

## Muscle Status Biomarkers and Athletes: A Review

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### Abstract

**Aim:** The aim of this review was to discuss the role of biomarkers of muscle status of athletes. **Results:** The research in the field of exercise science has identified various biomarkers for assessing athlete's health, performance, and recovery during training. However, there are biomarkers which changes in individual's participating in physical activity and exercise training programs. In the present review an approach was to review the current literature of molecular science and determined a set of validated biomarkers of muscle status and recovery of athletes that could be used by coaches and trainers. **Conclusion:** The present review will help sport scientists, coaches, trainers, clinical sport professionals, researchers, and athletes to better understand how to monitor biomarkers of muscle status of athletes, as they design training cycles that elicit maximal improvements in performance while minimizing overtraining and injury risk.

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### Introduction

The composition, metabolic capacity, structure, size, and contractile indices of skeletal muscle tissue (i.e. quality of skeletal muscle tissue) are an important aspect of athletic health and performance. Power, fatigue, strength, and endurance in athletes are directly affected by muscle condition or the fatigue and recovery state of the muscle. Furthermore, not enough recovery from exercise-induced muscle damage caused by training impairs performance, likely because of increased sense of effort, reduced exercise tolerance, reduced strength, and reduced power. Monitoring indices of muscle status will help athletes to alter their training/competition and recovery programme to optimize performance. Blood-based biomarker muscle status assessment should focus on endocrine regulation of muscle adaptations/repair, metabolic homeostasis (anabolic-catabolic balance, protein/amino acid deficiencies, and substrate availability), muscle damage, and muscle excitability. There are well-validated markers related to fatigue, recovery, protein synthesis, or fueling strategies, which are all major athlete concerns. Because hormone and amino acid concentrations in the blood are highly variable among individuals, these types of biomarkers are best assessed by analyzing progressive increases/decreases away from a baseline measure for each person. This requires monitoring for these types of biomarkers at multiple time points throughout training, off-season, and competition cycles. To observe chronic changes across a season, athletes may be tested every 4–6 weeks under similar conditions (i.e. fasted, in the morning, before training, the day after a rest day or similar training day).

### Hormonal Response

An appropriate hormonal signaling is necessary for the physiological adaptations to exercise training. Dependent on the magnitude of the training stimulus, often defined by acute program variables such as load, volume, duration, modality, and rest, hormones elicit specific training