

# 10 Sports nutrition

## Introduction

This unit introduces you to the links between nutrition, health and performance in sport and exercise. You will learn about the fundamentals of a healthy diet and develop an understanding of the influence of nutrition on exercise performance, along with a solid foundation of knowledge on which to develop good eating practices for yourself. You will also consider factors that affect food intake and choice, and methods of collecting and analysing dietary information to assess nutritional needs. By the end of this unit you should be able to demonstrate the application of nutrition strategies in a variety of sports contexts through examination of the diets of a range of sports from the amateur athlete to the Olympic elite performer.

It is important to emphasise that you will not develop the breath of knowledge and skills of a sports dietitian or nutritionist upon completion of this unit. What you will develop is an appreciation of how diet affects sporting performance before, during and after training and competition. You should be able to recognise the limitations in your own knowledge and know how and when to refer to a more suitably qualified professional.

It is also important to remember that where sport is concerned there should be no conflict between eating for health and eating for performance. The sound foundations of the sports performer's diet lie in the pursuit of healthy eating through a balanced and varied diet.

After completing this unit you should be able to achieve the following outcomes:

- Understand the concepts of nutrition and digestion.
- Understand energy intake and energy expenditure in sports performance.
- Understand the relationship between hydration and sports performance.
- Be able to plan a diet appropriate for a selected sports activity.





## Think it over

Take a few minutes to think about all the factors that might influence your food intake and choice. If you can think of 10 factors, this is good going, and a list in excess of 20 factors is excellent. Awareness of these factors will assist you in formulating realistic and achievable dietary goals and plans when meeting some of the assessment requirements of this unit.

The list you have devised may include simple factors such as likes and dislikes, time, money, taste, accessibility, religion, culture and convenience, as well as also others such as fashions and trends promoted by celebrities and sports personalities in the media, and food packaging and advertising, which can have a huge influence on our choice of food.

Now consider the range of nutrition-related topics that have featured in the news in the past two weeks or take a look at a range of health, fitness and sport-related magazines. Scan them for nutrition-related features and advertisements. How many are there? What kinds of topics do they focus on?

Finally, consider ways in which nutrition and eating habits might influence performance in sport and exercise.



## 10.1 Understand the concepts of nutrition and digestion

All activity stimulates your body's need for fuel and fluid and as such good nutrition is seen as important to performance in sport and exercise. Knowledge of the nutrients that your body requires, along with their different functions, provides the basis for the science of nutrition, the study of which is a relatively new area of scientific investigation and one in which new discoveries are constantly being made.

Good nutrition, and in particular healthy eating, sounds simple in theory but is often difficult to achieve in practice, particularly for those with busy lifestyles or intense training programmes. Nutritional topics now appear regularly in the media and in advertising, often presenting us with contradictory information on what is good for our health and/or performance.

### Key terms

**Sports nutrition** The influence of nutritional strategies on sports performance during the preparation for, participation in and recovery from training and competition.

**Nutrition** The means by which the energy and nutrients in food are taken in by your body to sustain growth and development and keep it alive and healthy.

**Healthy eating** The pursuit of a balanced diet to support health and reduce the risks of chronic disease.

**Balanced diet** A diet that provides the correct amount of all the nutrients required by your body without excess or deficiency.

**Food** Any substance derived from plants or animals containing a combination of the nutrients carbohydrates, fats, proteins, vitamins, minerals, fibre, water and alcohol, the amounts of which will vary from food to food.

**Diet** Usual eating habits and food consumption.



### Remember!

There should be no conflict between eating for health and eating for performance.



### Theory into practice

Take a few minutes to write down everything you had to eat and drink yesterday. Ensure you record sufficient information on the different types of food, their portion size and the cooking methods used, and don't forget any snacks and drinks as well as meals. You will use this information in future exercises throughout this unit. This will be known as your '24-hour diet recall'.

## Nutrition

The foods you consume contain the nutrients carbohydrate, protein, fat, vitamins, minerals, fibre and water. The amounts of these nutrients vary from food to food. Most foods you eat are categorised based on their macronutrient (carbohydrate, protein and fat) content, but they usually consist of more than one of these nutrients. For example, bread is classed as a carbohydrate food because it contains more carbohydrate than protein or fat, but it is also a source of these nutrients and others such as vitamins, minerals and fibre.

### Key term

**Macronutrients** Nutrients that are required by your body in daily amounts greater than a few grams such as carbohydrate, fat and protein.



▲ It is important to have a balanced diet in order to stay healthy



### Remember!

Macronutrients are the energy-providing nutrients of your diet.

### Macronutrients

The nutrients found in your food are also categorised according to the relative amounts required by your body. Carbohydrate, protein and fat are termed macronutrients, as they are required in relatively large amounts on a daily basis. These nutrients are also the energy-providing nutrients of your diet.

### ■ Carbohydrates

Carbohydrates consumed in your diet are made of the chemical elements carbon, hydrogen and oxygen. The main role of carbohydrates is energy production. They form your body's most readily available source of energy and can be accessed rapidly. One gram of carbohydrate, whether this is derived from sugar or starch, will provide you with approximately 4 kilocalories of energy. The carbohydrate foods you eat are divided into two basic types and are generally referred to as either simple or complex.



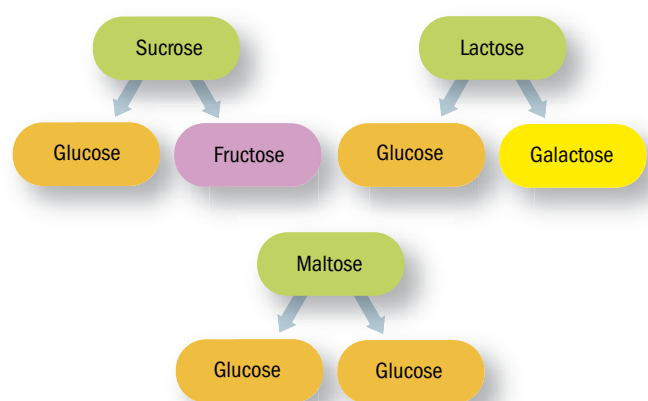
▲ Good sources of carbohydrate in the diet include bread, rice, pasta, potatoes and cereals

Simple carbohydrates are essentially sugars and are formed from single and double sugar units. They are easily digested and absorbed to provide your body with a quick energy source. The simplest unit of carbohydrates is the monosaccharide, the most common of which in your diet is glucose. Saccharide means sugar, mono means one; therefore a monosaccharide is a single sugar unit. Glucose is used to produce adenosine triphosphate (ATP), the compound required for muscle contraction (see page XX).

Other monosaccharides in your diet include fructose, also known as fruit sugar as it is found in fruits and vegetables, and galactose found in milk. Monosaccharides mostly occur combined together in carbohydrate foods. When two monosaccharides are found together they form a disaccharide or what is known as a double sugar. The most common disaccharide in your diet is sucrose or table sugar. Other disaccharides include lactose (found in milk) and maltose (found in beer and cereals).

Longer chains of these simple sugar units are known as polysaccharides or complex carbohydrates. These allow large quantities of glucose to be stored in the cells of plants as starch or in animals as glycogen in the muscles and liver. All carbohydrate consumed in your diet ends up as glucose to provide energy.

Complex carbohydrates are commonly known as starches and make up an important source of energy in most diets. They are composed of many sugar units so they are also called polysaccharides. These are



### ▲ Double sugars or disaccharides and their monosaccharides

broken down more slowly in your body and provide a sustained release of energy over longer periods. Complex carbohydrates should form the largest percentage of your total carbohydrate intake. Unrefined sources such as wholemeal bread, wholegrain rice and pasta are preferable as they also contain a higher nutritional value by way of micronutrients and fibre.

After you eat foods containing carbohydrate your blood sugar level rises, which stimulates the pancreas to secrete the hormone insulin. The role of insulin is to normalise blood sugar levels and aid the transport of glucose from the blood into the cells. Glucose is then used directly by the cells for energy or stored as glycogen in your liver and muscles if it is not required immediately to provide energy. Glycogen is a crucial source of glucose for fuelling activity.

Table 10.1 gives some examples of simple and complex carbohydrates.

Simple	Complex
Sugar, syrup, jam, honey, marmalade, sugary fizzy drinks, boiled sweets, fudge, fruit juice, sports drinks	Bread, bagels, crispbread, crackers, rice, pasta, noodles, couscous, potatoes, breakfast cereals, pulses, root vegetables

**Table 10.1 Simple and complex carbohydrates**

Any excess carbohydrate not required to replenish your body's glycogen stores is converted to fat and stored in your body's adipose tissue. Around 80 per cent is stored in your muscles while the rest is stored in your liver, with a small amount of circulating blood glucose (see Table 10.2).

Source	Glycogen stores (g)
Muscle	325
Liver	100
Blood glucose	15-20

**Table 10.2 Approximate adult glycogen stores**

Carbohydrate can only be stored in your body as glycogen in limited amounts – approximately 375–475



grams in the average adult, which is equivalent to approximately 1,500–2,000 kilocalories. Your day-to-day stores of glycogen are influenced by your dietary carbohydrate intake and levels of physical activity or training. Regular exercise can encourage your muscles to adapt to store more glycogen. This is an important training adaptation for the elite sports person, particularly those involved in endurance-type sports.



### Remember!

The intensity and duration of exercise influences the rate and amount of glycogen usage. The harder the exercise and the longer its duration, the greater the depletion of glycogen.

## Proteins

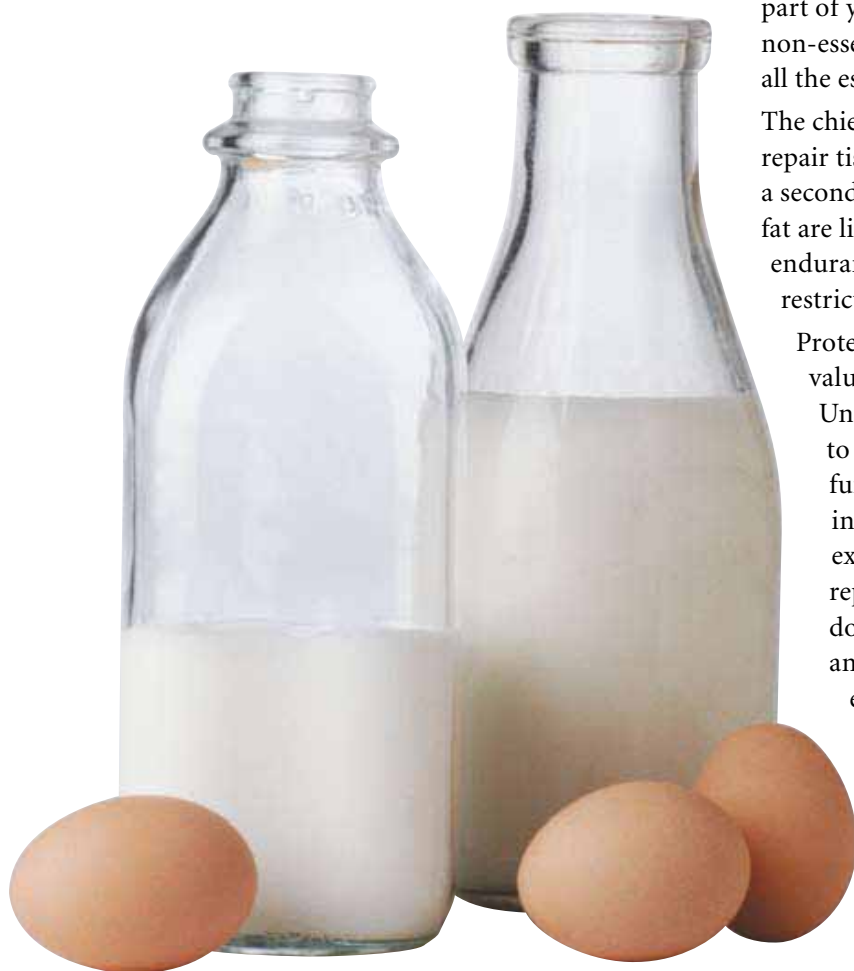
Proteins have a variety of functions that are essential to maintaining optimal health and physical performance. They contain the chemical elements carbon, hydrogen and oxygen, but are more complex in structure than carbohydrates and also contain nitrogen. Some proteins may also contain other elements such as sulphur or iron.

At this point in your study it is not necessary for you to be familiar with the names and functions of the individual amino acids. You should note that the body needs all 20 amino acids to be present simultaneously for protein synthesis to occur, in order to sustain optimal growth and functioning. Different proteins contain different numbers and combinations of these amino acids. Of the 20, there are eight that your body is unable to make for itself and as a result these are called essential amino acids (EAAs) – they are a necessary part of your diet. The remaining amino acids are called non-essential – your body is able to synthesise these if all the essential amino acids are present.

The chief role of protein in your body is to build and repair tissue. However, proteins may also be used as a secondary source of energy when carbohydrate and fat are limited, such as towards the end of prolonged endurance events or during the severe energy restriction that may accompany dieting.

Proteins, like carbohydrates, have an energy value of approximately 4 kilocalories per gram.

Unlike carbohydrate and fat, your body is unable to store excess protein. All proteins carry out functional roles in your body, so daily protein ingestion is required. If your protein intake exceeds requirements to support growth and repair, the excess amino acids are broken down, the nitrogen component is excreted and the rest of the molecule is used to provide energy immediately or converted to fat or carbohydrate and stored for later use.



◀ The typical UK diet contains adequate amounts of protein

Protein foods in your diet are classified into two groups (see Table 10.3). The value of foods for meeting your body's protein needs is determined by their composition of amino acids. Foods that contain all of the eight essential amino acids are known as first-class or complete proteins. These are mainly foods of animal origin such as eggs, meat, fish, milk and other dairy products, and soya. Foods that are lacking in one or more of the essential amino acids are called second-class or incomplete proteins. These are foods from plant sources such as cereals, bread, rice, pasta, pulses, nuts and seeds. Vegetarians and vegans must make sure that they eat a wide variety of these foods in careful combinations to ensure that adequate intakes of all essential amino acids are achieved; for example, beans and wheat complement each other well.

Complete	Incomplete
Meat, poultry, offal, fish, eggs, milk, cheese, yoghurt, soya	Cereals, bread, rice, pasta, noodles, pulses, peas, beans, lentils, nuts, seeds

**Table 10.3 Protein foods**



## Remember!

There are eight amino acids which your body is unable to make for itself. These are known as essential amino acids (EAAs).

## Fats

It is important to note that fat is an essential nutrient for your body. Fats, or lipids, are composed of the chemical elements carbon, hydrogen and oxygen, but in different ratios to carbohydrates. The ratio of hydrogen to oxygen is much higher, which explains why fat is a more concentrated source of energy than carbohydrate.

Triglycerides form the basic component of fats. Each triglyceride is made up of a glycerol molecule with three fatty acids attached. It is to these two substances that triglycerides are broken down when digested and

absorbed by your body. Fats consumed in your diet are obtained from both animal and vegetable sources and are of two main types: saturated and unsaturated.

Fatty acids contain chains of carbon atoms to which hydrogen atoms attach. The number of hydrogen atoms relative to the number of carbon atoms determines if a fatty acid is classified as saturated or unsaturated. If all the carbons are associated with two hydrogens, the fat is saturated, but if one or more of the carbons is without hydrogen then the fat is unsaturated. Unsaturated fatty acids can be of two kinds: monounsaturated and polyunsaturated.

All fats consumed in your diet are a mixture of these three different fatty acid types (see Table 10.4). Dietary fats that contain mostly saturated fatty acids are generally solid at room temperature, like butter and ordinary margarine and are usually found in foods of animal origin such as meat, eggs and dairy foods. The two exceptions are palm and coconut oil, which are plant sources. Fats that are composed mainly of unsaturated fatty acids are usually liquid at room temperature such as olive or sunflower oils.

Most dietary experts recommend that we should cut back on our fat intake for health. This is sound advice for athletes as it allows them to consume a greater proportion of energy intake from carbohydrates to maintain glycogen stores, to support training and competition.

Saturated	Monounsaturated	Polyunsaturated
Full-fat dairy products, butter, hard margarine, lard, dripping, suet, fatty meat, meat pies, paté, cream, cakes, biscuits, chocolate, coconut, coconut oil	Olive oil, olive oil spreads, rapeseed oil, corn oil, peanuts, peanut butter, peanut oil	Soft margarine, low-fat spreads labelled high in polyunsaturated fats, sunflower oil, safflower oil, soya oil, oily fish, nuts

**Table 10.4 Sources and types of fat in the diet**

There are two essential fatty acids that must be provided by the diet: linolenic and linoleic acid.

Fats have many and varied functions within your body, but the primary function is to provide a concentrated

source of energy, forming your body's largest potential energy store. Even the leanest of individuals will have large amounts of energy stored as fat. Fat is more than twice as energy dense as the other macronutrients, yielding 9 kilocalories per gram.

Fats also have many other functions. They protect and cushion your vital organs, provide a structural material for cells and act as an insulator preventing heat loss. Animal fats are a source of the fat-soluble vitamins A, D, E and K. Fats also provide flavour and texture to foods, features that often lead to over-consumption.



### Theory into practice

Take a look at your 24-hour diet recall. What types of fat do you normally eat? Do you think you eat too much fat? What might you need to do to reduce your intake of fat?

### Micronutrients

Vitamins and minerals are termed or referred to as micronutrients as they are required in much smaller amounts – in some cases in minute quantities. Despite your relatively small requirements for these nutrients, many play a critical role in regulating chemical reactions in your body.

### ■ Vitamins

Vitamins are vital, non-caloric nutrients required in very small amounts by your body. They perform specific metabolic functions and prevent particular deficiency diseases. Unlike macronutrients, they do not have a common chemical structure.

Most vitamins required to maintain health cannot be produced by your body and must be supplied by your diet. The exceptions are vitamin D, which your body is able to synthesise by the action of sunlight on the skin, and vitamin K, which can be produced by the bacteria of your large intestine. Vitamins play essential roles in regulating many metabolic processes in your body, particularly those that release energy. They are

also required to support growth, and the immune and nervous system functions, and some are involved in the production of hormones.

Vitamins are obtained from a wide variety of plant and animal sources and are grouped into two broad categories based on their solubility as either fat- or water-soluble. Vitamins A, D, E and K form the fat-soluble group, with the B vitamins and vitamin C making up the water-soluble group.

Your body requires differing amounts of each vitamin, with specific vitamins having specific functions. Individual vitamin requirements vary and are determined by age, sex, state of health and levels of physical activity. The Department of Health has set Dietary Reference Values (DRVs) (see page XX) for all nutrients for different groups of healthy people within the UK population. The Reference Nutrient Intake (RNI) value should meet the needs of almost all individuals in the population (97 per cent). A balanced and varied diet that provides an adequate energy content should supply sufficient intakes of all vitamins.

It is important to note that some vitamins can be harmful to health if they are consumed in large amounts above your body's requirements. This is particularly true for the fat-soluble vitamins as they have the potential to be stored in your body. The only situation in which large doses of any vitamin may be beneficial is when the body has a severe deficiency of a particular vitamin or when it is unable to absorb or metabolise vitamins efficiently. Supplementation with high doses of any vitamin should always be medically supervised and not self-prescribed.



### Remember!

Individual vitamin requirements vary and are determined by age, sex, state of health and physical activity level.

- Fat-soluble vitamins: all fat-soluble vitamins have a number of common features. As the term suggests, they are found in the fatty or oily parts of foods. Once digested they are absorbed and transported in



the lymph and ultimately reach the blood. As a result of their insolubility in water, they are not excreted in the urine and can accumulate in the liver and adipose tissue.

- Water-soluble vitamins: this group is formed from the B group of vitamins and vitamin C. Many of the B vitamins serve similar functions, facilitating the use of energy within your body. As a group the water-soluble vitamins have different characteristics from the fat-soluble group. Excesses are excreted via the urine and as a result your body has only limited stores, necessitating regular intakes. It should be noted that many of these vitamins are destroyed by food processing and preparation.

### Antioxidant vitamins

Beta-carotene (a form of vitamin A) and vitamins C and E are probably the most well known antioxidant nutrients in our diet and are often referred to as the ACE vitamins. Research suggests that antioxidants can help to prevent damage to the body from the effects of free radicals. There has been a lot of interest in the role of antioxidants from both health and performance perspectives. Intense training may deplete your body's stores of these vitamins. It is thought that they could have an important role to play in the protection of muscle fibres from free-radical damage during exercise and in reducing post-exercise muscle soreness, but more research is required in this area.

### Minerals

Minerals are vital, non-caloric nutrients that are essential to life, and like vitamins they are required in small or trace amounts. Minerals are classified in terms of the relative amounts required by your body and can be placed broadly into two categories.

- Macrominerals such as calcium are required in relatively large amounts, sometimes as much as several hundred milligrams.
- Trace elements such as copper and selenium are required in much smaller quantities (micrograms).

All minerals are essential to health and form important components of your body tissues such as bone, connective tissue, enzymes and hormones. Some have essential roles to play in nerve function and muscle

contraction. Others regulate fluid balance in your body. Levels of minerals within your body are closely controlled by absorption and excretion to prevent excessive build up. Some minerals compete with each other for absorption, especially iron, zinc and copper.

### Fibre

Fibre is a complex carbohydrate. Non-starch polysaccharide (NSP) is the new scientific term for dietary fibre. NSP forms the main component of plant cell walls and these are the principal component of dietary fibre. They resist digestion by the stomach and small intestine and provide bulk in your diet, which aids the transit of food through your digestive system.

Fibre is obtained from wholegrain cereals, nuts, pulses, fruits and vegetables. It is thought to have a role in both preventing and treating certain diseases including cancer of the colon, diabetes, heart disease and irritable bowel syndrome. A high-fibre intake accompanied with a high-fluid intake also helps to keep your bowel functioning efficiently. Adequate amounts may also play a role in weight control by helping to achieve the feeling of fullness.

There are two types of fibre: soluble and insoluble. Soluble fibre can be found in oats, rye, barley, peas, beans, lentils, fruits and vegetables. This type of fibre is important in the control of blood glucose and cholesterol. Insoluble fibre is found in wholewheat bread, rice and pasta, wholegrain breakfast cereals, fruits and vegetables. It is thought to be important in the prevention of bowel disorders. A healthy diet requires a good mix of both types of fibre, with adults requiring around 18 g in total per day. As a population we have a long way to go to achieve adequate intakes of this nutrient, as current average intakes are around 12 g per day.



### Remember!

Non-starch polysaccharide is the new scientific term for dietary fibre.

## Nutritional requirements

You require many different nutrients if you are to remain in good health and reduce your risk of diet-related disorders. The amount of each nutrient you need is referred to as the nutritional requirement. The requirements differ depending on age, sex, levels of activity and state of health. Some nutrients are more essential during different stages of life such as calcium in childhood and iron during pregnancy.

### ■ Essential and non-essential

#### Carbohydrates

To support health and performance, it is recommended that around 50–60 per cent of your total daily calorie intake is derived from carbohydrates. Greater intakes may be required by sportspeople engaged in regular intense training. For example, a marathon runner or a triathlete may require up to 65–70 per cent of total energy to be provided by carbohydrates.

However, a sedentary individual will require around 50 per cent of total daily calorie intake to be supplied by carbohydrates, of which the majority should be from starchy sources. This would equate to around 250 g per day for the average female and 300 g per day for the average male. As a simple guide, Table 10.5 estimates the carbohydrate requirements that can be prescribed based on activity levels.

Level of daily activity	Carbohydrate per kilogram of body weight (g)
< 1 hour	4–5
1 hour	5–6
1–2 hours	6–7
2–3	7–8
> 3 hours	8–10

**Table 10.5** Carbohydrate requirements based on daily activity levels



## Theory into practice

Based on your current body weight and levels of physical activity, estimate your carbohydrate requirements in grams per day. Do you think your carbohydrate requirements are constant, or do they vary from day to day?

Whether eating for health or performance, the best approach to achieving an adequate carbohydrate intake is to eat at regular intervals and ensure that all your meals and snacks are centred around starchy carbohydrate foods. People with high carbohydrate requirements may need to eat more frequent meals and snacks or rely on a greater intake of simple carbohydrates to achieve their requirements.



## Remember!

The best way to achieve an adequate carbohydrate intake is to ensure that all meals and snacks are based around starchy carbohydrate foods.



## Theory into practice

Take a look at your 24-hour diet recall and, using Table 10.6, estimate your carbohydrate intake for the day. For foods not in the list refer to McCance and Widdowson's tables (see the list of resources for this unit, on page XX).

- 1 Did you meet your estimated carbohydrate requirements?
- 2 If you did not meet your estimated requirements, devise a day's menu to meet your carbohydrate needs.

Food	Approximate carbohydrate content per serving (g)	Food	Approximate carbohydrate content per serving (g)
1 large slice of bread	15	1 currant bun	30
1 pitta bread	45	1 wholemeal scone	20
1 large naan bread	80	1 cereal bar	20
1 bagel	50	1 bag of crisps	10
1 tortilla	20	1 pint of milk	30
1 chapatti	30	1 small pot of yoghurt	25
1 crispbread	10	1 small can of rice pudding	30
1 large jacket potato	45	1 banana	30
1 medium portion of chips	55	1 apple	10
1 medium portion of new potatoes	35	1 orange	10
1 medium portion of boiled potatoes	35	1 satsuma	5
1 large serving of rice	60	1 handful of raisins	15
1 large serving of pasta	90	5 dried apricots	15
1 medium serving of couscous	35	1 small carton of fruit juice	20
1 slice of pizza	35	1 can of Lucozade drink	60
1 Shredded Wheat	15	1 can of lemonade	20
1 Weetabix	15	1 can of cola	35
1 medium serving of muesli	50	1 Mars bar	40
1 large tin of baked beans	60	1 small bar of milk chocolate	30
3 tablespoons of sweetcorn	10	2 teaspoons of honey	15
3 tablespoons of peas	10	2 teaspoons of jam or marmalade	10
3 tablespoons of carrots	10	1 tube of fruit gums	20
1 digestive biscuit	10	2 teaspoons of sugar	10
1 Jaffa cake	10		

**Table 10.6 Carbohydrate content of common foods**

### Protein

Active individuals require greater intakes of protein in order to promote tissue growth and repair following training and competition. Overall, protein intake should represent between 12 per cent and 15 per cent of your total daily energy intake.

In sports circles the misguided belief that additional dietary protein will automatically help to build muscle has been perpetuated since the times of the ancient Greeks. Regular exercise does increase protein needs but most people already eat enough protein in the typical diet, unless of course their diet is severely



calorie restricted. The sports performer is also likely to be eating more food to meet increased calorie requirements, and therefore should automatically be eating more protein to meet any theoretical increase in requirements.

Table 10.7 gives the estimated daily protein requirements for an adult.

Type of activity	Protein per kilogram of body weight (g)
Mainly sedentary	1
Mainly endurance	1.2–1.4
Mainly strength	1.2–1.7

**Table 10.7 Daily protein requirements based on type of activity**

Food	Approximate protein content per serving (g)
1 small lean steak	24
1 small chicken fillet	24
1 medium portion of fish	24
1 small portion of soya mince	10
1 pint of milk	18
1 small pot of yoghurt	6
1 small can of rice pudding	7
1 medium portion of Cheddar cheese	10
1 egg	6
1 large slice of pizza	12
1 thin slice of bread	1
1 Shredded Wheat	2
1 Weetabix	2
1 large portion of pasta	14
1 large portion of rice	8
1 large jacket potato	4
1 bag of crisps	2
1 cereal bar	3
1 small bar of milk chocolate	2
1 banana	1
1 small bag of peanuts	12
1 tablespoon of sesame seeds	2

**Table 10.8 Protein content of common foods**

## Theory into practice

- Using the information outlined in Table 10.7, estimate your daily protein requirements.
- Take a look at your 24-hour diet recall and, using Table 10.8, estimate your protein intake for the day. For foods not in the list refer to McCance and Widdowson's tables (see the list of resources for this unit, on page XX).
  - Did you meet your estimated protein requirements?
  - If you did not meet your estimated requirements, devise a day's menu to meet your protein needs.

## Fat

National diet and nutrition surveys have shown that the average diet in the UK contains around 40 per cent of calories from fat, a level deemed by experts to be too high. It is recommended that fat intakes are reduced to 30–35 per cent of total calorie intake. This equates to around 70 g per day for the average female and 90 g per day for the average male. Of this, only

6–10 per cent should be derived from saturated fats. Sportspeople involved in regular intense activity may need to reduce their overall fat intake further to around 25–30 per cent of total energy consumed to achieve adequate carbohydrate intakes, but in absolute terms this may equate to the same quantity of intake as that of the sedentary individual, as sportspeople will be eating more calories to meet their increased energy requirements.

Food	Approximate fat content per serving (g)
1 medium portion of thin-cut chips	20.0
1 medium portion of thick-cut chips	10.0
1 medium portion of roast potatoes	10.0
1 medium baked potato	0.2
1 medium portion of new potatoes	0.2
1 medium portion of boiled potatoes	0.2
1 medium portion of cheddar cheese	15.0
½ pt of whole milk	5.0
½ pt of semi-skimmed milk	2.5
½ pt of skimmed milk	0.3
1 small lean steak, grilled	5.0
1 small chicken fillet, grilled	3.0
1 small cod fillet, grilled	1.0
1 large thin sausage, grilled	10.0
Butter spread on 1 slice of bread	10.0
Margarine spread on 1 slice of bread	10.0
Low-fat spread on 1 slice of bread	5.0
1 small bar of milk chocolate	15.0
1 packet of crisps	10.0

Table 10.9 Fat content of common foods



### Remember!

Government guidelines recommend 70 g of fat per day for the average female and 90 g per day for the average male.

### Common terminology

#### Recommended Daily Allowance (RDA)

Dietary standards have been used in the UK since the Second World War. The first set of standards focused on Recommended Daily Allowance (RDA), which aimed to prevent nutritional deficiency through the recommendation of one intake target per nutrient.

In the late 1980s, the government set up a panel of experts to review the RDAs of nutrients for the UK population, and new Dietary Reference Values (DRVs) were established. The phrase 'dietary reference value' is an umbrella term that can be applied to any of the following measures of nutrient intake values:

- Reference Nutrient Intake (RNI)
- Estimated Average Requirements (EAR)
- Lower Reference Nutrient Intake (LRNI)
- Safe Intake (SI).



### Remember!

DRVs provide a yardstick against which the nutritional adequacy of your diet can be assessed.

#### Optimum Level

It is thought that some recommended nutrient intakes may be set too high or too low. The theory of optimal levels of nutrient intake is grounded in nutritional therapy and attempts to take more account of individual requirements, lifestyle habits and circumstances such as smoking and stress. Defining optimal nutrient intakes has presented nutrition scientists with considerable challenges. To determine an individual's optimum nutrient intake level requires biochemical screening through the analysis of blood or urine and this is not routine practice.

## ■ Safe Intake (SI)

Safe Intake (SI) is a term used to indicate the intake of a nutrient where there is insufficient scientific information to estimate the distribution of requirements within a population. It represents an intake that is thought to be adequate for most people's needs but not so high as to cause undesirable effects on health.

## ■ Estimated Average Requirements (EAR)

Estimated Average Requirements (EAR) is an assessment of the average requirement for food energy or nutrients. Many individuals require more than the EAR and many require less. The EAR is the value most used when assessing energy requirements and intakes.

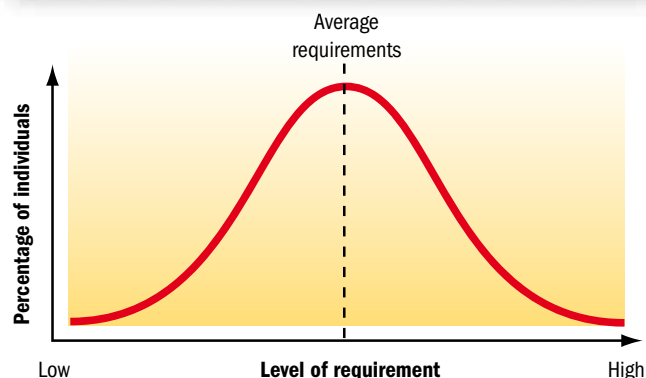
### Taking it further

To find out more about Dietary Reference Values, take a look at the Department of Health's *Report on Health and Social Subjects 41: Dietary Reference Values for Food Energy and Nutrients for the United Kingdom*, HMSO, 1991.



### Remember!

Dietary Reference Value is an umbrella term that can be applied to the other terms relating to nutrient intake such as RNI, EAR, LRNI and SI.



▲ The normal distribution curve of nutrient requirements in a population



## Assessment practice

Produce a leaflet aimed at sports participants that describes the importance of good nutrition to health and performance and introduces them to common terminology associated with nutrition. **P1**



## Grading tips

### Grading Tip **P1**

You must be able to describe nutrition and the relevant components of a diet along with frequently used terminology.

## Digestion

You have already seen that food provides the energy and nutrients you need to stay alive and in good health. Before your body can make use of this energy and nutrients, the food has to be broken down to release them through the process of digestion.

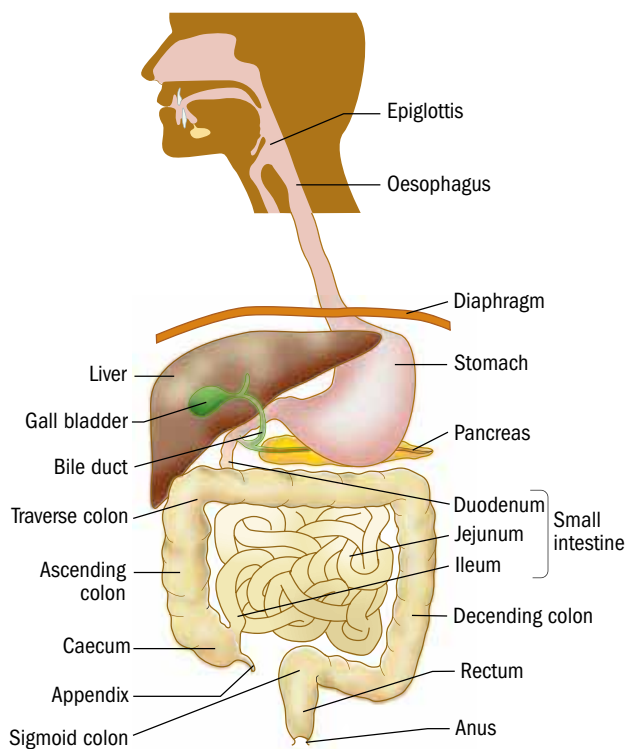
### Structure of digestive system

Digestion starts in the mouth (**buccal cavity**). Your teeth and jaws crush and grind food to mix it with saliva, which contains the enzyme amylase that begins the breakdown of starch. You then swallow the food, which enters the **oesophagus**. This is the tube that connects your mouth to your **stomach**. The food bolus is squeezed along the oesophagus by the process of peristalsis. It takes around 3–6 seconds for food to travel from your mouth to your stomach. Your stomach acts as a large mixing bowl, churning the food into a liquid called chyme. Lining your stomach are cells that produce and release gastric juices containing enzymes and hydrochloric acid, which assist in the breakdown of the food and kill any bacteria present in it. Food normally remains in your stomach for 1–4 hours, but fluid may pass through much more rapidly.



From your stomach the chyme passes to your **duodenum** and then to your **small intestine**, a tube about six metres long. As the chyme enters your small intestine, it is mixed with more **digestive juices**, this time from the **pancreas**. Pancreatic juice contains bile made by the **liver** as well as enzymes to further assist the breakdown of carbohydrate, protein and fat. It is also alkaline to neutralise the acid from the stomach. Your **gall bladder**, a pear-shaped organ, stores and concentrates bile until it is required for digestion. Then it is released into your digestive tract to emulsify fats and neutralise the acids in partly digested food. The process of peristalsis continues to move the chyme through your digestive system to your **large intestine** (another long tube in your digestive system) and eventually the **rectum** and **anal canal**.

As the chyme moves through your small intestine, vitamins, minerals, amino acids, fatty acids and sugars are absorbed by your intestinal wall. Lining the wall of your small intestine are finger-like projections known as villi, which increase the surface area available for absorption and speed up the process.



▲ The digestive system

By the time the chyme reaches your large intestine, it is less fluid and has been reduced to mainly indigestible matter. Your large intestine does not produce any digestive enzymes but continues to absorb mainly water. Bacteria in your large intestine produce vitamin K. The residue (faeces) left behind is eliminated (excreted) from your body through your anus.

## Function of the digestive system

### Digestion

Digestion can be considered a multi-stage process following the ingestion of raw materials (the food you eat). It involves mechanical and chemical elements in the process that ultimately leads to enzymes in the gut breaking down the larger chemical compounds in the foods you eat into smaller compounds so that they can be absorbed by your body.

### Absorption

This is the movement of digested food from your stomach and small intestine into your body tissues and blood. The process of absorption happens in specialised structures called villi that line your small intestine. These finger-like projections provide a large surface area for absorption to take place. Each villus has a network of capillaries to quickly absorb nutrients. Amino acids (from the breakdown of proteins) and glucose (from the breakdown of carbohydrates) enter your bloodstream directly. Fatty acids and glycerol (from the breakdown of fats) are taken up by your lymphatic system.

### Excretion

Excretion is the removal of potentially poisonous end-products from metabolism, normally in your urine and faeces. In humans the main organs of excretion are the kidneys, through which urine is eliminated, and the large intestine, through which solid or semi-solid waste is expelled.



## Assessment practice

Create a short PowerPoint® presentation to describe the structure and function of the digestive system.

**P2**



## Grading tips

### Grading Tip **P2**

You need to describe the digestive system and the enzymes that break down specific food types.

# 10.2 Understand energy intake and expenditure in sports performance

All activity stimulates your body's need for fuel, so understanding energy intake and expenditure is vital to successful sports performance.

## Energy

Energy is essential to life. It is obtained from the foods you eat and used to support your basal metabolic rate (the minimum amount of energy required to sustain your body's vital functions in a waking state), and all activity carried out at work and leisure. At some stages in the life cycle extra energy is required, such as when pregnant or breast-feeding and during illness and growth spurts.

### Measures

Energy is measured in calories or joules. As both of these units are very small they are multiplied by 1,000 and referred to as kilocalories (the UK system) or kilojoules (the metric or international system).

## Key terms

**Calorie** The energy required to raise 1 g of water by 1°C.

**Joule** One joule of energy moves a mass of 1 g at a velocity of 1 metre per second. Approximately 4.2 joules = 1 calorie.

**Kilocalorie** The energy required to raise the temperature of 1 kg of water by 1°C. Equal to 1,000 calories and used to convey the energy value of food. Kilocalories are often simply referred to as calories.

**Kilojoule** A unit of measurement for energy but like the calorie the joule is not a large unit of energy therefore kilojoules are more often used.



## Remember!

- 1 calorie (cal) = 4.2 joules (J)
- 1 kilocalorie (kcal) = 4.2 kilojoules (kJ)
- 1 kilocalorie (kcal) = 1,000 calories (cal)
- 1 kilojoule (kJ) = 1,000 joules (J)

## Sources

The various macronutrients supply different amounts of energy per unit of weight. The potential fuel sources available to your exercising muscles are listed below. However, their relative value as fuels for activity differs. Protein may be used during prolonged periods of exercise and towards the latter stages of endurance events like the marathon, particularly if fat and carbohydrate as sources of fuel within the working muscles have become limited.

### Fats

1 g fat = 9.0 kcal = 38 kJ

### Carbohydrates

1 g carbohydrate = 4.0 kcal = 17 kJ

### Proteins

1 g protein = 4.0 kcal = 17 kJ

Fat and carbohydrate, which is stored in the muscles as glycogen, are the main energy fuels for your exercising muscles. Exercising muscles prefer glucose as a fuel, particularly as the intensity of the activity being undertaken increases. When you exercise, your muscles use energy at a rate that is directly proportional to the intensity of the activity you are undertaking. If this energy is not replaced as it is used up, your muscles will be unable to maintain their rate of work and the intensity of the activity will need to be reduced or stopped as fatigue sets in.

## Measuring requirements

### Body composition

Individuals come in all shapes and sizes. However, the most commonly used method of classification of body type is known as somatotyping. This classification method recognises three basic body types:

- ectomorph: a slim build, long limbs, delicate bone structure, a low body fat and muscle content, and usually finds weight gain difficult

- endomorph: a heavy build, rounded shape, a tendency to gain weight, and generally finds weight loss difficult
- mesomorph: a muscular build and large bone structure.

For more information on the three basic somatotypes, see page XX.

Very few individuals fit neatly into these extremes. Most of us have characteristics of each body type to a varying degree, and although it is fashionable for many women in particular to want to be slim and ectomorph-like, it is important to note that it is not possible to alter our basic body type. The body is composed of a perplexing number of cells, tissues, organs and systems but the components of most interest to exercise scientists and nutritionists are muscle, bone and fat.

### Lean body mass

Body composition simply refers to the amount of lean body mass and body fat that makes up your total body weight. Lean body mass includes the bones, muscle, water, connective and organ tissues. Body fat includes both your essential and non-essential fat stores.

### Percentage body fat

Sportspeople and those actively engaged in fitness regimes are often concerned about their weight, whether for performance or health reasons. Unlike your basic body type, it is possible to alter your body composition, with exercise generally having the effect of increasing lean body mass and decreasing body fat.

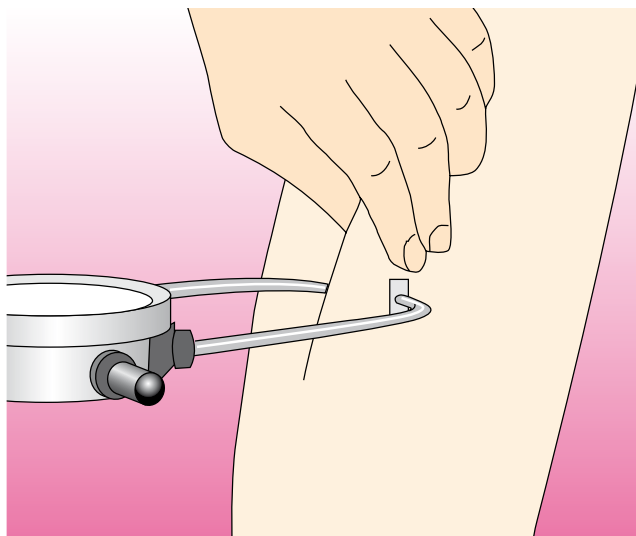
Methods of assessing percentage body fat include:

- skinfold analysis
- bioelectrical impedance analysis
- hydrodensitometry (underwater weighing).

All these methods have most merit in measuring changes in body composition over time rather than absolute values. A number of steps can be taken to minimise potential errors in measuring changes in body composition over time:

- always use the same method
- ensure the subject is assessed by the same person
- take repeat measurements at the same time of day.



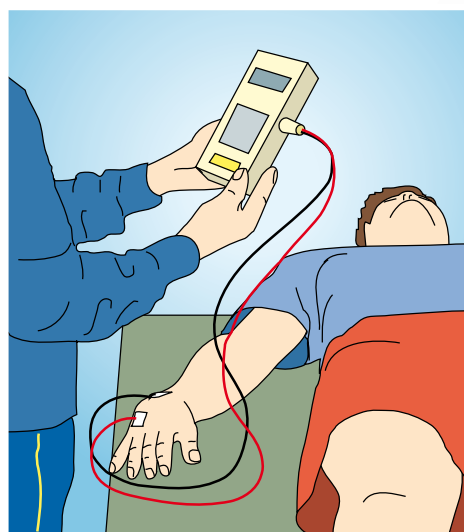


▲ **Skinfold callipers measure the amount of subcutaneous fat (fat immediately below the skin) in millimetres**

### Skinfold analysis

With this technique, callipers are used to measure the thickness of skinfolds at various sites, with the biceps, triceps, sub scapula and supra iliac crest being the most common anatomical sites of measurement. The sum of these measurements is then used to calculate percentage body fat using a method that takes into account the age and gender of the subject using equations or tables. (This technique is covered in more detail in Unit 6, on page XX.)

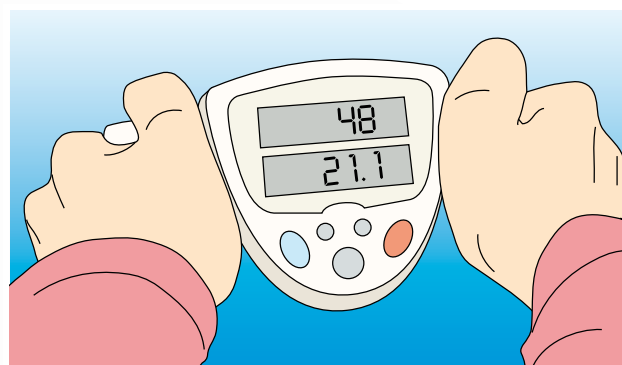
This is a relatively cheap and convenient method but it does require a high degree of skill. This method is thought to be generally reliable if performed correctly but it has been shown to have an error margin of  $\pm 3-4$  per cent and may not be effective for use on very fat or very thin subjects.



(a)



(b)



(c)

◀ **Bioelectrical impedance machines:**  
(a) using electrodes, (b) foot-to-foot and  
(c) hand-to-hand

### Bioelectrical impedance analysis

Bioelectrical impedance analysis (BIA) is fast becoming the standard technique for assessment of body composition, particularly in the health and fitness sector. Bioelectrical impedance machines have an advantage over callipers in providing a quick, easy and non-invasive method of estimating percentage body fat. There is now a range of equipment that uses BIA principles to assess body composition. Some require the

attachment of electrodes to the hands and feet of the subject (Bodystat), others require the athlete to stand on specially designed scales (Tanita) or to grip handles (Omron). (This technique is covered in more detail in Unit 6, on page XX.)

BIA measures the resistance to the flow of an electrical current through the body, using the fact that different body tissues display different impedance to the flow of the current. Tissues that contain a large amount of water, such as lean tissue, provide a lower impedance than tissues such as bone and fat.

When using BIA techniques a number of assumptions have to be made, and equations applied, to obtain a body fat percentage figure. One potential drawback to this method is that impedance measurements are related to the water content of tissues. This means that for accurate results subjects must be fully hydrated, and they are required to abstain from exercise and substances which exert a diuretic effect – such as alcohol or caffeine – for a period of at least 24 hours before the test. Invalid results may also be obtained for women if they are measured immediately before or during a period, when the body water content may be higher than normal.

### Hydrodensitometry

This is considered to be one of the most accurate methods of assessment of body composition. However, it is expensive and time consuming to perform and can be potentially stressful to the athlete as it requires him or her to be totally submerged in water. The technique measures body density that can be translated mathematically into percentage body fat. It relies on Archimedes' principle of water displacement to estimate body density. As a technique it is rarely used because it is expensive.

For more information on hydrodensitometry, see page XX.

### Body weight

Body weight describes the mass of your body. In scientific terms it is more precisely referred to as body mass and is usually measured in kilograms. Some individuals have problems controlling their body weight, often resulting in obesity. In an athletic context some sports are categorised based on body weight. Energy and nutrient requirements may also be expressed relative to body mass.

### Direct and indirect calorimetry

Energy expenditure can be assessed by direct or indirect calorimetry, essentially through the measurement of heat production.

- Direct calorimetry (DC) measures the actual amount of heat produced by the body. It requires the use of expensive and sophisticated equipment involving a sealed, airtight chamber where heat produced by the subject warms water surrounding it.
- Indirect calorimetry (IC) estimates heat production by measuring respiratory gases (oxygen consumption and carbon dioxide production). It can be undertaken using different techniques – the most common is via mouthpiece and Douglas bag collection or mouthpiece and gas analysis system, with energy consumption calculated from the amount of oxygen consumed. The consumption of 1 litre of oxygen equates to approximately 4.8 kcal of energy expended assuming a mixture of fats and carbohydrates are oxidised.

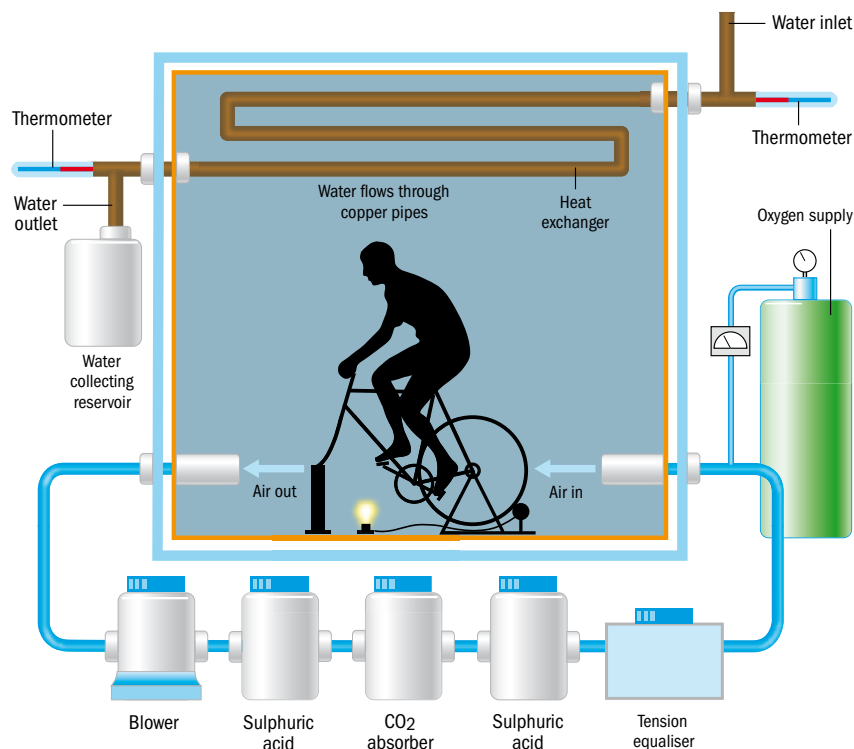
### Taking it further

Using the Internet, undertake a search using the search term 'body composition assessment'. Evaluate the range of body composition assessment products available in terms of their affordability, ease of application and suitability for use with sports performers.

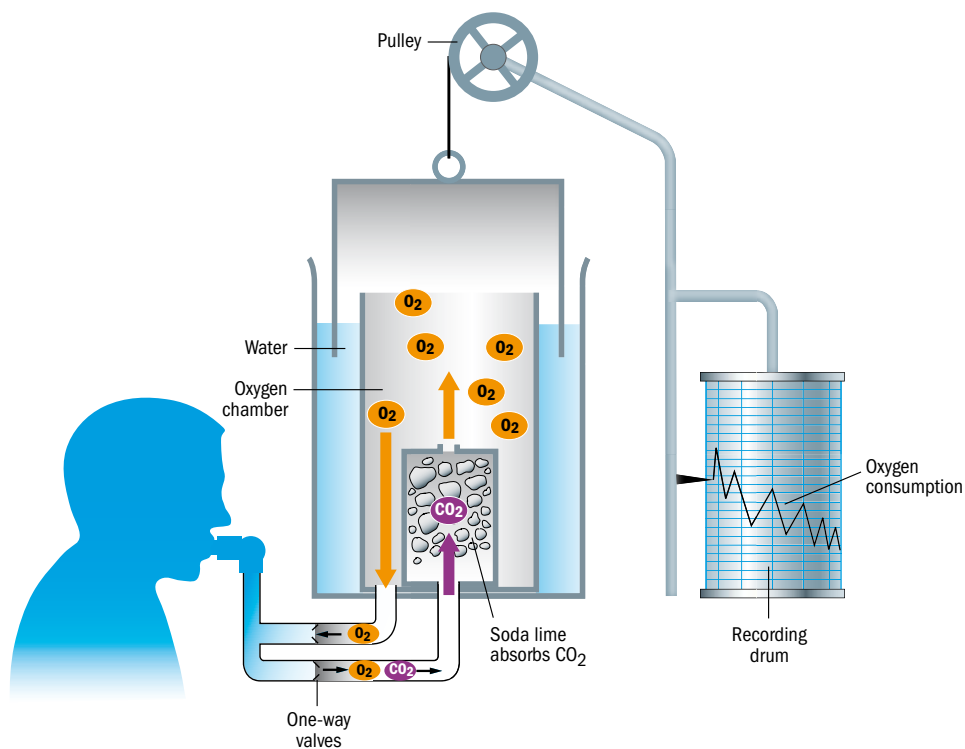
### Taking it further

Undertake your own research using the Internet to investigate other measures of energy expenditure including doubly labelled water and motion analysers.

(a)



(b)



▲ (a) Direct calorimetry and (b) indirect calorimetry





## Assessment practice

- 1 Hold a group discussion to identify the range of sports participation in your class.
- 2 Working in small groups, investigate the energy demands of some or all of these sports and then prepare a short presentation to describe energy intake and energy expenditure in sports performance. **P3**
- 3 Produce a fact sheet for a specific sport to explain energy intake and energy expenditure in sports performance. **M1**



## Grading tips

### Grading Tip **P3**

You need to consider the importance of energy balance in sports performance.

### Grading Tip **M1**

Consider the role nutritional supplements such as sports drinks, and energy gels and bars might have on achieving and maintaining energy balance.

## Energy balance

You are in energy balance when the amount of energy you take in (energy input) equals the amount of energy you expend (energy output). You will neither be losing nor gaining weight. Energy input comes from the food and drink you consume. There are four major components to energy output: resting metabolic rate (RMR), dietary thermogenesis (DT), physical activity (PA) and adaptive thermogenesis (AT).

- Resting metabolic rate can account for up to 60–75 per cent of total energy output and represents the largest component of your total daily energy expenditure. RMR is closely related to your lean body mass and so is influenced by your body composition. Muscle tissue is much more metabolically active



### ▲ Nutritional supplements are sometimes used to achieve and maintain energy balance

than fat tissue. Gains in muscle mass will result in increases in RMR. RMR is also influenced by your age, sex and genetic background.

- Dietary thermogenesis refers to the energy expended above that of RMR for the processes of digestion, absorption, transport and storage of food. It is influenced by the calorie content and composition of the meals consumed in your diet along with your individual nutritional status. High energy intakes and a regular eating pattern are thought to help us maintain higher rates of dietary thermogenesis, while skipping meals and restrictive dietary practices lead to a reduction in this component of total energy expenditure.
- Physical activity represents the most variable component of your total energy expenditure. This is the additional energy expended above RMR and DT, and will obviously contribute more to total daily energy expenditure in active individuals. Exactly how much varies according to how active your general lifestyle is, how often, how energetically, and for how

long you participate in sport and exercise, and what type of activity it is.

- Adaptive thermogenesis is energy expenditure that occurs as a result of environmental or physiological stresses placed on your body, such as a change in temperature that may require you to respond by shivering or stress that causes anxiety or fidgeting.

When energy intake exceeds expenditure, this is referred to as positive energy balance and weight is gained. If intake is less than requirements to meet energy expenditure, the additional energy required will be drawn from your body's fat reserves and weight will be lost. This is referred to as negative energy balance. Even small imbalances in energy intake and expenditure can produce profound effects on body composition and weight.



### Remember!

Energy balance is achieved when energy input equals energy output.

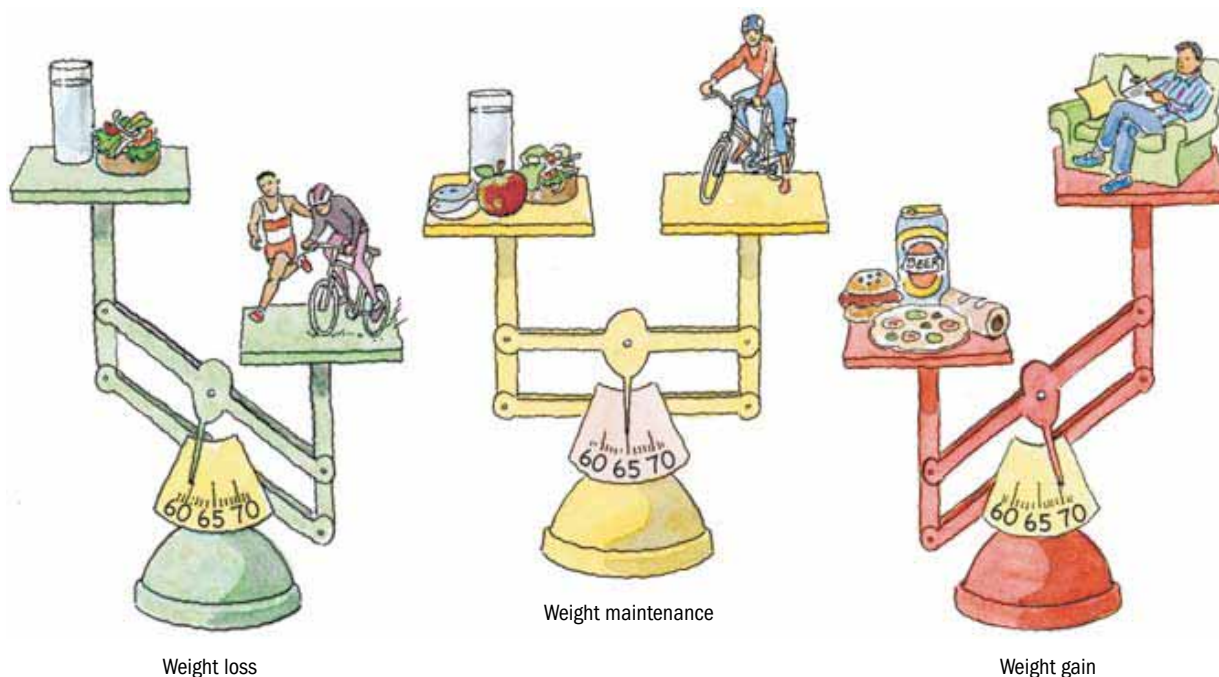
### Basal metabolism

To estimate energy requirements, you first need to calculate basal metabolic requirements (BMR) in kilocalories per day using the data in Table 10.10.

	Age (years)	Basal metabolic requirements in kilocalories per day (W = weight in kilograms)
Males	10-17	$BMR = 17.7W + 657$
	18-29	$BMR = 15.1W + 692$
	30-59	$BMR = 11.5W + 873$
	60-74	$BMR = 11.9W + 700$
Females	10-17	$BMR = 13.4W + 692$
	18-29	$BMR = 14.8W + 487$
	30-59	$BMR = 8.3W + 846$
	60-74	$BMR = 9.2W + 687$

(Schofield et al, 1985)

Table 10.10 Calculating basal metabolic requirements



### Energy balance



## Theory into practice

Calculate your BMR and record your answer in kilocalories per day.

### ■ Age

Your basal metabolism reduces with increasing age. After the age of 30 years, it falls by around 2 per cent per decade.

### ■ Gender

Males generally have greater muscle mass than females so they generally have a higher basal metabolic rate.

### ■ Climate

Exposure to hot or cold climates causes an increase in basal metabolism to maintain your body's internal temperature.

### Taking it further

Using your own research, identify any other factors that affect basal metabolism.

### ■ Physical activity

To estimate your total energy requirements you also need to consider your level of physical activity and training. The simplest method of estimating your total energy requirement is by multiplying your BMR by your physical activity level (PAL). Calculating PALs requires you to make an assumption about the energy demands of both your occupational and non-occupational activity levels (see Table 10.11).



## Theory into practice

Calculate your total energy requirements using the PAL that corresponds to your occupational and non-occupational activity levels.

Once you have calculated an estimate for your total energy requirements, the amount of carbohydrate, fat and protein you require can be predicted. Remember that in general sportspeople require an energy distribution of 50–60 per cent of calories from carbohydrate, 12–15 per cent from protein and 25–30 per cent from fat.

Non-occupational activity	Occupational activity					
	Light		Moderate		Heavy	
	Male	Female	Male	Female	Male	Female
Non-active	1.4	1.4	1.6	1.5	1.7	1.5
Moderately active	1.5	1.5	1.7	1.6	1.8	1.6
Very active	1.6	1.6	1.8	1.7	1.9	1.7

Table 10.11 Physical activity levels for three levels

## Activity

- 1 a Imagine you are a sportsperson in regular training and calculate the calories required in your diet to be contributed by the three macronutrients. Record your answers in kilocalories.  
b Once you know how many kilocalories are required from each of the three macronutrients, you can calculate the number of grams of each that you need, remembering that carbohydrate and protein provide 4 calories per gram and fat 9 calories per gram. Calculate the grams of carbohydrate, protein and fat required in your diet by dividing the kilocalories required by the appropriate energy value, and record your answers.
- 2 Plan a day's diet for a female endurance athlete who has an energy requirement of 2,500 kilocalories. In particular, pay attention to achieving an adequate carbohydrate intake and calculate the amount of energy to be contributed by carbohydrate, and the number of grams of carbohydrate this equates to.



## Assessment practice

- 1 Is energy balance important in sport? Prepare a short PowerPoint® presentation to support your views. **P4**
- 2 Explain the role of body composition assessment in the achievement and maintenance of energy balance in the sports performer? **M2**
- 3 Analyse the effects of energy balance on sports performance. To do this you might use some of the information you have collected in the Theory into practice and Taking it further activities in this section. **D1**



## Grading tips

### Grading Tip **P4**

Describe energy balance and its importance to sports performance.

### Grading Tip **M2**

Explain the importance of these measures in relation to the achievement and maintenance of energy balance in the sports performer.

### Grading Tip **D1**

Consider examples from different sports and categories of sports performer.



## 10.3 Understand the relationship between hydration and sports performance

Water is often overlooked as a nutrient, but it is one of the most important nutrients in your diet. Your body can not survive more than a few days without water. It is essential to life and performs numerous functions. During exercise, fluid requirements increase according to the type, duration and intensity of the exercise and the environmental conditions under which it is taking place. Understanding the relationship between hydration and sports performance is vital for achieving optimal performance in both training and competition.

### Hydration

Water acts as the main transport mechanism in your body, carrying nutrients, waste products and internal secretions. It also plays a vital role in temperature regulation, particularly during exercise, and aids the passage of food through your digestive system.

Water is the largest component of body mass, making up around 50–60 per cent of your total body weight. Actual amounts vary depending on age, sex and body composition. Muscle has a higher water content than fat tissue, so leaner individuals have a higher water content than fatter individuals of the same body mass.

Water is lost from your body through a number of routes including urine, faeces, evaporation from the skin and

expired breath. If water loss is high, your body becomes dehydrated. Under normal circumstances your body maintains a balance between fluid input and output. Table 10.12 illustrates the balance between sources of water intake and routes of water loss.

#### Signs and symptoms

Water is one of the most important nutrients required by your body. Water losses may be as high as a litre per hour during endurance-type exercise. This could be even higher if the exercise takes place in hot or humid conditions.

Fluid losses incurred by sportspeople during training and competition are linked to the body's need to maintain temperature within very narrow limits. During exercise, your body temperature rises and the extra heat this produces is lost through sweating – the process of evaporation of water from your skin's surface. If fluid lost through sweating is not replaced, there is a risk of dehydration and performance may suffer.

#### Dehydration

Dehydration can affect performance by reducing strength, power and aerobic capacity. Severe dehydration can cause heat stroke and has the potential to be fatal. A loss as small as 2 per cent of body mass can be enough to begin to affect your ability to perform muscular work. For a 75 kg male this would be equivalent to a fluid loss of only 1.5 litres from the body. It is therefore important to minimise the risks of dehydration, and very important to note that thirst is a poor indicator of your body's hydration status.

Daily water input		Daily water output	
Source	ml	Source	ml
Fluids	1,200	Urine	1,250
Food	1,000	Skin	850
Metabolism	350	Lungs	350
		Faeces	100
Total	2,550	Total	2,550

**Table 10.12 Daily water balance for a sedentary 70 kg adult male**



#### Remember!

Dehydration can hinder performance by affecting strength, power, coordination and aerobic capacity.

The warning signs for dehydration include:

- lack of energy and early fatigue during exercise
- feeling hot
- clammy or flushed skin
- not needing to go to the toilet
- nausea
- headache\*
- disorientation\*
- shortness of breath.\*

\* These are signs of advanced dehydration.

### ■ Hyperhydration

Hyperhydration is a state of increased hydration from normal, producing a greater than normal body water content. Starting exercise in a hyperhydrated state can improve thermoregulation, improving heat dissipation and exercise performance. However, this area of sports science research needs to be further investigated.

### Key term

**Thermoregulation** The ability to keep the body's temperature constant, even if the surrounding temperature is different.

### ■ Hypohydration

Hypohydration is a state of decreased hydration from normal, producing a less than normal body water content. Hypohydration increases core body temperature, impairs the sweating response and causes skeletal muscle fatigue.

### ■ Superhydration

Superhydration is a state of hydration achieved by manipulation with the ergogenic aid glycerol. When ingested with large volumes of water (1–2 litres), glycerol has been shown to increase water retention in the body. This reduces overall heat stress during exercise in hot conditions, lowering heart rate and body temperature. However, not all glycerol studies have shown improvements in hydration or endurance performance

### Key terms

**Ergogenic** Work-enhancing.

**Ergogenic aid** A substance that improves exercise performance.

and there are side effects to be considered including headaches, dizziness, gastrointestinal upsets and bloating.

### Fluid intake

To maintain water balance, a sedentary individual requires around 2–2.5 litres of fluid per day, the equivalent of 6–8 cups. Around 10 per cent of your daily fluid requirements are gained from the metabolic processes that release water within your body. The other 90 per cent is derived from your diet. Approximately 60 per cent of this comes directly from fluids and the rest comes from food, particularly that with a high water content.

During exercise, fluid requirements increase according to the type, duration and intensity of the exercise and the environmental conditions under which it is taking place. Your body's water losses can be very rapid when exercising in hot weather. The longer and harder the exercise, and the hotter and more humid the conditions, the greater the fluid losses that are likely to occur.

### ■ Pre-event

In an attempt to minimise the effects of fluid loss during training and competition, sportspeople should be encouraged to begin fully hydrated and to drink plenty of water both during and after the activity. Establishing patterns of fluid intake should be an integral part of the training process. Training should be used as the opportunity to practise well-rehearsed fluid replacement strategies that run smoothly in competitive situations. Drinking 300–500 ml of fluid 10–15 minutes before exercise is recommended.

### ■ Inter-event

Many factors can influence the effectiveness of fluid replacement strategies during exercise. Fluid replacement can be speeded by drinking still, cool drinks

of a reasonable volume that are not too concentrated, and they must be palatable to drink. The more intense the activity undertaken, the more the absorption of fluid is slowed. Unpleasant symptoms experienced when drinking during exercise usually mean you have left it too late to start drinking and your body is already dehydrated. Drinking 150–200 ml every 15–20 minutes during exercise is recommended, especially if the exercise lasts longer than an hour.

### ■ Post-event

Weight and urine-colour checks can provide a useful and simple way of monitoring fluid status during and after training and competition. A weight reduction of 1 kg is equivalent to 1 litre of fluid loss. Frequent trips to the toilet to pass plentiful quantities of pale-coloured urine are an indicator of good hydration, whereas scant quantities of dark-coloured urine indicate a poor level of hydration. These simple weight and urine checks before and after exercise can provide useful tools to assist in determining fluid requirements post-training or during competition. As a guide, after exercise fluid losses should be replaced 1.5 times within the first two hours of recovery.

### Sources

#### ■ Water

Water is considered to be an adequate fluid suitable for most exercise, but some sports drinks may be useful if running at higher intensities for longer durations.

#### ■ Sports drinks

Most sports drinks aim to provide three nutrients: carbohydrates to replace energy, water to replace fluid and electrolytes to replace minerals lost in sweat. The carbohydrate in sports drinks is usually glucose, fructose, sucrose or maltodextrins, which are all saccharides that are quickly absorbed. Modern sports drinks often contain a range of minerals and vitamins, but most often include the electrolytes sodium and potassium. Both of these macrominerals are lost in sweat. Sodium promotes the absorption of glucose and water. Magnesium is another mineral lost in sweat, and is present in water and most sports drinks.

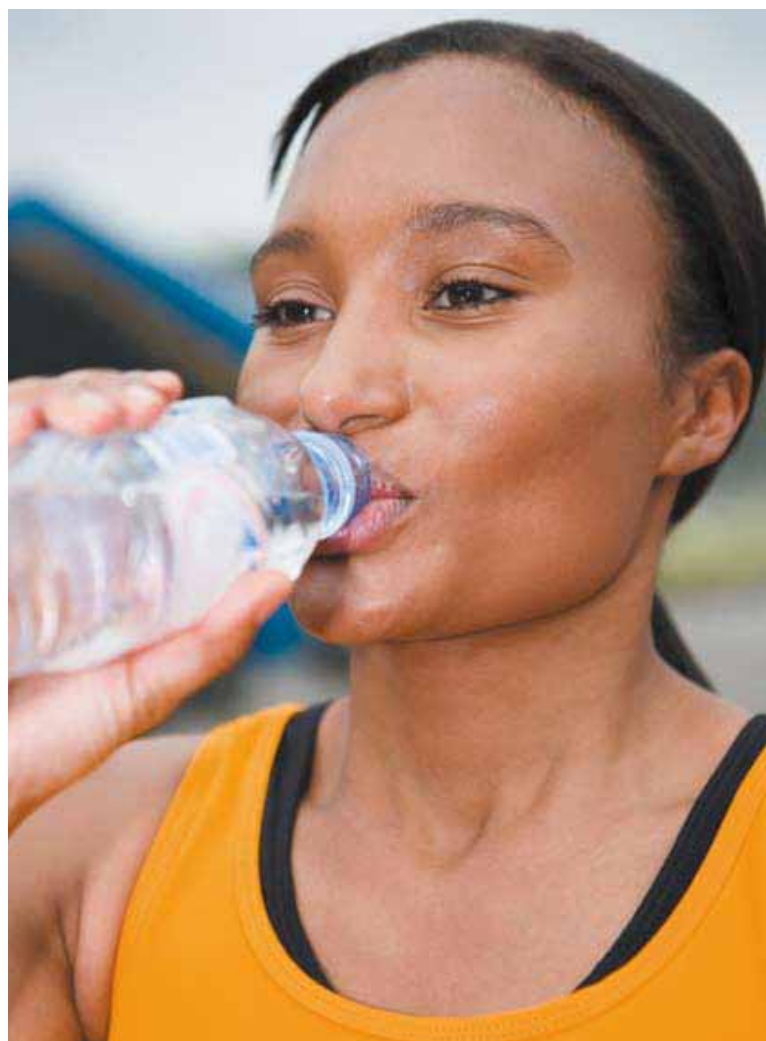
#### Hypertonic

Hypertonic drinks contain over 8 per cent of carbohydrate and have a slower rate of absorption. Although they provide a source of carbohydrate replenishment, they are not ideal for optimal rehydration and may need to be consumed with other fluids. These are best used in the recovery stage after exercise.

#### Isotonic

Isotonic drinks contain the same concentration of glucose to water as is found in your blood: 4–8 per cent or up to 8 g per 100 ml of water. They usually contain sodium, which makes them quicker to be absorbed into the bloodstream. An isotonic drink is useful whenever exercise has been prolonged or during warmer weather when sweat loss is higher. They can also be used effectively before exercise.

#### ▼ Minimising dehydration is important to performance



### Hypotonic

Hypotonic drinks have a lower concentration of carbohydrates and are more diluted than isotonic or hypertonic sports drinks. They contain less than 4 per cent carbohydrate (4 g per 100 ml of water) and are generally easily absorbed and well tolerated. Although water is adequate for non-endurance training or when sweat losses are small, these drinks may encourage fluid replacement through enhanced taste.

### Taking it further

Investigate a range of commercially available sports drinks and evaluate their potential use before, during and after exercise.

### Activity

Devise a simple five-point plan to ensure that sportspeople maintain an adequate state of hydration. You may choose to use this plan later when formulating your diet plan for a selected sports performer.

Before	During	After
300-500 ml 10-15 minutes before activity	150-200 ml every 15-20 minutes	based on body mass lost replace losses 150%

Table 10.13 Fluid replacement strategies for exercise

### Effects on sports performance

The greater the **frequency**, **intensity** and **duration** of exercise, the more important fluid replacement strategies become and the more likely that sports drinks will

have a useful contribution to make in terms of effects on performance and **recovery**, not only by providing a source of fluid but also of energy. Sound nutritional strategies, including those relating to fluid replacement, may have their biggest contribution to make in allowing the sportsperson to train consistently to meet the desired adaptations to training in terms of **specificity** and **progression**.

### Taking it further

Undertake your own research into the effects of sports drinks on immune function.



### Assessment practice

- 1 Describe hydration and its effects on sports performance. **P5**
- 2 Explain the effects of hydration on sports performance. **M3**



### Grading tips

#### Grading Tip **P5**

You must show knowledge of the relevance of hydration and how it impacts on sports performance. Try to link your answer to the body's energy balance and the digestive process.

#### Grading Tip **M3**

Produce a more detailed discussion on how specific sports drinks affect sports performance.



## 10.4 Be able to plan a diet appropriate for a selected sports activity

To be able to plan a diet for a selected sports activity, you need to consider the physiological demands of the activity, the phase of training and the individual's needs. These will help you to plan a balanced diet across the food groups that will provide adequate nutrition.

### Diet

Food is made of carbohydrates, fats, proteins, vitamins, minerals, non-starch polysaccharide (fibre) and water. The amounts of these nutrients vary from food to food. A balanced diet is one that provides the correct amounts of all nutrients without excess or deficiency.

#### Balanced diet

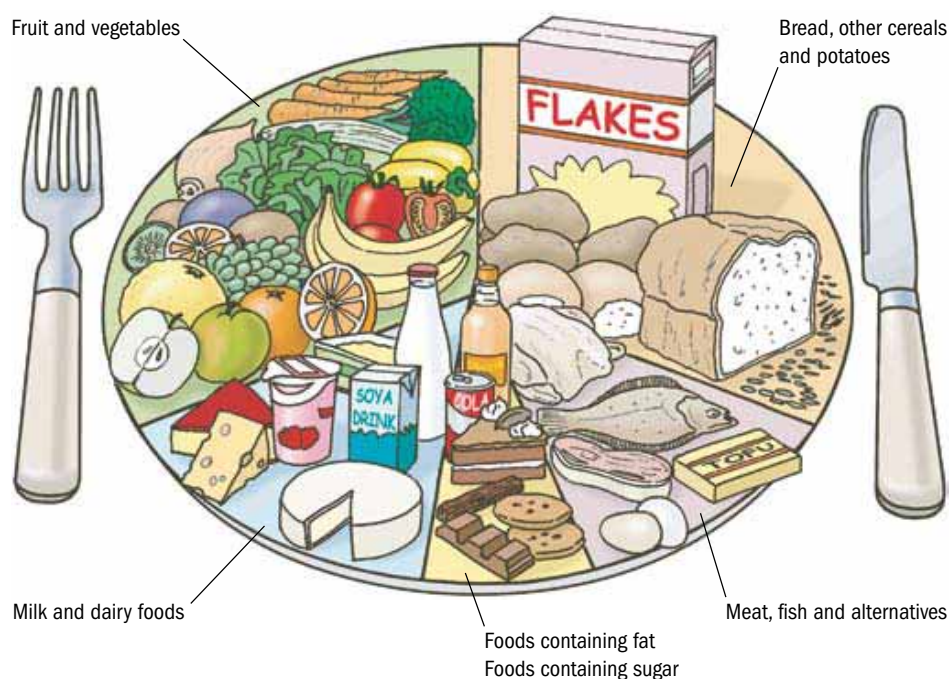
Foods that you eat in your diet are popularly classed as good or bad, healthy or unhealthy, with healthy eating often viewed by many as a hardship or a chore. However, there are no good or bad foods, only good or bad uses of food. It is better to look at the overall balance of foods eaten as either healthy or unhealthy.

Healthy eating involves choosing the right foods in the right balance most of the time to provide all the essential nutrients and energy required by your body. The principles of healthy eating aim to reduce the risk of chronic disease such as coronary heart disease, obesity, diabetes and cancer,

but following these principles will also benefit sports performance. Healthy eating principles should form the solid foundations on which sportspeople can build more specific nutritional strategies to support training and competition.

A simple guide to healthy eating:

- eat the correct amount to maintain a healthy body weight
- cut back on your fat intake, particularly fat from saturated sources
- eat plenty of foods with a high starch and fibre content
- don't eat sugary foods too often
- use salt sparingly and reduce your reliance on convenience foods
- ensure adequate intakes of vitamins and minerals by eating a wide variety of foods
- if you drink alcohol, keep within sensible limits
- enjoy your food and do not become obsessed with your diet or dieting.



The balance of good health model ►

## ■ Carbohydrates

Carbohydrates are either starches or sugars. Starchy foods, especially those that are unrefined such as whole grain bread, rice, pasta, cereals and potatoes, provide a steady supply of energy. However, these foods can be filling. To achieve optimal carbohydrate stores, the sportsperson may need to top up with sugary sources that are more rapidly absorbed like sweets, dried fruit, fruit juice, and sugary or sports drinks.

It is recommended that at least 50–60 per cent of your daily calorie intake comes from carbohydrates, and more for those engaged in regular intense heavy training. As a guide, 4–5 g of carbohydrate per kilogram of body weight should be sufficient if you do less than an hour's exercise each day, 5–6 g per kilogram of body weight if you exercise for an hour a day, 6–7 g for one to two hours per day and an intake equivalent to 8–10 g per kilogram of body weight for heavy training exceeding three hours per day.

The best approach is to base all your meals and snacks around starchy carbohydrate foods and eat at regular intervals. Glycogen – your body's store of carbohydrate – is replenished most efficiently within the first half to two hours after exercise.

## ■ Fats

Fat provides a concentrated source of energy and is the predominant fuel for low-intensity activity. Eating less fat will allow you to eat more carbohydrate. In the average UK diet, fat accounts for 40 per cent of total calorie intake. To promote good health it is recommended that intake is between 30 and 35 per cent. Those engaging in regular intense activity need to reduce this further to achieve recommended carbohydrate intakes.

## ■ Proteins

Many sportspeople believe they need to eat large amounts of protein to build muscle and increase strength, but in most cases it is not necessary to consume a high-protein diet by eating large quantities of meat, fish, eggs, pulses and dairy products. It will not improve performance or increase muscle mass. That can only be achieved by the appropriate training. Some of these foods are also high in animal fats, which should

be reduced for long-term health. They may also leave no appetite for carbohydrate foods to provide sufficient energy stores to support training. Eating a normal varied diet and meeting energy (calorie) requirements should automatically provide enough protein.

Normal protein requirements are in the region of 0.75 g per kilogram of body weight per day. The average UK diet significantly exceeds the Dietary Reference Value nutrient intake for protein set at 45 g per day for a female and 55.5 g per day for a male.

Active individuals require greater intakes of protein per kilogram of body weight in order to promote tissue growth and repair. The International Olympic Committee's second Consensus Conference on Nutrition for Sport in 2003 recommended an intake of 1.2–1.7 g per kilogram body weight per day. The lower end of this range should cover the requirements of most endurance athletes, with the upper end meeting the needs of those engaging in more strength and power activities.

## ■ Water

Dehydration affects performance and can result in fatigue. Water losses may be up to 1 litre per hour during endurance exercise. Thirst is a poor indicator of dehydration, so drinking before the sensation of thirst is recommended to ensure adequate fluid status. Normal fluid requirements are in the region of 30–35 ml per kilogram of body weight per day, or 1 ml per calorie of energy requirement.

## ■ Fibre

Dietary fibre is a carbohydrate that is mainly indigestible. There are two types of fibre: soluble and insoluble. They are both important for maintaining good health. Your daily requirement is 18 g per day. Sportspeople with high carbohydrate requirements will need to manage fibre intake because consuming large quantities of fibre-rich carbohydrate food can make the diet bulky and filling with the potential to limit overall food and energy intake.

## ■ Vitamins and minerals

Vitamins and minerals occur naturally in a wide variety of foods. A healthy, balanced and varied diet should

provide sufficient intakes. Any increase in requirements as a result of training should be met naturally by increased intake of unrefined starchy carbohydrate foods to meet energy requirements.

Sportspeople often believe they have higher requirements for vitamins and minerals than the average person. There is no doubt that an adequate supply of all the vitamins and minerals is necessary for health, but whether regular exercise increases requirements is a different matter. The scientific consensus is that exercise does not particularly increase the need for micronutrients, although there may be a case for increased requirements of nutrients involved in energy metabolism. Generally, the sports person will be eating greater quantities of food to meet increased energy requirements, and as a result will be automatically increasing vitamin and mineral intakes – as long as nutrient-rich foods are chosen.



## Assessment practice

- 1 Create a leaflet targeted at a specific sport to describe the components of a balanced diet to support sports performance. **P6**
- 2 Produce a short PowerPoint® presentation targeted at a different sport to explain the components of a balanced diet to support sports performance. **M4**



## Grading tips

### Grading Tip **P6**

You should consider the importance of carbohydrate, fat, protein, water, fibre, vitamins and minerals.

### Grading Tip **M4**

You should explain the significance of the various nutrients in a balanced diet.

## Activities

Different activities require different dietary plans or strategies to optimise performance.

### Aerobic

Aerobic or endurance activities will significantly challenge the athlete's energy and fluid stores. The longer and more intense the aerobic training or competition, the more depleted the stores are likely to become. A key goal for aerobic activities should be to maximise glycogen stores. An increase in carbohydrate intake during the two or three days before competition is a useful strategy to adopt. Carbohydrate supplements in the form of energy drinks, bars or gels may be a useful addition to the diet.

All endurance athletes should ensure that they start exercise fully hydrated. The longer the duration of the activity, the more important it is to consume fluids during it. Sports drinks may be a useful consideration as they provide a supply of carbohydrate as well as replacing fluids.

Some aerobic activities may benefit from the practice of carbohydrate loading. The amount of glycogen available for storage in the muscles is related to the amount of carbohydrate consumed in the diet and the level and intensity of activity undertaken. For most sports, eating a diet that consists of 5–10 g of carbohydrate per kilogram of body weight will maintain liver and muscle glycogen stores. However, the aim of carbohydrate loading is to increase the capacity of the muscles to store glycogen above their normal level. This may be useful to sportspeople who compete in endurance events that last longer than 90 minutes, such as marathon running, triathlons and endurance



## Remember!

The goal of carbohydrate loading is to increase the capacity of the muscles to store glycogen above their normal level, usually in preparation for an endurance event.

swimming. Although carbohydrate loading does not benefit all sports performers, everyone regularly training and competing in sports should focus on consuming a high carbohydrate diet at all times and will benefit from a carbohydrate-rich meal or snack before training or competition.

### Anaerobic

In anaerobic activities, such as strength, power and sprint sports, the key role of nutritional strategies is to support the development of lean body mass (muscle) as well as to meet energy demands. Although carbohydrate requirements are not as great as for aerobic activities, they are still important. Combining carbohydrate with protein post-exercise promotes an anabolic environment and increases protein synthesis that helps to promote muscle development, however, excessive protein intakes should be avoided. Some team sports may fall into this category.

### Muscular strength and endurance

Many sports can fall into this category dependent upon the particular physiological demands of the sport. For example, high levels of muscular strength and endurance are required for some team sports such as rugby as well as weight category sports such as judo. Nutritional demands will be dictated by the nature of the individual sport and participant requirements, but key nutrients for consideration in all cases are carbohydrate and fluid.

### Flexibility

For sports that require a good deal of flexibility such as gymnastics, diving and figure skating, weight control is a serious dietary issue. Evidence suggests participants in these aesthetic or appearance-orientated sports, where performance is subjectively evaluated by judges, may be more prone to eating-disordered behaviour. Leanness or a specific weight may be considered important for optimal performance, placing greater consciousness on what the sportsperson eats and how they look. However, it is important to remember that the fewer calories consumed, the fewer nutrients consumed. Calcium and iron intakes are reported to be particularly low in studies

investigating the dietary intakes of female participants in these sports.

The same healthy eating and balance of good health principles apply to the planning of dietary intakes for these sports but greater emphasis may be placed on a low-fat diet. However, this should not be at the expense of other essential nutrients such as carbohydrate, protein, vitamins and minerals. Adequate fluid intakes and hydration are also essential to maintain concentration for the very technical demands of these sports.

### Timing

May sportspeople undertake a periodised programme of training. Periodisation represents the organised division of the training year and has three basic objectives:

- to prepare the athlete for achievement of an optimum improvement in performance
- to prepare the athlete for a definite peak in the competition season
- to prepare the athlete for main competitions within that peak.

Training undertaken within the programme is a form of stress to the body. If it is undertaken properly, the athlete adapts to that stress. Good nutritional practices are important in allowing the body to adapt and to deliver performance improvements.

### ■ Pre-season

For most sports, pre-season nutritional requirements need to take account of the demands of training in terms of frequency, intensity, duration and specificity. As training progresses – particularly in terms of frequency, intensity and duration – it can be expected that the athlete's energy and nutrient demands will increase, particularly in respect of energy, carbohydrate and fluid requirements. If energy and nutrient demands are not met, the athlete will be put at an increased risk of injury and illness. In addition, reducing post-season weight gain is often a target of pre-season nutritional strategies.

### ■ Mid-season

Nutritional demands of the mid-season phase are focused on maintaining energy and fluid requirements



as the demands of the competition schedule get underway. During this time, less overall nutrition may be required but more attention may need to be placed on pre-event preparation and post-event recovery strategies to remain injury and illness free.

### ■ Post-season

Post-season presents a window of opportunity where the athlete can relax dietary intake a little but unnecessary weight gain should be monitored. It is likely during this period that energy and fluid requirements will be at their lowest.

### ■ Pre-event

Many of the principles of preparing for a competition mirror those of the training diet. For a competition, the pre-event meal should aim to top up muscle and liver glycogen stores. Therefore, it should be rich in carbohydrate but low in fat and fibre and contain a moderate amount of protein. It should be remembered that larger meals take longer to digest and that nerves can result in delayed digestion.

Competition is not a time to experiment with new foods. The pre-event meal should be made of familiar foods and provide adequate fluids. Solid foods can usually be consumed with comfort up to two hours before an event, but liquid meals or carbohydrate drinks can be consumed up to 30 to 60 minutes before.

Sports performers taking part in events lasting longer than 90 minutes should be advised, where possible, to taper training in the week leading up to the event, include a rest day, and consume a higher than normal carbohydrate and fluid intake.

### Activity

Devise suitable pre-event meal strategies for use by sportspeople competing at the following times of day:

- 9.30 a.m. (early-morning competition)
- 2.30 p.m. (afternoon competition)
- 6.00 p.m. (early-evening competition).

### ■ Inter-event

During training and competition, fluid loss is a major consideration. During intense training or competition isotonic sports drinks – which assist with fluid replacement and provide a source of fuel – may be consumed. This may be beneficial especially if training or competition lasts longer than 60 minutes. During endurance or ultra-endurance events lasting longer than four hours, solid foods may be required. In these instances, energy bars or gels might be useful as a more concentrated source of carbohydrate.



### Remember!

Regular sports performers should be encouraged to practise their fluid and fuelling regimes in training to ensure that they do not run into any unexpected problems during competition.

### ■ Post-event

Good nutrition can make its greatest contribution in aiding recovery between training sessions. For the regular sports performer, performance improvements are the product of the body's adaptation to the demands of training. Sound nutrition has its biggest impact in supporting the sports performer in training consistently and effectively to achieve the desired adaptations. To achieve steady improvements, all sportspeople must ensure that their diet consistently meets the demands placed on their bodies by training and competition.

What is consumed, how much and how soon after an intense workout or competition can all influence the recovery process. Refuelling should begin as soon as possible. Sensible choices in terms of food and fluids will allow the sports performer to recover more quickly for the next training session.

It is important to refuel as soon as possible after each workout or competition. The longer refuelling is delayed, the longer it will take to fully refuel. The sports performer may find it easier to have small, frequent

meals and snacks at regularly spaced intervals to help to maximise glycogen synthesis.

To refuel efficiently, a high carbohydrate diet is required. Post-exercise carbohydrates that are easy to eat and digest are preferred. Sports performers are advised to consume a high-carbohydrate (at least 50 g) low-fat snack as soon as possible after training or competition, preferably within the first half an hour – when the muscles' capacity to refuel is at their greatest. They should ensure that they eat their next meal, which should be rich in carbohydrate, within two hours.

After exercise, the replacement of fluids lost through sweating should also be a priority. Rehydration should start immediately. Drinks containing carbohydrates will also assist with energy and glycogen replacement. These may be particularly useful if the activity has been very intense and resulted in a suppression of appetite and a reluctance to eat solid foods.

### Activity

Jon is competing in a national badminton tournament tomorrow. Suggest a suitable pre-competition meal and provide some advice on how he might ensure that he keeps fuelled and hydrated during the tournament.

## Planning diets

Before you can safely and effectively plan and implement balanced eating programmes and nutritional strategies to support training and competition for others, you need to be able to critically evaluate your own eating habits and activity patterns and consider the relationship between them.

### Taking it further

As well as the types and amounts of food you eat, your food record may give you an idea about how your daily life dictates what, when, where and why you eat. Take another look at your food record and ask yourself the following questions.

- Is your diet better than you first thought or is there plenty of room for improvement? What healthy-eating goals might you not be achieving? Are there any that you achieve with ease?
- Does your diet meet any demands you make on it as a result of sport and exercise?



### Theory into practice

- 1 To assess your own eating habits, keep a record of all food and drink you consume for at least a three-day period, which should include one weekend day. For a more detailed evaluation, record your intake for a full week.

Write down *everything* you eat and drink. You must be as accurate and honest as possible, and be sure not to modify your usual intake at this stage otherwise you will not be evaluating your typical diet. You will need to carry your record around with you at all times and record food and drink as it is consumed to avoid forgetting any items. Your record should describe the following.

- The type of food and drink consumed and how much. Either estimate the portion size using standard household measures, such as slices of bread, pints of fluid, tablespoons of vegetables, or give the weight.
- The time the food and drink was consumed and where you were when you ate it. These points are useful when assessing external factors that affect your dietary intake.
- Your cooking methods and type of food preparation.
- Any activity or exercise you took part in, including an indication of its duration and intensity, i.e. light, moderate or hard.

- 2 When you have done this, look at your food record and compare it to the balance of good health model (see page XX). Write short report on your findings.

### Appropriate for selected activity

Optimal performance in sport and exercise requires optimal nutrition. Sportspeople should pay careful attention to foods that can enhance, not hinder, their preparation for, participation in and recovery from training and competition. Most sportspeople will obtain all the energy and nutrients they need by eating when they are hungry and choosing a balanced and varied diet. Good nutrition has a big part to play in aiding recovery between training sessions, allowing the sports performer to realise adaptations in response to the training programme.

The vast array of sports that exist can be categorised into the following groups:

- multi-sprint or team sports, e.g. soccer
- strength sports, e.g. sprinting
- endurance and ultra-endurance sports, e.g. marathon running and the triathlon
- weight category sports, e.g. boxing
- aesthetic sports, e.g. diving.

Each category requires sound nutritional strategies to support successful performance. Winning, avoiding injury and illness, and improving fitness are what matter to most competitive sportspeople. With the intermittent nature of team sports, the intensity at which they are performed can alter at any time. These changes in intensity are irregular and can be random, and may draw significantly on the body's glycogen stores. Performance may be impaired towards the end of a match if glycogen stores are running low. Weight-loss methods and restrictive dietary practices are often used by sportspeople within weight category and aesthetic sports, with potential dangers to both health and performance.

### Activity

Choose a sport that is not named in the bullet points above. Consider which category of sport it belongs to and examine the specific nutritional practices and requirements associated with it.

### Appropriate for selected sports performer

There are a number of methods for collecting information on what people eat and drink. These include the 24-hour diet recall, the diet history or interview technique, daily food records or diaries, weighed food intake records and food frequency questionnaires.



### Theory into practice

Work with one of your classmates. Before you start, decide on an appropriate template that could be designed for the purpose of recording all necessary information relating to meal times, types of food and fluid consumed and the cooking methods used.

- 1 a** Take it in turns to interview each other to recall all food and drink consumed in the past 24 hours. Use your template to record the details of your interview.  
**b** What are the main advantages and disadvantages of this method of dietary intake recording?
- 2 a** Interview the same person again but this time ask him or her to recall everything eaten and drunk in the past seven days. Record the details using the same template.  
**b** What are the main advantages and disadvantages of this method of dietary intake recording?

You may choose to use this technique in gaining information on dietary intake of selected sports performers. It is important when interviewing people about their dietary habits to adopt a professional approach and to maintain confidentiality. It should always be borne in mind that an individual's food intake is a very personal issue, and this information should be handled sensitively. It is also necessary to ask if there are any medical factors such as diabetes or allergies that impact on food habits. These people should always be referred to a qualified professional for dietary advice.



### Remember!

Any detailed or complex dietary analysis incorporating major dietary changes, particularly those relating to medical conditions, should always be referred to a qualified state registered dietitian, or an accredited sports dietitian if it concerns an athlete or sportsperson. The usual means of referral to a state registered dietitian are through a general practitioner, consultant or dentist.

- 24-hour diet recall: this method of dietary information collection is quick and easy to use. The interviewer questions the subject to collect information on what he or she usually eats and drinks. This method relies heavily on memory to recall all food and drink consumed. It is useful in assessing the quality of food intake and may reveal obvious dietary imbalances such as a potentially high fat intake. However, it is rarely adequate to provide a quantitative estimate of nutrient intakes to allow for comparison with Dietary Reference Values.
- The diet history or interview: this method is quick and easy to use. The interviewer questions the subject to collect information on what he or she usually eats and drinks, but over a longer time period. This method relies heavily on memory to recall all food and drink consumed in the period specified. Recollections of this kind nearly always underestimate intake and there is the danger of fabrication to impress the interviewer. The method is, however, useful in assessing the quality of dietary intake and may be able to reveal obvious dietary imbalances in the same way as the 24-hour recall.
- Daily food record or diet diary: this method can give a good overall guide to the types and quantities of food and drink consumed during the recording period. At least three days should be recorded and one of these should be a weekend day to account for any different food patterns at weekends. For a more detailed picture, a seven-day record is recommended. When dealing with sportspeople, the record should include rest and competition days as well as training days.

- Weighed food intake: with this method, individual foods are weighed before consumption. This method is time consuming and intrusive, and could lead to distortion of the overall pattern of foods consumed in order to make weighing and recording easier.



### Think it over

Sportspeople face a number of problems in achieving adequate nutritional intakes. Spend ten minutes considering the dilemmas that may face sportspeople in achieving their nutritional requirements.

### Assessment of needs

When developing sound eating habits and nutritional strategies to support training and competition, the following issues are important:

- the types of food eaten to support training and competition
- the timing of meals and snacks around training and competition
- ensuring a balanced diet is achieved in respect of all nutrients
- maintaining a sufficient fluid intake
- encouraging an adequate calcium and iron intake, particularly for females
- promoting long-term health and reducing the risk of chronic disease
- the problems of travelling to training and competition venues
- minimising the risk of injury and illness.

The nutritional requirements for different sports and sportspeople will vary according to:

- the type of sport and training methods undertaken
- the intensity of training or competition
- the duration of training or competition
- the frequency of training or competition
- the training status and fitness level of the sportsperson.



The balance of good health principles (see page XX) should be used to plan meals. These principles should form the foundations on which to develop more specific sports nutrition strategies. Sportspeople should be encouraged to eat sufficient carbohydrate and start refuelling as soon as possible after training, when muscle capacity to refuel is at its greatest. This may mean avoiding the restriction of traditional meal times. Eating may need to be fitted in around the training process, with smaller, more frequent meals and snacks being necessary. Snacks and fluids should be carried in the kit bag at all times.

Rest days are also important, and this time should be used to recover from the stresses of training and competition. A high fluid intake should be encouraged. In many sports, post-match alcohol consumption is part of traditional practices, but it is important to rehydrate with other fluids before drinking alcohol after training and competition. Where an injury has been sustained, alcohol consumption may delay the recovery process and should be avoided for at least 48 hours.

## Activity

- 1 Devise a list of simple training and competition guidelines for sportspeople. You may choose to use this list when planning a diet for a selected sports activity.
- 2 To support this list of guidelines, identify a number of appropriate items for the kit bag that could be used to replenish energy stores and fluid balance after exercise.

## ■ Weight gain

Weight can be gained in two ways: by increasing the amount of fat or the amount of lean body mass. Both will register as increases in weight on the scales but the results will be very different in terms of body composition.

Gains in fat weight are relatively easy to achieve – as most people wishing to lose weight would testify – but gains in lean body mass can only be achieved as a result of adaptations to a progressive strength training programme, supported by an adequate diet.

## ■ Weight loss

Most sportspeople are concerned about either attaining or maintaining an optimal body weight. There are some sports in which weight restrictions apply. These are called weight category sports and include body building, boxing, horse racing, martial arts and rowing. The sportsperson must compete within a given weight range.

For some sports it may be crucial to maintain a low body weight, which for some may be below their natural weight. These might be considered as weight-controlled sports, and include sports such as distance running, gymnastics, figure skating and diving. These sports may present challenges in maintaining a nutritionally adequate diet while reducing or maintaining weight. There are a variety of inappropriate weight-loss practices, such as fasting or skipping meals, laxative abuse, bingeing and purging, and intentional dehydration by the use of sweatsuits or saunas. When most athletes talk about achieving weight loss what they are usually trying to achieve is fat loss, as losses in muscle mass may result in unfavourable changes in their power-to-weight ratio.

## ■ Muscle gain

When the athlete talks about weight gain, what they usually mean is muscle gain. In this case strength training provides the stimulus for muscles to grow while adequate nutrition provides the opportunity for them to grow at an optimal rate.

Rates of weight/muscle gain are dependent on genetics and body type. To gain strength and size, it is necessary to achieve a slightly positive energy balance – somewhere in the region of an extra 500 calories per day – and a protein intake of about 1.4–1.7 g per kilogram of body mass. Eating a high protein diet, or supplementing with amino acids (as is common practice for many sportspeople wishing to gain muscle bulk and size) will not in itself lead to great increases in muscle size or strength. What is more important is achieving an adequate energy intake.

## ■ Fat gain

In very few instances the athlete may wish to gain fat weight, such as in contact sports where additional body fat may provide extra protection.

## Activity

- 1 What are the nutritional consequences of the unhealthy weight-loss practices identified above?
- 2 What impact might these practices have on performance in sport?

## Nutrition

### ■ Macronutrients

Performance in and recovery from exercise are enhanced by optimal nutrition. For most sports, carbohydrate requirements are likely to contribute in the region of 55–65 per cent of total energy intake, protein around 12–15 per cent and the remainder coming from fat.

### ■ Micronutrients

Vitamin and mineral supplementation will not improve the performance of athletes that are already consuming an adequate and varied diet. Those at risk of micronutrient deficiency are people who restrict energy intake, use severe weight-loss strategies or follow a high carbohydrate diet with low micronutrient density. Athletes should aim to consume diets that meet RNI values (see page XX) for micronutrient intakes.

### ■ Fibre

Athletes should aim to achieve fibre intakes in line with the sedentary population intake target of 18 g per day.

## Food groups

The balance of good health model has been adopted as the UK's National Food Guide. It was devised by the Health Education Authority as a new and simplified means of helping people to understand healthy eating. The model attempts to make following a balanced diet easier to implement by identifying the types and

proportions of foods required to achieve a healthy, balanced and varied diet, based around the five main food groups.

As you can see on page XX, the model depicts a plate with divisions of varying sizes representing each of these five groups. Those with a larger proportion of the plate should feature in larger proportions in your diet, while those with the smaller shares should be consumed in much smaller quantities or used only as occasional foods.

This UK guide to healthy eating applies to most people in the population, including those who engage in regular exercise and sport. It does not, however, apply to children under the age of five.

The key messages of the model are that you should aim to:

- base all your meals around starchy foods
- eat at least five servings of fruit and/or vegetables each day
- include milk and dairy foods, if possible three servings per day
- eat smaller portions of meat or fish, and try alternatives such as pulses
- limit your intake of foods with a high fat or sugar content.

Table 10.14 shows the recommended daily amounts and nutrients supplied by each of the main food groups.

## Activity

Sayeed has recently taken up the triathlon. His usual diet consists of a macronutrient energy distribution of 40 per cent carbohydrate, 40 per cent fat and 20 per cent protein. He is about to enter his first major competition.

- 1 What effect could this macronutrient distribution have on his performance?
- 2 What practical advice could you offer to improve his diet?
- 3 What could Sayeed do in his preparation for the competition to help to delay fatigue?

Food	What is a serving?	Recommended amount per day	Main nutrients supplied
<b>Grains and potatoes</b>			
Bread, rolls, muffins, bagels, crumpets, chapattis, naan bread, pitta bread, tortillas, scones, pikelets, potato cakes, breakfast cereals, rice, pasta, noodles, couscous and potatoes	3 tbsp breakfast cereal, 1 Weetabix or Shredded Wheat, 1 slice of bread, ½ a pitta, 1 heaped tbsp boiled potato, pasta, rice or couscous	These should form the main part of all meals and snacks About a third of the total volume of food consumed each day	Carbohydrate, NSP (mainly insoluble), calcium, iron and B vitamins
<b>Vegetables and fruits</b>			
All types of fresh, frozen, canned and dried fruits and vegetables (except potatoes) and fruit and vegetable juices	1 apple, orange, pear, banana, 1 small glass of fruit juice, 1 small salad, 2 tbsp vegetables, 2 tbsp stewed or tinned fruit in juice	At least five portions per day About a third of the total volume of food consumed each day	NSP (especially soluble), vitamin C, folate and potassium
<b>Oils</b>			
Butter, margarine, cooking oils, mayonnaise, salad dressing, cream, pastries, crisps, biscuits and cakes	1 tsp butter or margarine, 1 tsp vegetable or olive oil, 1 tsp mayonnaise	These should be eaten sparingly and lower-fat options selected	Fat, essential fatty acids and some vitamins
<b>Dairy</b>			
Milk, yoghurt, cheese, fromage frais	⅓ pint milk, 1¼ oz cheese, 1 small carton yoghurt or cottage cheese	Two or three servings per day About a sixth of the total volume of food consumed each day	Protein, calcium, vitamins A and D
<b>Meat, fish and alternative proteins</b>			
Meat, poultry, fish, eggs, pulses, nuts, meat and fish products (e.g. sausages, beefburgers, fish cakes, fish fingers)	2–3 oz lean meat, chicken or oily fish, 4–5 oz white fish, 2 eggs, 1 small tin baked beans, 2 tbsp nuts, 4 oz Quorn or soya product	Two servings per day About a sixth of the total volume of food consumed each day	Protein, iron, zinc, magnesium and B vitamins Pulses provide a good source of NSP

**Table 10.14 Food groups**

## ■ Sources

The sources of each food group are identified in Table 10.14, together with the main nutrients supplied by each food group.

## ■ Availability

Several factors influence food availability. These may include physical or environmental factors such as perishability and economic factors such as cost and budgeting priorities. Cooking skills and facilities, and nutritional knowledge, are also crucial factors in the provision and availability of food.



## Assessment practice

Identify a sportsperson on whom you can undertake a dietary assessment. You may wish to consider your own diet if you are actively engaged in sport at a competitive level, and use the information you have gathered through the practical activities in this unit. Decide on an appropriate method for collecting dietary intake information from your sportsperson.

- 1 Analyse the information you have obtained and write a report on your findings which suggests, where necessary, appropriate modifications

or improvements to support their health and performance. Use a combination of manual and computer-based methods of processing and analysing nutrient intake information.

- 2 Plan a two-week diet for your subject. Include advice on nutritional strategies to support the preparation for, participation in and recovery from training and competition. **P7**
- 3 Explain the two-week diet plan in terms of your selection of food and nutritional strategies. **M5**
- 4 Justify your food selection and nutritional strategies. Find ways of supporting your proposals by referring to relevant published material. **D2**



## Grading tips

### Grading Tip **P7**

You need to produce an appropriate two-week diet plan for a named sports performer. This should focus on aspects of achieving adequate fuelling and hydration.

### Grading Tip **M5**

Explain your choice of food selection, fuelling and hydration strategies and their likely impact on training

and competition performance. You should carefully consider the status of your sports performer (amateur, semi-professional, elite) in explaining your two-week plan.

### Grading Tip **D2**

You need to justify your selection by being critical and looking for means to support your views. Do this with reference to relevant published material such as the ACSM (American College of Sports Medicine), Position Stand on Nutrition for Athletic Performance or the International Olympic Committee's Consensus on Nutrition for Athletes.



## Knowledge check

- 1 Define the term 'diet'.
- 2 Define the term Reference Nutrient Intake (RNI). What is the significance of this dietary reference value?
- 3 Draw and label a simple diagram of the digestive system.
- 4 Explain the term 'energy balance'.
- 5 Explain the components and their relative contributions of total energy expenditure.
- 6 Describe one method for the estimation of energy requirements.
- 7 List four routes of water loss from the body.
- 8 Because water losses are greater during exercise, the sportsperson needs to employ sound strategies for fluid replacement. What might be the signs and symptoms of dehydration and how might these be avoided?
- 9 What are the advantages and disadvantages of high carbohydrate content in a sports drink?
- 10 Describe the skinfold analysis method of measuring body composition. Why is this method one of the most widely used field techniques for assessing body composition in sportspeople?
- 11 List two micronutrients for special attention in the diet of athletes. Why might these nutrients be of particular concern in the diets of female athletes?
- 12 How soon do you need to eat after a hard training session and why is it so important to eat afterwards?
- 13 Describe the components of a balanced diet.
- 14 Describe how you might undertake an assessment of the nutritional needs of a sportsperson.
- 15 What factors need to be taken into consideration when planning a diet for a selected sports activity?





## End of unit assessment

# Preparation for assessment

Sports nutrition describes the influence of nutritional strategies on sports performance during the preparation for, participation in and recovery from training and competition. Working with a sports performer of your choice over a number of weeks, this Preparation for assessment is designed to evidence that you can meet all of the learning outcomes for the unit.

- 1 Select a sports performer willing to participate and likely to benefit from the application of sports nutrition principles in practice. This could be a member of one of your college's sports teams.
- 2 Describe to the sports performer the importance of nutrition and common terminology associated with it, and developing a good knowledge and understanding of the practical application of sports nutrition principles. You may find it useful to produce a leaflet or information sheet for your sports performer to assist with this task. **P1**
- 3 In order for the sports performer to understand how the body uses food and extracts energy from it, describe the structure and function of the digestive system. Again, you may find it useful to produce a leaflet or information sheet for your sports performer to assist with this task. **P2**
- 4 Describe energy intake and expenditure to your sports performer and provide suitable evidence of undertaking this task. **P3**
- 5 Explain energy intake and expenditure in the context of the physiological demands of their sport, the demands placed on different fuel sources and how they might achieve an appropriate energy intake. Provide suitable evidence of undertaking this task. **M1**
- 6 Describe and explain energy balance to your sports performer and its importance in relation to successful performance in their sport. Provide suitable evidence of undertaking this task. This could be a review of relevant literature on the energy demands of the sport and the physical characteristics of elite performers in the sport. **P4 M2**
- 7 Over a suitable time frame, analyse the effects of energy balance on the performance of your sports performer. Present suitable evidence that you have undertaken this task. This could be records of weight or body composition monitoring. **D1**
- 8 Describe hydration and its effects on sports performance to your sports performer. Provide suitable evidence of undertaking this task. Suitable evidence might include a leaflet or information sheet. **P6**
- 9 Explain the effects of hydration and appropriate hydration strategies in the context of the physiological demands of their sport and the opportunities it affords for developing before, during and post-training and competition strategies for maintaining hydration. Provide suitable evidence of undertaking this task, such as a report on the strategies advised. **M1**
- 10 Describe and explain the components of a balanced diet to your sports performer. Again, for this task you may find it useful to produce a leaflet or information sheet. **P6 M4**
- 11 Plan and describe a two-week diet plan for your sports performer. Before you embark on this task, you need to be familiar with their usual dietary habits and intake and will need to decide on an appropriate means to record and assess this. **P7**
- 12 Describe and explain the two-week diet plan to your sports performer and provide a copy of your diet plan as evidence of undertaking this task. **M5**
- 13 Write a short report to justify your two-week plan. This should draw on evidence from relevant authoritative sources. **D2**



## Grading tip

In undertaking the tasks listed, you will find it useful to refer back to the Assessment practice activities in this unit for guidance on meeting the pass, merit and distinction criteria.

To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<b>P1</b> Describe nutrition, including nutritional requirements and common terminology associated with nutrition <b>Assessment practice Page XX</b>		
<b>P2</b> Describe the structure and function of the digestive system <b>Assessment practice Page XX</b>		
<b>P3</b> Describe energy intake and expenditure in sports performance <b>Assessment practice Page XX</b>	<b>M1</b> Explain energy intake and expenditure in sports performance <b>Assessment practice Page XX</b>	
<b>P4</b> Describe energy balance and its importance in relation to sports performance <b>Assessment practice Page XX</b>	<b>M2</b> Explain the importance of energy balance in relation to sports performance <b>Assessment practice Page XX</b>	<b>D1</b> Analyse the effects of energy balance on sports performance <b>Assessment practice Page XX</b>
<b>P5</b> Describe hydration and its effects on sports performance <b>Assessment practice Page XX</b>	<b>M3</b> Explain the effects of hydration on sports performance <b>Assessment practice Page XX</b>	
<b>P6</b> Describe the components of a balanced diet <b>Assessment practice Page XX</b>	<b>M4</b> Explain the components of a balanced diet <b>Assessment practice Page XX</b>	
<b>P7</b> Describe an appropriate two-week diet plan for a selected sports performer for a selected sports activity <b>Assessment practice Page XX</b>	<b>M5</b> Explain the two-week diet plan for a selected sports performer for a selected sports activity <b>Assessment practice Page XX</b>	<b>D2</b> Justify the two-week diet plan for a selected sports performer for a selected sports activity <b>Assessment practice Page XX</b>