



1 The history of sports nutrition: from the early days to the future

— **Bengt Saltin**, CMRC, University of Copenhagen, Denmark

An experimental approach to the field of human muscle energy metabolism had its start in the latter part of the 19th century. Laboratory experiments were performed to unravel whether not only glucose/ glycogen but also lipids could be used directly by contracting skeletal muscle. At the same time other researchers had a more applied approach searching for the optimal diet when exploring or crossing Ice Caps in the world. The laboratory approach gave clear cut answers demonstrating that lipids could be used by human skeletal muscle without first being converted to a sugar. The field studies gave support for this notion as it could be established that up to 60–70% of the energy intake could come from fat, and the subjects could still maintaining a daily high exercise output. The sledge dogs could, however, perform their heavy task with a diet containing up to 90% fat. Since these early days there has been a continuous progress in our understanding of the importance of intensity, diet and training status for the substrate choice by skeletal muscle when exercising. Most of the knowledge we have today comes from studies in the 1930s but the understanding of why carbohydrate usage is intensity dependant, and that muscle training improves fat utilization, and reduces lactate accumulation and why carbohydrate loading elongates time to exhaustion, are still not understood in great depth.



Methodological improvements in the 1950-60s such as the use of isotopes and the re-introduction of the biopsy needle (by Jonas Bergström) to take muscle biopsies brought about new tools for more direct measurements of both substrates used and metabolites produced by muscles. The key role of fatty acids (FA) was recognized as was the storage and usage of muscle glycogen.

In the wealth of training studies performed through the years a primary goal has been to establish in the relative importance of glucose and lipids for the energy turnover but also to pin point limiting factors and the regulatory mechanisms in handling these substrates. With regard to the lipids there is a consensus of its larger role after training but to what extent serum and/or muscle triglycerides (TG) contribute is intensely debated. There is also debate about where the limitation is for the lipid utilization during the exercise. There are arguments for the transport of FA into the muscle to be critical but equally strong arguments can be provided for a key role for the mitochondrial FA respiratory capacity. A player is also the regulation of the FA uptake by the mitochondria.

All available results on linking diet to performance points at carbohydrates being essential. Equally clear is that a high capacity for lipid oxidation in the active muscles of an endurance athlete is a requirement for optimal performance. In part this is explained by limited glycogen storage capacity but there is more to it than that. The explanation is not really known today but worthwhile to look for as it will provide the insight needed to guide the athlete both in regard to the ideal diet and the best training.

The final note is a tribute to the accomplishment by the early researchers in the field. Not only for the joy of reading their way of writing but just as much to how much of knowledge we have gained from their work. This relates not only to the more applied aspects and results but also our understanding of possible limiting factors and metabolic regulation when performing in endurance events.

2 What is the optimal composition of an athlete's diet?

— **Liz Broad**, Dietitian, Australia

The optimal composition of an athlete's diet will depend on the sport they are engaged in, the amount and type of training they undertake, and whether they need to manipulate their body weight or body composition. In short, athletes need individualised dietary advice that is based on sound scientific principles and that is easily incorporated into their daily routine. This interface – the conversion of science, into food is where a skilled sports nutrition professional is invaluable.

The first priority is to consider baseline nutrient requirements which fall in line with recommendations for the general population in terms of most micronutrient (vitamins, minerals, fibre) needs and general trends in terms of the balance of macronutrients (carbohydrate, fat, protein and alcohol). Once this is determined for the individual, daily nutrient requirements should be tailored to meet sport-specific requirements of the athlete.

One starting point would be to determine daily protein requirements. Given most athletes meet daily protein requirements as a result of their increased daily energy intake, the priority is to organise protein containing snacks around training to optimise the response to training and assist recovery following exercise. For example, orientating a snack that provides 10–20g of protein immediately after resistance training for a rugby union player requires education and forward planning. This athlete will easily meet daily protein requirements, however will they optimize the timing of their protein intake – unlikely without the support of a skilled professional. Once their protein intake is planned to support training, the remainder can be incorporated into the other meals and snacks to ensure a range of different food sources are used to meet essential nutrient requirements such as calcium (ie 3–4 serves of dairy), iron and zinc.



For optimal glycogen recovery 1g of carbohydrate/kg can be incorporated in recovery snacks immediately after a more prolonged training session, then aim to follow this up again with a similar amount in the subsequent 2 hr period. Consider whether you require carbohydrate during or before training, based on the goals of the training session itself and the relative importance of maintaining a strong work output throughout the entire session versus using the session to promote the metabolic and physiological adaptations to training. Once you have allocated appropriate carbohydrate to this, then as with protein, distribute the remainder of your requirements throughout the other meals and snacks for the day, using a range of different foods. In this instance, make sure this includes fruit and vegetables for their antioxidant content rather than making the carbohydrate predominantly cereal-based, and don't leave it all to the last meal of the day. For those with very high energy needs, lower fibre options and liquid options (juice, cordial, flavoured milks, etc) are useful inclusions as otherwise the diet becomes overwhelming.

Finally, once protein and carbohydrate requirements are met, assess the remaining energy left to achieve energy balance (for weight maintenance), or create a surplus or deficit of energy to achieve muscle /fat gain or body mass /fat loss, respectively. The targets set for body fat /mass loss should be moderate (~1000–1500kJ less than requirements) to ensure that carbohydrate and protein requirements aren't