Optimizing Nutrition for Health & Performance

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#1: Achieving a balanced diet

Most of us would be familiar with the classic food pyramid which aims to recommend through illustration how adults can achieve a balanced diet through consumption through a variety of portions from all food groups in the food pyramid (see Figure 1). The composition of this pyramid consists of food groups rich in five of the six nutrients essential for survival. At the bottom of the pyramid we have sources of carbohydrates in the form of fibrous and unrefined forms, such as, wholemeal bread, pasta, rice, porridge oats and other grains. Next most abundant in our diets should be fruit and vegetables which are a rich source of most vitamins and minerals. Representing a smaller portion of our diet would be the dairy group- this includes mainly milk, yoghurt and cheeses- as well as meat, fish, legumes and nuts. This food group is particularly rich in proteins and fats. Despite the food groups being rich in specific nutrients, these are not found in isolation and all food groups contain a mixture of nutrients. The top two tiers represents the groups of foods we should really moderate in our intake: trans fats, refined sources of sugars and table salt- as they have all been found to be culprits in the growing incidence of nutrition related disorders such as cardiovascular disease, cancer and metabolic syndrome. The sixth essential nutrient does not feature in the pyramid, this is water and it constitutes about 60% of our body mass. It plays a role in almost all reactions in our body and is necessary for thermoregulation, hence the increased necessity during exertion.

Figure 1 See www.fsai.ie and www.indi.ie for more detail and learn about portion sizes too

Resources:

For information on Healthy Eating visit Food Safety Authority Ireland
https://www.fsai.ie/science_and_health/healthy_eating.html

For more specific dietetic information on Healthy Eating, including a focus on athletes visit the Irish Nutrition and Dietetic Institute website at https://www.indi.ie/

#2: The consequences of poor nutrition

A well balanced diet ensures that we are consuming adequate quantities of all the essential nutrients necessary for the proper functioning of our body. In the case of athletes, were energy expenditure is very high- especially during periods of high intensity and/ or long duration training- a well-balanced diet with adequate energy intake is essential for maintaining health and maximising training effects. Low energy intakes can result in loss of muscle mass, menstrual dysfunction, inability to gain bone density, an inability to recover efficiently from training and competition, as well as an increased risk of injury. Neglecting proper nutrition from a young age has major implications for the athletes' health, and in turn the capacity of that athlete to compete later in life.

Athletes may sometimes be tempted to resort to extreme means of weight loss through drastic reduction in energy intake in order to create an energy deficit. The motivations can be strong and may be indicative of the high pressure to perform, leaving some vulnerable groups of athletes at a higher risk of developing negative eating patterns, which in the short term might seem rewarding due to the reduction in body weight, however in the longer term the athletes performance and health will be adversely affected. If these negative eating patterns are sustained, they may develop into an eating disorder. The prevalence of eating disorders is higher in athletes than the general population, and certain sports which have weight categories (such as rowing and boxing) and those which have tight fitting costumes or aesthetic points system, such as swimming, gymnastics and ballet, increase the vulnerability of athletes in developing eating disorders at a crucial age of physical development.

Resources:

Warrington, J. 'The Female Athlete'. Coaching Ireland. Accessible online through the Irish Sports Council website: http://www.irishsportscouncil.ie/Coaching-Ireland/Publications-/The-Female-Athlete.pdf

'Healthy Body Image' awareness & education campaign by the IOC:

- ✓ https://www.youtube.com/watch?v=Pl2P9VVv6oE
- ✓ https://www.youtube.com/watch?v=a7erGI_weAE
- ✓ https://www.youtube.com/watch?v=UDGqM0GwFYY
- ✓ https://www.youtube.com/watch?v=1sm95tKwilE

#3: Optimising your body composition, a matter of energy balance

Body composition, specifically body fat, can be optimised to improve performance through nutritional manipulation, specifically of the macronutrients: carbohydrate, fat and protein, as these contribute to energy intake. Advice for such manipulation needs to be assessed on a one-on-one basis with the athlete in order to increase energy expenditure or reduce energy intake ensuring appropriate fuelling for the training that is being performed by the athlete and also adequate intake of all other nutrients to maintain health. A sports Dietitian can effectively inform this process as there is a need for an understanding of the requirements of that athlete with consideration to their stage of development, as well as an understanding of the requirements and periodization of the training and competition, which needs to be translated into practical advice in order for the athlete to implement.

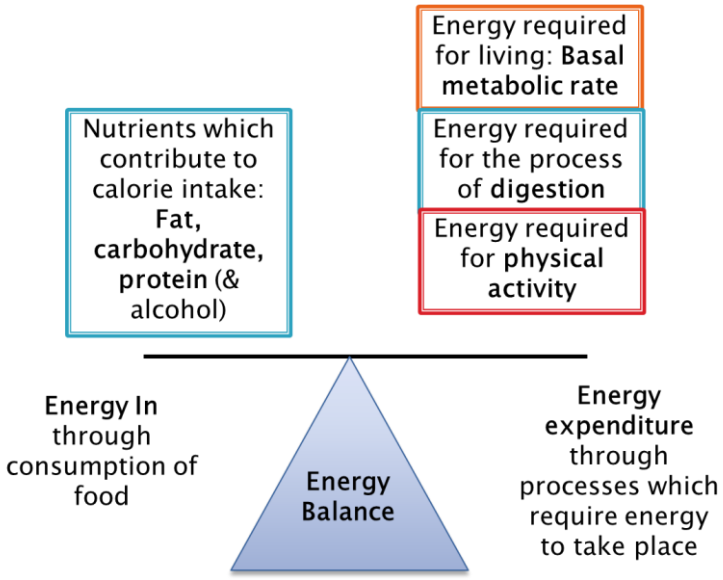


Figure 2 The energy balance equation illustrates the forms of calorie intake through food and energy expenditure through processes required by the body. An understanding of each component facilitates decision making on the modifiable and non-modifiable considerations for optimizing body composition.

A healthy body fat essential for living is 3% for men and 12% for woman. For good health the ranges are between 10-20% for men and 16-26% for woman. Athletes usually fall in a continuum on these ranges reflecting the sport and level they compete at. The increased requirement in woman is due to fertility related body fat. The athletes' ability to modify their body fat composition and a healthy standard for the athlete is individual and depends on many factors including age and ethnicity; nevertheless, at no time should the athlete be less than the essential values as it is detrimental to the athletes' health.

Resources:

IOC consensus statement on Body Composition for Health & Performance in athletes accessible online: http://www.olympic.org/Documents/Commissions_PDFfiles/Medical_commission/SPO_1159714_Ackland.pdf

For further information on body composition of athletes from different sports:

McArdle, W.D., F.I. Katch, & V.L. Katch. 2005. Sports and Exercise Nutrition 2nd ed. Baltimore: Lippincott Williams & Wilkins.

#4: Understanding the demands of your sport: energy production for muscular activity

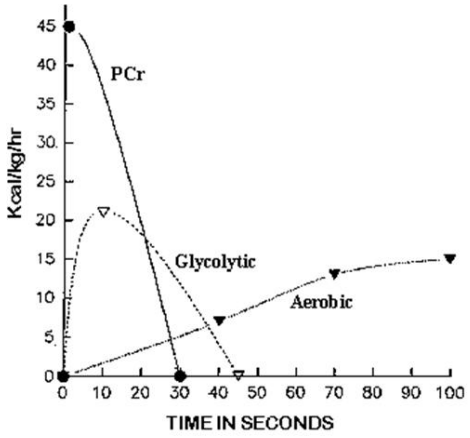
An understanding of the metabolic demands posed by the sport and specific requirements of the athlete are essential when planning to implement successful nutritional strategies, whether it be to optimize body composition, maximise performance, or fuel and recover effectively from training and performance.

The way in which the body converts food to fuel relies upon several different energy pathways. Having a basic understanding of these systems can help athletes train and eat efficiently for improved sports performance. Carbohydrate, fat, and protein contribute to the fuel supply needed by the body to perform exercise. These nutrients get converted to energy in the form of adenosine triphosphate or ATP. It is the energy released by the breakdown of ATP that allows muscle cells to contract. However, each nutrient has unique properties that determine how it gets converted to ATP.

Carbohydrate is the main nutrient that fuels exercise of a moderate to high intensity, while fat can fuel low intensity exercise for long periods of time. Proteins are generally used to maintain and repair body tissues, and are not normally used to power muscle activity.

As the body cannot easily store ATP (and what is stored gets used up within a few seconds), it is necessary to continually create ATP during exercise. In general, the two major ways the body converts nutrients to energy are aerobic metabolism (with oxygen) and anaerobic metabolism (without oxygen) and the main differences is how quickly they are able to replenish the ATP used by the working muscles.

Depending on the nature of the sport, the type, intensity and duration the metabolic demands tend to be specific and with repeated training induce specific physiological adaptations which maximise the athlete ability to perform maximally during competition. Therefore, nutritional requirements of the athletes should aim to fuel according to the specific energy systems being challenged in their relative amounts.



Time Course of Contributions from Different Energy Sources
Taken from Gleim, Anaerobic Testing and Evaluation, Med Exerc Nutr Health 1993;2:27-35

Figure 3 Graph displaying the rate each of the energy systems is able to produce ATP to fuel muscular activity. The three energy systems work together, however, depending on the nature of the sport one may be relied on more than the other two. This affects nutritional requirements of the athlete as well as influences body composition incurred by physiological adaptation in response to the metabolic stresses.

Resources:

To learn more about energy systems:

Wilmore, J.H. and Costill, D.L. Physiology of Sport and Exercise: 3rd Edition. 2005. Human Kinetics Publishing.

#5: Fuelling for your sport: Carbohydrate timing, type & quantity

Carbohydrates can be categorised in two broad types: the complex type which are digested slowly by the body to appear in our blood slowly and simple carbohydrates, ones which are easily digested by the body and appear quickly in our blood from the time of ingestion. Foods usually contain a mixture of these and can be described through their glycaemic index, which is a score from 0-100 depending on the rate of appearance in the blood as compared to pure glucose (which is scored at a 100).

Complex carbohydrates tend to have a lower glycaemic index (or GI) score and therefore provide sustained energy levels, and most often are a good source of fibre too. These types of carbohydrates are associated with healthy eating, but are also essential for the athlete during recovery and preparation. However, depending on timing and the demands of training and competition, athletes may also require foods with a high glycaemic index.

Recommendations for timing and quantity of carbohydrates have been set out to guide athletes in achieving their requirements are outlined in the following table:

Daily Needs for Fuel and Recovery:

	Situation	Carbohydrate Targets
Light	Low-intensity or skill-based activities	3-5 g per kg BM
Moderate	Moderate exercise programme (~1 hr / day)	5-7 g per kg BM
High	Endurance programme (i.e. moderate-to-high intensity exercise of 1-3 hr / day)	6-10 g per kg BM
Very High	Extreme commitment (i.e. moderate-to-high intensity exercise of >4-5 hr / day)	8-12 g per kg BM

Acute Fuelling Strategies:

	Situation	Carbohydrate Targets
General fuelling up	Preparation for events < 90 min exercise	7-12 g/kg per 24 hr as for daily fuel needs
Carbohydrate loading	Preparation for events >90 min of sustained/intermittent exercise	36-48 hours of 10-12 g/kg BM per 24 hour
Pre-event fuelling	Before exercise > 60 min	1-4 g/kg BM (consumed 1-4 hr pre-competition)
During brief exercise During sustained high-intensity exercise During endurance exercise including "stop and start" sports During ultra-endurance exercise	<45 min 45-75 min 1-2.5 hours 2.5-3 hours	Not required Small amounts including mouth rinse 30-60 g/hr Up to 90 g/hr using multiple transportable carbohydrates (glucose:fructose mix)
Speedy refuelling	<8 hr recovery between two fuel demanding sessions	1-1.2 g/kg BM every hour for first 4 hr then resume daily fuel needs

These two tables have been taken from the Australian Institute of Sport (AIS) website, where you can find extensive information, guidance, as well as practical advice on fuelling appropriately for your sport.

For further information visit: http://www.ausport.gov.au/

 # 6: Water: The sixth essential nutrient

The human bodies main component consists of water, ranging from about 75% of our total body weight as newly born babies, declining to 50% when we are elderly. All our cells in our body contain water and most chemical reaction in the body requires it for normal functioning. Water plays a crucial role in thermoregulation to keep the body at an optimal temperature of 37^{o}. Therefore, the need for proper hydration during exercise is enhanced, as the process of energy production to fuel muscular activity releases heat which the body needs to dissipate in order to maintain a stable temperature.

Dehydration is known to impair performance in an almost linear way (see Fig. 4). As one exercises, sweat rate increases in order to cool the body. When these sweat losses are not matched through appropriate hydration stategies blood volume decreases resulting in an increased heart rate and core body temperature. Cardiovascular function decreases as there is less oxygen and nutrient rich blood reaching the working muscles, resulting in the body to increase its reliance on the anaerobic energy system. The quicker depletion of glycogen and slower removal of waste products from this metabolism result in cramping and fatigue.

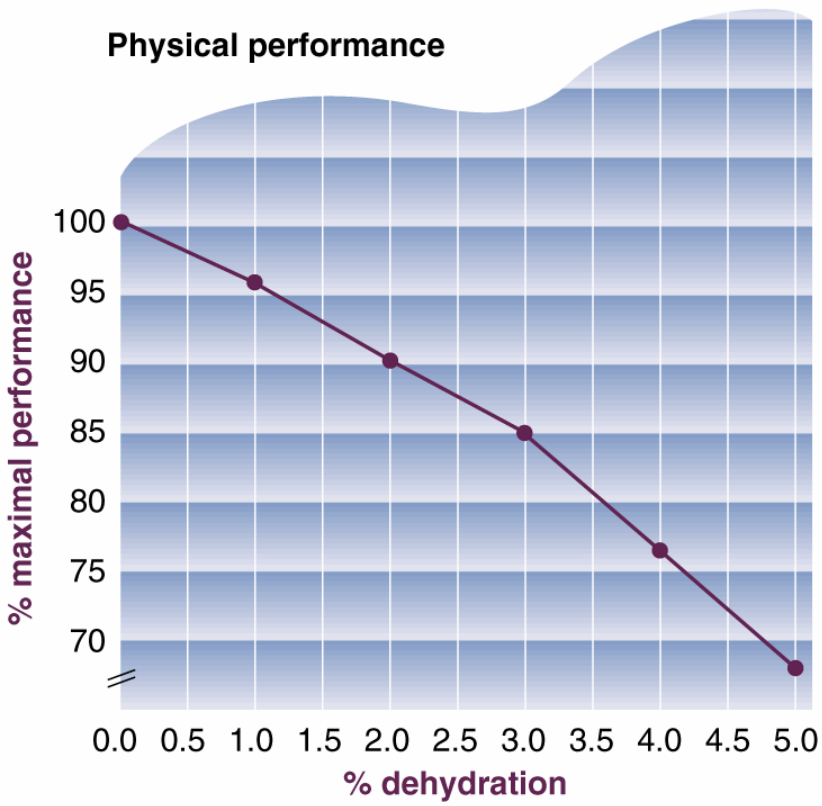


Figure 4 Illustration of decrement in performance with increasing dehydration as expressed as a percentage sweat loss.

The more dehydrated a person is, the higher the decrements in performance are. These include crucial aspects of performance such as endurance capacity, strength, speed, stamina and cognitive processes. With increasing dehydration from 1% upwards, is a concommitant increased risk of injury. Losses of 6% or more can result in severe heat camps, exhaustion, heat stroke, coma and ultimately death.

Resources:

For information about dehydration and treatment access HSE resources at: http://www.hse.ie/eng/health/az/D/Dehydration/Treating-dehydration.html

#7: Staying hydrated

Successful hydration strategies for athletes ensure the athlete starts exercise in a hydrated state (euhydration), hydrates appropriately during exercise replacing water and electrolytes lost in sweat, and post exercise rehydrates in such a manner return to a euhydrated state without delay. Individualized plans for athletes considering all factors which affect hydration are ideal, however if the following 5 recommendations are implemented, hydration goals should be met appropriately:

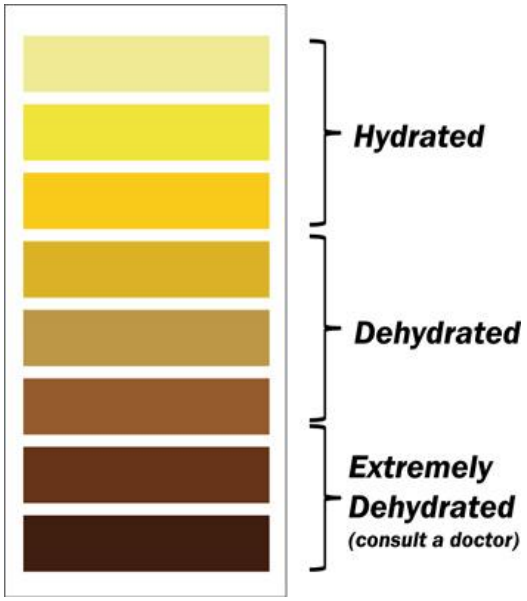


Figure 5 The colour of our urine is a useful indicator of hydration. Familiarising the athlete with the hydration chart can educate them in monitoring their own hydration level

1. **Begin each exercise session in fluid balance.** This requires drinking regularly throughout the day leading up to training or competition. Drink *ad libitum* consuming fluids with each meal and snack. Monitoring can be done through the colour of their urine, if this is clear then the athlete is hydrated, if this is yellow the athlete should increase their overall water intake. Requirements for fluid requirements vary, however a good starting point is to consume 35mL per kg of body mass. Accordingly, a 70kg man would need to consume approximately 2500mL of water per day to stay hydrated.

2. **Just before exercise commences**, consume 200-600 ml of fluid.

3. **Develop a plan for fluid intake** for all exercise sessions longer than 30 minutes. Aim to match previous fluid losses as closely as possible (within 1% of body mass). Take into account all the opportunities within the sport.

4. **Begin drinking early in the exercise session & continue to drink small amounts regularly.** An athlete should consume fluids during exercise in order to avoid dehydration during activity; a form of a carbohydrate-electrolyte drink should potentially be used for the athlete depending on several factors. In the case of opting for a sports drinks, one which is 4-8% carbohydrate, and contains 10-20 mmol/L sodium should be used.

5. **Replace any residual fluid deficit after exercise.** 150% of any fluid deficit (which should be monitored through pre- and post-exercise weigh-ins) in the 4-6 hours after exercise should be consumed to account for ongoing sweat and urinary losses. When fluid losses are high and/or rapid rehydration is required, sodium replacement may be required too. Sports drinks, oral rehydration solutions and salty foods can all contribute to sodium replacement.

Resources:

For more information about hydration access resources from Irish Sports Council at:

http://www.irishsportscouncil.ie/Coaching-Ireland/Publications-/Hydration-You-Are-What-You-Drink.pdf

#8: The importance of protein for recovery & health

Protein is necessary for several essential build and repair processes in the body, including supporting a healthy immune system. Athletes have an increased requirement for protein as prolonged and high intensity exercise causes substantial breakdown of muscle protein. In strength athletes, protein intake needs to match requirements to support increase and maintenance of muscle mass, whilst in endurance athletes protein contributes to small amounts of energy requirements and are necessary for the repair of muscle damage. Timing, quantity, distribution and combination of other nutrients during the ingestion of protein are all important consideration when informing an athletes nutritional program.

There are several resources which indicate appropriate requirements for protein intake for various athletes, below are the protein requirements as recommended by the Australian Institute of Sport:

Table 2: Protein rich foods for athletes. Each of the following foods provides approximately 10 g of protein. These foods have moderate to low fat contents and are rich in other nutrients.

Animal Foods	Plant Foods
2 small eggs	4 slices (120 g) wholemeal bread
30 g (1.5 slices) reduced fat cheese	3 cups (90 g) wholegrain cereal
70 g cottage cheese	2 cups (330 g) cooked pasta
1 cup (250 ml) low-fat milk	3 cups (400 g) cooked rice
35 g lean beef, lamb or pork (cooked weight)	3/4 cup (150 g) lentils or kidney beans
40 g lean chicken (cooked weight)	200 g baked beans
50 g grilled fish	120 g tofu
50 g canned tuna or salmon	60 g nuts or seeds
200 g reduced fat yoghurt	300 ml soy milk
150 g light fromage frais	100 g soy meat

Table 1: Estimated protein requirements for athletes

Group	Protein Intake (g/kg/day)
Sedentary men and women	0.8-1.0
Elite male endurance athletes	1.6
Moderate-intensity endurance athletes (a)	1.2
Recreational endurance athletes (b)	0.8-1.0
Football, power sports	1.4-1.7
Resistance athletes (early training)	1.5-1.7
Resistance athletes (steady state)	1.0-1.2
Female athletes	~15% lower than male athletes

(a) Exercising approximately four to five times per week for 45-60 min
(b) Exercising four to five times per week for 30 min at <55% VO_{2peak}

Source: Burke and Deakin, Clinical Sports Nutrition, 3rd Edition, McGraw-Hill Australia Pty Ltd, 2006

Figure 6 Animal and plant sources of protein which contribute to the protein intake of the athlete

Resources:

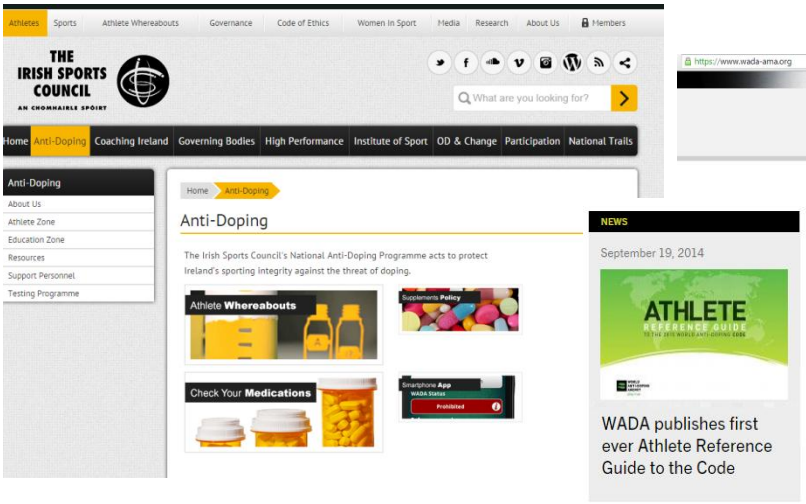
For practical tips on how to achieve recommended protein intake levels access resources from the AIS at: http://www.ausport.gov.au/ais/nutrition/factsheets/basics/protein_-_how_much

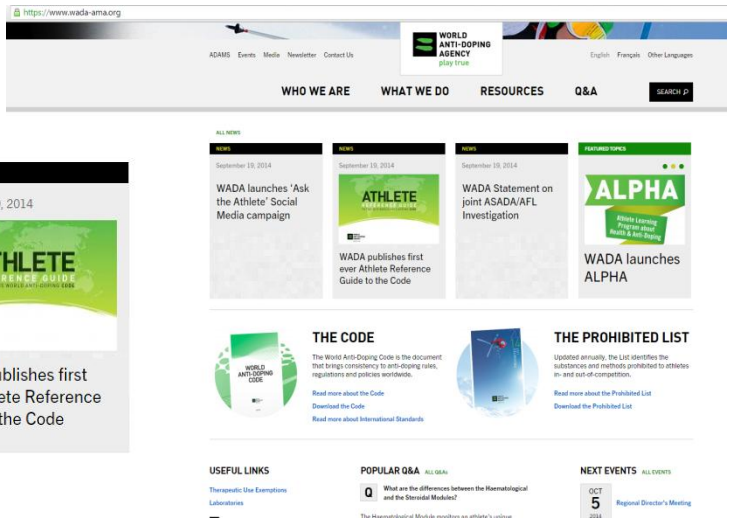
#9: Making informed decisions about supplements

After considering the previous 8 points above, one is able to make a better informed decision about sports supplements as there is a basic understanding of what is ESSENTIAL for the body to perform normal functions. Supplements can be a useful way of assisting the implementation of an athletes nutritional plan, however need to be used in an informed manner by the athlete. Supplements should never be used to replace a balanced diet from food, however can be tailored to provide some convenient support to assist the athlete in achieving the high nutritional requirements they have as a result of their sport.

Many supplements make big claims about what their product can deliver, therefore it is important to research the supplement well and find out where the evidence of the claims they are making originates from, and if this is substantiated or not. The European Food Safety Authority (EFSA) have recently introduced regulations for health and performance claims of products on or entering the market, ensuring that any claims by companies used for marketing is substantiated through scientific evidence.

As an athlete or coach, it is also important to be aware of nutritional ergogenic aids that may be used to enhance performance which may be banned by the World Anti-Doping Association (WADA) - the governing body regulating doping in sport. The Irish Sports Council and WADA have extensive online resources with information about doping in sport.





Resources:

European Food Safety Authority (EFSA) information on product claims:
http://www.efsa.europa.eu/en/topics/topic/nutrition.htm

World Anti-Doping Association (WADA) resources can be accessed online at:
http://www.usada.org/wp-content/uploads/2014-wada-prohibited-list.pdf

Irish Sports Council resources on anti-doping can be accessed online at:
http://www.irishsportscouncil.ie/Anti-Doping/

#10: A final message: Getting the basics right in nutrition goes a long way in maximising athletic performance.

Hopefully this article will help you as an athlete, coach or nutritionist in understanding how to go about fuelling for sport appropriately and where to look for further information on each of the subject areas touched upon. Assimilating information on nutrition with an underpinning of sports science takes years to master, and for this there are Sports Dietitians who are able to facilitate the process and prescribe tailored nutrition accordingly. When considering your needs as an athlete or the needs of a team you are coaching, getting these basic messages across will go a long way in making gains in training and performance. Where there are specific athletes who require further attention due to complexity of case, then one-on-one input from a Dietitian is warranted.

To find a qualified Dietitian in your area visit the Irish Nutrition & Dietetic Institute website at the following web address: https://www.indi.ie/