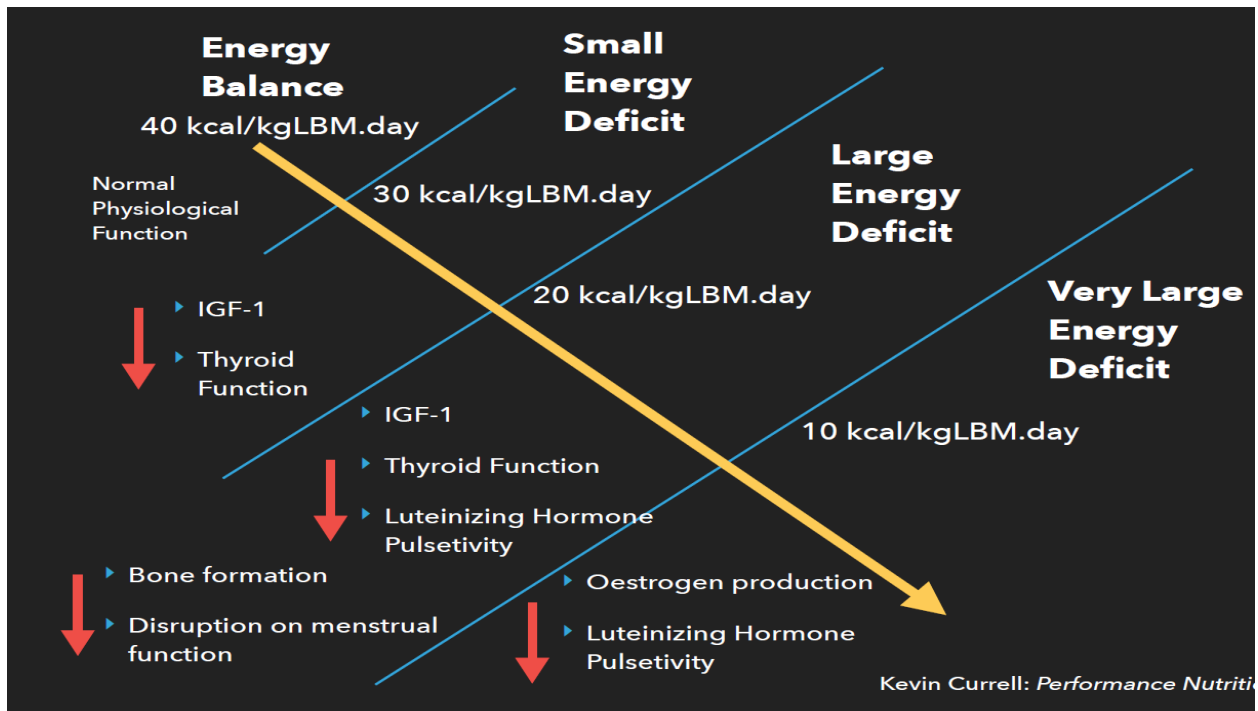
1. **Total**- Match your caloric intake with your training/activity requirements and goals.
2. **Type**- Focus on carbohydrates for energy and glycogen restoration, adequate protein for repair and muscle protein synthesis and healthy fats to minimize inflammation and support overall health.
3. **Timing**- Time your meals strategically around training sessions and competitions.

Energy availability (EA) is the difference between energy intake (diet) and

energy expenditure (exercise, training and competing, and NEAT- Non-Exercise Activity Thermogenesis). It is essential for health, performance and recovery.

Low Energy Availability (LEA) occurs when there is an imbalance between the energy intake and energy expenditure, resulting in an energy deficit.

LEA can be inadvertent, intentional or psychopathological (e.g., disordered eating). It is a factor that can adversely impact reproductive, skeletal and immune health, training, performance and recovery, as well as a risk factor for both macro- and micronutrient deficiencies.



(Currell, Kevin. 2017)

Determining Energy Availability

Energy availability = (Energy intake (kJ) – Energy expenditure during exercise (kJ))/fat-free mass (kg)

(Ong, J. L., & Brownlee, I. A., 2017)

MACRONUTRIENTS

CARBOHYDRATES

Carbohydrates (CHO) are the primary energy source for moderate-intense activity. A general carbohydrate guideline is to match needs with activity:

- Low intensity/skill based: 3–5 g/kg BW
- Moderate intensity: 5–7 g/kg BW
- High intensity: 6–10 g/kg BW
- Extreme: 8–12 g/kg BW

Carbohydrates and Recovery

During postexercise recovery, optimal nutritional intake is important to replenish endogenous substrate stores and to facilitate muscle-damage repair and reconditioning. After exhaustive endurance-type exercise, muscle glycogen repletion forms the most important factor determining the time needed to recover.

The postexercise carbohydrate (CHO) recommendations is 1 g/kg/ BW hour for four hours, then match activity needs (see above). This is the most important determinant of muscle glycogen synthesis.

Since it is not always feasible to ingest such large amounts of CHO, the combined ingestion of a small amount of protein ($0.2\text{--}0.4\text{ g} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$) with less CHO ($0.8\text{ g} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$) stimulates endogenous insulin release and results in similar muscle glycogen-repletion rates as the ingestion of $1.2\text{ g} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$ CHO.

Consuming CHO and protein (4:1) during the early phases of recovery has been shown to positively affect subsequent exercise performance and could be of specific benefit for athletes involved in multiple training or competition sessions on the same or consecutive days.

(Burke, L. M. 2015) (Smith-Ryan, A., & Antonio, J. 2013) (Beelen, M., et al. 2010)

Carbohydrate dosing relative to resistance training should be

commensurate with intensity guidelines outlined above.

PROTEIN

Optimum protein consumption is key to stimulating muscle protein synthesis and facilitating repair. Protein recovery guidelines for strength training include:

- Protein Dose: 1.6–2.0 g/kg BW
- 0.25–0.5 g/kg BW/meal in 4 divided meals
- Branch Chain Amino Acids- Leucine dose: 3 g is optimal to stimulate muscle protein synthesis (whey is a good source)
- The addition of 50 g of carbohydrate with protein pre- and post-exercise can decrease muscle breakdown
- Consuming 1–2 small protein rich meals in the first 3 hours post-exercise can capture the peak of muscle protein synthesis

(Dreyer, H. C., Drummond, et al. 2008) (Norton, L. E., & Layman, D. K. 2006) (Smith-Ryan, A., & Antonio, J. 2013) (Naderi, A. et al. 2016)

FAT

During the recovery process, fats are important as an energy source, hormone production and to reduce inflammation.

Essential Fatty Acid Balance

The Standard American Diet (SAD) is notoriously pro-inflammatory, with the Omega 6:Omega 3 greater than 4:1 (closer to 18:1).

To reduce inflammation and enhance recovery, athletes should focus on getting the fats in their diet from dark green leafy vegetables, flax/hemp seeds, walnuts, cold water fish, grass-fed beef, omega-3 eggs; and limit omega-6 (vegetable and seed oils). Saturated fat should come from grass fed, pasture raised animals. Olive and avocado oils are good choices for cooking.

(Simopoulos, A. P. 2008)

Athletes should consume 20 to 35 percent of their calories from fat.

MICRONUTRIENTS AND PHYTONUTRIENTS

Micronutrients include vitamins and minerals. They are required in small quantities to ensure normal metabolism, growth and physical well-being.

If your diet is 50-75% plant-based and includes healthy fats and adequate protein, you are likely to get the vitamins, minerals and phytonutrients you need without having to rely on supplementation.

Phytonutrients, also called phytochemicals, are chemicals produced by plants. Phytonutrient-rich foods include colorful fruits and vegetables, legumes, nuts, tea, cocoa, whole grains and many spices. Phytonutrients can aid in the recovery process due to their anti-inflammatory properties.

Antioxidants- Too much of a good thing?

Reactive oxygen species (ROS) and reactive nitrogen species (RNS) are free radicals that are produced during exercise that can cause skeletal muscle damage, fatigue and impair recovery. However, ROS and RNS also signal cellular adaptation processes.

Many athletes attempt to combat the deleterious effects of ROS and RNS by ingesting antioxidant supplements (e.g., vitamins A, C, E and the minerals Se and Zn). Unfortunately, interfering with ROS/RNS signalling in skeletal muscle during acute exercise may blunt favourable adaptations and can attenuate endurance training-induced and ROS/RNS mediated enhancements in antioxidant capacity, mitochondrial biogenesis, cellular defence mechanisms and insulin sensitivity.

In addition, antioxidant supplementation can have deleterious effects on the response to overload stress and high-intensity training, thereby adversely affecting the remodelling of skeletal muscle following resistance and high-intensity exercise.

The bottom line is that physiological doses (from the diet) are beneficial whereas supraphysiological doses (supplements) during exercise training may be detrimental to one's gains and recovery.

(Merry, T. L. and Ristow, M. 2016)

HYDRATION

Water regulates body temperature, lubricates joints and transport nutrients. Signs of dehydration can include fatigue, muscle cramps and dizziness.

During the recovery phase, staying hydrated can help stimulate blood flow to the muscles, which can reduce muscle pain. In addition, hydration can help flush out toxins which can exacerbate muscle soreness.

Are You Dehydrated?

<u>Urine Color</u>	<u>Meaning/Status</u>
Clear	Good hydration, overhydrated to mild dehydration
Pale Yellow	Good hydration or mild dehydration
Bright Yellow	Mild to moderate dehydration or possibly taking vitamin supplements
Orange, Amber	Moderate to severe dehydration
Tea / Apple Juice Colored	Severe dehydration

Endurance Sports Considerations

- Early consumption of at least 150% of fluid lost with dilute sodium solution (≤ 50 mmol/L, e.g., isotonic sports drink)
- Events greater than 90 minutes require pre-event hydration strategies 2–3 days prior (e.g., consume 400-600 mL of fluid every 2–3 hours containing Na 40–100 mmol/L)

- Aim to hydrate back to pre-race weight

(Smith-Ryan, A., & Antonio, J. 2013)

Homemade Electrolyte Recovery Drink

- 1/2 cup fresh orange juice
- 1/4 cup fresh lemon juice
- 2 cups raw coconut water
- 2 tbsp organic raw honey
- 1/8 tsp Himalayan pink salt

Blend ingredients and chill.

NUTRIENT TIMING FOR RECOVERY

Timing your nutrition for recovery should include ensuring pre-exercise meal(s) adequately fuel your activity and that you optimise your macronutrients, as mentioned above, to maintain glycogen stores and protein balance.

While there is some debate with respect to the post-exercise “optimum window,” one should consider that it is likely that glycogen replenishment and protein consumption soon after exercise or an event can help optimize adaptations and recovery and minimize adrenal stress and catabolism.

SUPPLEMENTS FOR RECOVERY

Supplements can play a role in helping to enhance repair, but only when the foundation (energy, macros, micros, hydration and timing) is covered.

Supplements can be categorized based on how they support (not block) inflammation as well as their role in muscle, tendon and bone repair.

Inflammation:

- Bromelain: Generally about 500 mg 3x/day away from food
- Curcumin: 500 mg 3x/day (find product with piperidine)
- Fish oil: 2000 mg 3x/day

Muscle Repair:

- Adequate Protein (see protein section)
- HMB (Beta-hydroxy-beta-methyl butyrate): 3g/day
- Fish Oil: 4000 mg/day
- Creatine Monohydrate: 5000 mg/day for 5 days (in divided doses), followed by 3000 mg/day
- Polyphenols (micronutrients from plant-based foods): Consume a variety of colorful fruits, vegetables, herbs and spices. Tart cherry juice has been shown to aid in muscle repair and soreness.

Tendon Repair:

- Collagen or gelatin: 10g/day
- Whey Protein: 20-40 g/day (about 3-5 g Leucine)
- Nitrates: From food (e.g. beets and chard)- increases circulation
- Citrulline Malate: 6,000 – 8,000 mg/day- increases circulation

Bone Repair:

- Adequate Protein and Carbohydrates
- Calcium: Aim for 1200 mg mostly from food sources
- Vitamin D: Per blood work (optimal levels are 40–60 ng/mL)

(Currell, Kevin., 2017) (Tipton, K. D., 2015)

Recovery smoothie (makes about 2 servings)

- 1 cup water
- 1 cup kale or spinach
- 1 peeled beet
- ½ cup frozen organic berries
- 1 banana
- ½ avocado
- ½ tsp raw cacao
- 30 g whey protein
- 2 tbsp ground flaxseed

Blend ingredients and enjoy!

Sleep

A growing body of literature demonstrates a positive relationship between sleep and optimal performance and recovery. Athletes often have low sleep quality and quantity that may be due to a combination of scheduling constraints and the low priority of sleep relative to other training demands. In addition, there may be a lack of awareness of the role of sleep in optimizing athletic performance.

Athletic performance, neurocognitive function and physical health have all been shown to be negatively affected by insufficient sleep. Athletes should aim for 9 to 10 hours of sleep.

(Simpson, N. S., Gibbs, E. L., & Matheson, G. O., 2017)

Sleep hygiene tips:

1. Start a bedtime routine.
2. Have a wind-down period and regular bedtime.
3. Turn off your electronics and keep them away from where you sleep.
4. Maintain a cool, dark and quiet sleep environment.
5. Avoid caffeine late in the day and alcohol in the evening.
6. Avoid processed foods and sugar.
7. Get some outside time during the day.
8. Consider a sleep study to evaluate for apnea if you have chronic insomnia.
9. Consult your healthcare provider regarding the use of supplements, (e.g. melatonin, valerian root, lemon balm and CBD).

(Bubbs, M., 2019)

Stress

The fight-or-flight response (stress response) is a physiological reaction that occurs in response to a perceived threat or danger. It enables the body to take action quickly in order to avoid harm. This response can also occur when we are not in any immediate physical danger, but are still experiencing stress, e.g. relationship or work stress.

Stress can result in several physiological reactions, such as: Increased heart rate, blood pressure, blood sugar, respiration, perspiration and muscle tension.

The general adaptation syndrome (GAS), developed by Hans Selye, describes three stages of responses that the body goes through in response to stress. These include:

1. *Alarm* – This occurs when we perceive something as stressful, and the body initiates the fight-or-flight response.
2. *Resistance* – The stress continues resulting in higher metabolic needs.
3. *Exhaustion* – Prolonged stress depletes the body's resources, resulting in suppression of the immune system and deterioration of body functions. This can lead to a variety of chronic health issues, such as heart disease, digestive problems, depression, and diabetes.

(Selye, H., 1950)

Heart Rate Variability(HRV) is a way to quantify the body's stress response. HRV measures the variation in time between each heartbeat. It is controlled by the autonomic nervous system (ANS), which regulates our heart rate, blood pressure, breathing, and digestion. The ANS is subdivided into the sympathetic and the parasympathetic nervous system, also known as the fight-or-flight mechanism and rest-relax.

As the brain processes information in the hypothalamus, it sends signals through the ANS to the body that either stimulates (sympathetic) or relaxes (parasympathetic) physiological functions.

Stress, poor sleep, unhealthy diet, dysfunctional relationships and over or under training can disrupt balance within the ANS , shifting your fight-or-flight response into overdrive.

HRV is a noninvasive way to identify ANS imbalances. If a person's system is in more of a sympathetic mode, the variation between subsequent heartbeats is low, whereas if one is in a more relaxed state, the variation between beats is high.

HRV changes can be improved with mindfulness, meditation, breathing, sleep optimization and periodized training.

Elite HRV is a good way to monitor your HRV.

(Young, H. A., & Benton, D., 2018).

Stress Management Tips:

- Meditation
- Mindfulness
- Re-balance work-home life
- Walk/Exercise
- Social time
- Bond with supportive people
- Supplement with L-Theanine or Ashwagandha

Training Periodization

Periodization is a systematic way to plan workouts in order to maximize progress while minimizing susceptibility to injury and allowing for optimal recovery. Programming is divided into macro- (yearly), meso- (monthly), and micro- (weekly) cycles, with recovery strategies incorporated into each of these cycles.

Each cycle takes into account the FITT principle:

- **Frequency**- number of workouts per week
- **Intensity**- level of effort of an activity
- **Type**- e.g. cardiovascular, stabilization, strength, power
- **Time**- work and rest intervals

The OPT Model (Optimum Performance Training) is an evidence-based fitness training system developed by the NASM, that progresses an individual through five training phases: stabilization endurance, strength endurance, hypertrophy, maximal strength and power. This model of periodization allows individuals to safely and progressively work towards health and performance-based outcomes.



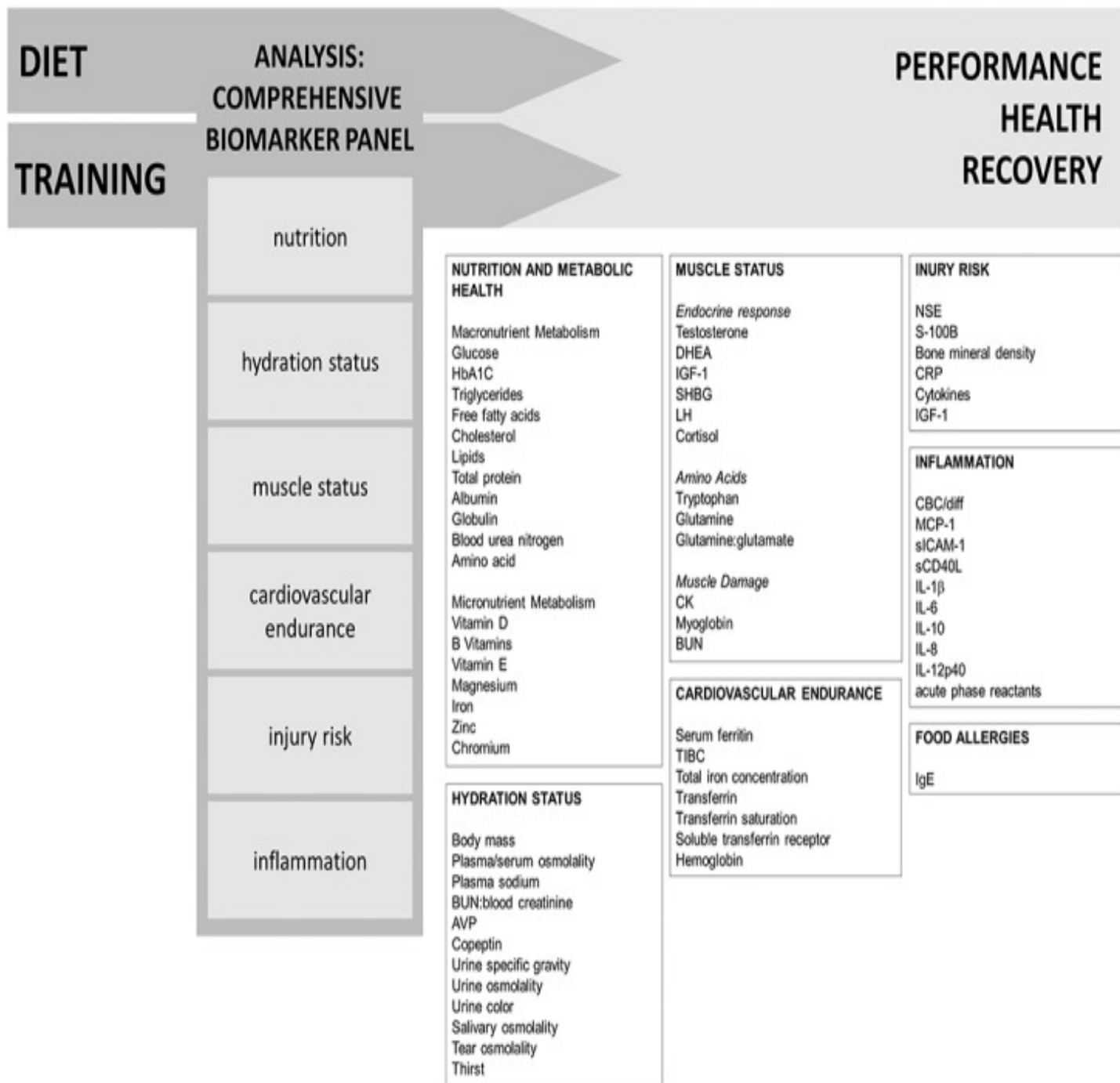
(Clark, M. A., Lucett, S., & Corn, R. J., 2008)

Monitoring

There are several key performance biomarkers that can be used to monitor training and recovery. These include:

1. Nutrition and metabolic health
2. Hydration status
3. Muscle status
4. Endurance performance
5. Injury status and risk
6. Inflammation

Through comprehensive monitoring of physiologic changes, training cycles can be designed that elicit maximal improvements in performance while minimizing overtraining and injury risk.



(Lee, E. C., et al, 2017)

Treatments and Modalities

There are a number of recovery techniques and modalities that have been used to address delayed onset muscle soreness (DOMS), perceived fatigue, muscle damage, and inflammatory markers after physical exercise. These include: Manual therapies (both practitioner and tool assisted), electrical stimulation, vibration, contrast hydrotherapy, cryotherapy, compression garments and hyperbaric oxygen

Manual therapies are treatment methods used by chiropractors, naturopaths, athletic trainers, physical therapists and massage therapists, to address neuro-musculo-skeletal pain and dysfunction as well as facilitate recovery. These can include techniques such as massage, joint manipulation, joint mobilization, soft tissue manipulation, stretching and dry needling. These techniques are aimed at increasing range of motion, treating joint dysfunction, improving soft tissue extensibility, reducing pain, reducing inflammation and enhancing healing.

Modalities such as cold water immersion and the use of compression garments have been shown to be effective for Delayed Onset Muscle Soreness (DOMS), perceived fatigue and inflammation.

One should also consider that while some of these modalities can provide symptomatic relief, there may be a drawback. For example, cryotherapy can reduce inflammation, which could adversely affect healing and adaptations to training. In this case, it may be prudent to reserve this for cases when return to play takes priority such as back to back games or tournaments.

(Dupuy, O., et al., 2018) (Malta, E.S., et al, 2021).

Key Points to Enhance Recovery:

- Focus on nutrition, sleep and stress management
- Periodize training
- Monitor physiology such as biomarkers and HRV
- Incorporate evidence based treatments
- Add some recovery modalities if appropriate

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