TOPIC 7
Nutrition, recovery strategies and performance

OVERVIEW
7.1 Nutritional considerations
7.2 Supplementation
7.3 Recovery strategies
7.4 Topic review

OUTCOMES
In this topic students will:
• explain the relationship between physiology and movement potential
• explain how a variety of training approaches and other interventions enhance performance and safety in physical activity (H8)
• design and implement training plans to improve performance (H10)
• design psychological strategies and nutritional plans in response to individual performance needs (H11)
• devise methods of gathering, interpreting and communicating information about health and physical activity concepts (H16)
• select appropriate options and formulate strategies based on a critical analysis of the factors that affect performance and safe participation. (H17)
7.1 Nutritional considerations

Programs designed to improve performance must be supported by solid nutritional practices. This involves many factors such as what to eat and drink, being aware of the most appropriate time for food intake and having recovery strategies in place to recoup expended energy. While complete nutritional balance is essential for optimal physical performance, the specific roles of carbohydrates and hydration (supplying sufficient water to the body’s cells) are the two most important considerations.

Foods not only contain nutrients that power essential body functions, but are the life source of energy supply. Because different foods have differing amounts of energy (carbohydrate supplies $16 \text{ kJ/gm}$, protein supplies $17 \text{ kJ/gm}$, and fat $37 \text{ kJ/gm}$), the type of food consumed prior to competition directly affects the quantity of energy available.

Fluid is also important because it is the body’s medium for cooling heated muscles and ultimately preventing dehydration. It assists in temperature regulation by transporting heat to the outside of the body. It is also important because it prevents damage to organs by diluting toxic waste, aiding oxygen transport to cells, assisting transport waste from the body, and helping eliminate carbon dioxide via the blood plasma. Thus, a deficiency in fuel or fluid supply contributes to a substandard performance and can place the health of the athlete at risk.

7.1.1 Pre-performance

Food consumed prior to activity is useful only if digested and its energy and nutrients made available to where they are required in the body. Glycogen reserves, for example, can be lowered by 55 per cent as a result of sustained aerobic activity lasting one hour and fully depleted in a two-hour session. Even bouts of explosive activity lasting from one to five minutes, as in interval training, basketball and football (depending on activity time, intensity and rest intervals), can cause acute depletion in the exercised muscles. Fluid levels rarely keep pace with the body’s requirements, and they need to be repeatedly replaced.

There are a number of important considerations for athletes to be aware of as part of pre-performance nutritional strategies:

- what type of food to eat and in what amount
- when to eat and drink
- how to carbohydrate load if required.

Type of food

Foods high in fat, protein and fibre such as meats require longer periods to digest than most other foods. Consuming large amounts of these types of food may lead to discomfort and possible indigestion. If solid food is difficult to digest, ‘liquid meals’ (drinks with high carbohydrate content) are recommended. Correctly prepared, they can be an adequate source of nutrition and energy, and significantly contribute to hydration. Athletes are advised to eat mostly complex carbohydrates (pasta, cereal, bread, fruits), because these provide slow energy release. It is strongly suggested that athletes do not experiment with unfamiliar food products on the day of competition.
FIGURE 7.2 A well-balanced diet provides a variety of food in proper proportions.

Australian Guide to Healthy Eating

Enjoy a wide variety of nutritious foods from these five food groups every day. Drink plenty of water.

- **Grain (cereal) foods,** mostly wholegrain and/or high cereal fibre varieties
- **Vegetables and legumes/beans**
- **Lean meats and poultry,** fish, eggs, tofu, nuts and seeds and legumes/beans
- **Milk, yoghurt, cheese and/or alternatives,** mostly reduced fat
- **Fruit**

Use small amounts

Only sometimes and in small amounts
Amount of food

Food ingested before a performance has the potential to cause discomfort. This may be increased by an existing or developing level of anxiety. Generally, the appropriate quantity of food relates to the type of competition, with competitors in sustained, endurance type competition (such as triathlons) requiring more kilojoules to fuel their metabolism than those in less demanding events. Additionally, large amounts of food are prone to causing more discomfort in high intensity or sustained events like running as opposed to events like cycling, skiing and swimming where athletes have the benefit of support in one form or another.

When to eat

Most athletes feel comfortable having a normal meal three to four hours prior to competition. As the time period to competition becomes shorter, food intake should be in the form of snacks and liquid preparations. Limited solids can still be consumed up to two hours prior to competition, while carbohydrate solution drinks are preferred in the 30 minutes prior to the event.

Table 7.1 provides an example of foods that benefit athletes in the hours prior to competition.

<table>
<thead>
<tr>
<th>TABLE 7.1 Suggested food intake prior to performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three to four hours before exercise</td>
</tr>
<tr>
<td>• crumpets with jam or honey + flavoured milk</td>
</tr>
<tr>
<td>• baked potato + cottage cheese filling + glass of milk</td>
</tr>
<tr>
<td>• baked beans on toast</td>
</tr>
<tr>
<td>• breakfast cereal with milk</td>
</tr>
<tr>
<td>• bread roll with cheese/meat filling + banana</td>
</tr>
<tr>
<td>• fruit salad with fruit-flavoured yoghurt</td>
</tr>
<tr>
<td>• pasta or rice with a sauce based on low-fat ingredients (e.g. tomato, vegetables, lean meat)</td>
</tr>
</tbody>
</table>


Hydration

People competing in competition or events should drink adequate fluid in the preceding days, particularly for an endurance event such as a marathon or triathlon. This increases the body’s weight, particularly if glycogen has been increased in the diet (because each gram of glycogen stores 2.6 grams of water with it). Many coaches now monitor the weight levels of athletes before endurance events to ensure adequate pre-event hydration suited to the individual athlete. As a general rule, 500–600 mL of fluid should be consumed in the two to three hour period prior to endurance performance and 250–300 mL in the last quarter hour.
Carbohydrate loading

Carbohydrate loading is a technique used to maximise the body’s storage of glycogen in preparation for a high-intensity endurance activity of more than 90 minutes. Average muscle glycogen levels are approximately 100–120 mmol/kg, but can increase by up to one-third in response to carbohydrate loading. This is significant considering that glycogen is the most important fuel for endurance events.

Although popular for many decades now, the practice of carbohydrate loading has been modified in recent years. The technique originally required a depletion stage followed by a loading phase to ensure glycogen saturation. Depletion was achieved through hard training and diet modifications that restricted consumption of carbohydrate-rich foods. A loading phase followed that involved the reverse — rest and a very high-carbohydrate loaded diet. While being nutritionally sound, this method created problems for many athletes in that energy levels were markedly reduced following the depletion stage, leading to lethargy, irritability, poor concentration and possible lack of motivation. In some cases, glycogen stores were so low that the athlete was unable to recover full supplies before the event.

It is now believed that athletes involved in short-term, low-intensity activities do not need to ‘glycogen load’. A normal diet supplies sufficient amounts. In the case of endurance athletes, muscle saturation of glycogen is best achieved through:

- a balanced diet that is high in carbohydrates, providing about 7–12 grams per kilo of body mass (weight). Complex carbohydrates such as breads, rice, grains and pastas are ideal. These may need to be ingested with simple carbohydrates such as soft drink, honey and jams to ensure carbohydrate intake is maximised.
- **Tapering** refers to a period immediately before competition when the volume and intensity of training is reduced. Tapering of training for two to four days before competition, enabling glycogen supplies to maximise. People who need to carbohydrate load will already be involved in training schedules that regularly utilise stored glycogen, so the body’s ability to store fuel will be greater than that of non-athletes (see figure 7.5).

Increased muscle and liver glycogen accumulated as a result of a proper carbohydrate loading program has a positive effect on endurance, improving performance in the order of about two to three per cent. This
make the practice a significant pre-competition strategy for activities such as triathlons, marathons, cycling and endurance swimming. However, it is important that procedures are fully understood and implemented effectively for full benefits to be realised. For instance, athletes who fail to taper, consume too much fibre or consume insufficient carbohydrate (preferring other nutrients instead) will fail to have glycogen reserves maximised during the loading process.

**FIGURE 7.6** Carbohydrate loading can improve endurance performance.

**FIGURE 7.7** High carbohydrate diets have a positive effect on muscle glycogen levels and the benefits can last well into endurance events.

**SNAPSHOT**

**Fuelling for prolonged events — carbohydrate loading**

During many endurance events, glycogen stores reduce to critically low levels, resulting in a reduction in power output and, possibly, skill. Starting the competition with elevated muscle glycogen stores can help postpone such fatigue. Carbohydrate loading increases muscle glycogen significantly (50–100 per cent) above normal resting values. This potentially results in a 20 per cent enhancement of endurance or, in fixed distance events, an improved race time of 2–3 per cent. It may also improve movement patterns and maintain skill at the end of prolonged team games.

Carbohydrate loading strategies have evolved significantly over the last 30 years. The most recent evidence suggests that optimal muscle glycogen levels can be achieved in well-trained athletes by combining an exercise.
taper with a high carbohydrate intake (7–12 grams per kilogram body mass). In most cases, 36–72 hours will be required to fully carbohydrate load.

Carbohydrate loading for endurance and ultra-endurance events
Aim for a daily carbohydrate intake of 7–12 grams per kilogram body mass over the period of loading. For example, an athlete of 65 kilograms might aim for a daily carbohydrate intake ranging from 455 grams to 780 grams. The following meal plan provides a guide to such targets.

<table>
<thead>
<tr>
<th>Timing</th>
<th>Food item</th>
<th>Carbohydrate content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>2 cups of cereal</td>
<td>50 g</td>
</tr>
<tr>
<td></td>
<td>1 cup of skim milk</td>
<td>15 g</td>
</tr>
<tr>
<td></td>
<td>2 large white toast slices</td>
<td>40 g</td>
</tr>
<tr>
<td></td>
<td>1 tablespoon jam</td>
<td>14 g</td>
</tr>
<tr>
<td></td>
<td>1 glass of juice</td>
<td>25 g</td>
</tr>
<tr>
<td></td>
<td>1 serve of protein powder drink</td>
<td>44 g</td>
</tr>
<tr>
<td></td>
<td>1 glass of skim milk</td>
<td>15 g</td>
</tr>
<tr>
<td>Lunch</td>
<td>2 rolls with salad filling</td>
<td>60 g</td>
</tr>
<tr>
<td></td>
<td>Banana</td>
<td>20 g</td>
</tr>
<tr>
<td></td>
<td>1 tub of low-fat flavoured yoghurt</td>
<td>26 g</td>
</tr>
<tr>
<td>Snack</td>
<td>Sports bar</td>
<td>42 g</td>
</tr>
<tr>
<td></td>
<td>600 mL sports drink</td>
<td>36 g</td>
</tr>
<tr>
<td>Dinner</td>
<td>3 cups of cooked pasta with tomato-based sauce</td>
<td>120 g</td>
</tr>
<tr>
<td></td>
<td>1 slice of bread</td>
<td>15 g</td>
</tr>
<tr>
<td>Dessert</td>
<td>250 g tinned fruit</td>
<td>35 g</td>
</tr>
<tr>
<td></td>
<td>3 scoops of low-fat ice cream</td>
<td>30 g</td>
</tr>
<tr>
<td>Approximate carbohydrate content of total diet</td>
<td>587 g</td>
<td></td>
</tr>
</tbody>
</table>


Carbohydrate loading for endurance events has the benefit of delaying the point at which the muscles being repeatedly used run out of fuel. This is illustrated in figure 7.8, which shows that a high-carbohydrate diet can delay fatigue by an hour or more.

![FIGURE 7.8 A high-carbohydrate diet delays the time at which exhaustion develops.](source)

7.1.2 During performance

Endurance events, particularly in hot and possibly humid conditions, can have a significant impact on the body’s fuel and fluid supplies. In these events, the need for carbohydrate and electrolyte replacement depends on a number of factors including intensity, duration, humidity, clothing type and individual sweat rates.

Nutritional considerations for performances need to address the following.

- The aim is to conserve muscle glycogen and maintain blood glucose levels.
- Carbohydrate supplementation is needed to avoid glycogen depletion. Be aware that at exercise intensities above 75 per cent of aerobic capacity, liquid carbohydrate feeding (sports drinks) can delay glycogen depletion by up to 30 minutes.
- Glycogen supplementation is not needed for low-intensity, short-duration exercise.
- Adequate hydration by regular fluid intake must be maintained. Athletes should have a fluid replacement plan that matches their body’s requirements (see page XXX) and the exercise duration and intensity. It is suggested that 200–300 mL of fluid, preferably in the form of a sports drink, be taken in every 15–20 minutes during exercise. Sports drinks contain liquid carbohydrate and serve both to hydrate and energise.
- An athlete should not wait until thirst develops before replenishing lost fluid.

To prevent thermal distress conditions during performance, adequate hydration is necessary. Hydration involves not only the supply of sufficient fluid, but also the development of mechanisms to keep fluid loss during exercise to a minimum. To ensure adequate hydration, athletes (and anyone exercising in the heat or for long periods) need to develop fluid intake and retention strategies that will prevent dehydration. The following are the most important.

- **Hydrate before, during and after physical activity.** Thirst is not a good indicator of the body’s need for fluid; by that time, dehydration has already started to take effect.
- **Drink every 15 to 20 minutes while running.** Runners lose between three and five cups each hour, so it is important never to miss an opportunity to ‘top up’.
- **Drink water or low-carbohydrate concentration sports drinks.** Cool plain water or sports drinks that have four to eight per cent carbohydrate concentration are recommended. Concentrations higher than eight per cent are not recommended because they slow the body’s absorption rates.
- **Ensure that you have trained properly and acclimatised to race conditions.** Trained and acclimatised athletes are able to control their body temperature more effectively than those who are untrained and who have failed to acclimatisate (see figure 7.10).
- **Wear clothing that ‘breathes’.** Light ‘airy’ clothing promotes heat loss through convection and evaporation.
• **Avoid activity in times of high temperature and high humidity.** In zone 3 climatic conditions (as illustrated in figure 7.11), body heat cannot be lost through evaporation because the air is already saturated. Exercise is considered safe when the temperature is below 30°C and the relative humidity is below 90 per cent.

• **Avoid excess fat and any salt and alcohol (which act as diuretics).** The use of salt tablets is unnecessary and to be discouraged, because most people receive sufficient salt in their normal diet.

• **Do not run if suffering from fever.** The core body temperature is already elevated during fever, and physical activity increases the body temperature and endangers the athlete’s life.

• **Learn to recognise the symptoms of heat stress.** The symptoms are chilling, unsteadiness, dry skin, loss of focus and profuse sweating.

![FIGURE 7.10](image1.png) Training and acclimatisation are the key factors in controlling body temperature.

![FIGURE 7.11](image2.png) The combination of high temperatures and high humidity poses the biggest danger to athletes engaged in physical activity.

**Inquiry**

**Fluid — who needs it?**

Read the snapshot ‘Fluid — who needs it?’, then discuss the variables that would make the fluid replacement plan for an untrained 100 metre swimmer different from that of a trained marathon runner.
SNAPSHOT

Fluid — who needs it?

Don’t get into the habit of eating or drinking in a marathon race: some prominent runners do, but it is not beneficial. JE Sullivan, 1909

Fortunately, sports science has progressed a long way since then and we now know that the regular ingestion of fluids is essential for sporting performance.

Hypohydration (total body water below normal) impairs the body’s ability to regulate heat, resulting in increased body temperature and an elevated heart rate. Perceived exertion is increased, causing the athlete to feel more fatigued than usual at a given work rate. Mental function is reduced, which can have negative implications for motor control, decision making and concentration. Gastric emptying is slowed, resulting in stomach discomfort. All these effects lead to impairment in exercise performance. Most types of exercise are adversely affected by hypohydration, especially when they are undertaken in hot conditions, and negative effects have been detected when fluid deficits are as low as 2 per cent (i.e. a deficit of 1.2 litres for a 60-kilogram athlete).

The good news is that by drinking regularly during exercise, athletes can prevent declines in concentration and skill level, improve perceived exertion, prevent excessive elevations in heart rate and body temperature, and improve performance — good justification for every athlete and coach to make fluid replacement a key priority during training and competition.

How much should athletes drink during exercise?

Fluid requirements vary remarkably between athletes and between exercise situations. Fluid losses are affected by:

- genetics — some people innately sweat more than others
- body size — larger athletes tend to sweat more than smaller athletes
- fitness — fitter people sweat earlier in exercise and in larger volumes
- environment — sweat losses are higher in hot, humid conditions
- exercise intensity — sweat losses increase as exercise intensity increases.

It is impossible to prescribe a general fluid replacement plan that will meet the needs of all athletes.

Fortunately, athletes can easily estimate their own fluid requirements by weighing themselves before and after exercise sessions. Each kilogram of weight lost is equivalent to one litre of fluid. Adding on the weight of any fluid or food consumed during the exercise session will provide an estimate of total fluid loss for the session. For example, an athlete who finishes an exercise session 1 kilogram lighter and has consumed 1 litre of fluid during the session has a total fluid loss of 2 litres ...

Once an athlete’s individual sweat losses are known, a plan can be prepared to help the athlete achieve better fluid replacement in subsequent exercise sessions. Fluid replacement plans will differ according to the athlete and the opportunities for drinking during the sport. However, where possible it is better to begin drinking early in exercise and adopt a pattern of drinking small volumes regularly rather than trying to tolerate large volumes in one hit. Most athletes can tolerate 200–300 millilitres every 15–20 minutes but tolerance will vary according to the exercise intensity.

How much do athletes actually drink?

Typically, athletes replace 30–70 per cent of sweat losses during exercise. Fluid replacement is an issue for all sports, including those such as swimming and water polo conducted in wet environments, and sports conducted in air conditioned stadiums ...

What should athletes drink?

Research shows that fluid intake is enhanced when beverages are cool (~15ºC), flavoured and contain sodium. This makes sports drinks an ideal choice during exercise. Sports drinks are not gimmicks. They are legitimate products that are well researched and proven to improve fluid intake and performance. A lot of science has gone into developing the flavour profile of sports drinks so that they encourage fluid intake during exercise. In addition, sports drinks contain carbohydrate at a concentration (4–8 per cent) that allows refuelling to take place during exercise ...
Water is still a suitable option during exercise. However, water drinkers need to be aware that water does not stimulate fluid intake to the same extent as sports drinks. Drinking to a plan is therefore crucial when drinking water. Don’t rely on thirst …


Summary of fluid guidelines
- Begin each exercise session in fluid balance. This requires drinking regularly throughout the day leading up to training or competition. Have a drink with all meals and snacks.
- Immediately before exercise commences, consume 200–600 millilitres of fluid.
- Develop a plan for fluid intake for all exercise sessions longer than 30 minutes. Aim to match previous fluid losses as closely as possible (within 1 per cent of body mass). Take into account all the opportunities within the sport.
- Begin drinking early in the exercise session and continue to drink small amounts regularly. Sports drinks or water are the best options.
- Replace any residual fluid deficit after exercise. You will need to drink 150 per cent of any fluid deficit in the 4–6 hours after exercise to account for ongoing sweat and urinary losses. When fluid losses are high and/or rapid rehydration is required, sodium replacement may be required. Sports drinks, oral rehydration solutions and salty foods can all contribute to sodium replacement …

7.1.3 Post-performance

A post-performance nutritional plan aims to return the body to its pre-event state as quickly as possible, enabling full training to resume in preparation for the next phase of competition. This is best achieved through proactive recovery, which emphasises immediate refuelling and rehydration which continues until a pre-event state is obtained. This means that refuelling and rehydration begin immediately and continue for 8–12 hours following the performance. This enables optimisation of body repair and regeneration processes.

Some find it difficult to establish an accurate amount of carbohydrate replenishment necessary to enable complete replacement of muscle glycogen stores. Research suggests that following endurance activity such as cycling or marathon running, a carbohydrate intake of 50–100 grams in the first two hours is highly beneficial. This initial intake is then followed by intakes of 50–75 grams every two hours until a total of 500–600 grams of carbohydrate has been consumed.

The best way to recover is to act quickly and eat food with high carbohydrate content. This is best achieved by:
- immediately replacing depleted muscle and liver glycogen stores. An intake high in carbohydrate and inclusive of food and drinks with a high glycemic index (GI) is most beneficial. The glycemic index is a ranking system for carbohydrates based on how they affect blood sugar level. The positive impact of foods with a high GI relative to those with a low GI is illustrated in figure 7.12.
- rehydrating to replace fluid and electrolytes lost during the event. A program for rehydration requires special fluid intake (water/carbohydrate solutions of five to eight per cent) in quantities larger than normal as voluntary fluid intake in response to thirst is insufficient in the initial stages of recovery. Some researchers suggest consumption of up to 150 per cent of fluid losses to enable full recovery.

![Figure 7.12](image-url) High GI foods raise blood glucose levels more and at a faster rate than low GI foods.
• active rest that enhances the manufacture of red blood cells, new proteins and specific cellular components damaged by stress-related movements.

**Inquiry**

**Dietary requirements of different sports**

Draw an enlarged copy of the following table into your workbook. Choose three sports or activities that are different in their dietary requirements and performance needs. Choices may include activities or sports such as the City to Surf marathon, sprinting, discus throwing and basketball. Use the table to compare the before, during and after the event dietary requirements for athletes competing in these events.

<table>
<thead>
<tr>
<th></th>
<th>Sport 1</th>
<th>Sport 2</th>
<th>Sport 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-performance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For more information for those interested in the science of sports nutrition, use the Gatorade Sports Science Nutrition weblink in your Resources tab.

**Inquiry**

**Nutritional considerations**

Use the following mind map to summarise the nutritional considerations for before, during and after event performances.

![FIGURE 7.13 Nutritional considerations for performances]

**Application**

**Talk by an elite athlete**

Invite an elite athlete to your school. It could be an ex-student who trains regularly and enters higher level competitions. Ask them questions about their training regime, nutritional consideration, pre-event, during event and post-event strategies and practices. Make notes and summarise your findings.

**Resources**

🔗 Weblink: Gatorade Sports Science Nutrition
7.2 Supplementation

Dietary supplementation is found in many forms, including vitamins, minerals, protein, caffeine and creatine products. Supplement intake is routine for many competitors because it is believed to improve athletic performance. However, while perhaps supplying a psychological boost, supplements may be of little value if the diet is already well balanced in terms of nutritional requirements.

7.2.1 Vitamins

Vitamins are inorganic compounds that are essential to maintaining bodily functions. They are required in only very small quantities in the body. They do not contain energy, but they function as catalysts that help the body use energy nutrients. In this capacity they assist such functions as energy release, metabolic regulation and tissue building.

The body is unable to manufacture vitamins, so diet must supply them. A balanced diet is important because food is the main source of vitamins.

However, some athletes are inclined to take supplements even though their normal diet contains all the necessary vitamins. If supplementation involves the use of multivitamin capsules that do not provide more than 100 per cent of daily requirements, then there is probably no cause for concern. However, such capsules can be expensive and wasteful, as the body has no use for and excretes most of the excess vitamins.

The intake of excessive quantities of vitamins (super-supplements or megadoses) is not only unnecessary but potentially dangerous. The body can store vitamins A and D, excess amounts of which may contribute to muscle and joint pain and headaches. Furthermore, overdoses of vitamin A can cause nausea, loss of appetite, fatigue and skin dryness. Some athletes feel that strenuous exercise produces stress, and may require antioxidant vitamins (specifically, vitamin C, vitamin E and beta-carotene). Research on the effects of megadoses of these vitamins is inconclusive at this stage. But it is known that super-supplementation does not improve performance. Fruits and vegetables are strongly recommended as ideal sources of antioxidants.

The value of a balanced diet is that the intake of vitamins is cheap, plentiful and regulated. Any need for supplementation is really a need to develop positive nutritional habits. Supplementation should not be a response to a desire for improved performance, but rather arise out of special needs — for example, ill health or the unavailability of a normal diet while travelling.

7.2.2 Minerals

Minerals are inorganic substances found in the body that are necessary for it to function adequately. Like vitamins, minerals belong to the group of micronutrients that are essential for the body to function properly, but do not provide energy. Iron and calcium are the two minerals that are most commonly deficient in athletes, and inadequate supplies will affect performance and contribute to health problems.

Iron is found in haemoglobin, which comprises most of the red blood cells in the body. These cells collect and transport oxygen, delivering it to where it is needed. Diminished haemoglobin levels affect performance because the muscle cells are deprived of oxygen, which is needed to break down the nutrients and produce energy.
A condition commonly associated with activity is ‘sports anaemia’. Most frequently experienced in the early stages of heavy training programs, it is characterised by a lack of energy and general fatigue. The condition tends to subside if training is gradual, progressive and supported by a balanced diet. It is unknown exactly why ‘sports anaemia’ develops. However, it is thought to be attributable to either a lower iron intake relative to the boost in exercise, or the body’s use of protein for functions other than red blood cell production. Again, a balanced diet is an excellent source of iron. High amounts are found in lean meat, while grain products and dark, leafy green vegetables such as spinach and lettuce are other valuable sources.

**FIGURE 7.15** Red meat, pork and poultry together with dark green leafy vegetables are foods that are good sources of iron.

People most at risk of iron deficiency are:
- endurance athletes, as a result of sweat loss
- females, as a result of menstrual blood loss
- vegetarians, as a result of a lack of red meat in the diet
- adolescent males, as a result of a growth spurt.

Unlike iron deficiency, which impacts on energy supply, calcium deficiency is more specific to health. Calcium is vital for bone structure, making bones strong and healthy. The quality of bone tissue deteriorates gradually from the age of about the mid-twenties, and this contributes to osteoporosis (brittle bones), which can be experienced (particularly by women) later in life. Adequate calcium intake during childhood and adolescence has a positive effect on bone quality during later life. Important sources of calcium are dairy products, leafy green vegetables and fish such as salmon and sardines.

Again, athletes should look to dietary sources rather than supplementation to gain adequate calcium.

People most at risk of calcium deficiency are:
- females, as a result of an insufficient intake of dairy products
- females whose menstrual cycles have ceased, leading to a loss of calcium from bone tissue.
7.2.3 Protein

Protein supplements have had strong favour with weight-lifters, body builders and strength athletes for a long time. These supplements may be natural or synthetic and available in powder, fluid or solid formulations. Many athletes believe that protein supplements are important because of their muscle building qualities, with higher intake positively affecting muscle size. This belief stems from the accepted role of protein in the body.

Protein’s primary importance to the body is its structural role in holding the cells together and in the growth, repair and maintenance of body tissue. It also has a functional role in hormone production and nervous system transmissions. Protein is composed of various types of amino acids. It can be a source of energy under extreme conditions, when carbohydrate and fat supplies are in very short supply or exhausted. Most people need to consume about one gram of protein for each kilogram of body weight. Well-balanced diets containing fish, chicken, red meat, cheese, breads, cereals and some types of bean contain ample protein.

It is well established that the general population consumes protein in proportions higher than required for general health maintenance. In the average Australian diet, 12 to 15 per cent of the recommended intake should consist of protein. Studies indicate that this level is easily achieved, with most people attaining 150 per cent of the recommended intake. Athletes, because of their high energy usage, may consume amounts in excess of this.

On the whole, research supports the idea that most athletes do not need or benefit from protein supplementation. While there may be a case to support some supplementation in specific cases such as strength athletes, endurance athletes in heavy training and possibly adolescents undergoing a growth spurt, the majority of the population, including athletes, are well served by a balanced diet. Surveys reveal that most athletes consume well in excess of 1.2–2.0 g/kg body mass per day, making supplementation both needless and wasteful. In addition, many protein supplements contain additives that have no health benefit and may increase the risk of certain cancers. Most agree that in the rare case that more protein is required, changes in the dietary balance is the preferred method of supplementation.

Furthermore, excess protein can negatively affect health. High amounts of protein can increase the amount of calcium excreted in the urine and possibly contribute to osteoporosis. Unlike carbohydrates that can be stored in the body, excess protein must be eliminated. The processing and filtration of additional urea can interfere with kidney function. Diets high in protein such as those containing large amounts of meat and dairy foods can contribute to obesity as a result of their high fat content. Of concern also is the fact that they may replace important foods such as fruits and vegetables, which provide both energy and most of the essential nutrients.
7.2.4 Caffeine

While much of the evidence relating to caffeine and performance is still inconclusive, there is general agreement on areas relating to cognitive function, anaerobic performance and aerobic performance.

Caffeine does appear to improve cognitive processes, such as alertness. Many studies report improved concentration, ‘clear headedness’, improved memory and reasoning following consumption of mild amounts of caffeine. Similarly, studies agree that caffeine does not appear to enhance performance in short-term high intensity activities such as sprinting. A diuretic is a drug that increases the amount of fluid (water and urine) passing from the body. Some studies report the diuretic properties of caffeine, suggesting that it should be avoided as it may contribute to dehydration. This might be the case for athletes working in hot, humid environments, but in general, for athletes accustomed to its use, the link with dehydration is not well supported.

Caffeine has ergogenic aid properties, which means that it improves performance by assisting specific metabolic processes. The most favourable evidence supporting ergogenic aid properties of caffeine relates to endurance sports such as marathon running. In the case of endurance performance, it is the ability of caffeine to mobilise fat stores in the body and convert them into free fatty acids that is important. Working muscles oxidise free fatty acids, making them a usable source of energy. It is believed that caffeine promotes ‘glycogen sparing’, a process whereby fat is metabolised early, sparing finite reserves of glycogen and subsequently prolonging the point at which exhaustion will occur. Research suggests that glycogen sparing is most significant in the first 15 minutes of sustained endurance activity where it is reported that glycogen consumption can be decreased by as much as 50 per cent under normal circumstances.

Inquiry

Caffeine and performance

Research information on caffeine and health, including its effects on physical performance. The weblink Caffeine and health may assist. Summarise the pros and cons associated with caffeine use to improve physical performance.

Resources

- Weblink: Caffeine and health

7.2.5 Creatine products

The body has two sources of creatine — production by body cells and food intake, particularly from meat. Food intake in a normal diet accounts for about one gram of creatine per day. It is in the muscle that creatine is converted to creatine phosphate and thereafter assists in the resynthesis of ATP. It is therefore important in making energy available to sustain short duration explosive activity such as weight-lifting and sprinting.

Because creatine cannot be stored in the body, the idea of supplementation is supported by many athletes, particularly those who are involved in predominantly anaerobic programs.

While manufacturers of creatine products continue to market its performance enhancing properties, including increasing strength, delaying fatigue and burning fat, many researchers have found little, if any benefit. For instance, there is no evidence so far to support the claim that fat metabolism is improved. The body is unable to store excess amounts of creatine so supplementation has little effect on athletes who already consume high amounts of protein.
Where muscle creatine storage levels are low, as might be the case with vegetarians, there may be a case for limited supplementation. Where this occurs, small amounts (two to three grams) taken a couple of times each day and co-ingested with carbohydrate and water provide the best results. Use of creatine products can raise creatine levels in muscle by 20–30 per cent, but this happens only if there is a considerable gap between the existing level and the point of saturation. Again, the benefits, while only marginal, will be with those in explosive type activities rather than those in endurance type events.

Some users of creatine products believe the substance might be directly related to muscle cramps. Others believe that, while true, this is probably the result of excessive doses rather than the specific properties of creatine. Creatine supplementation also causes increases in weight, a reason why some athletes avoid the product. On the positive side, research has established that muscle hypertrophy is more easily achieved when training is assisted by creatine supplementation, hence its popularity with strength trainers.

Much is still inconclusive in regard to creatine supplementation. While there may be some benefits in assisting some anaerobic based activities, little else may be gained from consumption. While there is probably no harm in small doses for exercising athletes, larger doses of creatine may have health risks including the possibility of developing renal disease.

**Inquiry**

**Cases for and against using supplementation**

In your workbook, enlarge the following table. Complete it by analysing evidence for and against supplementation to improve performance. The Supplementation weblink in your Resources tab may assist you in developing your arguments.

<table>
<thead>
<tr>
<th>The case FOR supplementation</th>
<th>The case AGAINST supplementation</th>
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</thead>
<tbody>
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</table>

**7.3 Recovery strategies**

Recovery strategies aim to ensure that the athlete is able to resume normal training and competition within the time span of the training program. Workouts and performances can weaken athletes, even those who are hardened, well conditioned and well prepared.
Active rest is still regarded as the most beneficial form of recovery. Rest allows both physiological and psychological revitalisation to take its course. During rest, muscles repair and rebuild while energy and fluid levels are restored to pre-event levels. Recovery is important to avoid symptoms of overtraining that may be evident in feelings of staleness, lack of interest and an inability to put in effort despite wanting to do so. The difference between programs that target active or accelerated recovery as opposed to programs that do not is illustrated in figure 7.19.

Recovery can be short term or long term, depending on the type of event or activity. Short-term recovery refers to the period immediately following training, game or performance. Short-term recovery requires activities such as cool-down following training, together with low intensity exercise to promote soft tissue repair and disperse lactic acid. The nutritional component of this period of recovery is characterised by replacement of fluid and energy supplies as quickly as possible.

Long-term recovery refers to recovery between competitions or following periods of peaking where the body needs to be rested from the demands of regular training. Long recovery periods are part of the annual plan in advanced training programs. An example is rugby league footballers having an extended break from training in the period following the grand final. Nutritional goals for long-term recovery relate to a continuation of healthy eating practices and avoidance of weight gain despite lower activity levels.

Recovery strategies can be categorised as physiological, neural, tissue damage or psychological. Elite athletes use a range of strategies designed to enable them to resume full training in the shortest possible time.

7.3.1 Physiological strategies
Physiological strategies need to focus on two elements — the removal of metabolic by-products and a nutritional plan to replace lost fluids and energy-rich nutrients. An effective cool-down is the recommended manner for removal of metabolic by-products.

Cool-down
The purpose of a cool-down following exercise is to gradually reduce heart rate and metabolism to the pre-exercise state. In doing this, a number of other elevated body functions, such as ventilation rate, blood distribution and adrenaline levels, gradually return to normal.

Vigorous or sustained exercise that is not concluded with a cool-down may result in blood pooling, causing dizziness. A proper cool-down also assists in the removal of waste products including lactic acid, which contributes to muscle stiffness and soreness. It may also assist in preventing muscle spasms, cramps and possibly assist in preventing delayed onset muscle soreness (DOMS).

While the cool-down needs to be active, it should also be gradual. An effective cool-down should consist of 5–10 minutes of walking/jogging/slow swimming, with the aim of slowly returning the body to pre-exercise temperature. Also important is static stretching. Muscle fibres involved in exercise tend to shorten and may
lose alignment as a result of aggressive movements. Static stretching assists in lengthening, relaxing and realigning muscle fibres, making the normal range of movement easier to accomplish. Some athletes now use compression garments as part of their cool-down procedure to assist the dispersion and removal of metabolic waste. Research suggests that wearing compression garments during the recovery period may have considerable physiological benefits. These include:

- improved blood lactate removal
- reduced symptoms associated with delayed onset muscle soreness (DOMS)
- less swelling in muscles and joints
- reduced muscle fatigue
- reduced sensations of post-exercise soreness.

### Application

#### The cool down

1. Use a table like the one below to construct a cool-down program consisting of five different activities for an athlete in each of the sports listed.

<table>
<thead>
<tr>
<th>Shot-put</th>
<th>Touch football</th>
<th>Endurance swimming</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<td>2.</td>
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<td>3.</td>
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<tr>
<td>5.</td>
<td>5.</td>
<td>5.</td>
</tr>
</tbody>
</table>

2. Comment on the need to make cool-down programs specific to the type of activity.

### Nutritional plan

A sound nutritional recovery plan addresses both fluid and solid intakes, with some products having the advantage of catering for both areas.

#### Fluid recovery

Effective measures to address dehydration need to be taken as part of pre-event and during event management plans. Despite this, the body loses considerable fluid in endurance events posing the threat of dehydration. Dehydration is characterised by:

- an increase in pulse rate
- an increase in core body temperature
- a decrease in blood pressure
- a decrease in water in the cells
- a gradual decline in circulatory function

The amount of fluid loss varies from one individual to another and is influenced by altitude, temperature, exercise intensity, exercise duration and sweating. Thirst is not a good indicator of dehydration as fluid losses can advance more rapidly than the thirst mechanism can adjust. Urine that is dark in colour is a good indicator of dehydration. If this occurs, fluid needs to be consumed until urine colour turns pale or slightly yellow.
Elite athletes weigh themselves before and after exercise, the weight difference representing fluid loss. Extended exercise in normal conditions can result in the loss of 0.5–1.5 kilograms of fluid per hour, or more than two per cent of body weight. In this case, drinking 600 mL for every half kilogram lost is recommended. However, as a general rule, drinking with intermittent sipping over an extended period gradually replaces lost fluid. Severe dehydration may require 24–48 hours to enable fluids to be totally replaced.

The type of drink chosen can also enhance the hydration process. Real fruit juices and milk drinks are encouraged along with drinks such as Gatorade because of the potential to replace a full range of nutrients including carbohydrates, vitamins and potassium.

**Fuel recovery**

Many athletes find it difficult to consume large amounts of foods immediately following a game or extended period of exercise. However, the need to replenish depleted glycogen and blood sugar in the first 30 minutes to two hours following exercise is of paramount importance to fuel recovery. During this period, muscles are most receptive to glycogen enrichment. If fuel recovery is postponed for more than two hours up to 50 per cent less glycogen is absorbed by fatigued muscles.

Research with athletes suggests that consumption of at least 50–100 grams of carbohydrate within two hours of intense exercise is necessary to initiate fuel replenishment. Some protein should also be ingested, but the ratio of carbohydrate to protein should be in the order of 4:1. Some protein is important because the amino acids repair damaged tissue. Further, protein enhances insulin supply, which increases the ability of muscles and the liver to store glycogen. However, excessive protein intake at the expense of carbohydrate is not recommended because of its inability to replenish glycogen.

In general, a high carbohydrate diet that is balanced in terms of macronutrient energy supply (carbohydrates, protein and fat) is recommended during exercise recovery. The focus on carbohydrate-rich food should continue for days if endurance exercise such as cycling or long distance running contributed to fuel losses. Examples of carbohydrate-rich foods and drinks include fruit juices such as orange juice, rice, pasta, bread, milk, yoghurt and fruit (fresh and dried).
7.3.2 Neural strategies

Neural strategies such as hydrotherapy and massage aim to relax muscles that have been fatigued or damaged as a result of high intensity exercise. Strenuous exercise affects the central nervous system and this may contribute to fatigue. Neural strategies, integrated with other recovery strategies, have become popular in recent years, particularly with teams involved in collision sports such as rugby league.

Hydrotherapy

Hydrotherapy involves the use of water to relax, soothe pain and assist metabolic recovery. Water provides support for movements, and eliminates jarring and straining movements that are associated with land drills and field exercises. Typical hydrotherapy methods involve use of steam rooms, spas, underwater massage (for example, a spa with jets) and heated swimming pools.

With hydrotherapy, active exercise can be incorporated through use of gravity assisted movements such as jumping. Swimming, assisted flotation exercises and even movements such as sprinting, jogging and combat exercise can be performed in a gravity assisted environment, lessening the risk of injury. Sports centres with heated swimming pools are ideal for hydrotherapy sessions. In some cases, hydrotherapy can be used in conjunction with cryotherapy (use of cold) techniques to help accelerate blood flow.

Three popular hydrotherapy techniques used with elite athletes are:

- hot water immersion (HWI)
- cold water immersion (CWI)
- contrast water therapy (CWT).

Hot water immersion causes dilation (widening) of blood vessels in the body’s extremities. As the temperature of the body’s surface area increases, blood flows more freely to the limbs, lowering blood pressure and enhancing the removal of waste.

Cold water immersion has the opposite effect on blood flow. Immersion in cold water (usually about 10–15 °C) causes blood flow to the extremities to be reduced. This occurs due to decreased heart rate and constriction of the blood vessels in response to the sudden drop in temperature.

Best results are obtained when HWI is alternated with CWI in what is called contrast water therapy. Here, the athlete moves between pools or showers that are either hot or cold. This practice enhances the cycle of blood vessel dilation/constriction thereby increasing blood mobility through the tissues. This causes a more rapid dispersal of waste, reduces muscle soreness and promotes a faster recovery.

Application

Hydrotherapy session

Contact a sports centre and organise a hydrotherapy session in a heated swimming pool. In small groups, plan a range of activities such as swimming without using leg movement and relay running. At the conclusion, evaluate the session in terms of perceived benefits to sportspeople who have just finished a game or gruelling endurance session.
Massage

Sports massage can be performed prior to or following an event. It is a specialised form of massage because, used as a recovery strategy, it serves a number of purposes. Used post-event, sports massage extends from the cool-down, focusing on body and mental relaxation. This is important as exercise induced tension can cause stress on joints, ligaments, tendons and muscles. By providing this level of support, the most important contribution of massage could well be in the form of injury prevention.

Post-event massage claims to help relieve swelling, reduce muscle tension, assist in eliminating toxic by-products, promote flexibility and generally prepare the athlete for the next training session or performance. Recovery strategies may necessitate an additional form of massage called rehabilitation massage where the focus is on injury treatment, specifically cramps, muscle damage, ligament repair, bruises, aches, general discomfort and soreness. Properly used, massage shortens the recovery time between training workouts and events.

Massage needs to directly address the needs of the athlete arising from the demands of the sport. Depending upon the sport and the stress it imposes, different muscle groups need to be addressed. For example, a netball centre court player who spends considerable time leaping, passing, sprinting and changing direction has different massage demands to a cyclist.

Massage therapists have a range of techniques they can utilise, some of the more popular methods being compression massage, cross-fibre massage, Swedish massage and tender point massage. Use the Massage weblink in your Resources tab to find out more about these and other forms of massage.

7.3.3 Tissue damage strategies

Tissue damage may be minor, as in the case of soreness, or more long term as might be the case with bruising or muscle tears. Various forms of cryotherapy, which involves the use of cooling to treat injury or quicken recovery, have become popular in this recovery strategy.

Ice is the most used form of cryotherapy because of its ability to slow down the tissue inflammatory process, preventing the build-up of waste. If this is not removed quickly, it contributes to muscle soreness and stiffness and reduces flexibility.
The ICER principle, used in the rehabilitation of soft tissue injury without the initial REST is frequently used, even if tissue damage has not occurred. Using a damp cloth to avoid direct contact, apply ice on and off for 10-minute intervals, for up to 40 minutes (10 minutes on followed by 10 minutes off, then 10 minutes on and 10 minutes off again). The process can be repeated periodically for a day or two, particularly if injury to the area is evident. Compression, elevation and rest are also used to enhance recuperation. See topic 11 for more details on RICER.

Ice baths have become popular in sports like touch football, rugby, soccer and endurance racing. This technique calls for immersion of affected body parts (often most of the body) in a bath of ice for a short period of time. Cold baths work on the principle that decreased temperature contracts blood vessels, decreasing their diameter. On emerging from the bath, the body warms and blood vessels enlarge. This allows fresh, oxygen-rich blood to flow into the muscles, stimulating recovery. As the plunge into an ice bath presents quite a shock to the body, short periods of one minute are recommended initially, building to longer periods as the body gradually adapts.

FIGURE 7.24 Ice baths and ice packs are commonly used as part of cryotherapy techniques.

7.3.4 Psychological strategies

While many of the strategies discussed provide significant physiological benefits, relaxation techniques target both the body and the mind. Following hard training and demanding performances, athletes may experience symptoms of low concentration, lack of motivation and increased levels of anxiety. Use of psychological strategies represents an important phase in emotional and possibly spiritual recovery.

The choice of relaxation method(s) is quite individual and involves experimentation to establish which technique works best. Debriefing sessions and performance evaluations are necessary but must be positive, focusing on the process and not the outcome. Mind relaxing activities such as reading, listening to music, and watching movies or television are helpful and used by most athletes. The benefits of other
more specialised psychological techniques such as progressive muscular relaxation, flotation, meditation, visualisation, centred breathing and positive self-talk are realised if practised frequently. Some physical/social activities such as light cross-training and/or golf are preferred by others.

A body that harbours mental or physical tension is not able to sleep and experience full recovery. Adequate sleep is still regarded as probably the most important recovery strategy, although too much sleep can be detrimental, contributing to feelings of sluggishness and lethargy. Relaxation techniques reduce tension, thereby facilitating both physical and psychological recovery.

### Inquiry

**Features and benefits of recovery strategies**

Make an enlarged copy of the table below in your workbook. For each of the listed recovery strategies, provide examples and outline their main features. In the right column, suggest benefits to performance. The websites listed in the *Recovery strategies* weblinks in your Resources tab may assist you.

<table>
<thead>
<tr>
<th>Recovery strategy</th>
<th>Examples and features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiological</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tissue damage</td>
<td></td>
<td></td>
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<tr>
<td>Psychological</td>
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</tbody>
</table>

### Inquiry

**Sport and science: Winning athletes gold**

Read the snapshot, ‘Sport and science: Winning athletes gold’, then answer the following questions.

1. What are the benefits of cold water immersion?
2. How does contrast water therapy help remove waste?
3. Facilities like the hot-cold walk through showers of the AIS are not available to all athletes. Suggest other ways to gain the benefits of this type of therapy.

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**SNAPSHOT**

**Sport and science: Winning athletes gold**

By altering water temperature or current in a pool, bath or shower, the human body responds in a variety of ways — including fluctuations in core temperature, heart rate and metabolism and the widening (dilation) or constriction of blood vessels.

This use of water to improve body recovery is known as hydrotherapy and is becoming one of the most widely used practices in elite sport. Here, we find out how it works.

Dr Jo Vaile is only 28 years old but has already established a strong career as a Senior Recovery Physiologist for the Australian Institute of Sport (AIS). She uses a wide range of recovery techniques with AIS athletes such as hydrotherapy, compression and stretching to help elite Australian athletes perform their best.
Exercise physiology is about understanding the complexities of how the body responds and adapts to the stress of exercise and how we can push the human body to new limits to enhance the likelihood of success,’ Dr Vaile said.

‘In sport, we constantly need to be ahead of the competition in order to succeed at an elite level where that one percent advantage over the opposition will make a difference between gold and silver,’ she said.

The human body responds to water immersion with changes in heart rate, blood pressure and blood flow. Exposure to cold water causes a decrease in core body and tissue temperature which results in a reduction in blood flow to the extremities (muscles, hands, feet) because the body is trying to protect itself and conserve ‘body heat’. To minimise the blood returning to the extremities the blood vessels constrict, heart rate slows down and blood pressure increases due to the constricted blood vessels.

At the AIS, athletes use cold water immersion in pools between 10–15 degrees Celsius, using the cold water to help decrease muscle inflammation, spasm and pain.

In warm water, the body is exposed to heat which causes dilation of the blood vessels near the surface of the skin. The core body temperature starts increases and redirects more blood to the extremities. The dilation of blood vessels lowers blood pressure by allowing the blood to flow more freely with less resistance.

At the AIS however, hot water is rarely used on its own. In fact, one of the most effective athlete recovery systems to date is alternating immersion in hot and cold water.

According to Dr Vaile, ‘contrast water therapy’ can reduce swelling and muscle pain through a pumping action which is created by alternating blood vessel constriction and dilation. The pumping action helps to flush out waste products from the muscles that build up during exercise, such as lactic acid, and minimises muscle tear.

‘Contrast water therapy may bring about changes to tissue temperature, blood flow, blood flow distribution, may reduce muscle spasm, hyperaemia of superficial blood vessels and inflammation, as well as improving the range of motion and flexibility,’ she said.

In one recent study of twelve elite male cyclists, the athletes were put through rigorous training with the only difference being their recovery strategy. Over five days, the athletes completed four experimental trials differing only in recovery intervention: cold water immersion, hot water immersion, contrast water therapy, or passive recovery.

The study found that both sprint and time trial performance were enhanced when athletes utilised both cold water immersion and contrast water therapy, in comparison to hot water immersion and passive recovery.

‘Overall, the study found that cold water immersion and contrast water therapy improved recovery from high-intensity cycling when compared to hot water immersion and passive recovery, with athletes better able to maintain performance across a five-day period,’ Dr Vaile said.

Dr Vaile is fascinated by hydrotherapy and after completing her Bachelor of Sport and Exercise Science, and went on to complete her PhD in the area.

‘So many athletes implement hydrotherapy for recovery in the hope of assisting the recovery of muscle damage or fatigue and I think it’s fascinating that hydrotherapy has the potential to be beneficial, not only in terms of recovery, but also in improving subsequent performance,’ she said.

Dr Vaile is currently in the UK with the Rollers and Gliders — the Australian Men’s and Women’s wheelchair basketball team who are competing in the World Championships.

‘Paralympic athletes are truly elite, they train and compete like any other athlete, but on top of that they face challenges every day in both sport and life due to their specific disability.’

Dr Vaile’s research into hydrotherapy earned her the European College of Sports Science Young Investigator Award and the John Sutton Best New Investigator Award at the Sports Medicine Australia Conference.
7.4 Topic review

7.4.1 Summary

• Nutritional considerations that affect performance need to address preperformance, during performance and post-performance aspects.
• Carbohydrates and water are essential components of any pre-event meal. The necessary quantity depends on factors such as activity duration, climatic conditions and body size.
• During events, nutritional considerations relate to maintaining hydration levels and enriching glucose levels if performances are extended.
• The post-event focus should be on high fluid intake coupled with a food intake with a ratio of 4:1 carbohydrate to protein. The first two hours following exercise is the most important refuelling period.
• Carbohydrate loading is important for endurance events. However, the athlete should achieve glycogen saturation by tapering their training intensity and increasing the carbohydrates in their diet. The traditional method of carbohydrate depletion followed by carbohydrate loading should be avoided because it is nutritionally unsound.
• Adequate fluid is essential because it is a component of blood plasma volume. Inadequate fluid intake leads to dehydration.
• Vitamin supplementation is usually unnecessary because the body obtains sufficient vitamins through a normal diet. However, athletes need to ensure adequate intake of iron and calcium, because they sometimes suffer ‘sports anaemia’ and low levels of calcium for various reasons.
• The perceived benefits of supplementation, specifically protein, caffeine and creatine, relate mostly to the type of event and individual circumstances. If protein and creatine levels in the body are satisfactory as a result of a balanced diet, supplementation can be a waste of money.
• There may be some advantage in supplementing caffeine, particularly in aiding endurance performance. Caffeine assists ‘glycogen sparing’, which preserves glycogen stores, enabling effort to be sustained for a longer period of time.
• To maintain body temperature, the athlete must be aware of strategies that conserve body fluid and adopt practices that replace fluid. Endurance exercise results in dehydration, which can have serious health effects.
• Adequate hydration requires the consumption of fluid before, during and after exercise. Fluid losses greater than one per cent affect performance, while progressive fluid loss adversely affects health.
• Neural strategies, such as hydrotherapy and massage assist in waste disposal within muscle, ensuring an uninterrupted continuation of the training program.
• Cryotherapy uses cold in the form of ice packs and ice baths to assist in eliminating metabolic waste following strenuous exercise.
• Psychological strategies such as relaxation are as important as physiological strategies in completing total recovery following strenuous activity.
7.4.2 Questions

Revision
1. Describe the nutritional considerations of which an athlete must be aware prior to performance. (H8) (3 marks)
2. What are the key pre-performance considerations of which an athlete must be aware? (H8) (3 marks)
3. What is carbohydrate loading? How can it be used in designing programs to improve endurance performance? (H11) (4 marks)
4. Establish the basic differences between a pre-event and post-event dietary intake for endurance athletes. (H16) (3 marks)
5. Outline the importance of fluid and carbohydrates to endurance performance. (H8) (2 marks)
6. What is glycogen sparing? How does it work to conserve fuel during endurance events? (H7) (3 marks)
7. Discuss strategies that athletes may adopt to counteract the effects of dehydration during endurance events. (H17) (5 marks)
8. Discuss the basic requirements of a diet that would support a sustained training program and suggest how it differs from a normal diet. (H7) (5 marks)
9. Vitamin and mineral supplementation is common, although unnecessary in many cases. Discuss situations in which supplementation of vitamins and minerals could be an advantage to the athlete. (H17) (4 marks)
10. Discuss the effect of protein supplementation on performance. (H8) (2 marks)
11. Analyse why caffeine may have a positive effect on endurance performance. (H8) (5 marks)
12. ‘Creatine supplementation is a waste of money.’ Discuss. (H17) (4 marks)
13. Explain the importance of cool-down in recovery from physical exertion. (H10) (3 marks)
14. Use examples to suggest why neural strategies might assist in recovery from exercise. (H10) (6 marks)
15. How does cryotherapy assist in rehabilitating tissue damage? (H10) (2 marks)
16. Use examples to describe psychological strategies that athletes use in recovery from strenuous activity. (H11) (5 marks)

Extension
Outline the nutritional and hydration strategies a triathlete needs to adopt before competing in an event held on a summer’s day. (H17) (8 marks)

7.4.3 Key terms

carbohydrate loading is the technique of loading the muscles with glycogen in preparation for a high-intensity endurance activity of more than 90 minutes. p. 221
cryotherapy involves the use of cooling to treat injury or quicken recovery from performances, particularly those that involve collisions and/or sustained intensity. p. 238
dehydration is an excessive loss of water. p. 224
A diuretic is a drug that increases the amount of fluid (water and urine) passing from the body.
electrolytes are salts and minerals, such as sodium, potassium, calcium and magnesium, that are important for many body functions such as chemical breakdown and nerve conduction. Electrolytes can be lost through perspiration during exercise. p. 224
An ergogenic aid is a substance or practice that improves or is believed to improve physical performance. p. 232
The **glycemic index** is a ranking system for carbohydrates based on how they affect blood sugar level. *p. 227*

**Hydration** involves supplying sufficient water to the body’s cells. *p. 218*

**Minerals** are inorganic substances found in the body that are necessary for it to function adequately. *p. 227*

**Proactive recovery** emphasises immediate refuelling and rehydration that continues until a pre-event state is obtained. *p. 227*

**Tapering** refers to a period immediately before competition when the volume and intensity of training is reduced. *p. 221*

**Vitamins** are inorganic compounds that are essential to maintaining bodily functions. *p. 229*