PART 1

Foundations of physical activity
In this chapter a student:

1.1 discusses factors that limit and enhance the capacity to move and perform
1.2 analyses the benefits of participation and performance in physical activity and sport
4.1 works collaboratively with others to enhance participation, enjoyment and performance
4.2 displays management and planning skills to achieve personal and group goals
4.3 performs movement skills with increasing proficiency
4.4 analyses and appraises information, opinions and observations to inform physical activity
and sport decisions

1. **Body systems and energy for physical activity**

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  - 1.1 discusses factors that limit and enhance the capacity to move and perform
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    and sport decisions

1. **Structure and function of the skeletal system**

The **skeletal system** is the bone structure of the body. The adult human body consists of 206 bones; however, not all of these are used to perform physical activity. An infant has 350 bones, as they are not yet fused together. Figure 1.2 shows the names of all of the skeletal bones that contribute to the support and, together with the **muscular system**, the movement of the body.

The skeletal system is made up of two main sections, the axial skeleton and the appendicular skeleton, both of which are important to the movement of the body. The axial skeleton includes the skull, spine and thorax. This section of the skeletal system provides support and movement of the upper body (see the orange section of figure 1.2 on page 4). The appendicular skeleton
includes the bones of the upper and lower arms, the wrists and hands, the pelvic area, the upper and lower legs, and the feet. All of these bones enable the body to be upright and supported, and they work together with the muscles to enable movement while the body is stationary or travelling through space (see Table 1.1 on pages 10 and 11).

**Role of the skeletal system**

The skeletal system contributes greatly to the movement of our body. The spine supports our head and allows trunk rotation, together with the voluntary movement of our arms, legs, feet and hands according to the sport or activity we wish to perform.

Bones are very important to movement for physical activity and exercise can strengthen our bones, along with the intake of calcium-rich foods. Bones are the inner support system of the body. They provide a rigid structure for the body and, along with the joints and muscles, help the body to move effectively. Figure 1.1 shows the structure of a bone—it is a very simple structure, yet a very important one. The bones in our body are all alive and the end of the bone shown in figure 1.1 has a growth plate that is very important to the growth of the bone. If the growth plate is damaged the growth of the bone may be stunted and physical problems can occur. For example, damage of the growth plate in one femur bone (upper leg) could cause reduced growth in one leg, resulting in one leg being shorter than the other.

**Figure 1.1** Structure of a femur bone

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**Learning experience**

How well do you know the bones of the body? The box of bones pictured on page 4 is in need of recognition. Identify each bone using the list below and check your answers by using the picture of the skeletal system that follows (figure 1.2).

- Cranium (skull)
- Sternum (breast bone)
- Ribs (mid region of the body)
- Radius and ulna (lower arm)
- Femur (upper leg)
- Tibia and fibula (lower leg)
- Tarsals, metatarsals and phalanges (ankles, feet and toes)
- Patella (knee)
- Carpals, metacarpals and phalanges (wrist and hands)
- Pelvis (lower mid region—hip bones)
- Vertebral column (spine)
- Humerus (upper arm)
- Clavicle (collar bone)
Figure 1.2
The skeletal system

Webconnect
Check your understanding of the location of bones by visiting the following interactive website: <www.innerbody.com/image/skelfov.html>.
Types of bones and joints

There are several different types of bones in the body. Some types vary in size and each have an important role to play in support and movement of the body. For example, long bones in the legs work with the joints and muscles to allow the body to stride out and extend when walking or running.

The bones in the body are classified by their shape and are grouped into six types: long, short, flat, irregular, sesamoid and sutural (see figure 1.2 for more detail).

- **Long bones** are long and slightly curved for strength, and can be found in the arms and legs. The femur is an example of a long bone.
- **Short bones** are small and nearly equal in length and width. They can be found in the wrist and ankles. Tarsals are short bones.
- **Flat bones** are generally thin and flat, with the purpose of protecting vital organs. For example, the skull is a flat bone that protects the brain and the sternum and ribs are flat bones that protect the heart and lungs.
- **Irregular bones** are an unusual shape and are not like any other bones mentioned above. For example, the bones that make up the spine (vertebrae) and some facial bones are categorised as irregular bones.
- **Sesamoid bones** are small and must cope with considerable stress at times. Examples of sesamoid bones are those in the tendons of the knee (patella) and wrist.
- **Sutural bones** are somewhat immovable and are small bones found in the skull.

Bones are held together by connective tissue that allows movement between the joints. Joints that are relied on for movement in physical activity contain connective tissue that allows muscles and bones to work together to move. There are many types of joints that allow various parts of the body to move in many different ways. The type of joint that is located at the point where one bone meets another is determined by the movement it needs to make when a muscle contracts or relaxes. The size of the joint, or area that exists between two bones that meet, is a key factor that determines how much movement will occur at that joint. The more space between the two bones, the greater the movement. For example, the knee joint has a lot of connective tissue between and around the joint and therefore has a large range of movement. It is also a site of potential injury, as this larger space of connective tissue can be placed under a lot of strain during exercise. This is why knee injuries are common in sports that require a lot of running or change in direction.

In some parts of the body, movement can be restricted by the type of joint and by the degree of movement that joint allows. For example, the bones of the elbow are connected by a hinge joint that allows quite limited movement in one direction only. However, the shoulder has a ball and socket joint, which is the joint with the largest range of movement. When a person exercises, the way in which they move is restricted by six moveable joints, known as synovial joints. These joints and the range of movement they allow for are outlined in figure 1.3.

**Evaluate why the bones of the body are a specific shape, given their location in the body.**
Match the following bones up with their type using the table opposite.

from *Hole’s human anatomy and physiology*, (1999), 8th edn, Shier, Butler and Lewis

<table>
<thead>
<tr>
<th>Type of bone</th>
<th>Name of bone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long bone (L)</td>
<td>Tarsal</td>
</tr>
<tr>
<td>Short bone (Sh)</td>
<td>Patella</td>
</tr>
<tr>
<td>Flat bone (F)</td>
<td>Femur</td>
</tr>
<tr>
<td>Irregular bone (I)</td>
<td>Scapula</td>
</tr>
<tr>
<td>Sesamoid bone (SB)</td>
<td>Vertebra</td>
</tr>
</tbody>
</table>

**Figure 1.3**
Six moveable joints of the body
2 Study the diagram of the skeletal system (figure 1.2) and complete the table below by naming the types of bones and their function during exercise.

<table>
<thead>
<tr>
<th>Name of bone</th>
<th>Type of bone</th>
<th>Function during exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertebral column</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femur</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cranium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pelvis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ribs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tarsals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tibia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radius</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulna</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clavicle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scapula</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patella</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humerus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic contribution to efficient movement

The skeletal system is the inner core for stable movement of the body. Bones provide the internal frame for our muscles and joints to work together to perform voluntary movement. To enable our body to move efficiently, the skeletal system provides support and leverage so that well-balanced movement can occur. For example, to run in a well-balanced way an athlete needs to use the stability of the skeletal system, in combination with the muscular system, from the position of the head, shoulders, arms and midline, as well as extension and flexion of the hip, knee, ankle and toes, to stride out and run well. The skeletal system is our main support structure in all physical activities.

Structure and function of the muscular system

The muscular system is a voluntary system. For movement to occur, the muscular system requires not only our will to move but also signals from our brain, sent by the central nervous system, which communicate that movement in a muscle should take place. In order for our body to participate in sport and physical activity, it needs to move effectively by combining the use of the
Figure 1.4 The major muscles of the muscular system

1. Deltoids
2. Biceps
3. External oblique
4. Wrist flexors
5. Hip flexors
6. Quadriceps
7. Tibialis anterior
8. Pectoralis major
9. Latissimus dorsi
10. Biceps
11. Abdominals
12. Brachioradialis
13. Rhomboid major
14. Latissimus dorsi
15. Iliotibial tract
16. Hamstrings
17. Gastrocnemius
18. Calcaneal tendon
19. Trapezius
20. Triceps
21. Wrist extensors
22. Gluteus maximus
23. Soleus
Body systems and energy for physical activity

Chapter

The body systems and energy for physical activity involve the skeletal system, joints, and muscles. The joints and muscles must voluntarily contract (tighten the muscle) and relax the muscle group to perform a selected movement. These movements can be discrete (one movement) or continuous (repeated movements).

**Role of the muscular system**

The role of the muscular system is to allow for movement to participate in day-to-day activities, and to perform sports and physical activity. The muscular system combines with the skeletal and circulatory systems to perform voluntary movements. The more movement muscles perform, the stronger and more efficient they become. This is known as a training effect. For example, a trained muscle will perform better than an untrained one. If the muscles stop training they become weaker, and reduce in size and efficiency. This is why an athlete needs to keep training to stay in good shape for competition.

**Muscle movement**

An example of the way a muscle uses contraction and relaxation to move or lift an object is the performance of a bicep curl. To perform a bicep curl with a hand weight, the hand needs to extend (open up) and hold the weight, and then contract to grip it. The arm is in a straight and slightly flexed position that is called an extended position. The hand is then raised towards the shoulder and the arm is flexed (bent toward the shoulder at the elbow)—contraction of the bicep muscles allows the weight to be raised. To lower the weight, the biceps relax and the triceps contract. The bicep and tricep muscles work together to perform the movement. (This action is illustrated in figure 1.5.)

**Movement terms**

Our body moves in different directions when we choose to perform an action. Table 1.1 outlines the way in which we describe the motion of the body and body parts. These terms are very important to describe what is happening during a physical activity skill. For example, a cyclist can be analysed for their flexion or extension at the hip, knee, and ankle, and suggestions made to increase or decrease this movement to improve their performance.

To analyse movements, it is a good idea to think of each being performed starting in the anatomical position (standing with your hands by your side, with your thumbs facing outwards—see figure 1.6). All of the joint actions outlined in table 1.1 are performed using this starting position.
<table>
<thead>
<tr>
<th>Joint action</th>
<th>Description of the joint action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>An action involving the angle between two bones decreasing with the movement</td>
</tr>
<tr>
<td>Extension</td>
<td>An action involving the angle between two bones increasing with the movement (it is the opposite of flexion)</td>
</tr>
<tr>
<td>Abduction</td>
<td>An action that involves movement away from the middle of the body</td>
</tr>
<tr>
<td>Adduction</td>
<td>An action that involves movement towards the middle of the body</td>
</tr>
<tr>
<td>Pronation (inversion)</td>
<td>An action where the foot or hand is turned inward</td>
</tr>
<tr>
<td>Joint action</td>
<td>Description of the joint action</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Supination (eversion)</td>
<td>An action where the foot or hand is turned outward (it is the opposite of pronation)</td>
</tr>
<tr>
<td>Rotation</td>
<td>An action performed by turning the upper body or head to one side</td>
</tr>
<tr>
<td>Circumduction</td>
<td>An action that is similar to rotation but involves the circular motion of a limb</td>
</tr>
<tr>
<td>Plantar flexion</td>
<td>An action of the foot, where the toes are pointed forward (for example, pressing on an accelerator when driving)</td>
</tr>
<tr>
<td>Dorsi flexion</td>
<td>An action of the foot, where the toes are lifted upward (for example, taking your foot off an accelerator when driving and pointing the toe toward the knee; it is the opposite of plantar flexion)</td>
</tr>
</tbody>
</table>
Structure of voluntary muscles

Unlike the heart muscle, which is an involuntary muscle, the skeletal muscles are voluntary (movement is initiated by choice). These muscles rely on joint mobility with the skeletal bones for leverage. This joint mobility exists because of the tendons that attach muscles to bones through connective tissue, and the type of connective tissue depends on the joint connecting the bones.

Basic contribution to efficient movement

There are several types of muscle fibres. The most important ones to sport and physical activity are fast twitch fibres for fast and short exercise, and slow twitch fibres for long duration and slow- to medium-paced physical activity. A sprinter will have more fast twitch fibres than an endurance athlete and the making of elite athletes will be determined by their ratio of these fibres, along with their body type and talent. Everyone has both fast and slow twitch fibres and training can enhance the performance of these fibres. This is why one athlete may seem like a natural sprinter while another may seem to be natural endurance athlete. Suitability to a particular sport comes down to the ratio of fibres in the body as well as the anatomical body type suited to a sport, along with natural talent and hard training.

Learning experience

After participating in an adequate warm-up, perform a repeated activity like step-ups, crunches or push-ups. Try to work continuously at a medium to hard intensity until you feel an uncomfortable burning sensation in your muscles and you cannot go any further. This is an example of anaerobic exercise and your lactate system, or anaerobic energy system, is telling your body to stop. If an athlete tries to push through this phase of exercise they will only be able to do so for a short period of time. The muscles will not feel comfortable at this phase of exercise and the burning sensation is a signal from the body that the intensity of the movement must be reduced or it will shut down and/or become injured. This is the body’s in-built safety system and if an athlete pushes beyond this injury or collapse may result.
Structure and function of the circulatory system

The circulatory system is a very complex system that relies on the heart and lungs to circulate blood, oxygen and waste products around and out of the body. During exercise this system works very efficiently to circulate oxygen to the working muscles by pumping blood through the heart muscle. This important system also eliminates waste products such as carbon dioxide, water and, in anaerobic exercise, lactic acid.

The heart is the centre of the circulatory system. It is a smooth muscle that is positioned in the centre of our chest and is on ‘automatic pilot’. This means that without instruction from the brain the heart will keep pumping blood around our body twenty-four hours a day, seven days a week, non-stop. Figure 1.7 demonstrates the cycle within the circulatory system.

Role of the circulatory system

The circulatory system regulates the blood circulation around the body, to transport oxygen to our muscles during exercise. When we are in a relaxed state our heart will pump slower than when we move around or perform vigorous exercise. When we exercise, the speed at which blood is pumped around our body is increased and our heart rate rises considerably. A heart that is working with ease is said to be an efficient one and the fitness of an athlete, particularly an endurance athlete, is an indicator of an efficient circulatory system.

Major components of the circulatory system

The following diagram illustrates the lungs, heart and body that make up the components of the circulatory system.

![Diagram of the circulatory system](image)

Figure 1.7
The circulatory system

Webconnect

1. Visit the following site to observe the circulatory system in motion: <http://library.thinkquest.org/11965/html/cyber-anatomy_car691.html>.
2. Visit the following site and observe an animated heart at work: <www.ehc.com/vbody.asp>.
3. After visiting the sites listed above, copy figure 1.7 into your workbook. Draw arrows on the diagram to indicate the flow of blood and oxygen in the circulatory system.
Basic contribution to efficient movement

In order to participate in physical activity and sports we need an efficient circulatory system. The heart and lungs work together to efficiently pump oxygen-rich blood around the body and filter the waste products from deoxygenated blood. The circulatory system is very important to our aerobic energy system and the way in which we use energy.

During exercise the heart will work much harder than at rest and a trained athlete will have a strong, fit heart to support their body during physical activity. If an athlete is physically fit they will have an efficient target heart rate for exercise and a relatively low resting heart rate (pulse). The average pulse rate for a fit teenager ranges between 60 and 70 beats per minute.

Pulse facts

A pulse is a measure of the beats your heart takes to pump blood around the body. It is usually measured at the radial (wrist) or carotid (neck) sites on the body. Your true resting pulse should be taken before you get up, after a good night’s sleep.

Factors that can affect pulse rates include digestion (processing food after eating), stress, sickness and fatigue, as they can all increase the pulse rate because the body is working harder to recover from these situations.

Learning experience

Perform an adequate warm-up and then complete the following steps for sections A and B to see how well your body copes with the demands of exercise. Record your results in your workbook.

Section A

Complete the following tasks to determine your heart rate efficiency and estimate your fitness level.

1. Take your resting heart rate (pulse) and record the number of beats per minute. (This is RHR on the graph.)
2. Raise your heart rate by stepping onto and back off a step as fast as possible for 2 minutes. Take your heart rate immediately after stopping and record the number of beats per minute. (This is Step HR 1 on the graph.)
3. Walk slowly for 1 minute and then rest for 5 minutes. Take your recovery heart rate at the end of this rest and record the number of beats per minute. (This is Rec. HR 1 on the graph.)
4. Raise your heart rate by stepping as fast as possible for 2 minutes. Take your heart rate immediately after stopping and record the number of beats per minute. (This is Step HR 2 on the graph.)
5. Walk slowly for 1 minute and then rest for 5 minutes. Take your recovery heart rate at the end of this rest and record the number of beats per minute. (This is Rec. HR 2 on the graph.)
6. Calculate your maximum heart rate using the following formula: $220 - \text{your age} = \text{beats per minute.}$ (This is MHR on the graph.) Using the details you recorded in steps 1–5, work out how far off your maximum heart rate you were for each activity.

Section B

Using a line graph like the one on page 15, plot your results from section A and discuss this activity with your class.
Structure and function of the respiratory system

The respiratory system consists of cavities that allow air to travel to our lungs and is a very effective system to supply oxygen to the body. The cavities and tubes of the respiratory system lead to our lungs and end with the very important alveoli (air sacks)—the point where oxygen is transported into our blood. The respiratory system works closely with the heart to create an efficient circulatory system.

Role of the respiratory system

The respiratory system supplies oxygen to all parts of the body. It supplies oxygen to our muscles to allow movement and oxygen to the brain to allow proper functioning of our body every second of every day. This system is very important for efficient aerobic exercise. It supplies oxygen to the body for all forms of exercise and is vitally important to all athletes, particularly endurance athletes whose main source of energy is oxygen.
Major components of the respiratory system

The respiratory system extends from the mouth and nose, which inhale and exhale air that moves through the larynx and trachea to the left and right bronchus and, bronchioles and finally to transfer oxygen to the blood at the alveoli. The movement of air in and out of the body is created by pressure that is regulated by the movement of the diaphragm (the muscle below the lungs). This muscle moves down and the ribs rise to allow air to move into the body (inhale). The opposite effect is performed in breathing out (exhaling) by raising the diaphragm and lowering the ribs to force the air from the body.

Learning experience

1. Copy figure 1.8 into your workbook. Draw an arrow from the mouth/nose to the alveoli to indicate the direction of the air when this person inhales (breaths in) to show the movement and transfer of oxygen. Then draw an arrow to indicate the direction of the diaphragm (the muscle under the lungs) when a breath is inhaled.

2. Discuss with your classmates some reasons why the respiratory system might not work as well as it should when exercising. For example, asthma will restrict breathing during exercise. Can you think of other factors that could help or hinder the respiratory system?
Body systems and energy for physical activity

Basic contribution to efficient movement

In order to exercise efficiently we need to train our body and this includes our lungs. A trained athlete has a high lung capacity and will be able to transport oxygen with ease into the working muscles to enable efficient movement when exercising.

An asthmatic is a person who has an impaired lung capacity and will have to work harder to allow air to travel through the bronchioles, as their tubes are restricted by the condition of asthma.

Learning experience

This activity will indicate how well your lungs perform while participating in physical activity. Perform an adequate warm-up and then complete the following steps for sections A and B to see how well your body copes with the demands of exercise. Record your results in your workbook.

Section A
Complete the following tasks to determine your breathing rate efficiency and estimate your fitness level.

1 Count the number of breaths that you expire (breath out) in one minute to determine your resting expiry rate and record the number of expirations per minute. (This is RER on the graph.)

2 Raise your heart rate by stepping onto and back off a bench as fast as possible for 2 minutes. Take your expiration rate immediately after stopping and record the number of expirations per minute. (This is Step ER 1 on the graph.)

3 Walk slowly for 1 minute and then rest for 5 minutes. Take your expiration rate at the end of this rest and record your recovery breathing rate as expirations per minute. (This is Rec. ER 1 on the graph.)

4 Raise your heart rate by stepping as fast as possible for 2 minutes. Take your expiration rate immediately after stopping and record the number of expirations per minute. (This is Step ER 2 on the graph.)

5 Walk slowly for 1 minute and then rest for 5 minutes. Take your expiration rate at the end of this rest and record the number of expirations per minute. (This is Rec. ER 2 on the graph.)

Section B
Using a line graph like the one below, plot your results from section A and discuss this activity with your class.
Energy and physical activity

‘You are what you eat.’ This saying indicates that what you put into your body is what you will get out of it—by eating healthy foods, you will look and feel much better. The intake of energy (the food we eat) for physical activity is an important factor to consider before, during and after the performance of any physical activity. If an athlete consumes a lot of sugary foods for instant energy (simple carbohydrates) this will not be of benefit to them, as this quick energy burst can result in very low energy levels soon after, as well as cravings for more. It is far better for an athlete to have a nutritious balance of foods in their diet to maximise their energy output. They will perform much better, feel great and as a result be able to maintain a healthier lifestyle.

Role of food as fuel sources

The three main nutrients we consume are carbohydrates, proteins and fats. The most efficient muscle fuel (or energy source we consume) are complex carbohydrates, as this nutrient supplies our muscles with glycogen, which in turn acts as an energy reserve for the muscles. Protein is important for muscle growth and repair, and fat is used for transportation of hormones and insulation, and can also be a source of fuel when glycogen stores are depleted (see figure 1.9).

Figure 1.9
Relationship between carbohydrates, glycogen and fats

Anaerobic and aerobic energy production

There are two main classifications for energy systems: the aerobic energy system and the anaerobic energy system.
The aerobic energy system is used for long duration or endurance exercise that uses oxygen to break down glucose. This system is used most often, as we use it for day-to-day living and basic activities. It is also the most important energy system for endurance athletes. Most physical activity will commence with this system and call upon the anaerobic system when faster or more powerful movement is required.

The anaerobic energy system is used for exercise that involves short duration or stops and starts. This system is broken into two types. The first is commonly known as the lactate energy system, which relies on the use of glycogen for energy, with lactic acid as the by-product. The second type is commonly known as the phosphate energy system. It relies on stores of creatine phosphate as the energy source and is used in very fast or explosive movements.

Of these three main ways that our body can make energy for movement, the energy system that is used is determined by the type, duration (the length of time) and intensity (how hard) of the exercise performed. Figure 1.10 illustrates the possible energy systems used by the body to move our muscles.

A combination of these energy systems is used for participation in most sports or physical activities. For example, an endurance athlete would use the aerobic system for the majority of a long-distance event but to maintain the same speed up a steep hill they would need to use the anaerobic lactate or phosphate systems for a small amount of time. Figure 1.11 indicates how the energy systems overlap and how all are used to a degree in most sports.
When an athlete is participating in a sport or physical activity, they need to balance their energy intake (the amount of food and drink consumed) with their energy expenditure (exercise completed) to maintain a good level of energy. This is often a fine balance for athletes who have an intense training program. The basic principle to energy balance is outlined in table 1.2.

### Table 1.2 Energy balance

<table>
<thead>
<tr>
<th>Description of energy balance</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy expenditure = energy intake</td>
<td>Stable, no change in weight</td>
</tr>
<tr>
<td>More energy expenditure + less energy intake</td>
<td>Weight loss</td>
</tr>
<tr>
<td>Less energy expenditure + more energy intake</td>
<td>Weight gain</td>
</tr>
</tbody>
</table>

**Energy input versus energy output**

Analyse a sports performance on television, noting the energy system/s that you think are used by the athletes who participate in this sport.

Can you think of any factors that would affect the efficient use of the energy system in a chosen sport? (For example, environmental conditions.)

Name five physical activities or sports. Identify the energy systems used in each sport and explain how they are utilised.
Learning experience

1. Participate in a variety of fitness tests and determine the type of energy systems that you have used for each of the tests. Graph your results using the same format as figure 1.11.

2. Maintaining energy balance can be difficult. It takes a lot of organisation and exercise to keep a healthy body shape that allows an athlete to participate in the sport of their choice. Referring to the illustration below, complete the following.
   a. Give each diagram a title to represent the energy balance or imbalance that is illustrated.
   b. Write one sentence to explain the balance or imbalance that each diagram represents.
Interrelationships between the body systems

Each of the body systems relate to each other and need to function together for our bodies to perform successfully. There are many other factors that need to be considered in an athlete’s training program, which are discussed in chapter 14.

It is vital that our body systems work together to efficiently perform a series of movements. All athletes rely on energy for their specific sport and the type of movement carried out will determine the energy system required and the way in which the body systems adapt to this activity will result in an efficient performance. A skilled and physically fit body will resemble an efficient machine that is well hydrated and fuelled, and is geared to automatically use the most efficient energy system for the task it is about to perform. This machine will perform well in the pursuit of effective movement during sport and physical activity if it is well tuned (trained).

The reliance of body systems on each other for effective functioning

The human body has an amazing capacity to adapt to the demand of exercise. When a person chooses to exercise, whether this exercise is mild or extremely active, the human body will activate the circulatory system (the cardiovascular and respiratory systems), together with the skeletal and muscular systems, to perform the voluntary movements that create the actions of an exercise pattern.

The human body and mind work together to allow a person to actively participate in many activities of choice. Our body systems rely on each other to work in harmony to move efficiently. An elite athlete, who works hard to improve their athletic performance through training, will be much more efficient in activating these body systems than an untrained person participating in sport for recreation. The type of sport in which a person participates will also affect the demand that is placed on each system; for example, an athlete who is a long-distance runner will place much more demand on their circulatory system than an athlete who is a javelin thrower.

Hydration and physical activity

The term hydration is used to describe the way in which the body uses and replaces fluid. Our body is made up of approximately 80% water and we need to keep this level stable or conditions such as dehydration, hyperthermia or heatstroke can cause health problems and a reduction in performance for an athlete.

Rapid fluid loss during physical activity can occur and several factors can increase this fluid loss. For example, humidity, high temperatures and the consumption of alcohol all cause unnecessary fluid loss.
Role and importance of water intake during physical activity

Drinking water or fluids containing water needs to be seriously considered by anyone participating in physical activity. The regulation of body fluids needs to be maintained by everyone prior to, during and after physical activity. If fluid, particularly water, is not consumed by an athlete they can become dehydrated, and in extreme cases of fluid loss may need medical attention to replace fluid in the body.

The intake of water to keep well hydrated is very important for everyone and is especially crucial for endurance athletes. All long-distance (or endurance) athletes, such as triathletes and marathon runners, need to balance energy intake with their fluid intake to allow them to perform at their best.

Managing fluid loss and replacement

While it is important to remain hydrated, the intake of too much water or weak electrolyte drinks can also be a danger. Hyponatremia, or water intoxication, is a very rare condition that can cause many complications, the worst being death. During events such as marathons, if too much water is consumed it cannot be processed by the body and this is how such complications occur.

Sources of hydration

Water is the best source of hydration for the body. However, many sports drinks are available and the market for these drinks is growing, with some targeting hydration through flavoured waters and electrolyte drinks. Drinks such as these need to be chosen carefully and factors such as content, cost and whether the drink supplies what the body needs following the specific demands placed on it by particular sports should be considered.

There are three main types of sports drinks and each one has a different purpose, depending on the type of training or competition in which an athlete is participating.

- Isotonic drinks are the most common sports drinks, also called electrolyte drinks. They are designed to quickly replace fluids lost by sweating, as well as provide a quick fix of glucose.
- Hypertonic drinks are used to supplement daily carbohydrate intake. They are high in carbohydrates. Long-distance or endurance athletes may use these after an event to help replenish their carbohydrate stores.
- Hypotonic drinks are designed to quickly replace fluids lost through sweating. They are low in carbohydrates and are the most efficient in replacing fluid and helping to reduce the effects of dehydration.
Learning experience

Purpose
To determine the appeal of sports drinks, including the difference between taste, content and value to hydration of the body during physical activity.

Teacher preparation
Select five to eight different drinks (depending on your class size, time length of the lesson and budget). Include water, cordial or soft drink and various other sports drinks. The teacher should cover the label of each drink or place each in a jug and number each one so that the students cannot identify each drink during the tasting process. Each student will need their own cup.
NOTE: The teacher needs to be aware of and make provisions for any allergies before purchasing and serving drinks.

Step 1
The teacher pours a small sip of the drinks, one at a time, and communicates the number allocated to that drink. Students taste the given drink.

Step 2
In a table such as the one below, students record the number of the drink and a description of the taste (for example, sweet, sour, bitter, etc.).

Step 3
Students give each drink a rating out of 10 for suitability as a sports drink (1 being not suitable for a sports drink and 10 being very suitable).

<table>
<thead>
<tr>
<th>Number</th>
<th>Name of the drink</th>
<th>Description</th>
<th>Rating</th>
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Step 4
The teacher reveals the names of the drinks and the class inspects the label to analyse contents.

Step 5
Conclude with a class discussion.

Closing question
Which drink do you feel is the best one to hydrate the body after exercise? Why?
Chapter cloze

When a choice to move is made one or more systems of the body will be activated to produce a __________ movement.
The _______ _______ is the inner support bone structure for our body and works together with the efficient system of the heart, blood vessels and lungs in our body, known as the _____ _______.
The _______ _______ is a voluntary system that requires our will to move and the central nervous system to send signals from our brain to the muscle to communicate movement to occur.

When a person participates in physical activity, they may perform _______ _______, which is exercise of long duration that uses oxygen as the main energy source, or _______ _______, which is exercise of short duration that does not use oxygen. Some physical activities require a combination of both systems.

Whether a person is an elite or recreational athlete they will need to take into consideration several factors to maintain efficient performance. _______ _______ is exercise completed. _______ _______, or fuel, is the amount of food and drink consumed. The type of exercise and fuel are vital to efficient performance and a person who wants to perform well will also keep their fluid intake up as they exercise, to maintain _________ and balance water loss.

Review questions

1. Briefly describe how bones are held in place.
2. How does oxygen reach the working muscles during exercise?
3. Explain the process of flexion and extension of the hamstring muscles and give two examples of this movement.
4. Which body system is the most important to exercise? Why?
5. How does an athlete balance their energy to perform well? Discuss the demands of training and competition in your answer.