

CHAPTER 12

Improving performance

CRITICAL QUESTIONS

How do athletes train for improved performance?
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What are the planning considerations for improving performance? (page 490)

What ethical issues are related to improving performance?
(page 507)



OVERVIEW

TRAINING FOR IMPROVED PERFORMANCE

Strength training
Aerobic training
Anaerobic training
Flexibility training
Skill training

PLANNING CONSIDERATIONS FOR IMPROVING PERFORMANCE

Initial planning considerations
Planning a training year
Elements to be considered when designing a training session
Planning to avoid overtraining

ETHICAL ISSUES RELATED TO IMPROVING PERFORMANCE

Use of drugs
Use of technology

OUTCOMES

ON COMPLETION OF THIS CHAPTER, YOU WILL BE ABLE TO:

- explain the relationship between physiology and movement potential (H7)
- explain how a variety of training approaches and other interventions enhance performance and safety in physical activity (H8)
- explain how movement skill is acquired and appraised (H9)
- design and implement training plans to improve performance (H10)
- select appropriate options and formulate strategies based on critical analysis of the factors that affect performance and safe participation. (H17)



TRAINING FOR IMPROVED PERFORMANCE

CRITICAL QUESTION

How do athletes train for improved performance?

Training is the fundamental ingredient that sustains physical performance because it improves energy production, skill execution and muscle stress tolerance. Effective training programs target the needs of each individual in terms of work volume and intensity. A training program should seek overall improvement in skill, flexibility, strength, speed, endurance and power. It should also address the athlete's nutritional needs and develop his or her psychological capacities.

Strength training

Strength is the ability of a muscle or muscle group to exert a force against a resistance.

Strength training is a general term that encompasses all types of exercise designed to improve strength and increase muscle size.

Strength is the ability of a muscle or muscle group to exert a force against a resistance. Strength is improved through use of strength training programs. **Strength training** is a general term that encompasses all types of exercise designed to improve strength and increase muscle size. Strength training is different to body building and weight-lifting, but strength development through training is an integral part of both these activities.

Strength training can be applied to a range of programs, including the development of muscular endurance, general strength, power, body bulk and muscle tone. However, to maximise results, programs need to address individual differences. This is achieved by manipulating program variables and making each program component personalised to suit individual needs. For example, the number of repetitions made in lifting a precise load differs between athletes who wish to develop muscle size and muscle endurance.

Strength program variables include:

- *repetitions* — the number of times an exercise is repeated without rest
- *repetitions maximum* — the maximum weight that can be lifted a specified number of times. For example, 1 RM equals the maximum weight that can be lifted only once; 8 RM equals the maximum weight that can be lifted eight times.
- *set* — a number of repetitions done in succession; for example, one set equals 10 repetitions
- *resistance* — the weight or load
- *rest* — the period of time between exercises, sets or sessions

An **adaptation** refers to a change in form or structure to suit new conditions or a new environment.

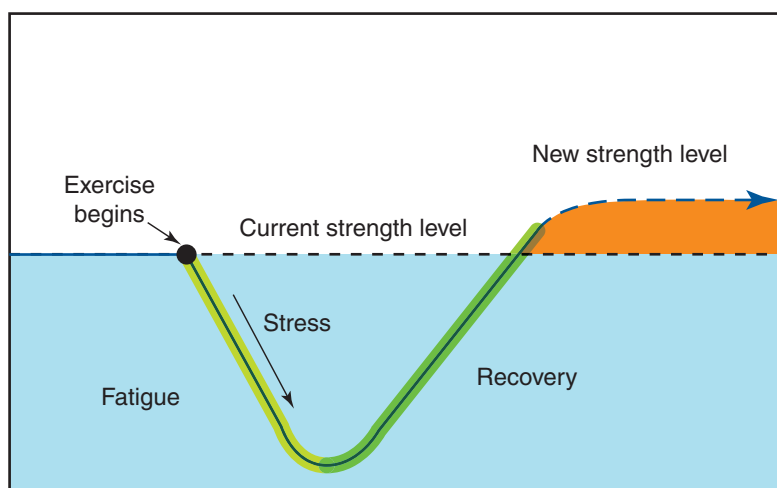


Figure 12.1: The general adaptation syndrome shows how the cycle of stress, fatigue and recovery leads to increases in strength.

- *periodisation* — the process of varying the training load over discrete periods of time.

Strength increases are made possible through **adaptations**. This means that a muscle becomes accustomed to a specific load through exposure to stress created by it. For example, a person who is just able to lift 20 kilograms during a biceps curl gradually becomes more comfortable in lifting that load following repeated training sessions. This is because that muscle group has made adaptations (hypertrophy, increased motor units engaged) and is ready to take on a higher level of resistance. The general adaptation syndrome is illustrated in figure 12.1.



Figure 12.2: Strength training must be appropriate to the individual.



Figure 12.3: Using spotters and good technique contributes to enhancing safety in strength training programs.

A strength training program will not be effective, nor will appropriate strength gains be made, unless the training program:

- *is exercise specific*; that is, adaptations will occur only in the parts of the body that are stressed by the exercise. Weight training is highly specific. For example, biceps development will generally have little effect on an athlete's running ability.
- *employs the overload principle*; that is, the individual is loaded beyond normal requirements
- *uses progressive resistance*; that is, resistance is increased as adaptations occur.

Using safe procedures is of paramount importance when using strength training programs. Muscle and ligament damage, back pain and joint injury can all result from not being aware of how to use strength training equipment safely or trying to progress too quickly to higher levels of resistance. Safe performance of strength training movements requires:

- a level that is appropriate to each individual, with competition being discouraged
- adequate warm-up and cool-down phases, including considerable emphasis on stretching
- focus on major muscle groups
- concentration on developing correct technique to avoid injury
- establishing 'good form' as opposed to 'cheating'. 'Cheating' implies transferring part of the load to other muscle groups, thereby enabling a greater weight to be lifted.
- using high repetitions and moderate loads early in the program and not increasing resistance increments too quickly
- checking that equipment is suitable and is adequately maintained
- ensuring that bouncing movements are avoided
- insisting that spotters (partners who assist in guiding a weight lift) are used, particularly while lifting heavy free weights.

While there are a number of different types of strength training, resistance, weight and isometric training regimes are the focus of this section.

Resistance training

Please review chapter 5, pages 161–5 for foundation information on this section.

Resistance training is a form of strength training where each muscular effort is opposed by a specific resistance. The resistance or opposing force can be generated in a number of ways, but

Isotonic movements are characterised by muscle shortening and lengthening against resistance.

application of **isotonic** measures such as use of hydraulic or elastic forces are the two most popular.

Isotonic movements are characterised by muscle shortening and lengthening against resistance. Muscle strength develops through programs that progressively increase the resistance, with adaptations taking place through adjusting to gradually increasing demands. Whereas hydraulic techniques provide fixed resistance throughout performance of the entire exercise, elastic bands offer most resistance towards the end of the movement.



Elastic resistance training

Elastic resistance using bands improves strength because resistance that is generated by tension increases as the band is stretched. Exposure to a progressively increasing stimulus ensures that muscle is strengthened through the full range, particularly at the end of the movement.

Bands are usually coloured to indicate different levels of resistance. An important feature of elastics is their versatility, portability and adaptability to a range of movements. Using a small number of bands, an extensive range of exercises can be performed working single or multiple joints simultaneously. However, bands are the least durable of all strength training types of equipment. They need to be regularly inspected and discarded if frayed, worn or have small tears.

Figure 12.4: An example of exercise using coloured bands for elastic resistance



INQUIRY

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Strength training with elastic resistance

Use the **Elastic resistance** weblink in your eBookPLUS. Read the information about elastic resistance and then answer the following questions.

1. What are the advantages of using elastic resistance when compared to other forms of strength training?
2. What strength benefits can be gained by using ERT (elastic resistance training)?

Hydraulic resistance training

Hydraulic resistance equipment is designed to generate resistance both through cylinder adjustments and in response to speed of movement. The faster the movement is executed, the greater is the resistance that will develop. Hydraulics has the advantage of providing resistance in both phases of a movement; that is, the pushing and then pulling, the lifting and lowering or whatever the specific action may be. Hydraulic equipment can be used to enhance strength development in a range of programs such as circuits, cardiorespiratory fitness and anaerobic training programs.

Figure 12.5: A gym with some examples of hydraulic exercise equipment



Figure 12.6: Weight training using free weights

Concentric contractions occur when a muscle shortens, causing movement at a joint.

Eccentric contractions occur when the muscle lengthens while under tension. The action often happens with the assistance of gravity.

while opposed by gravity assisted forces. With increasing loads, more motor units (and hence, more muscle fibres) are recruited to perform muscle actions. This causes significant hypertrophy in the muscle fibres involved. Through manipulation to the number of sets, repetitions, rest between sets and speed of movements, weight training can be varied to address specific requirements such as body building and the development of power. Heavier weights are used for programs that aim to increase muscle size, whereas lighter weights are used in muscular endurance type programs.

Specialised equipment is not necessarily required to create hydraulic resistance. Pool water can also be used to create resistance using a range of exercises that require the body to move forcefully through it. Movements such as jumping, striding and pushing are opposed by water, the resistance growing as the force exerted by the body against the water increases.

Weight training

Please review chapter 5, pages 161–5 for foundation information on this section.

Weight training is a form of strength training that uses set repetitions and specific units of weight to create progressive resistance, ultimately strengthening muscles. Free weights (barbells and dumbbells) or weight training machines (for example, Nautilus) are used coupled with a range of specialised techniques and unique exercises designed to overload muscles and enhance adaptations. The body's own weight can also be used as a form of weight training, such as in push-ups and pull-ups on a high bar.

Weight training is the preferred form of strength training to develop absolute strength, body building and lean muscle tissue.

Weight training uses both **concentric** and **eccentric contractions** to stress muscle fibres. During these types of contraction, muscles continually shorten and lengthen

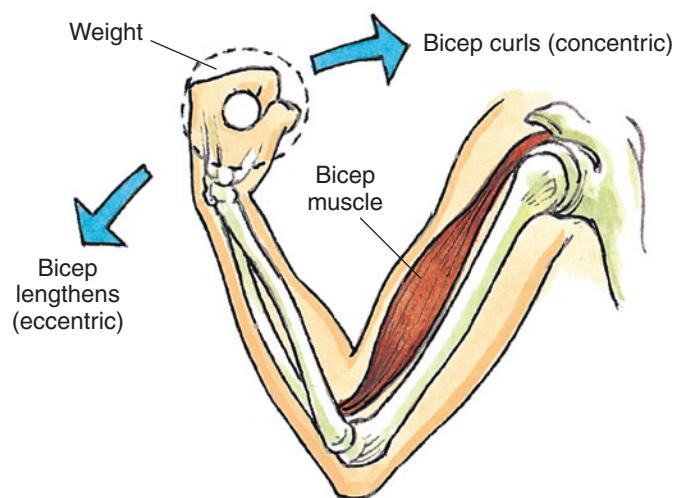





Figure 12.7: Concentric and eccentric contractions against a resistance improve strength development.

Table 12.1 shows how the variables can be altered to meet different needs of athletes. For example, strength gains require few repetitions with heavy weights, while the development of strength endurance requires the opposite.

Table 12.1: Prescription for a weight training program for trained athletes

Purpose	Weight resistance	Repetitions	Sets	Exercise speed	Time between sets (mins)
Strength 	Very heavy 80–100% RM*	4–6	5–6	Slow	Long 3–5
Best results are achieved at 4–6 RM. Note that 100% = 1 repetition, 90% = 5 repetitions and 80% = 8 repetitions. Train on 3 days per week with a day's rest between each session.					
Lean body mass 	Heavy 70–90% RM	6–12	3–6	Slow to medium	Short 1–3
The aim here is to increase muscle bulk (muscle hypertrophy) and decrease relative fat mass. This will provide better muscle definition. Needs to be combined with a nutrition program. Train on 3–5 days per week.					
Strength endurance 	Light-medium 40–60% RM	20–30	3–6	High	Short 1–3
Strength endurance is developed using low-intensity resistance combined with high repetitions — that is, about 20–30 repetitions per minute. Training needs to take place on 3–4 days per week.					

* RM = repetition maximum = the maximum weight a person can lift a specific number of times (e.g. 8 RM is the maximum weight that can be lifted eight times).

Plates

Weight discs or plates anchored to barbells comprise free weights. The weight of the barbell can be set at the exact load required, ensuring that the overload principle is implemented and resistance is gradual and progressive. This

means that as a muscle performing a specific exercise adapts to that level of resistance, additional plates can be added to marginally increase the resistance. As weights become heavy, athletes using this form of weight training engage spotters to guide each lift during both the concentric and eccentric phase. It is important that when performing an exercise such as a curl, the weight is lifted through the full range to ensure that motor unit recruitment is maximised.



Figure 12.8: Strength training using barbells



INQUIRY

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Strength versus resistance training

Use the **Strength versus resistance** weblink in your eBookPLUS. Read the information on strength versus resistance training, then answer the following questions.

1. What are the advantages and disadvantages of free weight exercises?
2. What are the advantages and disadvantages of resistance bands?
3. How can the strength benefits from resistance bands be maximised?

Dumbbells

A dumbbell is a weight consisting of two discs attached to a short bar and made for lifting with one hand. Dumbbells come with attached weights or can be loaded and secured with spin locks to provide the required resistance. Dumbbells provide versatility in weight training programs. They are used extensively in exercises that develop small muscle groups, such as those in the wrist, or to isolate specific muscles for development, such as the biceps.

Dumbbells are also important in injury rehabilitation where a specific joint or muscle needs to be strengthened using concentric/eccentric movements, as may be required in tennis elbow recovery. It is important in using dumbbells (and barbells) to ensure that elbows and knees are not fully locked at the end of each movement as this places stress on joints and can cause injury.



Figure 12.9: Dumbbells of different weights (left) and weights on a barbell (right)



APPLICATION

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Weight training with dumbbells

You will need a couple of sets of dumbbells for this application. Use the **Dumbbells** weblink in your eBookPLUS. Choose four exercises that you might be interested in. Read the information about how to perform the exercise correctly. Following a warm-up, complete the exercise using the dumbbells.



INQUIRY

Weight training with dumbbells

Answer the following questions arising from the application 'Weight training with dumbbells'.

1. List and briefly describe the four exercises you chose.
2. What muscle groups were targeted?
3. What level of resistance did you have? Were you able to alter this if too light or too heavy?
4. How many repetitions did you do with each?
5. What steps did you take to address safety concerns?



INQUIRY

Identifying strength training exercises and equipment

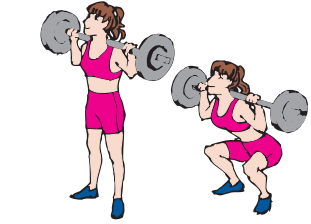
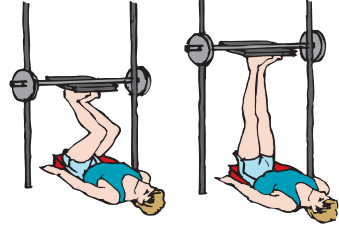
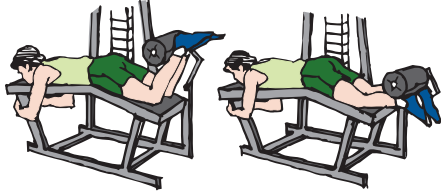
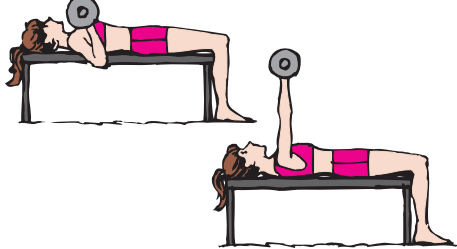
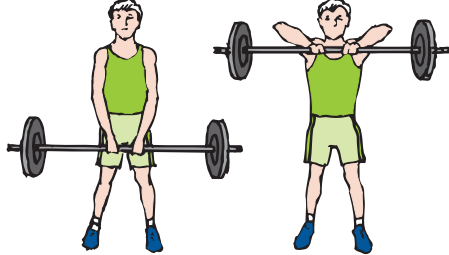
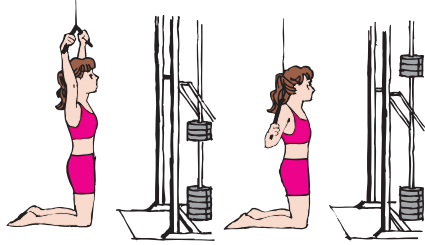
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Use the **Chest exercise** weblink in your eBookPLUS and watch the five minute video on exercises to develop the chest. Be prepared to answer the following questions as you watch the video.

1. What were the names of the exercises used?
2. What type of strength training equipment was used for each exercise?
3. What safety precaution did you observe?

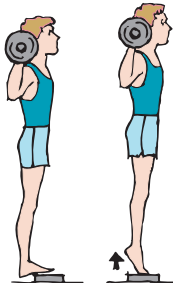
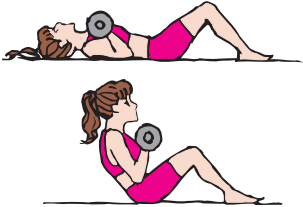
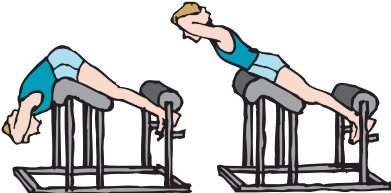
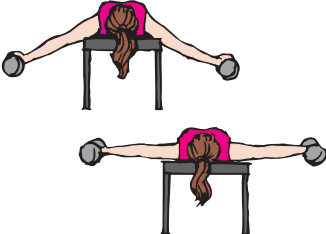
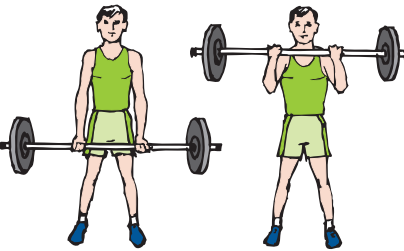
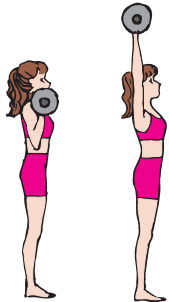
Discuss your findings with the class.

Table 12.2: Some exercises commonly used in weight training programs

Exercise	Muscle group	Description	Illustration
Squats	Legs	Use an overgrip (knuckles up). Keep head up and back flat. Squat until the thighs are parallel to the floor.	
Leg press	Legs	Lie under the press-bar with feet extended to make contact with a fastened bar or platform. Extend knees, hold and return.	
Leg curl	Hamstrings	With body lying face down on the bench, lock heels over rollers. Grasp front of bench and bring heels over until rollers touch back of thigh.	
Bench press	Chest, arms and shoulders	Lying face up on bench, hold bar with overgrip (palms forward) and with hands slightly wider than shoulders. Push bar up and then lower until it touches the chest.	
Upright rowing	Upper arms and shoulders	Using an overgrip (knuckles on top) hold bar in front of body with hands five centimetres apart. Lift the bar to the chin, keeping the elbows higher than the bar and then return.	
Lats pull-down	Back	Space hands widely apart on the bar. While kneeling, pull the bar until it touches the back of the neck.	

(continued)

Table 12.2 (continued)

Exercise	Muscle group	Description	Illustration
Heel raise	Calf muscles	With bar across shoulders and back straight, place balls of feet on a board. Keeping the body erect, rise on toes as high as possible and lower until heels touch the floor.	
Crunches	Abdominals	Hold a weight on the chest. Lie with the hips flexed. Sit up with curling action, taking shoulders as far off the ground as possible, then return to the floor.	
Back extensions	Lower back	Lie across a bench with heels hooked under a roller. Place hands behind head and bend forward until trunk is at right angles to the legs. Raise body to straight position.	
Lateral raises	Deltoids	From a prone position on a bench, grasp dumbbells. Raise sideways to a horizontal position. Return to start. Do not lock elbow joint during the movement.	
Barbell curls	Arms (biceps)	With arms shoulder width apart, hold bar at thigh height, palms facing out. Lift bar to shoulders and return in a smooth continuous movement keeping the back straight.	
Military press	Arms and shoulders	Standing erect and using an overgrip, extend the arms vertically, hold and return to the bent arm position in front of the chest.	



APPLICATION

Designing a strength development program

Use the exercises shown in table 12.2 (pages 469–70) and the prescription in table 12.1 (page 466) to develop a strength program for a sport of your choice. Other exercises such as those using elastics or hydraulics may also be included. Ensure that all major muscle groups are addressed, particularly those specific to your sport.

Compare your program with others in the class.

During **isometric training** (or static training), muscles develop tension but do not change in length.

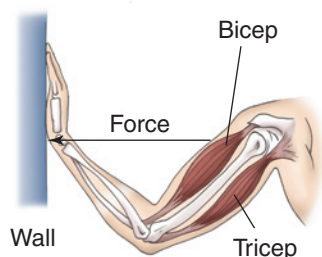


Figure 12.10: An example of an isometric exercise where force is exerted and tension in the muscles is increased, but muscle length remains the same

Isometric training

Isometric training programs are not as popular as isotonic programs, although they do have value. In isometric training, the resistance is fixed and remains so regardless of the amount of effort. A typical isometric exercise is pushing against a wall (as shown in figure 12.10) or pulling against an immovable object. Tension develops in the muscle because there is resistance, but the muscle does not shorten since the object will not move. A difficulty with isometric training programs is that isometric gains cannot be measured using isometric equipment, so there is a need for alternative programs, such as free weights, to gauge success.

The best strength gains through isometric training programs are made using six to eight repetitions, each lasting six seconds. Training should occur on four to five days each week. Isometric exercises must be performed at the joint angles where the strength is needed; for example, at the beginning, middle, or end of the contraction. Therefore, the full development of a muscle could require the application of an isometric force at four or five different angles through the range of motion of the joint.

The advantages of isometric training are that:

- equipment needs are minimal
- it is helpful to overcome weaker points ('sticking points') in the muscle
- it takes little time, is simple to learn and easy to perform
- it is valuable in rehabilitating an injury, such as a muscle tear
- much can be performed in a variety of places — for example, kitchen or office.

Disadvantages of isometric training are that:

- it does not increase strength through the full range of motion of the joint unless applied at all the respective angles
- it causes a rise in blood pressure
- speed is reduced through strengthening in a static position
- other methods, such as isotonic testing, must be used to measure progress
- it does not produce muscular endurance
- most benefits occur early in training.

Aerobic training

Please review chapter 5, pages 153–6 for foundation information on this section.

Aerobic training engages and develops the aerobic system of energy supply. Training, whether it is continuous, Fartlek or long interval, will be sustained, of moderate intensity and address the overload principle.

Continuous/uniform training

Continuous training provides a foundation for most other methods of training including anaerobic training. Because it is sustained, enduring and, in most



cases, of low to moderate intensity, continuous training provides the groundwork for other forms of fitness. Generally, continuous training is used to improve cardiorespiratory endurance, local muscular endurance and overall aerobic capacity. However, elite athletes intermittently use high-intensity continuous training to develop leg speed prior to competition.

Continuous training requires working at a level of intensity appropriate to one's fitness level and performance needs. Joggers need to work at only 50–60 per cent of their maximal heart rate. However, athletes in marathons, triathlons and five to 10 kilometre races need to work at higher levels of intensity. This is illustrated in table 12.3.

Figure 12.11: There are many forms of continuous training but they are all characteristically of low to moderate intensity and long duration.

Table 12.3: Ways of adapting continuous training to performance needs

Intensity (% maximal heart rate)	Pace/predominant energy pathway	Duration	Performance needs
50–60	Easy Aerobic	60 minutes +	Joggers Ultra distance runners
60–70	Moderate Aerobic	45–90 minutes	Marathon runners
70–80	Slightly faster Aerobic	35–40 minutes	Marathon runners 10 km runners
80–90	Fast Anaerobic	10–20 minutes	Marathon 5 km runners
90–100	Very fast Anaerobic	1–5 minutes	800 m runners 1500 m runners

Source: Based on <http://www.brianmac.co.uk/conintrn.htm>.

Aerobic, continuous training develops both glycogen and fat utilisation in the provision of energy. It improves cardiorespiratory efficiency, particularly stroke volume, contributing to significant reduction of heart rate both during work and at rest. The principle of overload is important in continuous training both to instigate adaptations and maintain the higher level of fitness achieved. The most effective way of doing this is to increase duration, which in turn increases work volume. Three to four times per week is generally sufficient to satisfy frequency requirements, although elite athletes will train on five to six days per week. Intensity can be increased up to a point. Once a person trains at 80–90 maximal heart rate, the anaerobic pathway gains greater benefits than the aerobic system.

High-intensity continuous training is performed at intensities between 80 and 100 per cent of maximal heart rate. This form of training is exceedingly strenuous and demands a lot of the athlete physically and psychologically. High-intensity continuous training can significantly deplete energy stores and contribute to muscle fatigue. For this reason, it is generally used on an occasional basis or when specifically required to improve leg speed or to develop the anaerobic pathway as might be required towards the conclusion of a marathon.

Athletes who typically benefit from continuous training are runners, cross-country skiers, joggers, cyclists, triathletes, footballers of all codes (particularly during pre-season) and graded tennis players. For some, continuous training is their predominant form of training. For others, continuous training provides the aerobic base on which to build many other fitness components.

Fartlek training

Like continuous training, Fartlek is also a beneficial form of aerobic training and can provide substantial cardiorespiratory benefits. Pace and terrain variations employed with Fartlek training mean that some thought and planning needs to be given to enable full benefits from this training technique.

There are many different types of Fartlek training. Elite athletes vary the type of Fartlek to suit their individual needs. For example, Watson Fartlek is used in preparation for cross-country. Whistle Fartlek may be used where motivation has waned or there is a need for variety. Types of Fartlek training and their specific features are summarised in table 12.4.

Table 12.4: Types of Fartlek training

Fartlek type	Target activity	Warm-up/ cool-down	Specific features
Watson Fartlek	3 km, 5 km, 10 km and cross-country	10 minutes warm-up 10 minutes cool-down	Stride hard for 4 minutes with 1 minute jog recovery Repeat 8 times
Saltin Fartlek	3 km, 5 km, 1500 m	10 minutes warm-up 10 minutes cool-down	Stride hard for 3 minutes with 1 minute jog-run recovery Repeat 6 times
Astrand Fartlek	800 m	10 minutes warm-up 10 minutes cool-down	Maximum effort for 75 seconds followed by 150 seconds jog-run Maximum effort for 60 seconds followed by 120 seconds jog-run Repeat 3 times
Gerschler Fartlek	General fitness Steady state running	10 minutes warm-up 10 minutes cool-down	Stride hard for 30 seconds, jog 90 seconds Repeat with 15 second decreases in recovery jog; for example, 30-90, 30-75, 30-60, 30-45, 30-30, 30-15 Repeat 3 times
Whistle Fartlek	General Provides variety	10 minutes warm-up 10 minutes cool-down	Run hard between whistle blasts. Pyramid session of 4 minutes, 3 minutes, 2 minutes, 1 minute, 2 minutes, 3 minutes, 4 minutes with a 60 second jog-run recovery between each run
Fartlek for games players	Games General fitness	10 minutes warm-up 10 minutes cool-down	Incorporate running, jogging, walking, change of direction, backward running, sprinting into creative patterns and movements

Source: Based on <http://www.brianmac.co.uk/fartlek.htm>.

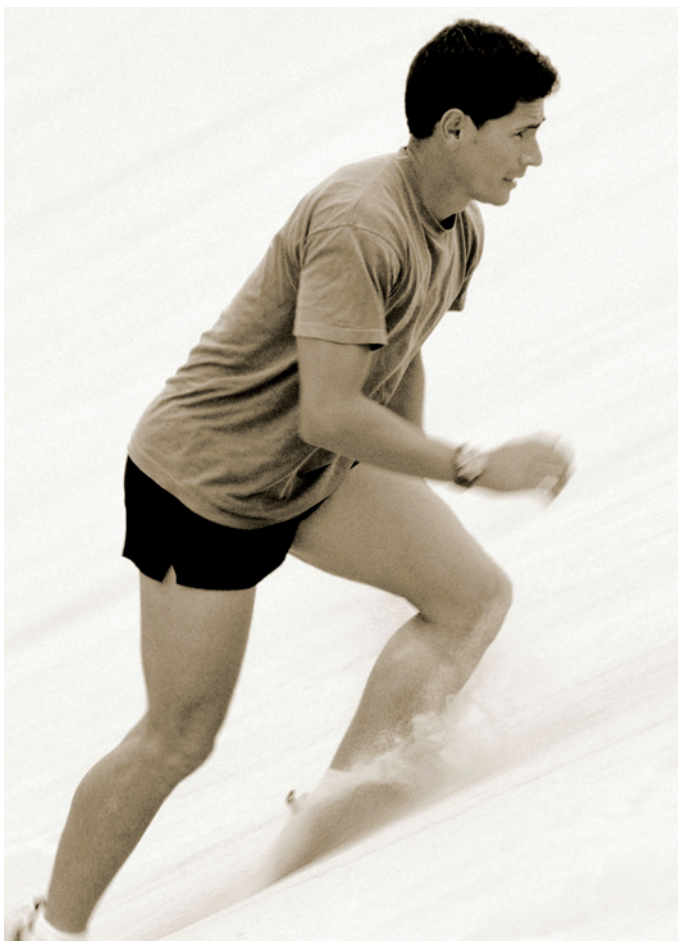


Figure 12.12: Fartlek training utilises speed play over a variety of terrain.

An all-purpose program for Fartlek training requires general running interspersed with periods of higher paced running over varying terrain. These short bursts may continue for 100–200 metres or so followed by recovery jogging. During the recovery period, ventilation rate should come back to where it was before intensity was increased and the jogger should feel that energy stores have been replenished. This period is then followed by another burst. However, the intensity level is marginally increased, challenging the overload principle. This cycle is repeated for the duration of the session. It is important that athletes learn to monitor their feelings and be aware of physiological responses, such as heightened levels of lactic acid, and modify effort appropriately.

A typical all-purpose session might include the following:

- warm-up: five to 10 minute jog
- steady run for 1.5–2 kilometres
- recovery: walking/jogging for five minutes
- speed work: periods of low-paced running followed by short sprints
- easy running incorporating three or four 'quick steps'. Follow this by quick acceleration/deceleration running.
- easy running for five minutes
- speed play: uphill/downhill for 100–200 metres
- easy running
- high-intensity running for two minutes
- repeat the program twice
- cool-down following final session.

For elite athletes, Fartlek training incorporates the same principles, but overload is increased and speed over short distances targeted for specific development. At this level, there is a strong resemblance between Fartlek and interval training. However, the biggest difference is that Fartlek training covers diverse terrain, uses variable interval distances and encourages pace judgement based on feelings rather than specific time requirements.



APPLICATION

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Fartlek training session

Use the **Fartlek training** weblink in your eBookPLUS. Use the information as a basis for construction of a sample Fartlek training session relevant to a sport or activity of your choice. Compare your session with those in the class.

Long interval

Long interval training uses repetitions of high speed intensity work followed by periods of recovery to develop aerobic fitness. Like resistance training, interval training has specific terminology. Intervals when repeated are called repetitions and a group of repetitions is called a set. Pace refers to the time taken

to run an interval. While this training method is commonly used to enhance anaerobic capacity, it has proved excellent in developing aerobic fitness.

Long interval training is a preferred form of training by distance runners, triathletes and footballers in preparation for competition. Unlike Fartlek training, long distance interval training is practised on athletics tracks or flat grounds. The principles are the same as for anaerobic interval training, except that the interval distances are considerably longer, the type of activity may vary within the interval and the rest period is shorter.

Work phases in long interval training usually range from two to five minutes and these are followed by rest phases that may be only 30 seconds. Variety can be added by changing the work–rest ratio each time an interval is run. For example, an interval with a work–rest ratio of five minutes:30 seconds could be followed by a five minute:45 second interval. Mixed intervals are then repeated for 30–40 minutes, ensuring that the aerobic system is progressively challenged.

There are a number of ways of organising long interval training. One method is to specify a set distance, say 400 metres, and run at a predetermined speed over the distance, reaching the finish within the allocated time period. This is followed by walk recovery and a repetition of the run until the required number of intervals has been completed. An alternative method is to vary the activity within the interval between jog, walk, run and rest. The interval distance can be set at, say, 600 metres, or varied as in a ‘ladder’ workout where interval distances could change from anywhere between 400 and 1600 metres or more, depending on which interval was being run. This latter method provides a lot more variety and suits athletes whose competition demands require work over multiple distances.

Interval training has the advantage of being able to be tightly monitored while providing variety within the workout. It can even be performed at fitness centres using stationary bikes and rowing machines. Near maximal workouts over pre-established time periods are followed by rest recovery or low-intensity recovery, effectively mimicking an outside workout.

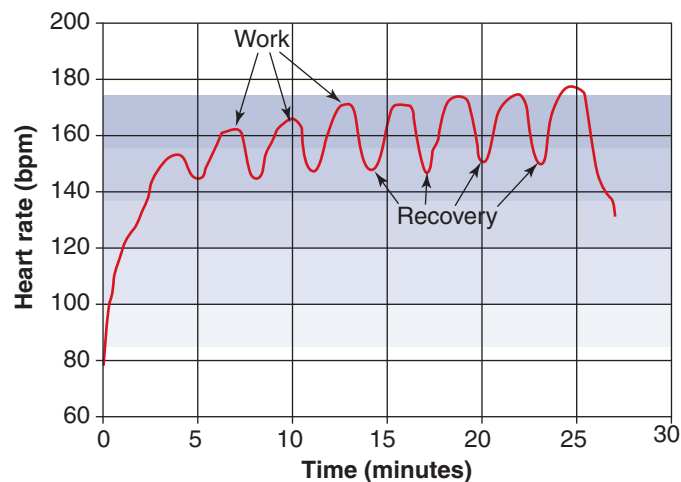


Figure 12.13: A typical graph showing heart rate response to work–recovery intervals over a period of time

Aerobic training improves energy supply and performance of the aerobic system. The effects of training on the aerobic system are summarised in table 12.5.

Table 12.5: The effects of training on the aerobic energy system

Area	Effect	How this improves training
Fuel storage and utilisation	Increased haemoglobin	More oxygen is carried to the working muscles.
	Increased myoglobin	More oxygen is delivered from the cell membrane to the mitochondria where fuel is burnt.
	Increased ability to use fat	The reserve fuel can be used earlier in endurance events.
	Increased storage of ATP and CP	Immediate fuel storage is increased up to 25 per cent.
	Increased glycogen storage	Fuel for lactic acid and aerobic systems is increased.
	Increased ability to use glucose	Increased enzyme activity enables faster breakdown of glycogen.
Oxygen transport system at rest	Increased heart size	This is particularly evident in size of left ventricle, making more blood available per beat.
	Decreased heart rate	This is a sign of increased heart efficiency, as it is able to supply the required blood with less beats/minute.
	Increased stroke volume	More blood is available per stroke.
	Increased cardiac output	More blood is available to tissues.
Oxygen transport system at maximal exercise	Increased oxygen uptake	There is an increased ability of muscles to extract and use the oxygen being delivered in the blood.
	Increased cardiac output	More blood is available to tissues.
	Increased stroke volume	More blood is available per stroke.
Respiration	Increased efficiency	More oxygen is extracted from air to alveoli and delivered to muscles.
Other	Increased muscle size	This produces more strength.
	Decreased body fat	There is less excess to carry in endurance events.
	Increased strength and power	Produces faster, more forceful movements.
	Increased muscle elasticity	There is increased muscle power and less likelihood of injury.
	Increased mitochondria	There are more sites on muscle fibre for burning fuel.



INQUIRY

Aerobic training

Choose a sport or activity where aerobic fitness predominates. Construct a list of activities that would be useful in developing aerobic fitness relevant to your selection. Include continuous, Fartlek and long interval components. Arrange the activities into a program that could be used over a one week period. Ensure that issues related to frequency, intensity, duration and variety are addressed together with ways of measuring improvement.

Discuss your program with the class.

Anaerobic training

The **anaerobic system** functions to enable energy production during the absence of oxygen.

Training for improvement in speed and power relates specifically to the **anaerobic system**. Development in this area helps athletes to hit harder, jump higher, run faster and throw further. These attributes are required in a range of games, individual sports and all athletic events.



Figure 12.14: Anaerobic training targets explosive type movements and activities.

Developing power through resistance/weight training

The anaerobic system is the dominant pathway for energy supply during explosive activities such as weight-lifting, throwing and sprinting. An athlete who trains for anaerobic events using exercises and practices that simulate what is required in the game or activity will further develop the capacity of the fast-twitch fibres.

Power is the rate at which force is produced per unit of time.

Resistance training builds **power** through recruiting and enlarging muscle fibres. Power equals force x distance divided by time, and, as such, can be increased by manipulating any one of the three variables — force, distance or time — while keeping the other two constant. For example, power is increased by decreasing the length of time a movement is performed while keeping force (resistance) and distance constant. This equates to performing a movement explosively. Therefore, to increase power using resistance training, movements need to be performed quickly, causing preferential recruitment of fast-twitch fibres.

Figure 12.15: There are many ways of creating resistance to increase power.



Starting strength is the ability to ‘turn on’ as many muscle fibres as possible in the performance of a movement.

Explosive strength is the ability to extend the ‘turned on’ period of explosiveness.

Strength is a major component of power. This gives rise to the term ‘strength dominated power’, which refers to power in which strength is the dominant ingredient. **Starting strength** and **explosive strength** are two important components that influence power development.


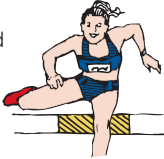
Starting strength is very important in movements such as power lifting, where inertia must be overcome and momentum generated before residual ATP supplies are depleted. Remember that we have sufficient ATP for a short explosive movement lasting a second or so. Following that, we rely on resynthesis of ATP by the reserve energy substance, creatine phosphate, to enable us to continue the movement. ‘Turning on’ high numbers of motor units energises athletic movements, making them characteristically explosive.

The explosive strength phase is characterised by the application of force at a rapid rate and seen in acceleration of the body or object. The muscle fibres contract quickly as creatine phosphate works rapidly and repeatedly, resynthesising ADP back to ATP. Explosive strength is important in activities such as shot-put, javelin throwing and high jump. The development of strength to improve power is crucial. However, emphasis on strength development at the expense of explosiveness results in strength production but with an inability to make the movement powerful. The resultant action has a low rate of utilisation of fast-twitch fibres, preventing a quick contraction of muscle fibres.

Resistance training programs designed to develop power and speed seek to enhance fast-twitch fibres involved in the activity. These are recruited when exercises are performed at speed and closely resemble the movement required in the sport. If the resistance (weight) is too heavy, the exercise will necessarily be performed slowly, leading to recruitment of slow-twitch fibres. A power-dominated resistance training program for a high jumper would address general strength throughout the body, but give particular attention to leg flexion and extension exercises in accordance with the power prescription.

An exercise prescription for the development of power is illustrated in table 12.6.

Table 12.6: Prescription for developing power in a resistance training program

Purpose	Weight resistance	Repetitions	Sets	Exercise speed	Time between sets (mins)
Power (beginners/ non-competitive adults) 	Medium-heavy 60–75% RM	5–10	3–5	Fast	Medium 2–3
Caution needs to be heeded with power programs as heavy weights lifted quickly can cause injury. Beginners should use medium weights and focus on correct technique. Train on 3 days per week.					
Power (experienced athlete) 	Heavy 75–85% RM	3–8	3–5	Fast	Medium 2–3
Weight chosen must allow a fast action. If the weight is too heavy, endurance will develop at the expense of power. At least 2 minutes between sets is essential to enable sufficient phosphate recovery in the muscle to power another explosive action. Train on 3–4 days per week.					

* RM = repetition maximum = the maximum weight a person can lift a specific number of times (e.g. 8 RM is the maximum weight that can be lifted eight times).

To develop speed, the resistance is medium to high and the contractions are executed quickly. Movements, although fast, must be rhythmical. By commencing slowly when beginning a program and working on technique, speed techniques can be developed in a smooth, sustainable manner. The principle of specificity to the activity is important. Activities requiring application of explosive forces to propel implements (discus, javelin and shot) require higher resistances and fewer repetitions during resistance training. Programs designed to develop power and endurance (for sports such as basketball and soccer) require use of moderate resistance, with more repetitions than required for explosive activities. However, there still needs to be emphasis on speed during execution of the movements to ensure appropriate power development.



APPLICATION

eBookplus

Plyometrics refers to a special range of exercises in which a muscle is lengthened using an eccentric contraction and this is rapidly followed by a shortening or concentric contraction.

Resistance training program

Use the **Resistance training** weblink in your eBookPLUS. Use information at the site together with what you have read to design a resistance training program that develops power/speed for a specific sport. Detail your exercise prescription.

Plyometrics

Gains in strength can be converted to power only by the use of specific training approaches that 'program' the muscle fibres to contract quickly. One of the most widely used practices for doing this is **plyometrics**.

Plyometrics has considerable value in power development because it has been demonstrated that if a muscle is stretched (preloaded) before it is shortened, it will contract more forcefully. The elastic recoil of muscle fibres results in a more powerful movement. In other words, a muscle has the potential to develop maximum tension if it is stretched rapidly. The faster it is forced to stretch, the greater will be the tension that can be applied.

Plyometrics has been used for a number of decades to improve performances in sports such as athletics, basketball, Australian rules and weightlifting, where the development of reactive power is critical. Exercises that use plyometrics type movements use body weight and gravity to instigate the eccentric contraction or 'cocking' phase that energises the muscle's recoil ability.

Instinctive use of plyometric principles is seen in athletes such as high jumpers, who lower their centre of gravity immediately prior to the jump. Also, a person performing a vertical jump is always observed bending knees and dropping their arms to their sides just prior to the jump. Typical movements used in what is commonly called explosive jump training are standing jumps, multiple jumps, depth jumps and bounding. Many of these are illustrated in figure 12.16 (page 480).



APPLICATION

eBookplus

Developing a plyometrics program

Develop a series of plyometric exercises that might be suitable for a sport you play or a sport you like. A range of plyometric exercises is available at the **Plyometrics** weblinks in your eBookPLUS.

As a class choose the 12 best and have students whose exercises have been selected demonstrate that exercise to the class. Compile the exercises and elect one student to run the class through the program.

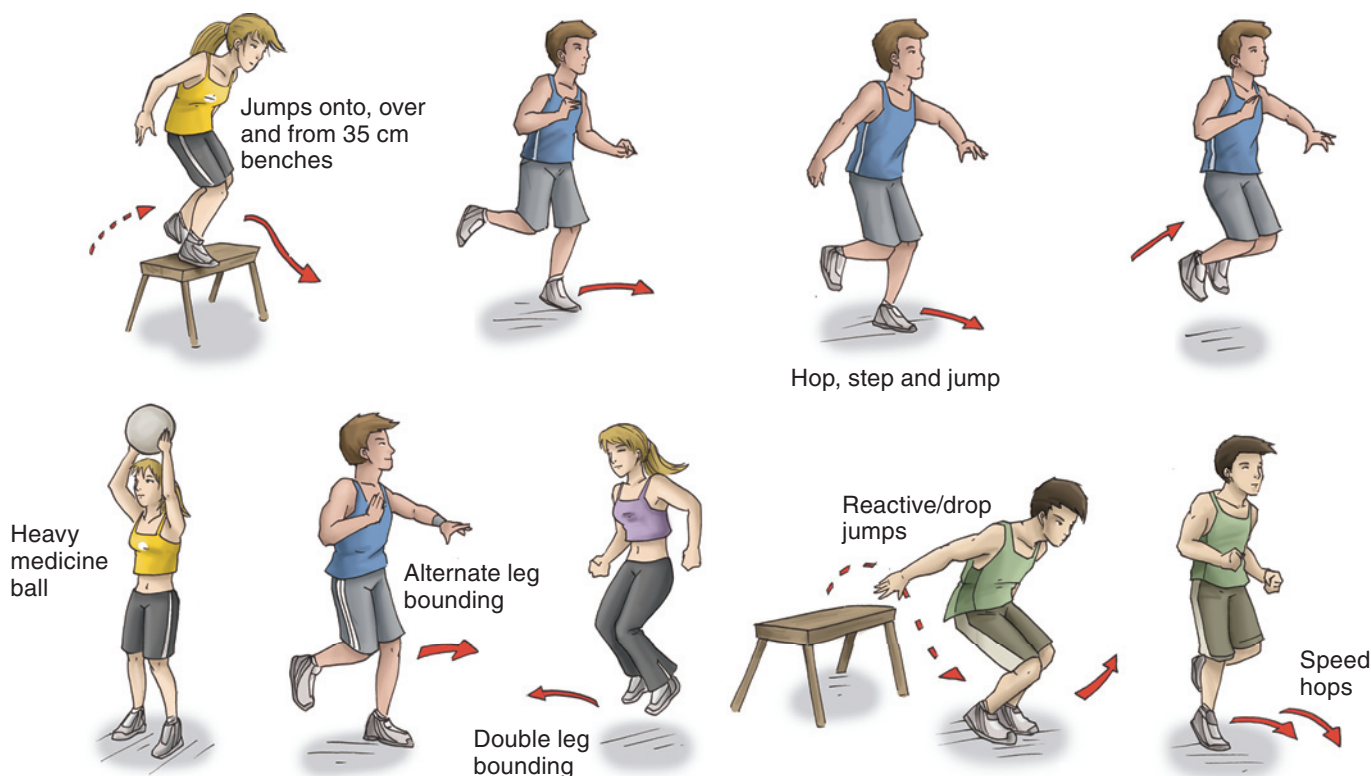


Figure 12.16: Examples of high-impact plyometric drills



INQUIRY

Using power programs safely

Outline the potential dangers of resistance training programs for power and plyometric training. What precautions need to be taken before commencing power programs?

Short interval

Short interval training is similar to long interval training except that the intervals are brief and recovery longer to enable restoration of ATP stores. Once again, the method involves alternating short bursts of intense activity with periods of rest or recovery. Initially, low intensity intervals supported by sufficient recovery should dominate the training program. However, as fitness improves, progressive adjustments to variables (rest, intensity, distance, repetitions) must ensure that the program addresses the overload principle. Ultimately, short interval training aims to raise the anaerobic threshold.

Interval training should be adapted to meet the specific needs of the sport, activity or fitness goals. If short interval training is aimed at improving performance in games, work intervals should mimic patterns and directions that will feature in the game. This may require short runs with sidesteps, swerves and/or pivots and an acceleration/deceleration phase to follow.

Short interval training improves the ability of the muscles to tolerate lactic acid. Work that is of very high intensity and of short duration engages the anaerobic system. An ATP-PC target interval program might require the athlete to work at 95 per cent intensity for 15 seconds and follow this with a one minute recovery. This will allow almost complete resynthesis of creatine



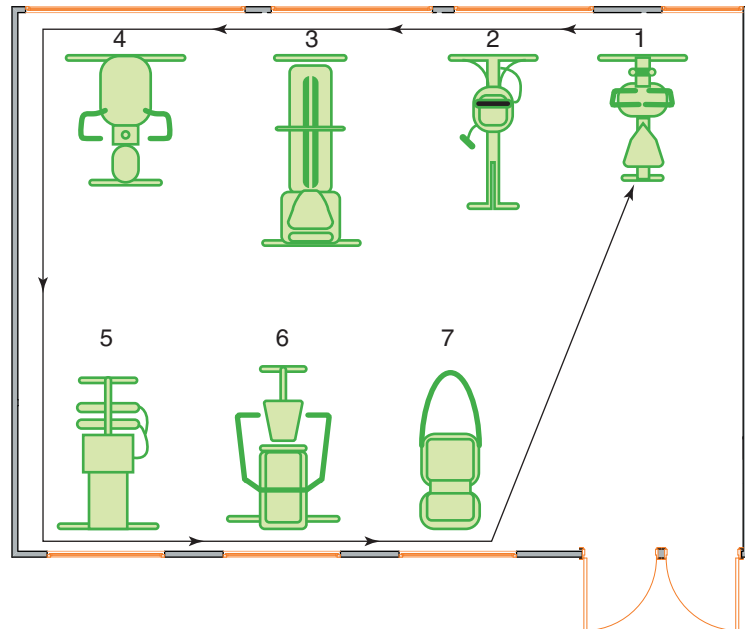
Figure 12.17: Short interval training increases the capacity of the anaerobic system.

phosphate stores. Fifteen to 20 repetitions would then be required to complete the set.

In contrast, a short interval program that targets lactic acid system enhancement would require less intensity (75–85 per cent) but a longer distance, taking around 30–45 seconds to complete each repetition. This effort produces lactate as the anaerobic threshold is approached and possibly exceeded. Increased tolerance to lactate is a reward for training at this level of intensity. This type of interval training requires the athlete to use active recovery such as walking or a slow jog to assist dispersal of lactic acid.

Short interval training can also be performed utilising a circuit format. This may have stations where short sprints are required, but other stations where resistance training exercises such as push-ups, together with other activities such as skipping, plyometrics and agility drills, are incorporated. Each specific exercise is the work component while the rest interval is taken while moving to the next station. Short interval programs can also be developed using stationary cycles in fitness centres and using the same technique for work:rest periods as just mentioned.

Figure 12.18: Gymsnasiums and fitness centres provide ideal settings for short interval anaerobic training using machines and utilising a circuit format.



Following is an example of how short interval training can be applied to a games program.

1. Warm-up: three to five minutes
2. Two minutes moderate or high-intensity sprints
3. Two minutes low-intensity jogs, forward, backward and sideways
4. Repeat steps 2 and 3
5. One minute high-intensity agility sprints
6. One minute moderate-intensity recovery runs
7. 30 seconds high-intensity bursts through markers, simulating evading opponents

8. 30 second low-intensity recovery jog
9. Repeat steps 7 and 8 four times
10. Six, 50 metre sprints followed by one minute recovery
11. Five minute cool-down.



APPLICATION

Flexibility is the range through which joints and body parts are able to move.

Short interval training

Choose any sport. Investigate and develop a short interval training program suitable for that sport. Conduct a selection of your programs with the class.

Flexibility training

Flexibility training requires that muscles stretch or lengthen safely. Muscle strength and muscle length are both directly related to the number of muscle fibres engaged. Just as muscle contraction is more forceful if many fibres are engaged, the total length of a stretched muscle is proportional to the number of fibres stretched. When a muscle is stretched, some fibres lengthen while others remain at rest. The more muscle fibres that are stretched, the more length is developed by the muscle for a given stretch.

Stretching and improved flexibility are important for a number of reasons, including:

- injury prevention
- injury rehabilitation through stretching scar and surrounding tissue, making it more functional
- improved skill execution
- minimising post-exercise muscle soreness, particularly through use of static stretching
- reducing musculoskeletal discomfort through postural improvement.

All stretching movements need to be safe. The body has an in-built safety mechanism called the *stretch reflex* to warn about elongating fibres beyond safe limits. When the muscle is stretched, so is the muscle spindle, which then acts to register changes in length of the fibre. The message is sent to the central nervous system (CNS), which activates the stretch reflex. This unit responds by causing the stretched muscle to contract.

The more abrupt the change in muscle length, the more forceful will be the muscle contraction. This mechanism helps to protect the body from injury. Safe flexibility exercises require stretches to be slow, controlled and sustained for periods of time. This allows the muscle spindle to become accustomed to the new length and, as a result, reduces its signalling to the central nervous system. Stretching on a regular basis is advocated to progressively teach stretch receptors to allow greater lengthening of the stretched muscles.

Flexibility is affected by a number of factors including:




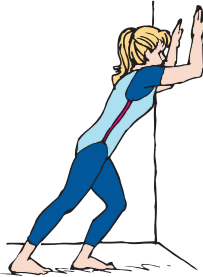
- *age* — muscles shorten and tighten with age
- *gender* — generally speaking, females are more flexible than males
- *temperature* — increased temperature, both atmospheric and body, improves flexibility
- *exercise* — people who are frequently involved in exercise are usually more flexible than sedentary people
- *specificity* — flexibility is joint specific. The fact that a person is flexible in the shoulders does not automatically mean similar flexibility exists in the hips.

A flexibility training program needs to be conducted with certain guidelines in mind. These include:

- performance of a safe stretch program on at least three to four occasions per week
- ensuring muscles are warmed up before stretching
- stretching no further than the muscles will go without pain
- not aiming at excessive flexibility, as this causes joint instability and increased risk of injury.

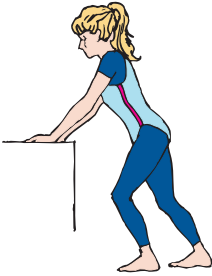
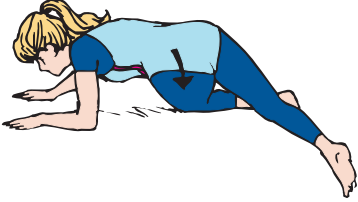




Team sports such as football, basketball, netball and hockey can cause muscle tightness and shortening because the muscles do not experience the full range of movement. Stretching during the warm-up and cool-down phases can promote the flexibility that will assist these activities. The overload principle applies equally to flexibility training. In other words, the muscle must be stretched beyond its normal length (by approximately 10 per cent) to cause changes to take place; that is, to increase flexibility. Table 12.7 illustrates some stretching exercises that could comprise a flexibility program for sprinting.

Table 12.7: Stretching exercises for a sprint training program

Stretch	How performed	Illustration
Quadriceps stretch	Clasp the foot first with one hand and pull the foot towards the buttocks. Keep knees close together. Do not arch the back or flex the hip. Tilt the pelvis posteriorly and shift the front of the thigh forward. Do not flex at the hip. Repeat with other foot.	
Hamstring stretch	Standing, let the knees bend as you touch your toes. Now straighten one, then the other. Do not bounce. Now cross the legs and repeat to stretch both hamstrings.	
Adductor stretch — sitting	Sit with soles of feet together and with the elbows resting on the inside of the knees. Gently counter-resist on the knees, then relax and let the legs stretch closer to the floor.	
Calf stretch	Leaning against a wall, lift the arch of the foot slightly. Keep the hip and the knee in a straight line and lean forward. Stretch each leg separately. Do not let the arch collapse to a flat-footed position as you do this stretch, as this may cause overstretching of ligaments in the foot.	

(continued)

Table 12.7 (continued)

Stretch	How performed	Illustration
Achilles and soleus stretch	Leaning against a table, lift the arch of the foot slightly. Keep the hip and the knee in a straight line and lean forward. Now bend the knee to stretch the Achilles tendon and soleus.	
Advanced hip stretch	In the cat stretch position, place one leg at 45 degrees to the body over and behind the other leg. Place the top of this foot to the floor. Let body weight gently stretch into the hip of the bent leg. Do not collapse to the floor.	
Hip abductor stretch	Place the leg to be stretched behind the toes eight to 10 centimetres away from the opposite heel. Turn the toes of the behind leg inwards 30 degrees and let body weight fall into this hip. You may need to rest on heels to get a more effective stretch.	
Latissimus dorsi stretch	Sit with one leg bent and the foot just resting against the inside of the opposite thigh. Place the opposite hand on this leg then bring the other hand over and reach towards the outstretched leg. Clasp the outside of the ankle, look under the elbow and pull up to stretch the side of the trunk.	
Triceps stretch	Put one hand up and behind the neck and resist against the other hand which is placed on the back of the wrist. Point the elbow to the ceiling.	
Knee hug stretch	This is for the hip, gluteus maximus and lower back. Pull one knee up on to the chest. Progress to bringing the forehead to the knee. Advance by keeping the outstretched leg off the ground as you stretch each leg. This will strengthen the abdominals as you stretch the hip extensors.	

Source: Adapted from F. St George, *The Muscle Fitness Book*, Simon & Schuster, Sydney, p. 219.

Static, dynamic and ballistic stretching are three forms of flexibility training commonly used by athletes as part of training routines and prior to performance. Many athletes use two or three forms of stretching depending upon the demands of the competition. The principle of specificity when applied to stretching programs suggests that static flexibility is improved by static stretching, while dynamic flexibility is improved by dynamic type movements. Additionally, it should be noted that flexibility is speed specific; that is, the type of movements following stretching that benefit most are those performed closest to the speed developed during warm-up stretching. Some evidence suggests that dynamic stretching is best for the warm-up and static stretching for the cool-down, although a combination of both is preferred for games-based activity.

Static flexibility

Static stretching is a safe form of stretching in which the stretch is held for a period of 10–30 seconds.

Static stretching is a technique whereby a muscle is gradually lengthened and held in that position for a period of 10–30 seconds. Static stretching is commonly used because it is safe and does not require the use of equipment. The movement is smooth and is performed slowly, taking the muscle to a point where there is stretch without discomfort. Static stretching is used extensively in the rehabilitation of injury and the warm-up and cool-down phases of training. An example of a static stretch is sitting down with legs extended and gently reaching forward to hold the toes (without bouncing).

Figure 12.19: Examples of static stretches



APPLICATION

Static flexibility

Brainstorm the class for a range of 10 static flexibility exercises. Have one student organise a warm-up and run the class through the exercises. Choose the best five and list them in your workbook for reference.

Dynamic flexibility

Dynamic flexibility is the ability to perform extensive muscular movements causing joints to go through a full range of motion.

Dynamic flexibility training involves making slow controlled movements through the full range of motion. During dynamic flexibility movements, specific parts of the body such as the arms are moved (for example, circling) in a gradual, controlled manner while reach and speed is gradually increased. There are no jerky movements. The stretch reflex is important in establishing the safe limit to the range of motion.



Dynamic stretching is a lot safer than ballistic stretching. It is more effective in raising muscle temperature and core body temperature, effectively decreasing the risk of injury. Where activities or sports require slow controlled movements, such as in balance beam routines and ice skating, static stretching is the preferred form of flexibility training. However, where muscles need to be stretched in preparation for forceful movements such as kicking, dynamic stretching is the preferred flexibility method.

Figure 12.20: Dynamic flexibility exercises aim to mimic movements required in the sport or activity.

Ballistic stretching involves repeated movements such as punching and bouncing to gain extra stretch. It should be practised only by elite athletes, and with care.

Ballistic flexibility

Ballistic stretching is used in preparation for athletic events in which explosive movements are required. This type of stretching involves forcing parts of the body beyond the normal range of motion. Ballistic tasks involve activities such as hurdles, boxing, high kicks in aerobic competitions and certain movements in gymnastic routines.

Ballistic stretching is potentially dangerous as it activates the stretch reflex that prevents muscle fibre damage through overstretching. For this reason, ballistic stretching should be used only by advanced athletes and even then should follow a thorough warm-up and another form of stretching. The movements must be controlled and executed rhythmically to avoid jerky actions and excessive momentum at the end point of the stretch. Violent ballistic stretching causes micro-tears in muscle fibres, weakening the tissue or even rupturing the muscle or tendon. An example of ballistic stretching is touching toes using a bouncing motion, as illustrated in figure 12.21.



Figure 12.21: Touching toes using a bouncing motion is an example of ballistic stretching. It should be used only by elite athletes under supervision as it can damage muscles through overstretching.

Skill training

Skills are the fundamental components of games and sporting activities. They represent the building blocks for better movement execution and the basis on which to assemble advanced techniques. Once taught, skills are practised in drills and applied in games. The process of skill development and refinement is continuous, with even the most elite players spending considerable time cultivating mechanical and technical efficiency.

Quality skill training stems from effective coaching. Skill development relies on correct analysis and the provision of feedback. This entails knowledge of technique, observation, teaching skills, provision of suitable skill-building drills and advice regarding performance. Aids such as demonstrations and videos may also be useful in identifying strengths, faults and deficiencies in the performance. When observing skill in action, it is important to initially concentrate on large, slow movements, then on the smaller, faster movements.

The focus of skill training is technique development and correction. Coaches need to be aware that all players will not necessarily perform a skill in exactly the same manner. One has only to observe elite sportspeople to see a range of techniques applied to serving a tennis ball, swinging a golf club or swimming. These occur because of differences in player height, weight and mechanics. However, corrections are essential if the manner in which the skill is being executed can be improved or if the current technique is undermining performance.

Skill building through drills is the backbone of any games based training session. Once players are warmed up and conditioned, coaches need to spend the majority of the remaining time on skills practices. These need to specifically target:

- improvement in the fundamentals of the game
- individual needs in specific areas — for example, ball handling
- performance under gradually increasing pressure
- provision of enjoyment through competitive situations
- an increase in knowledge of the game
- development of cognitive or thinking abilities
- development of communication via skills practices.

Many skills are difficult for young players to learn and need to be broken down into **subroutines**. For example, the subroutines in the layup in basketball for a right-handed player consist of catching the ball in the air, landing on the right foot, stepping onto the left foot, driving towards the basket, releasing the ball and landing. This is called the part method of teaching. However, as the movement is learned, the skill can be incorporated into a skills practice situation such as continuous layups from one side of the court. As **temporal patterning** develops, the challenging nature of skill learning can be increased by adding to the range of skills that needs to be mastered to complete a movement.

Drills practice

Players learn physical skills through repetition of movements in what are called *skills practices* or *drills*. The players need to grasp a mental picture of the skill through demonstration/video and be made aware of the important points in learning the skill (teaching points). During a drills practice, the



Figure 12.22: Skill building involves an interaction of cognitive and movement processes.

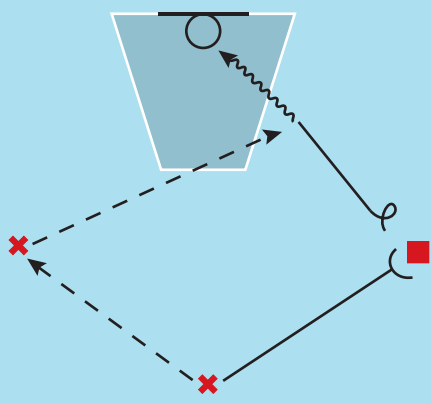
Subroutines are the individual components that collectively comprise a skill.

Temporal patterning refers to the ability to execute the subroutines in correct sequence.

Pass, screen away and cut

Pass left, move right and set screen.
Reverse pivot, move to basket, receive
ball and drive for layup.
Rotate anticlockwise.

→ Pass C Screen
~~~~~ Dribble      P Reverse pivot



**Figure 12.23:** A drill commonly used in basketball

player focuses on executing the selected skill as correctly as possible. There will be errors in the initial stages but, with practice, feedback and refinement, the player will gradually improve.

It is important to have a variety of drills for teaching a particular skill or combination of skills. Skills taught repeatedly under the same conditions and using the same situations do not challenge players and lead to loss of interest and motivation. Effective coaches plan their drills and illustrate them on paper for quick reference. An example is shown in figure 12.23. Drills can be varied by changing the complexity of the activity, concentrating on one or more skills, using a real game or small-side games and by changing group organisation (for example, individual, pair, grid work).

## Modified and small-sided games

These are fun games often organised on smaller modified areas of play, but requiring the use of the same skills as the real game. These games can be used to focus on particular skills and provide the opportunity for players to apply newly learned techniques. Minor games add fun and enjoyment to a training session. Examples include end ball and corner ball for basketball and netball.

Small games are an important part of skill training because they mimic the major game but have fewer players — for example, three-on-three basketball or five-a-side hockey. They are played under game conditions and provide the opportunity for all players to be involved continuously. Small-sided games cater for skill development, fitness, decision making and tactical awareness

opportunities. Small games can also be used to impose certain conditions (conditional games) on the play in order to practise a particular skill; it might require, for example, that all shots at the basket must be jump shots.

## Games for specific outcomes

Small games can often be created to achieve a specific outcome. Examples of specific outcomes might be to improve:

- defensive skills
- attacking ability
- ability to create space
- ability to find and utilise support
- ability to target an opposition weakness
- decision making and tactical awareness.

Small games such as these provide opportunity for concentrated practice and decision making within structures that closely resemble the game situation. It is similar to taking a small part out of a big game, analysing it, developing options and rehearsing these in preparation for the main event.

Some games target specific outcomes such as improved decision making or the development of tactical awareness. For junior players, initiative games that focus on solving problems in a movement context may be used as a lead up to more complex situations. With older players, *phase practice* is often used to achieve this outcome. Phase practice involves the repetitive practice of a specific part of the game under competitive game conditions — for example, passing into the circle in netball and positioning for a corner in hockey. The emphasis is on repetition, improved skill execution and decision making. This practice may be performed with or without opposition — for example, a three-on-one drill.



**Figure 12.24:** Small-sided games such as three-on-three basketball can help athletes to train in the use of specific skills.



In certain situations, *functional practice* may be necessary to address a specific element in a game that is causing concern. Functional practice involves use of small games or drills that directly target the skill of a particular player or group of players who have a special function in the game — for example, the forwards in rugby union or shooters in netball. These games are designed specifically to make use of particular players' strengths or improve weaknesses, and be practised with or without opposition.

An example of how functional practice improves the attacking ability of forwards and the defensive ability of guards is playing two-on-one half-court basketball. In this game there are two offensive players (forwards) against one defensive opponent. Offensive players need to decide how to draw an opponent to them and offload the ball to their team-mate who has moved to a more favourable scoring position. Meanwhile, the defensive player needs to think how to best prevent a basket being scored by using position, skill, anticipation and knowledge of where to move to minimise the imbalance.



## APPLICATION

### Developing a skills practice

Using a game of your choice, develop a drill that can be used for learning a particular movement such as a layup in basketball or tackling in football. List teaching points and illustrate player movements using a legend, like the one shown in figure 12.23. Present your skills practice in small groups.

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## INQUIRY

### Training to improve performance

Draw and complete a web or bubble map to summarise responses to the critical question 'How do athletes train to improve performance?'

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## INQUIRY

### Analysing training types

Choose one of the following training types:

1. strength
2. aerobic
3. anaerobic
4. flexibility
5. skill.

Develop a PowerPoint presentation that:

- briefly describes the features of that training type
- explains how that training type best suits specific performance requirements, such as flexibility training for gymnastics
- illustrates a relevant training program
- identifies how training adaptations can be measured and monitored
- recommends safe training procedures
- identifies potentially harmful training procedures.

Take turns to show your PowerPoint to the class. Discuss each PowerPoint and, in particular, how well it addresses the areas of concern.

Use your PowerPoint structure and information you have gained from others to investigate and analyse *one* of the remaining four training types. Draw up a table that shows a comparison of the two types you have investigated.

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# PLANNING CONSIDERATIONS FOR IMPROVING PERFORMANCE

## CRITICAL QUESTION

*What are the planning considerations for improving performance?*

Success in any competition requires careful planning, organisation and commitment. Lack of effective planning leads to frustration and failure. Effective planning encompasses a range of challenges including considerations that relate to individual needs, team goals, events, environments, skills and fitness.

## Initial planning considerations

Training programs need to be thoroughly planned if the potential of players and the performance of teams are to be optimised. Short-term training sessions need to be linked to long-term training plans that measure improvement against established goals.

## Performance and fitness needs

Effective programs are developed based on data gained from previous seasons and current performances. Data are gathered in the form of tests, standards, statistical information, equipment needs, social interactions and performance records. This information becomes the basis of planning that will address both individual and team considerations. Performance and fitness elements need to be considered in terms of both individual and team requirements. For example, some individuals may have maintained a high level of fitness during the off-season; the team's performance during the last season was poorer than expected due mainly to fitness concerns. Some of these considerations are listed in table 12.8.

**Table 12.8:** Individual and team planning considerations

| Individual                                                                                                                                                                                                                                                                                                                                                                             | Team                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• physical fitness</li><li>• physical attributes such as strength, power, endurance and flexibility</li><li>• skills such as running and batting</li><li>• development of game sense and tactics</li><li>• psychological considerations such as arousal and motivation</li><li>• social considerations such as friendships and support</li></ul> | <ul style="list-style-type: none"><li>• establishment of team goals</li><li>• development of tactics and strategies that involve groups of players such as line-outs for rugby forwards</li><li>• organisational considerations such as training days and venues</li><li>• leadership issues such as captaincy</li><li>• allocation of support roles such as managers and equipment personnel</li></ul> |



**Figure 12.25:** Individual fitness needs to be addressed early so that team performance goals can materialise. If individual members of a rugby forwards pack have not attained full fitness, the team's performance in the scrums will be poor.



**Figure 12.26:** Proper planning requires an overview of all major events and competitions.

**Figure 12.27:** Planning for training, safety and protection of athletes needs to consider both the climate and season. For example, fluid is essential in hot conditions to help avoid heat stress.

## Schedule of events/competitions

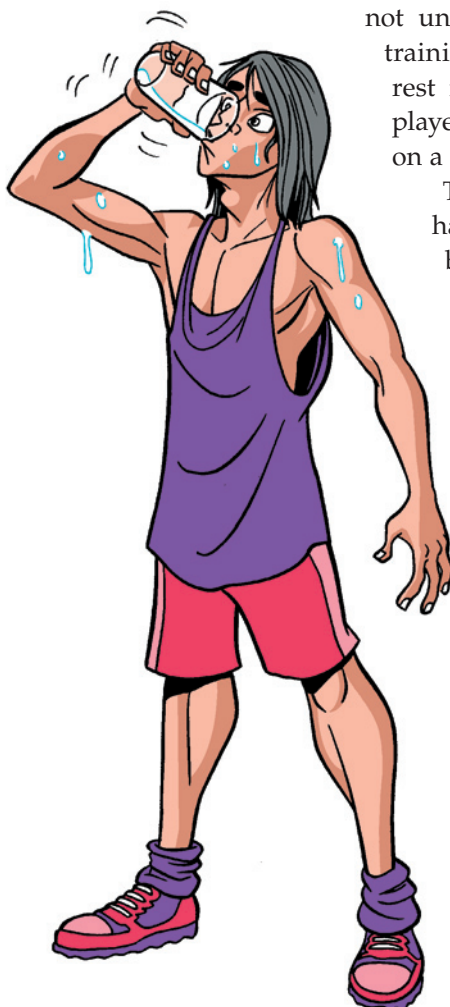
Planning must address the competition period to ensure that players are fit and game strategies are in place. In games competitions where players usually compete weekly, but over a long period of time, players need to peak regularly and be prepared for training one or two days after. In the long term players need to have an elevated level of preparedness for finals. Training plans need

to reflect schedules and ensure that players are not underloaded or overloaded in terms of training volume. Intervals of training and rest need to be scheduled so that games players are able to rise to competition needs on a cyclic basis.

Track athletes and swimmers usually have totally different schedules, with big events occurring periodically throughout the year. Once again, training programs must address schedules to ensure that peaking occurs at competition time, which means that training volume must be effectively managed.

## Climate and season

Initial planning needs to consider seasonal variations together with climatic influences. It is important that athletes are fully prepared in terms of attire both for training and during competition. Heat, wind, rain, cold, fog and humidity are examples of climatic influences that require the implementation of specific strategies. For example, protective/reflective clothing, sun-screens and fluid may need to be provided to athletes to prevent heat stress during hot weather.



## INQUIRY

## Planning for performance

1. Describe specific considerations that should be addressed in planning for performance in events and competitions.
2. Copy and complete a table like the one below to summarise the specific considerations for an elite athlete and an amateur participant planning to perform in events and competitions.

| Elite athlete | Recreational/amateur participant |
|---------------|----------------------------------|
|               |                                  |
|               |                                  |
|               |                                  |

**Periodisation** is the process of structuring training into manageable phases.



## INQUIRY

eBookplus

# Planning a training year

Effective planning requires that the training year be divided into manageable areas, making establishing and measuring targets and goals a realistic proposition. The process of structuring training into phases or periods that can be managed independently of other periods is called **periodisation**. Periodisation has a number of purposes:

- training volume and intensity can be monitored and adjusted where necessary
- time periods to allow adaptations to take place are programmed
- overtraining and undertraining problems should not occur.

## Periodisation

Use the **Periodisation** weblink in your eBookPLUS and read the information about traditional and block periodisation methods. Briefly summarise how to use the traditional periodisation method in structuring training for an individual sport.

## Phases of competition

There are three distinct phases of competition: pre-season, in-season and off-season. Each of these phases has specific demands in terms of goals, needs, and training and performance requirements.

### Pre-season (preparation phase)

This phase might last from six to 12 weeks or longer, depending on the type of competition. It requires a high volume of training at moderate levels of intensity. The training needs to target the appropriate energy system. As a result, training sessions are longer in an effort to increase stamina together with mental aspects, such as increasing drive and commitment. The basic aims of the pre-season phase are to:

- improve all aspects of fitness, such as strength and flexibility, and particularly those specifically required in the sport
- develop technique
- improve performance biomechanics
- introduce strategies and familiarise players with them
- teach appropriate mental skills.

These aims are best achieved through programs that focus on endurance, strength and skill in a variety of environments. Examples of commonly used methods include:

- continuous training
- Fartlek training
- interval training
- circuits
- resistance work
- variations of long slow work with short fast work.

Important fitness components such as speed, strength and flexibility need to receive specific attention. Towards the end of the pre-season phase, physical condition and quality of skill performance (for example, technique, biomechanics and strategies) should have reached the targeted level.



**Figure 12.28:** Developing fitness is a major aim of pre-season training.



### In-season (competition phase)

The competition phase varies in duration, depending on the sport. During this phase, maintaining fitness developed in the pre-season phase is continued. However, a general increase in intensity is matched by a corresponding decrease in volume. In other words, less time is spent on continuous repetitive work, but the effort put into training escalates. The aim during this period is to:

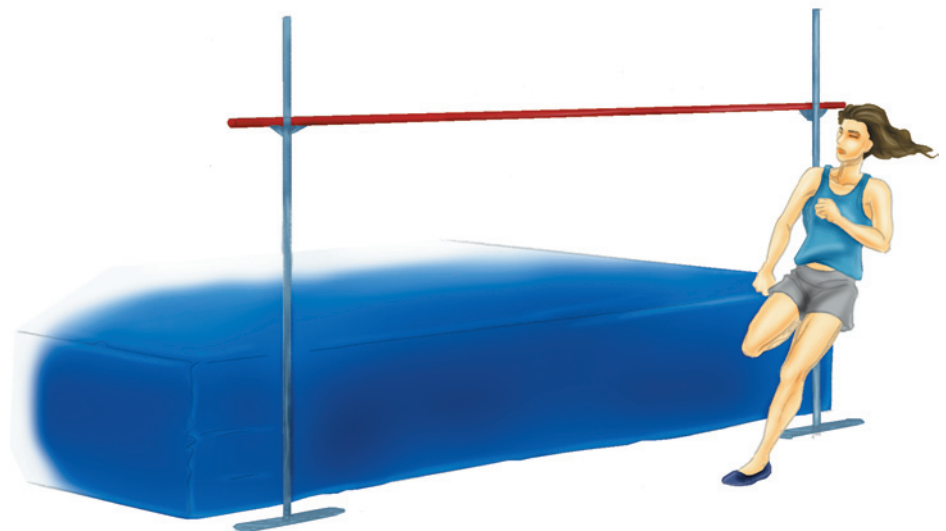
- maintain stamina
- practise and improve tactics and strategies
- perfect skill execution
- gain competitive experience
- continue work on developing appropriate mental skills.

This is best achieved through:

- supplementary work on required fitness components, including strength, power, agility, flexibility and speed
- use of highly specific skills practices (drills)
- continuation of conditioning training
- use of small games, grids and resistance work to increase intensity and provide relief.

The principle of specificity needs to be applied more rigidly during the competition phase. The gradual increase in intensity should be matched by focus on activities that relate directly to competition requirements. Specificity needs also to be applied to the mix of volume and intensity. For instance, in power sports requiring explosive actions such as sprinting and high jump, some volume is sacrificed at the expense of increased intensity. However, in endurance activities such as cross-country running and triathlons, the volume remains steady.

The number of training sessions required varies in accordance with the type of activity. This relates to the athlete's ability to *load* (train) and *unload* (regenerate). Excessive emphasis on work without ample time for restoration leads to development of a state known as *overtraining*. The competitive phase has many periods in which volume and intensity are manipulated to provide the greatest gain. However, it is important that the athlete peaks for each competition and particularly for major events within the season.



**Figure 12.29:** The in-season phase is characterised by an increase in intensity together with emphasis on technique, strategies and tactics.

## Off-season (transition phase)

This phase is one of physical and mental recovery from training and competition. It provides time for general refreshment, allowing both mental and physical abilities to recuperate. It is sometimes thought that off-season training means absence of all activity. This is incorrect, as a complete lay-off leads to a loss of the immense gains made during training and makes the pre-season preparation more difficult and protracted.

The off-season phase is characterised by:

- one week of total rest
- remaining weeks consisting of active rest, with training sessions being reduced to a couple of times per week and a corresponding reduction in both volume and intensity
- a change in environment, such as outdoors to indoors or use of swimming for runners and cyclists
- diet modification to reflect the decreased workload
- maintenance of strength and flexibility
- work on weaknesses, such as injuries, or perhaps on specific technical skills.

The value of the off-season phase should not be underestimated in terms of refreshing the athlete. Although it is generally a short period lasting a month or so, it provides the opportunity to restore mental and physical energy and prevent the onset of staleness in the coming competitive season. A plan for development and maintenance of strength, endurance and speed is illustrated in figure 12.30.

|                  | PRE-SEASON                      |                                              | IN-SEASON                                                   |                   | OFF-SEASON        |
|------------------|---------------------------------|----------------------------------------------|-------------------------------------------------------------|-------------------|-------------------|
|                  | General preparatory             | Specific preparatory                         | Pre-competitive                                             | Main competitions | Transition        |
| <b>Strength</b>  | Anatomical adaptation           | Maximum strength                             | Conversion:<br>• power<br>• muscular endurance<br>• or both | Maintenance       | Regeneration      |
| <b>Endurance</b> | Aerobic endurance               | Develop the foundation of specific endurance | Specific endurance                                          |                   | Aerobic endurance |
| <b>Speed</b>     | Aerobic and anaerobic endurance | Develop the foundation of speed              | Specific speed, agility and reaction time                   |                   |                   |

**Figure 12.30:** The development of specific attributes during the phases of competition (Source: TO Bompia, *Theory and Methodology of Training*, 3rd edn, Kendall Hunt, 1994, Dubuque, Iowa, p. 251.)

**Macrocycles** are long-term planning periods or overviews.

**Microcycles** are short training cycles containing specific details and usually cover a period of about 7–10 days.

## Subphases

Preparation for competition can be divided into manageable blocks called **macrocycles** and **microcycles**. Macrocycles are long-term planning frameworks and may represent an entire planning program, sometimes called an annual plan. The macrocycle encompasses the available preparation time preceding

a major competition and identifies all lead up competitions and major events along the way. The macrocycle plan provides an overview of what is to happen in terms of long-term training and preparation. While noting competition dates, it also references training specifics such as volume and intensity over a period of time and maintenance or increase of fitness components such as strength and endurance. An example of a macrocycle is shown in table 12.9.

**Table 12.9:** Example of a macrocycle

|             | January                                                  | February                                                 | March                                                    | April                                                    | May                                                      | June                                                     | July                                                     | August                                                   | September                                                | October                                                  | Nov-Dec                                                  |                                                          |   |            |   |
|-------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|---|------------|---|
| Cycle       | Pre-season                                               | General                                                  | Specific                                                 |                                                          |                                                          | Competition                                              |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |   | Transition |   |
|             |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |   |            |   |
| Competition |                                                          |                                                          | 6                                                        | 1                                                        | 2                                                        | 6                                                        | 6                                                        | 3                                                        | 6                                                        | 6                                                        | 4                                                        | 6                                                        | 6 |            | 5 |
|             |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |   |            |   |
| Strength    | Introduce                                                | Volume                                                   |                                                          |                                                          | Intensity                                                |                                                          |                                                          | Maintain                                                 |                                                          |                                                          |                                                          |                                                          |   |            |   |
| Speed       | None                                                     | Introduce                                                |                                                          |                                                          | Volume                                                   |                                                          |                                                          | Intensity                                                |                                                          |                                                          | Maintain                                                 |                                                          |   |            |   |
| Flexibility | Introduce                                                | Develop                                                  |                                                          |                                                          | Maintain                                                 |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |   |            |   |
| Endurance   | Introduce                                                | Volume                                                   |                                                          |                                                          | Intensity                                                |                                                          |                                                          | Maintain                                                 |                                                          |                                                          |                                                          |                                                          |   |            |   |
| Technique   | Introduce                                                | Develop                                                  |                                                          |                                                          | Maintain                                                 |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |   |            |   |
| Plyometrics | None                                                     | Introduce                                                | Develop                                                  | Maintain                                                 |                                                          |                                                          | None                                                     |                                                          |                                                          | Maintain                                                 |                                                          |                                                          |   |            |   |
| Psychology  | Introduce                                                | Develop                                                  | Monitor                                                  |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |   |            |   |
|             |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |   |            |   |
| Evaluation  | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> | <div><div></div><div></div><div></div><div>✓</div></div> |   |            |   |
|             |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |                                                          |   |            |   |
| Key         |                                                          | 1                                                        |                                                          | 2                                                        |                                                          | 3                                                        |                                                          | 4                                                        |                                                          | 5                                                        |                                                          | 6                                                        |   |            |   |
|             |                                                          | School                                                   |                                                          | Zone                                                     |                                                          | Regional                                                 |                                                          | State                                                    |                                                          | National                                                 |                                                          | Other                                                    |   |            |   |

While macrocycles represent an overview, more specific detail is contained in mesocycles and microcycles. Mesocycles are periods of four to eight weeks, while microcycles are much shorter, usually seven to 10 days. This allows for detailed planning and specific objectives to be achieved. The microcycle includes detailed information about frequency of training, intensity, duration and volume together with skills, activities, resistance training, plyometrics and specific session organisation. Table 12.10 is an example of a microcycle.

**Table 12.10:** An example of a microcycle

| Day       | Date | AM Session        | PM Session                                                        |
|-----------|------|-------------------|-------------------------------------------------------------------|
| Monday    | 9/3  | Strength training | Warm-up<br>Circuit<br>Skill development<br>Technique<br>Cool-down |
| Tuesday   | 10/3 | Plyometrics       | Warm-up<br>Long interval<br>Technique<br>Cool-down                |
| Wednesday | 11/3 | Strength training | Warm-up<br>Speed/short interval<br>Skill development<br>Cool-down |

(continued)

**Table 12.10** (continued)

| Day                      | Date                                                                                                                                                                                               | AM Session        | PM Session                                                |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------------------------------------------------|
| Thursday                 | 12/3                                                                                                                                                                                               | Pilates           | Warm-up<br>Circuit<br>Technique<br>Cool-down              |
| Friday                   | 13/3                                                                                                                                                                                               | Strength training | Warm-up<br>Skill development<br>Speed drills<br>Cool-down |
| Saturday                 | 14/3                                                                                                                                                                                               | Competition       |                                                           |
| Sunday                   | 15/3                                                                                                                                                                                               | Rest              | Rest                                                      |
|                          |                                                                                                                                                                                                    |                   |                                                           |
| <b>Objectives</b>        | To maintain strength, speed and power.<br>Continue to develop technique through specific exercises.<br>Maintain and develop core strength, flexibility and cardiorespiratory fitness.              |                   |                                                           |
| <b>Warm-up</b>           | Detail exercises for duration, repetitions and recovery.<br>Example: legs, shoulders, abdominals, 10 minutes, 10–15 repetitions, 1 minute recovery.                                                |                   |                                                           |
| <b>Cool-down</b>         | Detail exercises and duration.<br>Example: light jog (5 minutes), stretching (10 minutes).                                                                                                         |                   |                                                           |
| <b>Strength</b>          | Detail each session for sets, repetitions, resistance, speed, rest between sets and recovery.<br>Example: biceps curl, 60% of 1 RM, 2 sets × 15 reps, moderate speed, 3 minute rests between sets. |                   |                                                           |
| <b>Endurance</b>         | Detail activities to maintain cardiorespiratory endurance.<br>Example: circuit training × 2, long interval training × 2.                                                                           |                   |                                                           |
| <b>Speed and agility</b> | Detail activities to maintain speed.<br>Example: short interval × 2, agility sprints, grid work.                                                                                                   |                   |                                                           |
| <b>Flexibility</b>       | Detail exercises to maintain flexibility and improve core stability.<br>Example: core session at fitness centre, general stretching program, Pilates.                                              |                   |                                                           |
| <b>Technique</b>         | Detail how to continue development on technique improvement.<br>Example: focus on biomechanics and good form, organise session with guest coach to examine technique, video aspects of technique.  |                   |                                                           |
| <b>Plyometrics</b>       | Detail each session for sets, repetitions, recovery.<br>Example: jumps, reactive drop jumps, speed hops, alternate leg bounding — 2 sets × 10 reps with 3 minute rest.                             |                   |                                                           |
| <b>Psychology</b>        | Detail and be alert for signs of overtraining.<br>Example: lack of motivation, tiredness.<br>Discuss motivation strategies with athletes.                                                          |                   |                                                           |



## INQUIRY

## Develop a periodisation chart

Choose a sport with which you are familiar. Using the example in table 12.9 (page 495), develop a periodisation chart for the fitness and skill requirements for your chosen sport. Justify why specific information has been included.



**Peaking** is the phase of training in which performance is optimised to meet the demands of a race, competition or series.

**Tapering** is the period immediately before competition when the volume and intensity of training is reduced.

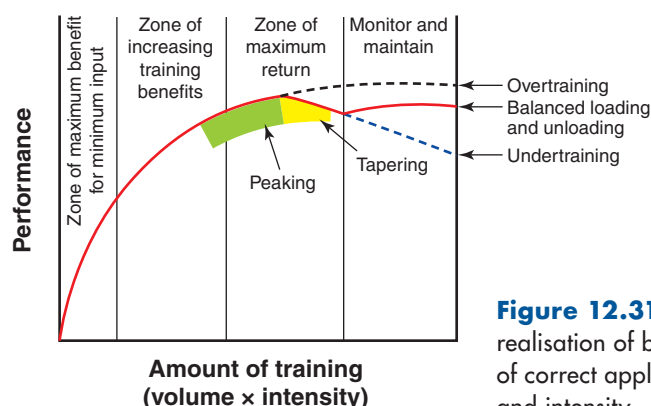
## Peaking

To arrive at a point at which an athlete **peaks** usually involves months of preparation, gradual increases in volume and intensity of training and a short **tapering** period (see below) just prior to performance. For example, a marathon runner trains for four to six months, and this involves periods of base building (no speed work), sharpening (which requires specific endurance), speed work and finally a tapering phase approaching the peak. The training program needs to be organised so that physical and mental functioning is optimised at the right time. The peaking period is actually a temporary state that is reached only during the competitive phase of training. When this occurs, a number of physiological indicators are apparent, including:

- a state of excellent health
- heightened rate of recovery from training
- body systems, particularly the circulatory, respiratory, muscular and energy systems, tuned for optimal functioning
- adjustments to technical and tactical preparation completed
- superior neuromuscular coordination.

During the peaking phase the athlete experiences a number of social and psychological indicators including:

- heightened self-confidence and motivation
- an ability to tolerate higher levels of frustration and react positively to practices that simulate the competition environment
- a state of mental alertness and readiness for action.



**Figure 12.31:** Peaking is the realisation of benefits accrued as a result of correct application of training volume and intensity.

## Tapering

Concentrated training with increasing volume and intensity reduces strength and subsequently impacts on performance. A tapering period is fundamental for allowing tissue to rebuild and for the full replacement of energy stores.

Tapering is essential because intense training, while having numerous positive benefits, has an adverse effect on some aspects of performance. While the manner in which athletes taper varies from one sport to another, it must involve a reduction in volume and intensity to be effective. It is now known that the tapering period that follows a quality preparation brings about an increase in the strength and power of the athlete. However, this is more pronounced in swimmers and less obvious in runners. Research shows that runners and swimmers who reduce training by 60 per cent for a 15- to 21-day period show no loss in maximal aerobic capacity. More importantly, swimmers tested experienced a 3.1 per cent improvement in performance as a result of reduced training and demonstrated a 17.7–24.6 per cent increase in arm strength and power.



Read the snapshot 'Success or failure: it's all a matter of timing as athletes chase perfect taper'. Discuss the importance of tapering and suggest how tapering programs differ for:

- swimming
- track
- team games.

## SNAPSHOT

## Success or failure: it's all a matter of timing as athletes chase perfect taper

By Martin Blake

Shane Kelly remembers it only too well. Kelly came to the world track cycling championships in Melbourne in May 2004 ill-prepared for the level of competition he was about to confront.

He was performing in front of his home crowd ... with family and friends at Vodafone Arena. And, of course, there was the expectation of simply being Shane Kelly, one of Australia's greatest cyclists ever.

But he missed a medal in his favourite kilometre time-trial, an event in which he is a triple world champion. It was the first time since 1992 he had not been in the medals in the event — by Kelly's high standards, a dramatic flop.

The reason? It was an Olympic year and Kelly didn't have his taper right for the worlds, which were a month or so earlier. 'I would have loved to have done my best,' he said last week. 'But I had to push that aside because the Olympics were the big one. That's how I had to take it.'

Tapering, the art of tailoring your practice to produce optimum performance on the right day, has been around for years. Bart Cummings does it with horses and has 11 Melbourne Cups to show for it and sporting coaches have been trying to do the same thing with varying success.

In broad terms, it's about doing the hard slog a long way out from a major event, then tapering off as it draws closer. This process may happen several times inside the same year. But it varies from athlete to athlete, depending upon how they react to their

periods of hard training and their recovery rate. Nowadays sports scientists talk about a 'super-compensation', where a tired athlete's body gets an enormous boost from a period of rest, as though the body is expecting more of the same hard work. Ideally, this is when they compete in a major event.

The coaches and athletes don't necessarily know if they are getting it right. But they are clear on one point: it's crucially important ... In three major sports to be contested at the Commonwealth Games — swimming, track cycling and athletics — the national titles have been held in the past few weeks. This presents the coaches and athletes with a different problem: how to get their athletes 'up' twice in a short space of time ...

For the first time this year, Swimming Australia programmed the selection trials only a month out from a major event. Previously, there has been a gap of a few months. It's a product of the packed international schedule, but it did not necessarily please the coaches. 'It's a challenge,' says Bernard Savage, Swimming Australia's head of sports science.

Freestyler Libby Lenton and breastroker Jade Edmiston also broke world records in their events at Melbourne and will go through the same process. Savage said they undoubtedly would be flat for a while before ramping up the intensity. 'We're still a month out, so I would say those swimmers would have a solid week of training next week,' says Savage. 'After that, they might back off a bit. But they can't just expect to float into the Commonwealth Games from the trials. They'll lose too much condition if they do that.'

Coaches are fanatical about it, so much so that when Stephan Widmer, coach of Jones and Lenton, had his log books stolen from his car recently, he was mortified.

Alan Thompson, the national swimming coach, says his sport has never found definitive answers to the riddle. Thompson quotes figures that suggest only 50 per cent of personal-best times in swimming have come in Olympic finals.

‘That’s about the average,’ he said. ‘We never get on top of it. You can buy plenty of books on anything and plenty on swimming. But you can’t buy one on tapering. You try certain things with some athletes and then you can do the same thing with the same athlete on a different occasion and get a completely different result.’

Troy Flanagan, head of sports science at the Victorian Institute of Sport, confirms the suspicion that it is a field that is far from fully explored. ‘Coaches are still using trial and error,’ says Flanagan. ‘There’s a real art to it and the rate of personal-best times in Olympic finals is still very low. Considering you have four years to get it right, the strike-rate

should be higher. But there’s so much that is not known about the human body.’

The notion that an athlete can reach a certain level of expertise and hold it year-round is bunk. Kelly says: ‘You can hold a certain competitive level all year. But at your absolute best in my event, I reckon it’s twice a year. If possible, I’d prefer to focus on one a year.’ Flanagan says technology may eventually provide the answers. At the VIS, swimmers have been using a mobile sports science unit that uses blood samples to measure variables and levels of fatigue.

‘We’re only beginning to understand all this but with this type of technology, I think we’re going to get better,’ says Flanagan.

Thompson is not necessarily convinced. ‘Everyone’s got their thoughts and how far down you have to take an athlete and it varies with the coaches. The problem is, we can’t hit one nail on the head and say, “This works”.’

*Source: The Sunday Age, 12 February 2006, ‘Sport’, p. 8.*



## INQUIRY

### Case studies of elite athletes

Carry out research to find case studies of elite athletes in relation to:

- how they train
- pre, during and post-performance diet and hydration
- psychological preparation for competition.

Outline the relevant features of each area and discuss how they affect performance.

### Sport specific subphases

Subphases provide an opportunity to target specific areas that require further development. For example, one athlete in a group may need additional work on technique while another may benefit more from improved fitness. There are many areas that could be the subject of specific examination and additional work, including testing, monitoring, evaluation, specialisation, loading, unloading, volume, intensity or whatever is required depending on the individual’s needs. This is covered in more detail in the next section.

## Elements to be considered when designing a training session

When designing a training session, a number of elements need to be considered as part of the planning process. Adherence to these elements ensures that sessions are challenging, productive and within health and safety guidelines.

## Health and safety considerations

Disregard for health and safety can lead to injury, illness and poor performance. Important considerations include:

- *injury prevention*. Activities such as warm-up/cool-down and stretching are safety prerequisites for all physical activity. Athletes need knowledge of how to safely use specialised equipment such as strength training machines. Spotting and supervision is required in many gymnastic and weight-lifting activities.
- *protective equipment*. Essential protective equipment such as mouthguards, helmets, face guards, padding, wetsuits and gloves need to be worn both during practice and games.
- *general equipment*. Bats, clubs, javelins, poles for pole vault, springboards, climbing frames and the like need to be regularly checked for safety. Cracked, worn or suspect equipment needs to be repaired or discarded.
- *apparel*. Clothing such as shorts, tops, jumpers and ski suits needs to be comfortable while providing protection, and allowing freedom of movement and airflow. Good footwear must be supportive and protective. Poor footwear contributes to blisters, calluses and even structural deformities.
- *environmental hazards*. Depending on the sport, sunglasses, sunscreens, protective suits, hats and caps may be needed to protect the body from potentially damaging ultraviolet rays.
- *illnesses*. The risk of illnesses such as colds and influenza can be minimised through use of safe health practices and awareness of modes of viral transfer.



**Figure 12.32:** A session overview provides an opportunity to outline goals and make clear the immediate performance objectives.

## Providing an overview of the session to athletes

At the beginning of a training session and particularly where teams are involved, it is common for coaches to provide a brief overview of what will be expected during the session. This ensures that the intentions of the coach and expectations of players are channelled in the same direction. It also has the advantage of gathering the players in a forum situation, where specific issues can be addressed. Some of these may include:

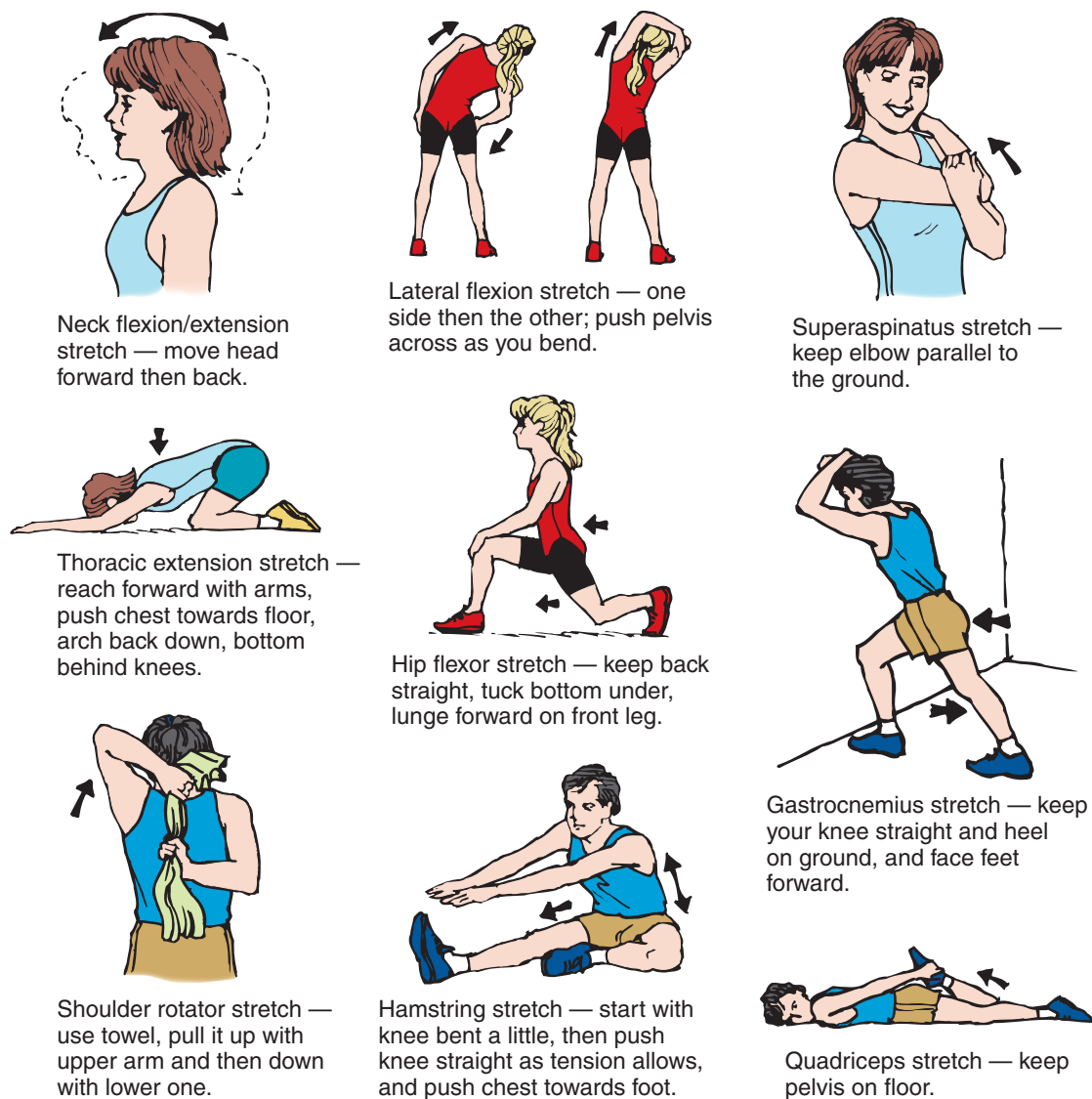
- recording of player presence or absence
- assessment of injuries
- discussion of previous performance
- an outline of specific goals
- special tactics suggestions that might need to be considered.

## Warm-up and cool-down

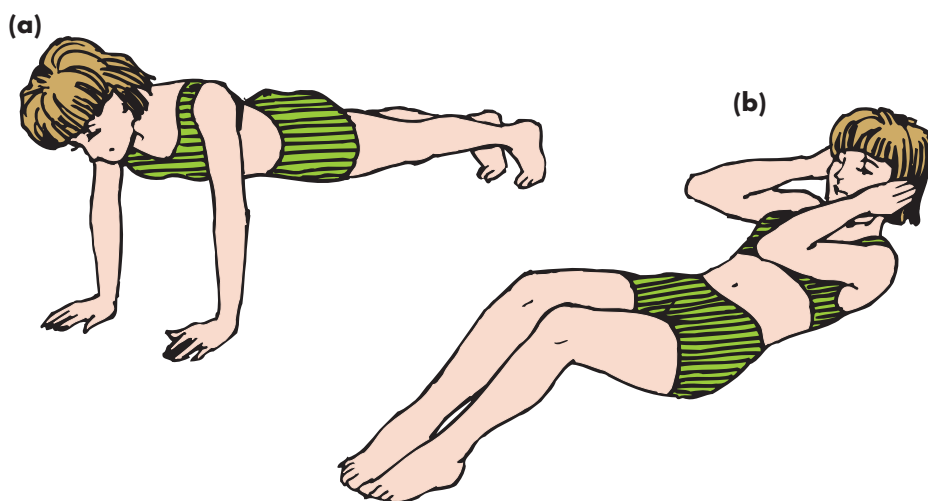
An effective warm-up consists of the following phases.

- *Phase 1: general body warm-up until the body begins to sweat*. Some suggested activities are jogging and skipping.
- *Phase 2: stretching*. This is important in ensuring that the required muscle groups are extended beyond the range that is required of them in the sport itself. In addition, stretching promotes blood circulation, increases muscle relaxation and improves performance. Stretching exercises need to be safe. Sports Medicine Australia has issued a brochure that contains an extensive range of warm-up exercises, some of which are illustrated in figure 12.33.
- *Phase 3: callisthenics*. These are general body exercises, such as push-ups and abdominal crunches, that involve large muscle groups (see figure 12.34). These exercises should be specific to the game; that is, they should work the muscle groups used in the game or activity. For this reason, the exercises should not be exhausting.



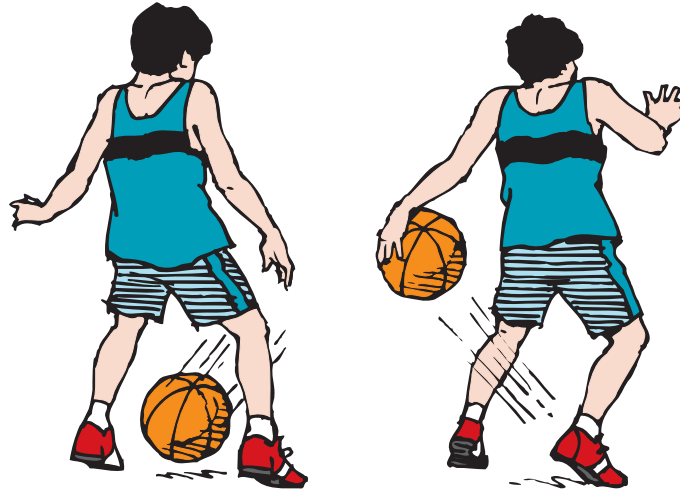


**Figure 12.33:** Some general stretching exercises appropriate for warm-ups  
(Source: Adapted from Sports Medicine Australia.)



**Figure 12.34:** Callisthenics such as (a) push-ups and (b) abdominal crunches help strengthen muscle and prepare it for use.

- *Phase 4: Skill rehearsal.* In this phase, the athlete performs some routines required later in the game. Team game players such as soccer players and basketballers participate in patterns (for example, dribbling in basketball) that increase agility and replicate movements required in the game. There is an emphasis on maintaining the body temperature established through previous physical work.



**Figure 12.35:** During skill rehearsal, players practise many of the moves required in the game.

The **cool-down** is the period of time following physical activity where the body temperature, circulation and respiratory rates are returned to their pre-exercise state (or as close to this state as possible).

The practical part of a training session is concluded with a **cool-down**. The procedure here is virtually the reverse of the warm-up. However, it is not as intense and need not extend for the same period of time.

## Skill instruction and practice

Instruction at a training session refers to delivery of a body of knowledge by a coach (or coaches and trainers) to the players. Good instruction requires prior organisation and effective communication skills. All coaching sessions need to be well planned, provide guidance on how to perform the fundamental skills, and should allow these to be practised in related drills and movements. There should also be instruction on the other related aspects of the session including warm-up and cool-down, stretching and flexibility, strategies and tactics, game plans and, finally, procedural details such as the time and venue for the next game. Effective instruction is:

- *brief* — it is important that instruction is concise and factual to allow maximal practice time
- *well timed* — use words when their impact will be greatest
- *specific* — instruction needs to be specific to the skill, game and situation; it should not be general
- *constructive* — focus on the positive points for improvement, not on how poorly the skill is being performed
- *clear* — there should be no misunderstanding about the information communicated by the coach. Questions should be encouraged if the message is not understood.
- *informative* — all instruction should relate specifically to information that the players need to know. Additional, unrelated material is confusing and can actually hinder the learning process.
- *demonstrable* — effective instruction is supported by visual aids such as demonstrations to provide clear pictures of skills and techniques.



**Figure 12.36:** Effective instruction requires prior knowledge and good communication skills.

## Conditioning

Fitness training is an integral part of every training session. Most sports have a short fitness session immediately following the warm-up. Supplementary fitness in the form of circuits, interval training, continuous training and callisthenics usually takes place following a session of individual and team play. Work on fitness should not be overemphasised in the first session, as this will fatigue players and adversely affect concentration and performance in the skills and team play session. It is essential that during the fitness session heart rate reaches *training zone intensity* (70 to 85 per cent maximal heart rate) and remains there for at least 20 minutes.

While the fitness session needs to be thorough and challenging, it does not need to be totally exhausting, which would lead to an excessive build-up of lactic acid. Effective coaches are able to continue to address fitness needs through skills practices. Most drills requiring agility, speed, endurance, power and coordination help the development of fitness components. Coaches need to be aware of the element of fatigue in skill learning. While fitness can be addressed in some skill-learning situations, it is important not to fatigue players unduly, as concentration and interest will suffer. It is particularly important to make regular testing part of the fitness program in order to provide feedback and to be a source of motivation.



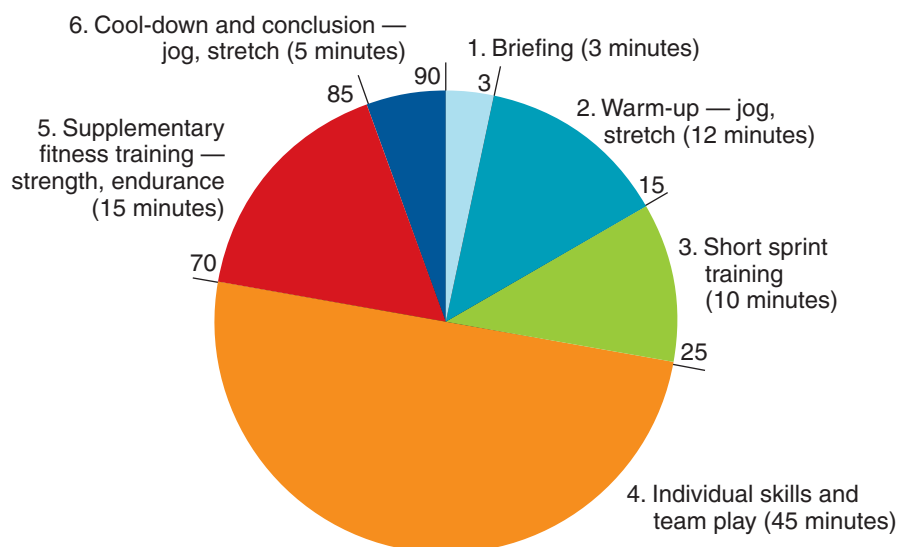
**Figure 12.37:** Conditioning is an integral part of every training session.

## Evaluation

Evaluation is an appraisal of performances after the training session. It is normally carried out during and after the cool-down and involves coaches and players reporting on the value of the session. An evaluation should address performance outcomes; that is, it should address the performance goals for the session (for example, learning the serve in tennis) and how well the goals were achieved. Evaluation also needs to address behavioural outcomes such as punctuality. Players should be given the chance to express opinions on issues that may have arisen from the training session.

Evaluation of the coaching session is followed by a brief reminder of the date, time and venue of the next fixture and training session and a recheck of player availability. Individuals with specific problems, such as taping requirements, should see the coach and make special arrangements. It is important that training sessions finish at the arranged time.

The final step, following the session, is an evaluation by the coach as a preparation for future sessions. This could include an analysis of the fitness testing and skills testing results and a review of the game performance. The time allocation to the various elements of a training session is illustrated in figure 12.38.



**Figure 12.38:** Time allocation in a 90 minute training session (Source: FS Pyke, *Better Coaching: Advanced Coaches Manual*, Australian Sports Commission, 1991, p. 249.)



## APPLICATION

## Designing a training session

Design a training session for a sport of your choice. Include time allocation for the different elements plus warm-up and cool-down activities, skills practices, strategies and information relating to other training session elements. Compare your session with others in your class. Choose one of the training session plans and conduct it with the class. Evaluate the session by considering the following questions.

1. Did the activities match the abilities of the group?
2. What was the reaction of the group?
3. How could the session be modified or improved?



## INQUIRY

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## Structuring training sessions

Briefly examine different methods of structuring training sessions. You may wish to use the **Training sessions** weblinks in your eBookPLUS or research others. Write a brief report on your findings.

## Planning to avoid overtraining

**Overtraining** is a chronic psychological and physiological condition caused by training loads that are too demanding for an athlete to manage.

Sometimes, because of poor scheduling or high levels of dedication, an athlete can suffer chronic training stress, which leads to performance deterioration. In the early stages, it might be recognised as staleness. However, staleness can progress to a more chronic condition known as **overtraining**, which leads to burnout.



Overtraining develops as a result of subjecting athletes to high-intensity training practices when they are in a stage of fatigue. High-intensity training requires a longer period for regeneration and refreshment than does moderate training. Athletes must be careful to balance work requirements with an appropriate recovery period. When there is too much work and insufficient time for recovery, the athlete becomes physically fatigued and mentally drained in what is called the overtraining state.

The onset of the overtraining state can be recognised by lack of motivation and poorer performances. However, its steady development is concealed and difficult to establish objectively. While the best signs are an increasing resting heart rate and higher blood lactate levels, the observation of performance, amount of drive and level of enthusiasm is the most effective detection method. Other signs include insomnia, infections and decreased appetite.

## Amount and intensity of training

Overtraining is primarily caused by too much training, so adjustment to the amount and intensity of training needs to be made. Some individuals have lower training stress thresholds and may show signs of overtraining when others do not. Personal factors, medical conditions, sleep (quantity and quality), drugs, nutrition, environmental stress and general health all need to be examined in light of training volume.

Better attention to training volume and intensity projections established in periodisation charts help prevent overtraining. The level of intensity needs to be varied from one activity to the next and from one training session to the next. Athletes need not overload in every training session. Recovery strategies need to be an integral part of training. For game players, recovery sessions might focus on strategies, skill building, team talks or watching videos of opposition plays. Volume or the amount of training can be varied by manipulating frequency and duration of sessions. Less and shorter training sessions may be needed and may even achieve the same or better results. There is a fine line between too little and too much training, with optimal performance being the product of training balance, periodised recovery, variety and individual differences.

## Physiological considerations

The underlying cause of overtraining is a combination of physiological and psychological factors. While the poorer performance is obvious, the exact causes might be more difficult to identify. Two important physiological considerations include lethargy and injury.

Lethargy is characterised by feelings of slowness, tiredness and lack of energy. Athletes in a lethargic state do not train or perform to their best ability, leading to a gradual deterioration in performance. Even simple tasks appear difficult while concentration and focusing skills appear to be diminished. As lethargy is usually the result of excessive training volume and intensity without sufficient rest and relaxation periods, measures need to be taken to address the problem.

Injury comes in many forms such as bone breakages and pain associated with overuse. Depending on the extent and seriousness of injury, athletes may be out of training and performances for a considerable period of time. The principle of reversibility is relevant to the injured athlete. If the athlete is unable to manage any training and conditioning, important gains made in



**Figure 12.39:** Lethargy and injury are two important physiological problems that can arise from overtraining.

cardiorespiratory endurance, strength and power are overturned. Other considerations such as match practice and experience are also affected.

Injury may occur in training and games as a result of poor warm-up, accidents and excessive load. Training volume may cause injury as might be the case with endurance runners being affected by shin splints. It is important to establish routines and practices such as use of taping, protective equipment and balanced periodisation plans to minimise the risk of injury. While the physical effects of injury are obvious, the psychological and in some cases, financial, costs are sometimes more significant.

## Psychological considerations

The most important psychological considerations in relation to overtraining relate to motivation or lack of it. When physical stability is threatened, emotional factors assume greater magnitude and affect health and well-being. The result is a loss of motivation, enthusiasm for training and competitive desire.

Symptoms might include:

- increased nervousness
- poor concentration span
- irritability or anger
- emotional sensitivity
- depression.

Strategies to improve the mental well-being of athletes suffering overtraining include:

- the reduction or cessation of training
- active rest
- use of relaxation techniques
- change of routine and environment such as using cycling as a break from swimming
- replacing pressure with positive reinforcement.

Prevention of the overtraining state is best achieved through being careful not to exceed an athlete's stress tolerance, and adapting the volume and intensity of training to each individual.



## INQUIRY

## Overtraining

Investigate the following issues regarding overtraining.

1. How much training is too much?
2. What are the signs of overtraining in athletes?
3. What measures can be taken to address overtraining in athletes?
4. How can overtraining be avoided?

You may wish to use the **Overtraining** weblinks in your eBookPLUS to assist you in your investigation.

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# ETHICAL ISSUES RELATED TO IMPROVING PERFORMANCE

## CRITICAL QUESTION

*What ethical issues are related to improving performance?*

When the desire to improve performance becomes a powerful motivating factor, sometimes ethical issues come to the forefront. Performance enhancing drugs and the use of advanced technology are growing concerns, particularly among elite athletes where the line between success and failure, fame and anonymity can be all too thin.

## Use of drugs

Performance enhancing drugs are substances that can improve an athlete's performance in a particular sport or activity. Drug use in sport, or doping carries serious health risks and can jeopardise an athlete's future in the sport.

## Dangers of performance enhancing drug use

The consequences of drug use by athletes can, in some cases, be more damaging than habitual social drug use by non-athletes. Some drugs carry serious health risks including liver tumours, cancer, high blood pressure, kidney tumours, trembling, depression and body fluid retention as might be the case with steroids. While some changes, such as testicular atrophy and reduced sperm production, can be reversed, others such as baldness and gynaecomastia (breast enlargement) cannot.

Changes in social, psychological and emotional behaviours are also apparent. Steroids, in particular, are related to mood swings, irritability, aggression, sexual arousal, confusion and memory loss. Other drugs such as alcohol and diuretics result in reduced concentration and reaction time, as well as reducing important sporting abilities such as coordination.

Drug use has the potential to affect livelihood. Use of performance enhancing drugs is banned in competition. Athletes found guilty of using performance enhancing drugs are banned from competition for extended periods of time, usually years. They lose their reputation and their income when sponsorships and endorsements are cancelled. Anti-doping regulations are very strict (see page 510) and athletes who cheat by using drugs to improve their chances of success take great risks. Athletes convicted of drug use stand to lose all that they could earn as well as their reputation, pride and personal accomplishment.



## INQUIRY

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## The ethics of drug use in sport

Organise a class debate on the subject: 'That performance enhancing drug use in sport is cheating'. The **Drug use in sport** weblinks in your eBookPLUS may assist you.

## Using drugs for strength

Human growth hormone (HGH) and anabolic steroids are drugs usually associated with a desire to improve strength and power in sports such as weight-lifting, body building, shot-put, hammer throw, wrestling and sprinting.

**Human growth hormone** is a naturally occurring substance that increases the rate at which amino acids are transported to skeletal muscle cells.

## Human growth hormone

**Human growth hormone** (HGH) or somatotropin is a hormone produced naturally by the body that is responsible for growth. It exists in every cell in the body that contains growth hormone receptors. Taking artificial forms of the hormone can lead to increased muscle size and strength. It also acts in the mobilisation of fat and making it available as a source of energy. This allows glycogen to be held in storage for the later phase of endurance events, where a sprint finish may be required.



**Figure 12.40:** Artificial forms of human growth hormone are taken by some athletes.

**Steroids** are derivatives of the male sex hormone testosterone and cause development of masculine characteristics.

The long-term effects of using artificial growth hormone are serious and include:

- overgrowth of face, hands and feet (acromegaly)
- gigantism
- muscle weakness
- diabetes
- heart disease
- disfigurement from bony overgrowth
- osteoporosis and arthritis.

## Anabolic steroids

**Steroids** can be *anabolic* (tissue building) or *androgenic* (producing masculine characteristics such as strength, power, speed and aggressiveness). It is impossible to produce a steroid that is completely anabolic or completely androgenic. This is particularly significant to female athletes who take anabolic steroids to increase strength as they gain unwanted male features such as facial and body hair in the process.

Steroids were widely used in past decades to increase weight, strength and power and reduce the recovery time between workouts. They stimulate protein synthesis in muscle cells, while

simultaneously arresting its breakdown. This increases the body's ability to utilise protein and prevent its degeneration. Steroid use has been an issue in sports such as weight-lifting, body building, track and field (particularly throwing events) and some team sports where bulk and aggression is an advantage.

The effects of steroids depend on the dosage, regularity and time period of use. They can include:

- testicular atrophy and a decreased level of reproductive hormone
- increased or decreased libido (sex drive)
- liver damage
- higher blood pressure as well as decreased HDL (high density lipoprotein) and increased LDL (low density lipoprotein), leading to increased chance of heart disease and high susceptibility to blood clotting
- increased nervous tension and possible manic or depressive episodes
- increased masculinity and heightened risk of musculo-tendinous injury.

The effects on women include:

- infertility, clitoral hypertrophy and sore nipples
- increased sex drive
- masculine appearance, including deepening voice and facial hair
- increased aggressiveness.



**Erythropoietin (EPO)** is a natural hormone that stimulates red blood cell production.

## Using drugs for aerobic performance

### Erythropoietin

**Erythropoietin (EPO)** was originally developed for people with anaemia and kidney deficiencies to help them to manufacture extra red blood cells. Erythropoietin acts on bone marrow, stimulating red blood cell production. It is a form of 'blood doping', because the increased number of red blood cells allows athletes to absorb more oxygen and improve their stamina.

Athletes whose performance could benefit from EPO use are those who feature in endurance events where sustained effort is required, such as marathons, triathlons and distance cycling. However, athletes taking EPO are also more at risk in endurance events because they lose valuable fluid, causing changes to blood consistency. Erythropoietin increases blood viscosity, contributing to poor circulation, blood clots and even stroke. It also causes chest pain, headache, high blood pressure, joint pain, fatigue and shortness of breath after each dose. It has caused death in a number of cases. The drug has performance enhancing properties and, until recently, it was undetectable by testing procedures. However, tests are now available that detect EPO in both blood and urine.

## Using drugs to mask other drugs

Some drugs, such as diuretics and alcohol, are used to mask other drugs, dilute urine or decrease excretion of the ergogenic drug.

### Diuretics

**Diuretics** are drugs that increase the amount of fluid (water and urine) passing from the body.

**Diuretics** are used to treat health problems such as liver and kidney disease. They have played a role in sports such as racing, boxing and weight-lifting, where weight reduction is often essential. They are banned because they can clear evidence of steroid use from the body. Apart from the interruptions to training caused by the need to urinate frequently, some detrimental effects of diuretics include:

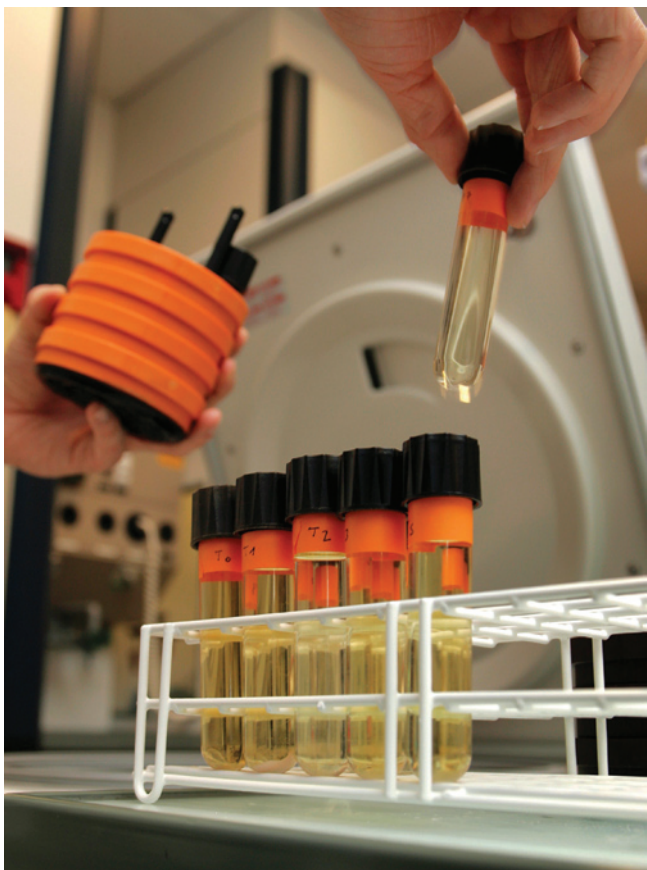
- dehydration
- dizziness and possible fainting
- headache
- loss of coordination
- heart and kidney failure.

### Alcohol

Alcohol is a depressant; that is, it slows bodily functions. It is a powerful drug and toxic in large quantities. Alcohol is particularly dangerous when consumed with other drugs, such as sleeping pills. Alcohol is commonly found in cough mixture, so athletes have been known to use cough mixture as a masking drug.

The effects of alcohol on the body are progressive and depend on the quantity consumed, the person's size and tolerance level, and the length of time between drinks. The effects of alcohol include:

- dizziness and loss of coordination
- loss of inhibition
- slowed reactions and slurred speech
- blurred vision
- possible aggression
- vomiting
- unconsciousness or death if large amounts are taken.



**Figure 12.41:** Urine samples being tested in a laboratory for EPO

## Benefits and limitations of anti-doping

Sample collection (also known as doping control or drug testing) is an essential part of promoting and protecting doping-free sport. It is the process to detect the use of a prohibited substance, or prohibited method, by an athlete. Sample collection consists of testing, conducted by an anti-doping organisation such as the Australian Sports Anti-Doping Authority (ASADA) (see the snapshot 'ASADA: its role and procedures').

Sample collection in sport is now quite extensive throughout the world, with many thousands of tests performed each year.

The *benefits* of sample collection (testing) include the following.

- It protects the right of athletes to compete in a sporting environment free from doping.
- Athletes should be rewarded on their natural ability and training outcomes, not chemical enhancement.
- Knowing that athletes can be tested any time, anywhere, is a deterrent to athletes who might consider doping.
- Doping is harmful to the health of athletes.
- Athletes like being tested because they like being able to prove that they are competing clean.

The *limitations* of sample collection include the following.

- On 1 January each year, a revised World Anti-Doping Agency Prohibited List is released, so athletes must be aware of what is prohibited and keep up-to-date with their information.
- Because athletes have previously tampered with samples, athletes must remove clothing from the knees to the mid-torso, and from the hands to the elbows, and a chaperone (of the same gender as the athlete) must witness the urine sample leaving the athlete's body. This process can be confronting for some athletes.
- Testing is very costly, amounting to several millions of dollars annually worldwide.



### INQUIRY

## Role of ASADA

Read the snapshot on ASADA and answer the following questions.

1. Discuss reasons why ASADA has chosen 'pure performance' as its vision.
2. Explain why doping is the 'biggest threat to the value of sport in the twenty-first century'.
3. Identify ways in which the anti-doping organisation is protecting 'Australia's sporting integrity'.
4. In groups, discuss the benefits and limitations of anti-doping (drug testing) and draw mind maps to summarise the group's views.
5. Learn more about the work of the **World Anti-Doping Agency** and the **Australian Sports Anti-Doping Authority** using the weblinks in your eBookPLUS.

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## ASADA: its role and procedures

ASADA is the Australian National Anti-Doping Organisation responsible for the Australian Government's commitment to implement the principles of the World Anti-Doping Code (the Code).

ASADA aims to develop a sporting culture free from doping in which performance is purely dependent on an athlete's talent, determination, courage and honesty. To achieve this, ASADA works to provide a comprehensive anti-doping program for the Australian sporting community including:

- sample collection
- education
- investigations of possible anti-doping rule violations
- presentation of cases at hearings
- monitoring national sporting organisations' compliance with their anti-doping requirements.

### ASADA's vision

Australia's driving force for pure performance in sport.

### ASADA's mission

To protect Australia's sporting integrity through the elimination of doping.

### What is doping?

Doping is the use of a prohibited substance or method that is included on the World Anti-Doping Agency's Prohibited List. To be included on the list, the substance or method must meet any two of the following criteria:

1. there is medical or other scientific evidence that the substance or method has the potential to enhance performance
2. there is medical or scientific evidence that the substance or method is a risk to athletes' health
3. use of the substance or method is contrary to the spirit of sport.

Doping is widely recognised as the biggest threat to the value of sport in the twenty-first century.

### Why is doping prohibited?

Athletes who dope are cheating. It's the same as marathon runners hopping into a golf cart for

part of their race. When athletes who are doping compete against athletes who are competing clean, they rob the true athletes of what is rightfully their moment. They rob the real winner of their opportunity to reach their true potential, achieve their deserved success and personal glory that results.

Just like we all expect athletes to run between the white lines, compete within the rules of their sport, and accept the decisions of the officials, athletes are expected to play by the anti-doping rules and let the real winners enjoy their success.

### What are the collection procedures?

Sample collection (testing) procedures for urine samples involve:

1. *selection*: athletes can be selected for testing anywhere and at any time.
2. *notification*: the athlete is notified by an ASADA doping control officer or chaperone of their selection. The athlete is accompanied by a chaperone from this moment until the completion of the doping control process.
3. *reporting to the Doping Control Station*: the athlete must report to the doping control station immediately.
4. *selecting a collection vessel*: the athlete selects a beaker for urine collection in the presence of the chaperone or doping control officer.
5. *providing the sample*: the athlete provides a urine sample under the direct supervision of a same gender chaperone.
6. *selection of the sample collection kit*: the athlete selects a sample collection kit and checks that it has not been tampered with.
7. *splitting and sealing the sample*: the athlete pours a measured amount of urine into each of the 'A' and 'B' labelled containers and seals the samples.
8. *measuring concentration*: the doping control officer checks the concentration of the urine sample to ensure it is suitable for analysis.
9. *final paperwork*: the required documentation will be completed.
10. *securing and transporting the sample*: the athlete's sample is sent to a WADA-accredited laboratory for analysis. The competitor's name and contact details will not be disclosed to the laboratory.

(continued)

## Analysis

The laboratory will analyse part 'A' of the urine sample for the presence of prohibited substances or doping methods. If part 'A' of the competitor's urine sample

returns a positive result (adverse analytical finding) the competitor has the right to have part 'B' of their urine sample analysed to confirm the analytical result.

**Source:** Australian Sports Anti-Doping Authority, July 2009.



## INQUIRY

## Performance enhancing drugs and drug tests

1. Read the snapshot 'Absolutely, positively, zero tolerance' and answer these questions.
  - (a) Which banned drugs are the main focus of anti-doping tests?
  - (b) What are the main reasons elite athletes might risk taking performance enhancing drugs, in spite of the dangers?
  - (c) What effects can performance enhancing drugs have on an athlete's health?
2. Why are 'deliberate cheats really rare' in Australia today?

## SNAPSHOT

### Absolutely, positively, zero tolerance

By Kate Guest

The history of drug use in sport is as long as that of sport itself. In ancient Greece, Olympians would ingest ground horse hooves, believing it gave an extra spring to their step. Today, for a small proportion of athletes, the hunger to win can be sated only by sophisticated performance-enhancing drugs designed by an illicit network of scientists — but with heavy costs, financially, professionally and physically.

A stringent anti-doping program is crucial to maintaining athletes' health, ensuring a fair playing field and guaranteeing the credibility of major sporting events such as the Commonwealth Games. Dr Peter Harcourt, chief medical officer of Melbourne 2006, says the methods to be used at these games are at the forefront of anti-doping technology...

These will include testing procedures...for the detection of human growth hormone (HGH), which builds bone strength and muscle mass, and erythropoietin (EPO), a red blood cell-boosting hormone that increases endurance.

There will also be wider use of blood testing than at the Manchester Games. Blood testing targets substances that are particularly difficult to detect in urine tests, and when used in conjunction the two deliver a more sensitive and robust testing program...

Athletes are chosen for testing via both random and targeted selection. Targeted selection is aimed

at high-risk sports, such as weight-lifting, as well as high place-getters and all world-record holders (a world record is not official until the athlete has passed a drug test).

Traditionally, low-risk sports receive less scrutiny, however, random selection means athletes cannot expect to avoid a test just because they compete in a low-risk sport.

For the first time at either an Olympic or Commonwealth Games, drug testing at Melbourne 2006 will be accompanied by a compulsory drug education campaign for all athletes. 'There's a huge amount of effort in Australia towards educating elite athletes. In a sense, what we want to try and do in Melbourne 2006 is extend that education to all athletes. Education is just as equal a part of our strategy as the testing; it's not all just about drug tests,' says Harcourt.

This two-pronged attack will leave athletes with no excuses for using prohibited substances, inadvertently or otherwise. And, by educating athletes about inadvertent drug use, organisers hope that the only athletes caught cheating will be those who have done so deliberately.

The drugs cheating athletes might take depend on their sport and the strengths and skills it requires. The most commonly used and tested-for prohibited substances include anabolic steroids, HGH, EPO, beta-blockers and diuretics.

Prohibited substances can be taken for a variety of uses, including building muscle mass, increasing endurance, steady the heartbeat, losing weight or



masking the use of other drugs. They also test for recreational drugs such as marijuana, ecstasy and cocaine.

Harcourt says the constant improvement in drug detection science and education programs means deliberate cheats are 'really rare' these days, at least in Australia.

'I rub shoulders with a lot of elite athletes and, really, flat out cheating — I'm not saying it doesn't happen, but it's so rare, certainly in Australia. I think there are some countries where it's not rare, but their education and knowledge are not as substantial as Australia's.' ...

Athletes found guilty of taking a prohibited substance fall into two categories: those who have done so deliberately and those who have done so inadvertently through their own mistake or that of a coach or doctor.

While drug issues operate on the principle of strict liability, the WADA code does make some allowances for these cases.

Given the wall of opposition they face, today's deliberate drug cheats require plenty of cash, and a great deal of technological savvy — or at least access to people with the right knowledge, says Harcourt.

In addition to the risk they run to their career and reputation, most dangerous of all, he says, is the gamble they take with their health.

'Just look at what's happened overseas in East Germany, Russia and Eastern bloc countries, and more recently in cycling communities with the use

of EPO,' says Harcourt. 'There's been a very high incidence of quite nasty medical problems, death, and quite nasty psychiatric problems.'

So what motivates an athlete to take such risks and use a prohibited substance?

Jeff Bond, a sports psychologist and former head of the Sport Psychology Department at the Australian Institute of Sport, believes that when the contravention is deliberate there is really only one motivation — winning.

And he says athletes at the top of their game with the means to employ the right advisers may be arrogant enough to believe they can beat the testing.

'They believe they're smarter than everyone else and their profile is such that they will be able to get away with it. They think they can get away with anything, and they think all will be forgiven if they do get caught.'

Bond says the decision to take a prohibited substance is generally made in a state of desperation, whether to win, attract sponsors or overcome injury ...

The struggle against doping in sport is an uphill and probably endless one, but nevertheless anti-doping organisations are making ground.

'I suspect the way sport is becoming more and more professional there will be always a way for athletes to find other ways of making a breakthrough. We haven't seen the end of it all,' says Bond ...

*Source: Sydney Morning Herald, 21 November 2005.*



## INQUIRY

### Pros and cons of drug testing

Draw and complete a table like the one below to identify the pros and cons of drug testing.

| Pros of drug testing | Cons of drug testing |
|----------------------|----------------------|
|                      |                      |



## INQUIRY

### Drug testing

Investigate the following issues.

1. At what level of competition should drug testing be introduced?
2. Which drugs should be tested for?
3. What should be the consequences of drug use in sport?

The **Drug testing** weblinks in your eBookPLUS will assist you.

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## Use of technology

The use of technology to assist sport has gained considerable attention in recent decades, particularly since the first moon landing in 1969. This feat depended on extensive development and use of computer technology and on the construction of strong but lightweight attire and equipment. The benefits of NASA's immense technological advancement were soon realised by the rest of the world, and entrepreneurs in both business and sport adapted the technology for refinement in their own areas. Improved cycling helmets, graphite golf club shafts, lycra bodysuits and the controversial fast swimsuits are only some of the sport-related technologies of the last half century. It would

be difficult to discern which advances were more significant in terms of performances or more beneficial to sport itself. Certainly, computer timing in sports such as swimming and video analysis to improve skill execution rank among the most important developments.

## Training innovation

Institutes of sport and research centres have, as a result of considerable public funding, developed sophisticated methods of measuring and analysing physiological progress as a result of training. Athletes attending sports academies now have access to a wealth of information that is used to monitor the pace of adaptations, together with machines and instruments to observe, analyse and evaluate technique. Two areas where there have been considerable training innovation are in lactate threshold testing and biomechanical analysis.

### Lactate threshold testing

Most athletes use heart rate monitors to establish their level of intensity relative to their target heart rate during exercise. Elite athletes often aim to train at levels of intensity close to the lactate threshold or level at which lactate begins to accumulate rapidly in the blood. This point is characterised by a burning sensation, increased ventilation rate and deteriorating performance. Determining the point at which blood lactate starts to accumulate rapidly is important for athletes as training regimes are geared to push back this point for as long as possible while still working at high levels of intensity.

There is a range of equipment and a number of ways to establish lactate threshold. The most accurate and reliable method is testing blood samples during graded exercise tests in the laboratory. In these tests, treadmills, bicycle ergometers or rowing machines are used with blood samples being taken at graded levels of intensity. Using this information, a lactate performance curve is generated and this shows rises in lactate levels. Equipment to do this is both expensive and limited in terms of availability.

More convenient and less expensive are portable lactate analysers. However, they require athletes to undergo periodic fitness tests that have a set of protocols so that measurement can be compared from one occasion to the next. Simpler field

(a)



(b)



**Figure 12.42:** (a) Lactate threshold testing in the laboratory and (b) a chart that identifies the lactate threshold differences before and after training.



**Figure 12.43:** Instrument for field testing of lactate threshold

tests require athletes to perform work similar to what is required in competition. With the aid of special heart rate monitors that have a split time facility, the lactate threshold can be established. For more detailed information on lactate threshold testing, use the **Lactate threshold** weblink in your eBookPLUS.

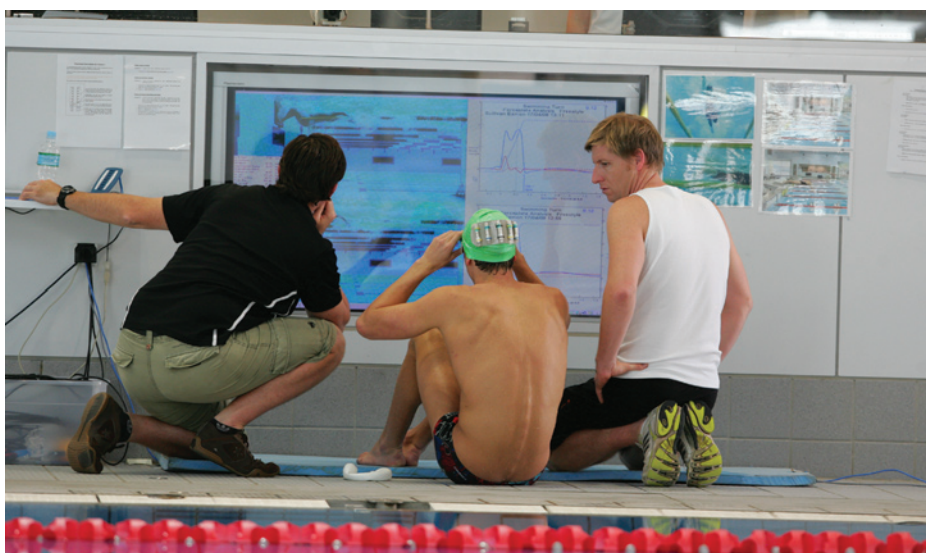
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## Biomechanical analysis

Biomechanical analysis is used to improve sporting performance. It explores the various techniques applied to skills such as throwing, catching, bowling, jumping and manipulating objects. Measures such as video analysis, photography, use of comparative images and slow motion replays allows performance of skills to be subjected to a high degree of scrutiny. Movements are explored in detail, problems identified and ways of making them more biomechanically efficient recommended. Biomechanical analysis aims to make execution of any movement more skilful, efficient and safe.

Video analysis, for example, is now used in a range of coaching, viewing and performance appraisal situations. Video allows analysis of player movements, strategies and techniques, with a view to:

- *improving technique.* The way a player executes a movement such as a tennis serve or swimming stroke can be observed repeatedly in slow motion to locate error.
- *improving visualisation.* By observing a skill performed repeatedly or in slow motion, a player's conceptualisation of what is required for proper execution is enhanced.
- *establishing biomechanical efficiency.* By observing the movements of skilful players, coaches can gain an insight into how movements can be performed more efficiently and demonstrate these to their players.
- *analysing strategies.* Coaches (particularly in team sports where there are numerous movements occurring with the ball and away from the ball) find video replays useful for analysing the effectiveness of strategies used both by their team and their opponents.



**Figure 12.44:** Coaches and sports scientists use video analysis to monitor and improve a swimmer's stroke and other elements of technique.





## Biomechanical analysis at the AIS

At the Australian Institute of Sport in Canberra, the Biomechanics and Performance Analysis unit works with elite athletes to 'refine technique and improve performance utilising some of the most advanced equipment and technology in the world'.

Use the **Biomechanical analysis** weblink in your eBookPlus to find out more about the technology and methods used at the unit. Summarise the information in point form.

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### Equipment advances

Modern athletes have a considerable advantage in terms of equipment available to improve performances or make skill execution easier and safer. Some examples of equipment advances are shown in table 12.11.

#### Fast swimsuits

The technology of racing swimsuits advanced considerably from 2000. Manufacturers competed to produce suits with the most performance-enhancing features while staying within the competition rules of not improving buoyancy. For example, the features of the Speedo LZR Racer, approved and worn by the medal-winning swimmers at the Beijing Olympics in 2008, included:

- fabric that had the lowest possible level of friction drag in the water, developed using NASA's wind tunnel technology
- a streamlined shape with a corset-like support around the lower torso to help swimmers hold the best position in the water
- fully bonded seams to reduce drag while allowing full movement and flexibility.

Issues of fairness and equity were raised. Some suggested that swimmers who wore the fast suits had a significant advantage over other swimmers who could not afford them. Others saw the technology as a natural progression in the sport and used the example of the cyclists' aerodynamic helmet shape, which was launched controversially at the 1984 Olympics but

is now standard equipment worn by all racing cyclists.

The debate escalated in mid-2009 when a new range of suits was introduced, made from all-polyurethane fabric that significantly improved buoyancy. Swimming's governing body, FINA, acknowledged that the technology had gone too far and imposed a ban from 2010 on 'any device or swimsuit that may aid speed, buoyancy or endurance'. This was not before a large number of world records were broken at the 2009 World Championships by some swimmers wearing the all-polyurethane full-body suits.

New rules from 2010 specify the type of textile and the shape of the suits for men and women. Use the **FINA** weblink in your eBookPLUS to access the latest rules and restrictions.

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#### Golf balls

The golf ball used today is larger and technology has been able to embed it with the most appropriate number and size of dimples for maximum elevation and distance given the clubhead speed applied by the golfer. Manufacturers strive to design and create the most technologically superior golf balls for top class competition. Use the **Golf ball technology** weblink in your eBookPlus to read about one example.

Other examples of equipment advances are shown in table 12.11.

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**Figure 12.45:** The Speedo LZR Racer was approved and worn by many swimmers at the 2008 Beijing Olympics but was banned from use in competitions from 2010.



**Table 12.11:** Training innovations and their effect on performance

| Sport               | Equipment advances                                                                                                           | Implications                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| High jump           | High jump mats used instead of sand<br>Techniques like the Fosbury flop instead of the scissors                              | Heights cleared by athletes are increased because landing on their back is now possible.                                                                                                                                                                                                                                                                                                                                                                        |
| Pole vault          | Carbon fibre poles                                                                                                           | Material allows greater flex and therefore increased vertical propulsion over the bar.                                                                                                                                                                                                                                                                                                                                                                          |
| Running             | Lightweight nylon used in spikes<br>Lycra clothing                                                                           | Weight and air resistance effects on times are reduced, and comfort for the athlete is increased.                                                                                                                                                                                                                                                                                                                                                               |
| Swimming            | Bodysuits<br>Caps<br>Goggles<br>Breaststroke whip kick<br>Underwater dolphin movement in backstroke and butterfly            | Drag component is reduced. Streamlining is improved.<br><br>Swimmer achieves greater propulsion through water.<br>Swimmer produces more efficient and powerful force.                                                                                                                                                                                                                                                                                           |
| Golf                | Synthetic fibres (for example, tungsten used in golf balls)<br><br>Graphite shafts<br><br>Metal alloy heads on driving clubs | Balls respond better for distance, spin and control. Durability is improved. Dimples vary to give balls different characteristics (for example, distance or spin).<br>More variation in 'flex' creates a higher 'whipping' action for extra distance.<br>Greater area of contact results in high level of result (that is, less margin for error). Accuracy is increased. Lighter material allows more mass at the point of contact, creating greater distance. |
| Cycling             | Carbon fibre components<br><br>Helmets<br><br>Suspension on mountain bikes                                                   | Frames, pedals, wheels, gears, etc. weigh less, so create less resistance.<br>The efficiency of the cyclist's effort is increased. The shapes and designs of components are more aerodynamically sound.<br>Cyclists can ride more extreme country safely. The stress on cyclists' bodies is reduced, so energy is focused on creating forward motion.                                                                                                           |
| Sprint running      | Crouch start versus standing start                                                                                           | Biomechanical efficiency is increased and quadriceps are able to create greater forward force out of the blocks.                                                                                                                                                                                                                                                                                                                                                |
| Discus/shot-put     | Rotation (spin) delivery                                                                                                     | Velocity of projectile is increased at point of release. Momentum is increased as a result of the combined muscle actions involved.                                                                                                                                                                                                                                                                                                                             |
| Athletics           | Rubber compound used in tracks and runways                                                                                   | Tracks respond to effort, so the efficiency of an athlete's output is increased. There is a high reaction component for jumps and forward motion.                                                                                                                                                                                                                                                                                                               |
| Australian football | Configuration of studs used in football boots                                                                                | There is less stress on players' feet because boots are like running shoes; agility is increased.                                                                                                                                                                                                                                                                                                                                                               |



## INQUIRY

## Technology and sport

Divide the class into small groups. Allocate each group one of the following technology areas:

- computerised timing; for example touch pads and multifunction stopwatches
- video analysis; for example, biomechanical analysis and slow motion replays
- equipment; for example, golf clubs and balls
- clothing; for example, racer swimsuits and lycra clothing
- physiological performance; for example, lactate and maximal oxygen uptake testing.

In your groups, research the area and investigate how this technology has been used to improve performance. Present findings from each group to the class.



## Ethical issues

Develop an argument to address the following issues.

- Has technology gone too far in attempting to improve sports performance?
- Has access to performance enhancing drugs created unfair competition?

If you are unsure of how to develop an argument, use the information at the

**Develop an argument** weblink in your eBookPLUS.

The **Drugs and sport** weblinks may assist you with information in developing your argument.

Choose a sample of arguments to be read to the class as a stimulus for further debate.

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## SUMMARY

- Strength training is a general term that encompasses all types of exercise designed to improve strength and increase muscle size.
- Three forms of strength training are resistance training, weight training and isometric training. All forms improve strength but use different equipment to do so.
- Effective strength training requires exercise designed for specific muscle groups. By manipulating variables such as resistance, sets, speed, repetitions and rest, strength training can address different needs.
- Three types of aerobic training are continuous, Fartlek and long interval. Aerobic training is sustained, of low to moderate intensity and improves the capacity of the aerobic system of energy supply.
- Anaerobic training aims to improve speed and power. Preferred methods to enable this include resistance training, plyometrics and short interval training.
- Training for power and speed requires resistance training programs to ensure that exercise speed is increased. Plyometrics, or bounding activities, are excellent for developing power.
- Three common forms of flexibility include static, dynamic and ballistic. Static flexibility is an indication of the range of movement at a series of joints while the body is in a fixed position. It is considered the safest form of stretching. Dynamic flexibility is the ability of the muscles to move a joint through its full range of motion. It is commonly used in warm-ups for games-based sports where movements require a full range of motion.
- Skill training is improved by drills practice, modified and small-sided games and games for specific outcomes. Skill training attempts to improve technique together with other important game skills such as decision making and tactical awareness.
- When planning to improve performance, some general considerations such as fitness requirements, timing of events, climate and seasonal adjustments need to be considered.
- Planning to improve performance requires developing a detailed overview of what is to be done to achieve the goals. It is a summary of smaller phases that are consummated in the overall plan. The process of structuring training into phases or periods that can be managed independently of other periods is called periodisation.

- There are three phases of competition — pre-season, in-season and off-season. Training volume and intensity vary according to which phase players are in.
- Macrocycles are long-term planning frameworks and may represent an entire planning program. It encompasses the available preparation time preceding a major competition and identifies all lead-up competitions and major events along the way.
- A microcycle includes detailed information about frequency of training, intensity, duration and volume, together with skills, activities, resistance training, plyometrics and specific session organisation.
- Peaking and tapering are two important issues for elite athletes. Peaking is the phase of training in which performance is optimised to meet the demands of a race, competition or series. Tapering is a period immediately before competition when the volume and intensity of training is reduced.
- Elements to be considered when designing a training session include health and safety, overview, warm-up, cool-down, instruction, practice, conditioning and evaluation. Planning to address these elements improves the quality and outcomes of the session.
- Overtraining is a chronic psychological and physiological condition caused by training loads that are too demanding for an athlete to manage. Adjustments to the amount and intensity of training are necessary to overcome the problem. Overtraining is characterised by certain physiological considerations such as lethargy and injury, together with psychological considerations such as loss of motivation.
- Some athletes try to improve performance using artificial means such as drugs. Human growth hormone, steroids and EPO are the drugs most commonly used. These drugs are illegal, so athletes sometimes try to mask their use with other drugs. While testing is used to identify performance enhancing drugs in the body, ethical considerations relating to fairness need to be addressed.
- Use of technology has flourished in sport in recent years. Training innovation such as lactate threshold testing and biomechanical analysis, together with equipment advances, such as golf balls having soft urethane elastomer covers with a dimple pattern, have ensured that time and distance records continue to be broken.

## QUESTIONS

### Revision

1. Define strength training. How can strength be developed within a weight training program? (H8)
2. Describe the difference between elastic and hydraulic resistance training. (H9)
3. Explain how strength is developed using isometric training. (H8)
4. Contrast the key features of continuous, Fartlek and long interval training. (H8)
5. Explain how speed and power are developed through resistance training. (H7)
6. Outline the nature of plyometric training. Suggest a range of exercises that could be used as part of a power development program. (H10)
7. Outline the key differences between static and dynamic flexibility training. (H9)
8. Indicate circumstances where a ballistic flexibility program might be utilised. (H17)
9. Describe how decision making and tactical awareness might be developed within a small-sided game. (H17)

10. Outline the function of drills practice. Briefly outline a drills practice suitable for use in a games-based training session. (H9)
11. Explain why climate and season are important considerations in training plans. (H17)
12. Explain why knowledge of a schedule of events is an important consideration when planning to improve performance. (H10)
13. Define periodisation. Why is it important in the construction of a training program? (H8)
14. Describe characteristics of the preparation phase that makes it different from the competition phase of a training program. (H10)
15. Explain what is meant by peaking and tapering in performance. How would you assess if an athlete was at the peak of performance? (H9, H16)
16. Describe the elements of a training program. Suggest how each element improves movement potential. (H7)
17. Outline health and safety considerations of which an athlete needs to be aware. (H8)
18. Explain the importance of warm-up and cool-down in a training session. (H8)
19. Explain how overtraining is identified. (H16)
20. Explain how planning can be structured to avoid overtraining. (H17)
21. Outline the harm caused by performance enhancing drugs. (H7)
22. Argue a case against using steroids to increase strength. (H17)
23. Explain what EPO is and why might it be the drug choice of athletes in endurance events. (H16)
24. Briefly outline the benefits and limitations of drug testing. (H16)
25. Use examples to describe how technology is being used to improve performance. (H8)
26. 'The only way that there will ever be a level playing field in elite sport is to allow all athletes to use performance enhancing drugs.' Discuss. (H17)

### Extension

1. Investigate an area in which technology has made a significant difference to performance. Outline how the changes work to improve performance and suggest future developments in this area. (H8)
2. Choose a sport or activity. Using the syllabus as a support or scaffold, apply each of the critical questions listed in 'students learn to ...' sections of the syllabus. (H7–H11, H16, H17)

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A summary quiz and revision test on this chapter's content are available in Microsoft Word format in your eBookPLUS.