FOOD, NUTRITION AND HYDRATION IN SPORTS

Dr. Nieves Palacios Gil-Antuñano
Dr. Zigor Montalvo Zenarruzabeitia
Mrs. Ana María Ribas Camacho

Medicine, Endocrinology and Nutrition Service.
Center of Sports Medicine.
Consejo Superior de Deportes.
It is advisable to follow a varied and balanced diet, as well as a healthy lifestyle.
Contents

01. Food and Nutrition for Athletes 04
02. The Food Wheel 05
03. The Athlete’s Energy Needs 05
04. The Main Components: Carbohydrates, Fats and Proteins 06
05. Micronutrients: Vitamins and Minerals 08
06. Anti-oxidants and Physical Exercise 16
07. The Best Diet for Athletes 18
08. The Pace of Meals 18
09. Food and Competition 20
10. Hydration and Athletic Performance 21
   - The Importance of Being Properly Hydrated 21
   - Replenishment of Liquids Among Athletes 24
11. Adaptation to Climate and Time Zone Changes 25
Food is the way to provide the body with the essential substances for maintaining life. It is a voluntary, and conscious process through which a specific food is chosen and eaten. As of that moment, nutrition begins, consisting of the set of processes through which the body transforms and uses the substances which the ingested foods contain.

There are many ways to feed oneself, and it is an athlete’s responsibility to know how to properly choose the foods which are most appropriate for his or her health and which have a positive influence on physical performance.

A proper diet, in terms of quantity and quality, before, during and after training and competition, is essential to optimizing performance. Good food cannot replace incorrect training or being in poor physical shape, but an inadequate diet can damage a well-trained athlete’s performance.
This is a way to classify different foods on the basis of the majority of their composition, which determines their main role.

There are no whole foods which contain all of the nutrients required by the human body in an optimal amount. In general, even though a food may supply different nutrients, it will always have some in greater quantity, which will be the nutrients that determine its place on the food wheel. If at least one or two foods from each group on this wheel form part of the diet or daily menu in the proper amount, the result will be a proper diet.

There are seven groups of foods on the wheel, each of which is assigned a different color, in accordance with their main role:

- Plastic foods or tissue producers, in which proteins predominate (in red)
  - GROUP I: Milk and dairy products (yogurt, cheese, etc.).
  - GROUP II: Meat, fish and eggs.

- Mixed foods: energetic, plastic and regulatory (in orange)
  - GROUP III: Pulses, nuts and potatoes. These are foods which mainly contain energy, because they provide calories, but they are also plastic (because they contain vegetable proteins) and regulatory (due to their vitamins and minerals). Carbohydrates predominate in them and provide important amounts of fiber, which is necessary to regulate intestinal transit.

- Regulating foods in which vitamins and minerals are predominant (in green)
  - GROUP IV: Vegetables.
  - GROUP V: Fruit. They play a role in the mechanism for absorption and the use of other nutritional substances. They also provide dietary fiber.

- Energy foods (in yellow)
  - GROUP VI: Cereals (bread, pasta, corn, flour, etc.), honey, sugar and sweets. Most notable in these foods are carbohydrates.
  - GROUP VII: Butters and oils. High-energy foods. Predominating in them are lipids or fats.

A monotonous diet based on very few foods or foods which all belong to the same group leads to a lack of one or more nutrients.

### 3. The Athlete’s Energy Needs

Energy intake must make up for calorie expenditure and allow athletes to maintain a proper body weight for performing optimally in their sport. Physical activity increases energy needs and the need for certain nutrients, which is why it is important
to consume a well-balanced diet based on a wide variety of foods, following criteria of proper selection. Moreover, there are other factors which condition each individual’s calorie requirements:

- Intensity and type of activity
- Duration of exercise
- Age, sex and body composition
- Ambient temperature
- Degree of training

4. The Main Components

CARBOHYDRATES
The fundamental role they play is in providing energy. One gram of carbohydrates provides approximately 4 kcal.

They constitute the main fuel for muscles while a person takes part in physical activities, which is why it is very important to eat a diet rich in carbohydrates. Among athletes, they should constitute approximately 60-65% of the total energy for the day. With these amounts, their energy reserves can be maintained (in the form of glycogen), which are necessary for muscles contraction. There are two different types of carbohydrates:

- Simple or of rapid absorption
  Monosaccharides and disaccharides which are found in fruit, jams, sweets and milk (lactose).

- Complex or of slow absorption
  These are found in cereals and their by-products (flour, pasta, rice, bread, corn, oatmeal, etc.), in pulses (beans, lentils and chick peas) and in potatoes.

Eating a diet rich in carbohydrates is one of the fundamental principles which must govern an athlete’s diet.

FATS
These mainly provide energy. One gram of fat provides approximately 9 kcal.

They must provide between 20-30% of the total calories in one’s diet.
Either an excess or lack of fat can lead to adverse effects on the body:

- A diet rich in fats (more than 35% of the total energy requirements) means that the diet will also be lacking carbohydrates, and therefore a proper level of glycogen stores will not be attained. Added to this is a predisposition towards an increase in weight caused by this type of diet, and therefore there is a dual effect compromising athletic performance. From another perspective, an excess of fats in one’s diet, especially if they are of animal origin or saturated fats, may lead to an increase in blood cholesterol, with negative consequences on the person’s health in the future.

- If the diet’s fat content is low (less than 15%), there is a risk of suffering from a lack of fat-soluble vitamins (A, D, E, K) and essential fatty acids.

Therefore, a proper diet for athletes must include proportions of fats which are not greater than 30%, with the desirable contribution being approximately 20-25% (there are exceptions, such as extreme cold conditions, in which requirements may be greater).

Vegetable oils (with the exception of palm and coconut oil), oily fishes and nuts are the best fat profile foods.

In exercise, the importance of fats as a substrate that provides energy is limited to what we refer to as the aerobic energy metabolism. The contribution of fats as a fuel for muscles increases as the duration of physical exertion increases and the intensity thereof decreases.

**PROTEINS**

Proteins are the substances which form the foundation of our organic structure. They are made up of a total of twenty different amino acids, which are divided into two large groups:

- **Essential amino acids**
  Phenylalanine, isoleukine, leukine, lysine, methionone, treonine, tryptophan and valine (and only for children: arginine and histidine). They must be consumed in foods, because the body is unable to produce them.

- **Unessential amino acids**
  Our body can produce them.
A high-quality protein is one which contains an adequate amount of all the essential amino acids. Those proteins originating from foods of animal origin (fish, meat, milk and eggs) are considered to be of higher quality than those from foods of a plant origin, because they possess all the necessary amino acids in the proper proportions to meet the body’s needs, whereas this is not fulfilled by plant-based proteins (with the exception of soy). Therefore, in order to reach the proper quality of animal proteins, a combination of proteins from different plant products must be consumed (lentils with rice, for example).

It is recommended that proteins constitute approximately 12-15% of the total energy in the diet. These requirements are covered by a reasonable intake of meat, eggs, fish and dairy products. In certain disciplines, athletes, wishing to improve their muscle development, may greatly surpass the recommended intake of proteins by taking dietary supplements. An excess of proteins in the diet may lead to an accumulation of toxic waste and other harmful effects to an athlete’s proper shape.

5. Micronutrients

These are the vitamins and minerals.

Their role is to control and regulate the metabolism. They are not energy-providing nutrients, but they are essential to the human being, because they cannot be produced by the body itself, but rather must be received from outside of the body by eating foods.

They are important for maintaining a proper state of health, especially if one practices sports, because they play a role in the adaptation processes which take place inside the body during training and the recovery period.

In order to maintain proper levels of micronutrients, it is advisable to consume a varied and well-balanced diet that is rich in foods of plant origin, which are the richest in vitamins and minerals (instead of over-using supplements). A lack of micronutrients not only decreases athletic performance, but may also be harmful to one’s health. On the other hand, there is no evidence that, in the absence of a lack of vitamins and minerals, taking supplements has positive effects on training.
VITAMINS
Vitamins are very complex elements (molecules) of a wide-ranging composition. They play an active role in controlling processes for obtaining energy (on the basis of carbohydrates, fats and proteins) and in synthesizing a large number of vital substances and structures (enzymes, hormones, proteins, etc.). Some also have other very specific roles (such as vitamin A, which plays a part in vision, vitamin K in blood clotting processes, etc.).

• Fat-soluble vitamins
  - Vitamin A or retinol
  - Vitamin D or calciferol
  - Vitamin E or tocoferol
  - Vitamin K or phylloquinone

• Water-soluble vitamins
  B complex
  - Vitamin B1 or thiamine
  - Vitamin B2 or riboflavin
  - Vitamin B3 or niacin
  - Vitamin B5 or pantothenic acid
  - Vitamin B6 or pyridoxine
  - Vitamin B8 or biotin (vitamin H)
  - Vitamin B9 or folic acid
  - Vitamin B12 or cyanocobalamin

Vitamin C or ascorbic acid

The following table provides a summary of the general functions, symptoms of deficiency and overdose, dietary sources and daily recommendations of each of the above:

<table>
<thead>
<tr>
<th>WATER-SOLUBLE</th>
<th>Functions</th>
<th>Symptoms when lacking</th>
<th>Symptoms of overdose</th>
<th>Dietary sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 (thiamine)</td>
<td>Metabolism of carbohydrates. Proper functioning of nervous system.</td>
<td>Beriberi (failure of nervous system, fatigue, muscle weakness, cardiac insufficiency).</td>
<td>None on record.</td>
<td>Lean meats, liver, whole cereals.</td>
</tr>
<tr>
<td>B2 (riboflavin)</td>
<td>Energy metabolism.</td>
<td>Fatigue, failure of the sense of sight, problems in lips and/or mouth.</td>
<td>None on record.</td>
<td>Widely distributed amongst foods (milk and dairy products, pulses, cereals, meat, vegetables, etc.).</td>
</tr>
<tr>
<td>B5 (pantothenic acid)</td>
<td>Energy and protein metabolism. Maintaining proper activity of nervous system.</td>
<td>Fatigue, problems with coordination, sleep disorders, muscle problems, vomiting.</td>
<td>None on record.</td>
<td>Widely distributed amongst foods (eggs, milk and dairy products, pulses, etc.).</td>
</tr>
<tr>
<td>WATER-SOLUBLE</td>
<td>Functions</td>
<td>Symptoms when lacking</td>
<td>Symptoms of overdose</td>
<td>Dietary sources</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
<td>-----------------------</td>
<td>----------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>B6 (pyridoxin)</td>
<td>Metabolism of proteins. Formation of red blood cells.</td>
<td>Muscular problems, anemia, skin disorders, vomiting, tremors, irritability.</td>
<td>Possible damage to nerves (sensory neuropathy) and liver.</td>
<td>Fish, lean meats, whole cereals.</td>
</tr>
<tr>
<td>B8 (biotin o H)</td>
<td>Lipids and glycogen synthesis. Protein metabolism. Proper functioning of the nervous and circulatory systems.</td>
<td>Muscle pain, depression, fatigue, skin problems, impotence, insomnia, anaemia.</td>
<td>None on record.</td>
<td>Pulses, vegetables, fresh produces, nuts, egg yolk, meat, liver.</td>
</tr>
<tr>
<td>B9 (folic acid)</td>
<td>Protein metabolism. Metabolism of nucleic acids (DNA and RNA), formation of red blood cells.</td>
<td>Anemia, gastrointestinal problems, decrease in physical resistance, diarrhea (*). Kidney disorders.</td>
<td>May mimic the symptoms of anaemia.</td>
<td>Pulses, whole grains, vegetables and leafy-green produces, oranges, bananas and nuts.</td>
</tr>
<tr>
<td>FAT-SOLUBLE</td>
<td>Functions</td>
<td>Symptoms when lacking</td>
<td>Symptoms of overdose</td>
<td>Dietary sources</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-----------------------</td>
<td>----------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>A (retinol)</td>
<td>Formation of tissues. Proper functioning of sight.</td>
<td>Important disorders in sight. Changes in various tissues.</td>
<td>Headache, vomiting, skin problems, dryness of mucous membranes, bone inflammation, loss of appetite.</td>
<td>Green vegetables and oranges (as precursors) and in liver, dairy products and whole by-products (as an active substance).</td>
</tr>
<tr>
<td>K (phylloquinone)</td>
<td>Important for the clotting of blood (healing and scarring of wounds and lesions).</td>
<td>Hemorrhages.</td>
<td>Not well-known (synthetic forms may lead to jaundice).</td>
<td>Leafy green vegetables, liver, egg yolk and on the basis of intestinal bacteria.</td>
</tr>
</tbody>
</table>

(*) (A diet lacking folic acid may lead to anaemia in 130 days).

**MINERALS**

Minerals are essential elements and therefore, just like vitamins, they must form part of the everyday diet of athletes in a proper amount.

They play a role in a wide range of processes in both the general metabolism (mechanism for creating energy, synthesis of a wide range of vital substances and structures, etc.) and more specific roles (forming part of the bone, transporting oxygen, muscle contraction, etc.).

Minerals may be classified as: macrominerals (calcium, phosphorus and magnesium), microminerals or oligoelements (iron, iodine, fluoride, chrome, copper, selenium, zinc, cobalt, manganese and molybdenum) and electrolytes (sodium, potassium and chlorine).
Calcium
This is the essential element in the skeleton. Proper calcium intake coupled with adequate exercise and normal hormone levels are fundamental to reaching and maintaining optimal bone mass during the years in which an athlete is young.

Starting in childhood, calcium needs increase, reaching their maximum during adolescence. It is important to reach the recommended number of servings of calcium at all ages. Though exercise helps keep bones strong, if you practice exhausting exercise, it may become harmful, giving rise to a decrease in the bones’ mineral density, especially among athletic women who have problems with their menstrual cycles.

Iron
Many athletes may undergo a decrease in their blood iron levels as a result of lesser intestinal absorption, an increase in elimination and/or destruction of red blood cells, low iron intake in the diet and, in the case of women, menstruation. This deficiency makes it difficult for oxygen to reach the cells and is associated with a decrease in athletic performance. Iron deficiency and anemia are produced less often when one’s diet provides a sufficient amount of foods rich in this mineral.

Zinc
This is a mineral which has taken on special interest in the sports world in recent years, due to the important roles it plays:

- It helps regulate the activity of many enzymes
- It promotes the proper transport of nutrients
- It maintains the excitability of nerves and muscles
- It is a structural component of bones
- It strengthens the immune system and is an anti-oxidant

All of these aspects are fundamental to the physiology of exercise. This mineral helps fight the oxidative stress produced by intense physical activity, through its anti-oxidant activity. It also facilitates the regeneration of the small muscular injuries which may occur among athletes, and it even modifies the accumulation of lactic acid due to its influence on the lactate dehydrogenase enzyme.

Zinc is found with greater bio-availability in foods of animal origin such as red meats, eggs, seafood (especially oysters), cured cheese, etc. However, plant-based foods have a lesser availability of this mineral, due to the presence of fiber in their makeup. If a varied, well-balanced diet is consumed, zinc deficiencies rarely take place.
Magnesium
Magnesium is essential, because it intervenes in more than 300 different enzymatic reactions. It takes part in the metabolism of the foods components, in the transformation of complex nutrients into their elementary units and in the synthesis of a large number of organic products. It is a basic mineral for athletes due to its role in muscle relaxation and in the proper functioning of the heart.

Magnesium deficiencies appear only on rare occasions, but when they do, there are important repercussions: cramps and muscle pains, irregular heartbeat, decrease in blood pressure, weakness, etc.

Practicing exhausting sports leads to a loss of magnesium, and this lack leads to a decrease in the capacity for resistance and adaptation to exertion. Due to all of this, it is fundamental to assess how much magnesium is ingested in an athlete’s diet.

This mineral is abundant in nuts, pulses, whole grain cereals and green vegetables (lettuce, escarole, Swiss chard, spinach, etc.). Meat, dairy products and seafood are somewhat poorer sources. This mineral is also present in the composition of certain natural mineral waters.

The following table summarizes the general functions, symptoms in the event of deficiencies and overdose, dietary sources and daily recommended allowances for each of the most important minerals and oligoelements:

<table>
<thead>
<tr>
<th>MINERAL SUBSTANCE</th>
<th>Most important functions</th>
<th>Symptoms when lacking</th>
<th>Symptoms of overdose</th>
<th>Dietary sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrominerals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MINERAL SUBSTANCE</td>
<td>Most important functions</td>
<td>Symptoms when lacking</td>
<td>Symptoms of overdose</td>
<td>Dietary sources</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------</td>
<td>-----------------------</td>
<td>----------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>Muscle relaxation. Mainten-</td>
<td>In the case of vomit-</td>
<td>Muscle weakness. Heart</td>
<td>A wide variety of</td>
</tr>
<tr>
<td></td>
<td>ance of internal equili-</td>
<td>ing and/or diarrhea of</td>
<td>disorders.</td>
<td>fruits and vege-</td>
</tr>
<tr>
<td></td>
<td>brium. Functioning of</td>
<td>significance, muscle</td>
<td></td>
<td>tables, milk, fish</td>
</tr>
<tr>
<td></td>
<td>nerves. Maintaining a</td>
<td>weakness and even paral-</td>
<td></td>
<td>and meat.</td>
</tr>
<tr>
<td></td>
<td>proper state of hydration.</td>
<td>ysis occur.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>Maintenance of internal</td>
<td>Muscle cramps. Mental</td>
<td>High blood pressure.</td>
<td>Table salt, foods</td>
</tr>
<tr>
<td></td>
<td>equilibrium. Functioning</td>
<td>apathy. Loss of appete-</td>
<td></td>
<td>in brine, cheese,</td>
</tr>
<tr>
<td></td>
<td>of nerves. Maintaining a</td>
<td>te.</td>
<td></td>
<td>milk, sports</td>
</tr>
<tr>
<td></td>
<td>proper state of hydration.</td>
<td></td>
<td></td>
<td>drinks, etc.</td>
</tr>
<tr>
<td>Migominers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>Protein and energy</td>
<td>Problems in growth. Al-</td>
<td>Diarrhea. Nausea. Vom-</td>
<td>Whole grain cere-</td>
</tr>
<tr>
<td></td>
<td>metabolism. Formation of</td>
<td>teration of behavior</td>
<td>iting. Low blood pres-</td>
<td>als, nuts, vegeta-</td>
</tr>
<tr>
<td></td>
<td>bone. Metabolic regulator.</td>
<td>(depression). Weakness.</td>
<td>sure.</td>
<td>bles and green pro-</td>
</tr>
<tr>
<td></td>
<td>Functioning of nerves and</td>
<td>Muscle spasms.</td>
<td></td>
<td>ducts.</td>
</tr>
<tr>
<td></td>
<td>muscle.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>Proper capturing and trans-</td>
<td>Anemia caused by iron</td>
<td>Siderosis, cirrhosis</td>
<td>HIGH AVAILABILITY</td>
</tr>
<tr>
<td></td>
<td>port of oxygen. Energy</td>
<td>deficiency (weakness, less</td>
<td>of the liver.</td>
<td>- Fish, especially</td>
</tr>
<tr>
<td></td>
<td>metabolism.</td>
<td>resistance to infections).</td>
<td></td>
<td>mollusks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Meat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MEDIUM AVAILABILI-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Eggs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LOW AVAILABILITY</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Pulses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Whole grains</td>
</tr>
<tr>
<td>MINERAL SUBSTANCE</td>
<td>Most important functions</td>
<td>Symptoms when lacking</td>
<td>Symptoms of overdose</td>
<td>Dietary sources</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------</td>
<td>-----------------------</td>
<td>---------------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>Fluoride (F)</strong></td>
<td>Proper formation of bones and teeth. Fights cavities.</td>
<td>Increases the rate of cavities. Increases the rate of loss of teeth.</td>
<td>Spots on teeth. Increases bone density. Neurological disorders, problems with hair and skin.</td>
<td>Tea and seafood. Mainly fluoride-added drinking water.</td>
</tr>
<tr>
<td><strong>Copper (Cu)</strong></td>
<td>Synthesis of hemoglobin and proper use of iron.</td>
<td>Anaemia (rare).</td>
<td>Wilson’s disease.</td>
<td>Fish, meat, drinking water.</td>
</tr>
<tr>
<td><strong>Iodine (I)</strong></td>
<td>Proper functioning of hormones.</td>
<td>Goiter.</td>
<td>Decrease in hormone activity.</td>
<td>Fish, seafood, certain vegetables, etc.</td>
</tr>
<tr>
<td><strong>Chrome (Cr)</strong></td>
<td>Energy metabolism of glucose.</td>
<td>Decreases the use of glucose.</td>
<td>Damage to skin and kidneys (rare).</td>
<td>Fats, vegetable oils, meat.</td>
</tr>
<tr>
<td><strong>Sulphur (S)</strong></td>
<td>Essential component of many tissues (cartilage).</td>
<td>Accompanies lack of protein.</td>
<td>Decreased growth.</td>
<td>Sulfuric amino acids (foods with proteins).</td>
</tr>
</tbody>
</table>
6. Anti-oxidants and Physical Exercise

High-performance sports are very demanding, and sometimes very intense and exhausting training periods are withstood.

Over-training may give rise to a sustained state of stress, which is translated into an ongoing situation of oxidation. This circumstance leads to an excessive amount of free radicals, which can lead to chronic fatigue.

In the presence of high concentrations of these substances (free radicals), the body must defend itself using anti-oxidants, which act to delay the oxidation of other molecules and neutralize free radicals, thereby avoiding damage to the tissues.

Among all of them, vitamins are the epitome of anti-oxidants, but minerals also play an important role, especially selenium and zinc, as well as polyphenols (a heterogeneous set of molecules with common characteristics), the most notable of them, is the group known as flavonoids.

• Vitamin C
It is the classical anti-oxidant. It aids in the development of bone structures, improves the absorption of iron, favors growth and the repairing of normal connective tissue and intervenes in the production of collagen, in the metabolism of fats and in the healing of wounds. All in all, it stimulates the repair and formation of the most important tissues which are necessary during physical activity. This vitamin does not increase athletic performance, yet it plays a fundamental part in facilitating the absorption of other vitamins and minerals. At the same time, it helps to control the excess free radicals created by intense activities, through its powerful anti-oxidant action, balancing catabolic processes (of destruction).

• Vitamin E
It constitutes a group of fat-soluble components divided into two groups: tocopherols and tocotrienols, the former being the most notable. This vitamin is able to prevent arteriosclerosis, because it prevents the oxidation of cholesterol and the build-up thereof on the walls of the arteries. In the same way, it avoids the appearance of thromboses which make blood circulation difficult by narrowing the walls of the blood vessels. Its anti-oxidant effect promotes the elimination of the free radicals produced by the body itself, as well as those which come from outside of the body. This vitamin’s ability to protect the cell membranes and prevent their oxidation is what is responsible for its preventive powers in many degenerative diseases which appear little by little, as people get older. The foods which contain this vitamin are those with fats of plant origin (especially sunflower oil).

• Selenium
It is a mineral which delays cell aging and helps to prevent cell degeneration. It also increases the production of white corpuscle and neutralizes the effect of heavy metals. Its action is closely linked to the activity of vitamin E. It is found naturally in foods of animal origin, some vegetables and grain cereals, and in nuts.

• Catechins
These are flavonoids which appear to have an acknowledged anti-carcinogenic effect, though their properties are many more. They have anti-arthritic, anti-inflammatory, anti-aggregant, immuno-stimulant and liver-
protecting properties. The most interesting catechins appear in green tea leaves, to such an extent that as much as 30% of this type of tea (dry) is composed of these substances. Teas made with this plant are used to aid in the treatment of a large number of diseases, which include arteriosclerosis and hypercholesterolemia.

- **Phenolic Compounds**
These are anti-oxidants found in fruits and vegetables. It is important to include them in one’s diet, because they block the action of free radicals and are attributed preventative properties on the cell matter and cells.

<table>
<thead>
<tr>
<th>ANTI-OXIDANT SUBSTANCES</th>
<th>FOODS</th>
</tr>
</thead>
</table>
| Vitamin C                | - Kiwi and other citric fruits  
- Tomato  
- Broccoli  
- Papaya  
- Melon  
- Parsley  
- Acerola (Barbados cherry)  
- Soy sprouts |
| Vitamin E                | - Vegetable oils (soy, corn and sunflower)  
- Olive oil  
- Nuts (hazelnuts, almonds, walnuts)  
- Seeds  
- Whole grain cereals  
- Wheat germ  
- Pulses |
| Selenium                 | - Sunflower seeds  
- Meat and entrails  
- Fish  
- Garlic and onion  
- Broccoli  
- Dairy foods  
- Brewer’s yeast |
| Catechins                | - Green tea  
- Berries  
- Apricot |
| Phenolic compounds       | - Fruits  
- Vegetables |
7. The Best Diet for Athletes

Among athletes, a well-balanced diet must supply enough energy to meet all needs, and it must provide all of the nutrients in the proper amounts, bearing in mind each individual’s characteristics and requirements, and adapting intake to the type of sport practiced and to training sessions (intensity, number of sessions, schedule, etc.).

If the food wheel indicates the need to have at least one food from each group per day, in order to know the proper amounts thereof, a pyramid has been created. At its base are the foods whose consumption is recommended daily and in the largest amount (foods rich in carbohydrates, fruits and vegetables) and at the top are those to be consumed only occasionally. Most of the factors which determine a person’s state of health are related to both the foods eaten and regularly practicing physical exercise. The recommendations for the proper pattern of physical activity can also be shown in the form of a pyramid with the goal of promoting both healthy eating and practicing physical activities and sports, so as to turn the growing rate of certain diseases around.

8. The Pace of Meals

It is advisable to eat about 4-5 meals throughout the day in order to better distribute energy intake and reach the main meals with less sensation of hunger (or anxiety), and to eat amounts which are not too large. One must take training schedules into account, always attempting to eat some food approximately two hours beforehand, and upon completing the physical exertion. The energy distribution of a day may be as follows:
Breakfast: 15-25%
Lunch: 25-35%
Snack: 10-15%
Dinner: 25-35%

You can also eat something at mid-morning, depending on when you eat breakfast and lunch. Adjusting the number of meals and their schedule must be done in a personalized way, because it depends a lot on the individual circumstances of each athlete.

Example of a training day menu:

<table>
<thead>
<tr>
<th>MENU (Approximately 3,000 kcal)</th>
<th>Serving size</th>
<th>Energy (kcal)</th>
<th>Protein (g)</th>
<th>Carbo-hydrates (g)</th>
<th>Fat (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BREAKFAST</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 bowl of cereal</td>
<td>60 g</td>
<td>232</td>
<td>4,7</td>
<td>51</td>
<td>0,25</td>
</tr>
<tr>
<td>2 spoonfuls of nonfat yogurt</td>
<td>80 g</td>
<td>33</td>
<td>3,5</td>
<td>4</td>
<td>0,4</td>
</tr>
<tr>
<td>Nonfat milk</td>
<td>200 ml</td>
<td>70</td>
<td>7</td>
<td>10</td>
<td>0,2</td>
</tr>
<tr>
<td>1 glass of orange juice</td>
<td>150 ml</td>
<td>63</td>
<td>1</td>
<td>15</td>
<td>0,3</td>
</tr>
<tr>
<td>1 piece of whole wheat toast</td>
<td>40 g</td>
<td>90</td>
<td>3,2</td>
<td>20</td>
<td>0,5</td>
</tr>
<tr>
<td>Jam/jelly</td>
<td>20 g</td>
<td>29</td>
<td>0,1</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td><strong>MORNING SNACK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 apples</td>
<td>200 g</td>
<td>100</td>
<td>0,6</td>
<td>24</td>
<td>0,7</td>
</tr>
<tr>
<td>1 nonfat yogurt</td>
<td>125 g</td>
<td>52</td>
<td>6</td>
<td>6,75</td>
<td>0,6</td>
</tr>
<tr>
<td><strong>LUNCH</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasta w/tomato sauce and tuna</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>salad</td>
<td>100 g</td>
<td>360</td>
<td>12</td>
<td>76,5</td>
<td>1,4</td>
</tr>
<tr>
<td>1 dish of pasta</td>
<td>30 g</td>
<td>34</td>
<td>0,5</td>
<td>2,6</td>
<td>2,5</td>
</tr>
<tr>
<td>Fried tomato sauce</td>
<td>50 g</td>
<td>140</td>
<td>12</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>½ can of tuna</td>
<td>125 g</td>
<td>18</td>
<td>1</td>
<td>3</td>
<td>0,2</td>
</tr>
<tr>
<td>1 bowl of salad</td>
<td>10 g</td>
<td>70</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>1 spoonful of oil and vinegar</td>
<td>200 g</td>
<td>122</td>
<td>0,8</td>
<td>28</td>
<td>0,8</td>
</tr>
<tr>
<td>2 pears</td>
<td>50 g</td>
<td>119,5</td>
<td>4</td>
<td>24,5</td>
<td>0,6</td>
</tr>
<tr>
<td><strong>TEA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 granola bar</td>
<td>25 g</td>
<td>96,5</td>
<td>2</td>
<td>21</td>
<td>0,1</td>
</tr>
<tr>
<td>Nonfat yogurt</td>
<td>125 g</td>
<td>52,5</td>
<td>6</td>
<td>6,75</td>
<td>0,6</td>
</tr>
<tr>
<td><strong>AFTER TRAINING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 banana</td>
<td>150 g</td>
<td>135</td>
<td>2</td>
<td>30</td>
<td>0,75</td>
</tr>
<tr>
<td>1 granola bar</td>
<td>25 g</td>
<td>96,5</td>
<td>2</td>
<td>21</td>
<td>0,1</td>
</tr>
<tr>
<td><strong>DINNER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed vegetables: carrot, zucchini and boiled potato, with pork loin and rice on the side</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrot</td>
<td>125 g</td>
<td>52</td>
<td>1,5</td>
<td>11,2</td>
<td>0,4</td>
</tr>
<tr>
<td>Zucchini</td>
<td>150 g</td>
<td>45</td>
<td>2</td>
<td>9</td>
<td>0,3</td>
</tr>
<tr>
<td>Boiled potato</td>
<td>150 g</td>
<td>129</td>
<td>3</td>
<td>28,5</td>
<td>0,15</td>
</tr>
<tr>
<td>Tomato sauce</td>
<td>30 g</td>
<td>35</td>
<td>0,5</td>
<td>2,6</td>
<td>2,5</td>
</tr>
<tr>
<td>Pork loin</td>
<td>100 g</td>
<td>290</td>
<td>16</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Whole-grain rice</td>
<td>50 g</td>
<td>175</td>
<td>4</td>
<td>38,5</td>
<td>0,5</td>
</tr>
<tr>
<td>Whole-grain bread</td>
<td>50 g</td>
<td>120</td>
<td>4</td>
<td>25</td>
<td>0,6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>2,750</td>
<td>14% protein</td>
<td>66% carbo-hydrates</td>
<td>20% fat</td>
</tr>
</tbody>
</table>

You must know that an optimal state of nutrition is not achieved through the meal prior to competition, and not even by following specific dietary guidelines, or two days before a race. A good state of nutrition is the result of proper eating habits practiced day by day, for a long time and with great regularity. This is a sort of “invisible training” that is not a matter of just a few meals.
9. Food and Competition

• Eating Several Days Before the Competition
During the week prior to the competition, the two main objectives are to:

- Optimize carbohydrate stores in muscles and the liver (in the form of glycogen) so as to compete with the greatest possible energy reserves.
- Stay well-hydrated.

The preparation will be dictated by the type of competition the athlete will be in and the frequency of the competitions.

On the days prior to the event, it is important for the diet to be based on a high intake of carbohydrates (from 65-75%). The rest will be divided up as 15-20% fats and 10-12% proteins.

• Eating on the Day of the Competition
The meal hours before the competition may end up completing the body’s glycogen reserves. The liver, responsible for maintaining blood plasma levels of glucose, to maintain its small reserve of carbohydrates, requires eating frequent meals. Those athletes who fast before competition (small dinner and no breakfast) and fail to consume carbohydrates during the competition have a greater chance of developing hypoglycemia while the physical exertion takes place.

Intake prior to the competition must be:
- Rich in carbohydrates
- Low in fats, protein and fiber
- Foods with a lot of condiments should be avoided
- You should avoid experimenting with new foods or dishes
- The meal should be eaten 3-4 hours before the competition, so that there is time to complete proper digestion before starting the exercise. During the hour before the competition, it is very recommendable for all foods to be in liquid form, because they are easier to assimilate more quickly.

Eating During Exercise
While taking part in long-lasting sports (more than 60 minutes), foods should have a foundation of carbohydrates. The goal is to consume them at a rate of approximately 40-60 g/hour, because they help put off the occurrence of fatigue and maintain the performance level, especially in the final stages of physical exertion.

Sports drinks (which are specially designed for people who do exercise) are very appropriate, because they serve to replenish the electrolytes
and liquids losses which take place due to sweat (they prevent dehydration), in addition to providing carbohydrates.

There are sports such as cycling and sailing, during which it is possible to eat solid foods in the form of energetic bars, cereals, nuts, bananas, etc.

Eating After Exercise
As soon as finishing exercise, it is recommended to have drinks specially designed for athletes and foods rich in carbohydrates.

The immediate objective is to replenish glycogen reserves (in the liver and muscles) and lost liquids. The important thing is to know how to choose them right, selecting foods with a moderate to high glucemic level so that restoration is rapid.

It is recommended to have an approximate intake of 1 g of carbohydrates for every kg of body weight during the two hours after exercising.

Included amongst proper meals are pasta, noodles, rice and boiled or baked potatoes, avoiding fatty foods to the greatest extent possible (fried, breaded and stewed foods), because they slow down the replenishment of carbohydrates and may cause gastrointestinal troubles.

10. Hydration and Athletic Performance

THE IMPORTANCE OF BEING PROPERLY HYDRATED
Water is the most abundant component in the human body and is essential to life: you can go several weeks without eating, but only a few days without drinking.

Water is a calorie-free nutrient (it provides no calories) necessary in order for the body to remain properly structured and operating perfectly. The loss of just 10% of the body’s water constitutes a serious risk to health.

Water is directly involved in different functions:
- Cooling
- Providing nutrients to muscle cells
- Eliminating waste substances
- Lubricating joints
- Regulating the electrolytes in the blood

• Liquid Balance and Regulation of Body Temperature
The total amount of water in the body is maintained within certain very narrow limits due to a great equilibrium between the volume of liquid ingested and that excreted by the body.

The sources of water are drinks, foods and the water produced by the body’s general metabolism. This whole quantity of water must make up for daily water losses through urine, feces, sweat and water vapor eliminated through the lungs.

Most of the water is stored in muscles (72% of its weight is water), whereas the fatty tissues contain a percentage that is quite a bit lower. Approximately 80% of the energy produced by muscle contraction is released in the form of heat. Our body must eliminate that large amount of heat in order to avoid an increase in body temperature, which would have very negative consequences on our health, so it must turn to the mechanism of sweat, which, at the same time as “cooling” the body, causes a significant loss of liquids.
Thermal regulation and an equilibrium of liquids are fundamental factors in athletic performance.

What Is Dehydration?
It is the dynamic loss of the body's liquids due to sweating during physical exercise without replenishing liquids, or when that replenishment does not make up for the amount lost.

Dehydration has a negative impact on health and on physical performance: it damages the ability to make both short-term, high-intensity efforts and efforts longer in duration.

Dehydration may be caused by:
1) Intense physical exertion (involuntary dehydration)
2) Restriction of liquids before and/or during physical activity
3) Exposure to a hot, humid environment (like a sauna)
4) Use of diuretics
• What Are Electrolytes?
They are particles that help to regulate the balance of liquids in the body. They are in the blood plasma (the liquid part of the blood) and in sweat, in different amounts. The most important are sodium, chlorine and potassium.

If there are not enough electrolytes, symptoms of a deficiency may appear, including muscle cramps, weakness and apathy.

The sweat secreted on the surface of the skin contains a wide variety of electrolytes, the loss of any of them being significant (especially sodium) when large volumes of sweat are produced.

The degree of sweating depends on a large number of factors of a mainly external nature, such as the duration and intensity of the physical activity, the ambient temperature and humidity, the clothing used, etc.

• What Is Thirst?
Thirst is the need or natural desire to drink, caused by a decrease in the water contained in the tissues.

Under regular conditions, thirst is a good sign to announce more or less important decreases in hydration, but when a lot of liquid is lost, as when taking part in prolonged and/or intense physical exercise, the disappearance of thirst does not mean that the body has reached a status of equilibrium between water losses and intakes (euhydration): the athlete may stop drinking without having completed proper rehydration (recovery of the water lost until achieving its normalization within the body).

Therefore, thirst is not a reliable indicator of the body’s liquid needs, which is why proper hydration practices must be promoted to accompany the rest of one’s everyday diet (adapting to individual needs) and form part of the training plan (“invisible training”).

• What Is a Sports Drink or Drink for Athletes?
It is a drink specially designed for people who undergo great physical exertion with intense wear and tear on the muscles.

These drinks have a specific composition to achieve a rapid absorption of water and electrolytes and prevent fatigue, being three their fundamental objectives:

1) Providing carbohydrates that maintain a proper concentration of glucose in the blood and delay the exhaustion of glycogen stores
2) Replenishment of electrolytes, especially sodium
3) Water replenishment to avoid dehydration

Sodium is the electrolyte which is lost in greatest quantity through sweat. When it is added to sports drinks, it plays three roles: improving, along with a certain amount of sugar, the absorption of liquids, maintaining the thirst stimulus and promoting the retention of liquids at the kidney level.

It also accelerates the absorption of carbohydrates and improves the taste of the drink.

Carbohydrates provide energy to muscles and delay the uprise of fatigue, especially in exercise that lasts a long time. They also allow a faster absorption of water and sodium.

These drinks have a very good taste, and therefore they are easier to drink than water alone.
This type of preparations, specially adapted, helps to solve specific problems so that an optimal nutritional balance can be achieved. The beneficial effects are not just limited to athletes who perform regular and intense muscular exercise, but also to those people who, due to their jobs, exert themselves significantly or under adverse conditions, and those people who do physical exercise and training in their leisure time.

REPLENISHMENT OF LIQUIDS AMONG ATHLETES
It is very important to stay well-hydrated throughout the day.

The need to ingest 1 liter of liquid for every 1,000 kcal consumed is accepted as an approximate, theoretical value, though it is very important for that consumption to be carried out with a proper distribution. For instance, it must be a basic rule to drink water or a sports drink throughout the day and before, during and after training. In order to reach proper liquid intake levels, one must acquire specific habits.

• Before Exercising
It is recommended to ingest approximately 400-600 ml of water or sports drinks 1-2 hours before performing exercise, in order to start the activity with proper hydration. This allows for a lesser increase in the athlete’s central body temperature and decreases the perception of exertion. If a drink with carbohydrates is consumed (sports drink), it helps to replenish the muscles’ glycogen stores completely.

• During Exercise
Athletes must start to drink early, and at regular intervals in order to consume liquids at a pace which makes it possible to replenish the water and electrolytes lost through sweat and to maintain blood glucose levels. Achieving a water equilibrium is not always possible, because the amount of sweat excreted can surpass the maximum capacity for emptying the stomach.

• After Exercising
The replenishment of liquids after exercising is fundamental to an athlete’s proper recovery and must be started as soon as possible.

One practical way to determine the amount of liquids that must be replenished is for the athletes to weigh themselves before and after training: the difference between the two weights indicates the amount of liquid lost and, therefore, that which has to be consumed to become properly rehydrated.

After long-lasting exercise, a drink that contains sodium is advised, making it possible to increase the retention of liquids while supplying the electrolytes eliminated through sweat. Carbohydrates must also be administered, so as to rapidly replenish the muscles’ glycogen stores, worn down during exertion.

Remarks
1.- Liquids, whatever their temperature, always have positive effects, though cool drinks are more desirable throughout the course of long duration races, above all if they are performed in a hot environment.

2.- It is very important to achieve and maintain a proper state of hydration prior to competition, but this does not replace drinking liquids during the competition in order to avoid dehydration and hyperthermia.
3.- Digestive troubles caused by the abundant intake of liquids during competition can be avoided by drinking them during training sessions, to grow accustomed to doing so.

4.- Having drinks which contain alcohol is not recommended while practicing sports.

*Information to take into account regarding the composition of the drink used for rehydration:*
- It should provide energy in the form of carbohydrates of rapid absorption
- It should replenish the electrolytes and water lost during the activity
- It should be absorbed well in the intestine
- It should have a good taste
- It should maintain blood plasma volume
- It should not contain alcohol

**11. Adaptation to Climate and Time Zone Changes**

Elite athletes, due to the need to compete, travel around the world on long trips, with the resulting time changes which may lead to significant changes in the endogenous and exogenous biological rhythms, giving rise to a series of symptoms, such as a lack of sleep, irritability, loss of appetite, fatigue, dizziness and gastro-intestinal disorders: this process is known by the name of “jet-lag.”

Acclimatization is the procedure the body uses to adapt physiologically to the changes which take place in its surrounding environment and which, in general, are directly related with climate. In those cases in which environmental conditions are adverse, with a high temperature and high level of humidity, what is pursued through
acclimatization is the optimization of the body’s main cooling mechanisms so that it can better tolerate the thermal stress which is produced during exercise in that environment.

When an athlete adapts to heat and humidity, the production of sweat rises, thereby ensuring that body temperature does not go up too much. It is important for acclimatized athletes to know that they must be very careful about hydration because, due to a phenomenon of compensation and body temperature maintenance, they lose more liquid due to sweating than do athletes who are not acclimatized.

Moreover, due to the effect of adaptation, the production of sweat is clearly moved forward and begins to take place at lower body temperatures than those of unacclimatized persons. This sweat has a lower concentration of mineral salts, the loss of which is therefore lower.

The time necessary to become acclimatized in a proper manner is between one and two weeks, depending on the individual capacity of each athlete. During this time period, it is recommended to perform more intense training sessions early in the morning or later in the evening. At a later time, these paces of training can be introduced at different times of day little by little.

There are several ways to mitigate the negative effects of doing exercise in extreme environments. One of them, and perhaps the most important, is to eat a proper diet, and to follow proper hydration guidelines throughout the day.

When exercise takes place in an environment of extreme cold, most body heat is lost due to radiation and convection. Physiologically, there are mainly two responses to minimize the effects of hypothermia (decrease in central body temperature), and they are muscle contraction due to involuntary trembling (shivering) and peripheral vasoconstriction, which decreases the flow of blood in the skin. Also produced are adaptation of heart rate (bradycardia) and breathing. Athletes may also become acclimatized and begin to shiver at lower temperatures. In turn, they maintain an intermittent blood vessel dilation that allows for greater warming of the limbs.

In these climate conditions of cold and dry air (which are usually accompanied by low temperatures), the loss of liquids is greater, and therefore ensuring proper hydration is of vital importance. It is fundamental to mention this topic, because, given that there is no visible sweat, the athlete is unable to notice losses, and therefore he or she does not perform proper replenishment either.

The appearance of blood vessel constriction as an adaptive mechanism reduces the levels of free fatty acids, increasing the use of carbohydrates as an energy source, and therefore it is fundamental to eat a proper diet in which a special emphasis is placed on the consumption of carbohydrates.
Whoever wishes to optimize their health and athletic performance must feed themselves properly in order to be well-nourished and must be appropriately hydrated using the right drink.

It is important to eat a wide variety of foods in the correct amounts and to drink liquids before, during and after any physical exertion.
Published in partnership with:

POWERADE
bebida para deportistas

Coca-Cola España
cuidamos tu sed