Exploring SPORTS SCIENCE

A resource book of activities and information for National Science Week 2000

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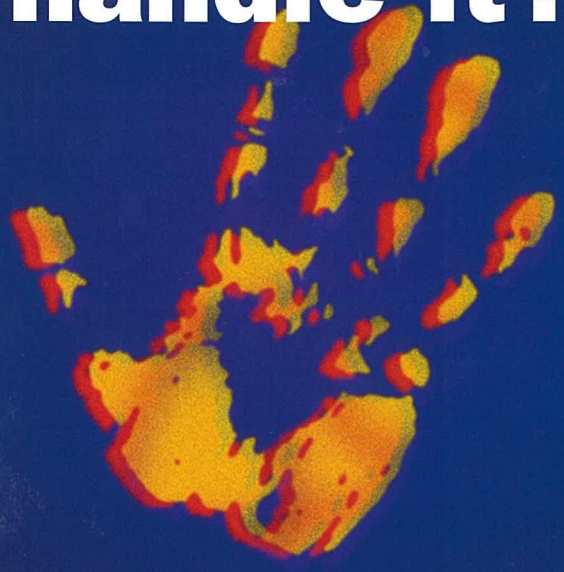

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Exploring Sports Science

A resource book of activities and information for National Science Week 2000

Exploring Sports Science is a resource book of activities and information published by the Australian Science Teachers Association (ASTA). The book is designed for teachers and students and provides many interesting and exciting activities for use at school and at home. The book can be used during National Science Week and throughout the year.

National Science Week is a partnership between ASTA, the ABC and the Australian Science Festival. National Science Week helps to focus community attention on science and its importance in the school curriculum and promotes the image of science.

National Science Week involves students at all levels of learning, parents, scientists and other members of the community in a broad range of science-related activities that show that science is enjoyable.

ASTA encourages science teachers to organise a celebration of science during National Science Week and hopes that this book will provide useful ideas for this year's theme: *Exploring Sports Science*.

The ideas and suggestions are written for students from K to 12. Some you may find too difficult for your students and others will find them not advanced enough. They are there to trigger your own ideas.

ASTA has a National Science Week Coordinator in each State and Territory who organises activities and events during National Science Week. If you would like to find out what is going on in schools in your State or Territory, contact the Association in your State or Territory listed in the Resource List Flier in this book.

If you would like more information about community activities planned for your State or Territory please contact your local National Science Week Coordinating Committee. The contact details are also in the Resource List.

National Science Week is one of many programs that ASTA organises to enrich school science education for students and teachers in primary and secondary schools. If you would like more information, please contact ASTA or your State/Territory Science Teachers Association. A free copy of this resource book is one of the many benefits of membership.

ASTA is pleased to have received funding for this project from the Department of Industry, Science and Resources. On behalf of ASTA I would like to thank and congratulate the author and designers of *Exploring Sports Science*, the National Science Week Coordinators in each State/Territory of Australia and all the teachers and students who become involved in activities during National Science Week.

I do hope you find this resource book interesting, useful and enjoyable. Please contact me or the ASTA office and let us know your views and opinions about *Exploring Sport Science* or about National Science Week in general.

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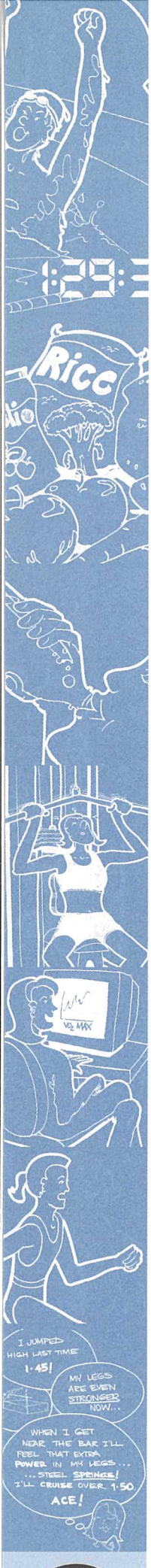

Exploring Sports Science

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Introduction

A physically fit human body can achieve amazing feats. From the routine of a female gymnast to the achievements of a marathon runner, the range of possibilities is endless. Humans can run, swim, climb, somersault, jump, complete complex twist and turn routines, skate, ride bicycles and horses. The variety of possible human movements and activities for all of us is vast. Over the centuries a wide variety of sports, athletics and physical competitions have developed. Once rules have been applied, serious competition is then a possibility. Every day, countless Australians both in team sports and individual pursuits enjoy participation, training and competition.

Science has a role to play in all human activity. Sport is no exception. Any aspect of training, performance, diet and equipment can be improved by the application of scientific principles and method. An individual athlete or member of a team can look at his or her performance and ask the question 'How can I improve my performance?' Attempts to answer this question lead the athlete or sportsperson to sports science. To be a top athlete in the twenty-first century, an athlete has to use every legal method and tool at his or her disposal.

Australia takes great pride in its sporting heroes and great enjoyment from following and watching a wide variety of sports. The country in the past had thrilled to the success of people such as Dawn Fraser in the pool, Betty Cuthbert on the track, Jack Brabham in motor racing and our many tennis stars at Wimbledon. World successes in the seventies and eighties were becoming fewer. Something had to be done. Science was being applied to sport across the world. Sports science was growing and Australia needed to be at the cutting edge.

To help Australia become more competitive in a wide range of sports on the world stage, the Australian Institute of Sport was established in Canberra in 1981. It quickly developed and specialised in areas such as physiology, nutrition, psychology, biomechanics and sports medicine. This excellent facility has done much to raise the profile of Australian sport and athletes as well as provide countless resources and facilities for Australia's sportspeople.

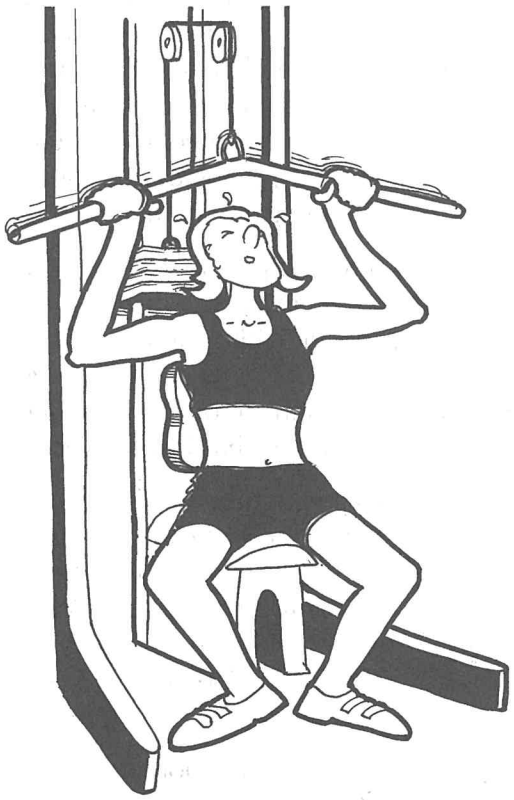
⚠ Safety warning

All student activities included in *Exploring Sports Science* have been designed to minimise hazards. However, there is no guarantee expressed or implied that an activity or procedure will not cause injury. Teachers selecting an activity should test it with their own materials before using it in class and consider the occupational health and safety requirements within their state or territory. Where physical activity is involved the teacher should be qualified to conduct that activity.

Any necessary safety precautions should be clearly outlined by the teacher before starting the activity. Students must also be provided with all safety equipment prior to commencement.

1: Physiology and fitness

In our society, optimum health, fitness and muscles are sought by many. We see people on footpaths, public ovals and gymnasiums building up their strength, fitness and muscle. In this process sports science plays a prominent role. The human body is an intricate machine, capable of incredible feats of strength, coordination, movement and manipulation. It can be trained to move faster, run longer, jump higher or swim further. Performing all of these tasks involves efficient muscles.



Muscles

Muscles are tissues which cause movement. Up to 40% of the human male body is muscle tissue. In the female body the percentage is slightly less. Many of our muscles are skeletal muscles. They attach to the bones and when contracted cause the skeleton to move. Skeletal muscles are voluntary muscles which are in a resting state when we are relaxed but can be activated at will. There are over 600 skeletal muscles in the human body. Other muscles such as the intestinal muscles, muscles in the blood vessels, and the heart are involuntary muscles, which act independently of our will. One important involuntary muscle is the heart. It beats constantly throughout life, without ever resting, to distribute blood, oxygen, digested food and hormones around the body. Good performance depends on the heart efficiently supplying oxygen to the muscles.

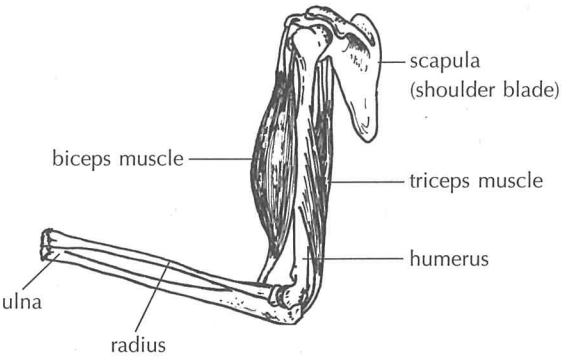
Muscles are made up of specialised cells called fibres. They differ in structure from other cells in that they have several nuclei and are elongated in shape. All fibres run the full length of the muscle and some are up to 30 centimetres in length. Fibres form bundles very much like several wires in a cable or many threads lying parallel. The fibres themselves are made up of strands called myofibrils and myofilaments. These in turn are made up of tiny threads of protein called actin and miocin. Fibres are microscopic, but can be studied in detail in thin section. Cross-sections of fibre bundles or muscles can be studied under the microscope, after a tiny section of muscle has been frozen in liquid nitrogen and shaved into minute slices.

Muscle is a machine, which converts chemical energy into mechanical energy. It does this with surprising efficiency rated at approximately 40%. To activate muscle, the brain sends an electrical impulse to the muscles. This causes the myofilaments to slide over each other, shortening the length of the fibres and increasing their volume in cross-section. Within these myofilaments small knobs and notches slide over each other and then interlock. This process is called contraction and can easily be demonstrated using the biceps muscle in the upper arm as an example. The biceps contracts by becoming shorter and fatter when the brain sends it a signal saying 'I want to raise my lower arm'. As this happens, chemical energy is being converted into mechanical energy. To straighten the arm the biceps relaxes and the fibres lengthen again.

Teachers' notes

Two types of muscle fibres and the white inelastic tissue between them can easily be identified in cross-section.

Anaerobic fibres do not need oxygen to release energy for movement. These muscles allow spurts of energy and strength such as a gymnast would need during vaulting. **Aerobic muscles** do need oxygen to operate, and are more fatigue resistant. They allow sustained effort over a longer period of time. These muscles are the type which benefit marathon runners.



Muscles in upper arm

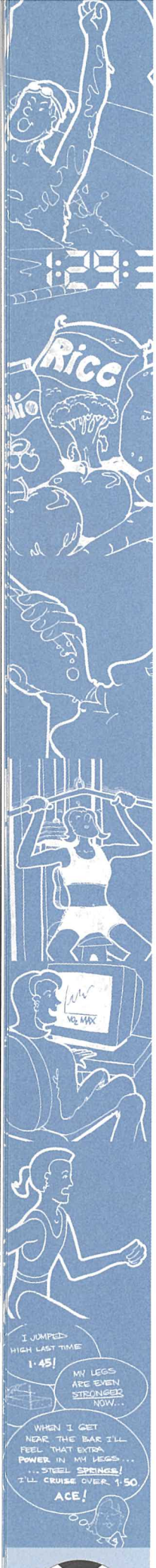
Planning an investigation (hints for upper primary students)

The following steps might be helpful for students and teachers. Not all steps are appropriate for every investigation.

- Research the topic thoroughly.
- Write down everything that you already know that might be relevant to your investigation.
- Clarify what you are trying to find out. Discuss this with others, including your teacher. Write out the question your investigation will answer.
- Plan your investigation.
- Decide which things need to be kept the same and not vary during the investigation. Things that stay the same are called constants and things that don't stay the same are called variables. List the constants and the variables, highlighting the controlled variables.
- Decide how you will record results, including any measurements that need to be taken. Charts, tables, graphs and diagrams are all appropriate.
- Decide what equipment you will need and collect it. If you do not know how to use any equipment or carry out any procedure, ask your teacher.
- Ask your teacher to approve your investigation plan.
- Carry out your investigation, observing carefully.
- Record observations and results.
- Write out the answer to your question.
- Think about and record any factors that could have affected the investigation, results and conclusion.

Cycling

The most efficient form of human transport using muscle power is bicycle riding. Humans cannot run faster than 45 km/h but can ride a bike at over 100 km/h. Riding a bike is also an activity that can be sustained for extended periods of time. The process involves energy from the muscles in the legs being transferred through the pedals to the chain drive, gears and wheels. A bike has dynamic stability — it must be moving to be stable. If it goes very slowly or stops, it usually falls over. Air resistance and drag reduce its speed when it is moving. Overcoming these problems has led to many modifications to bikes themselves, the rider's position and helmet shape. Aerobars in place of handlebars, superthin blades instead of spokes, sitting in the 'racing tuck' position and wearing streamlined helmets all help reduce air resistance and drag and increase speed.



Teachers' notes

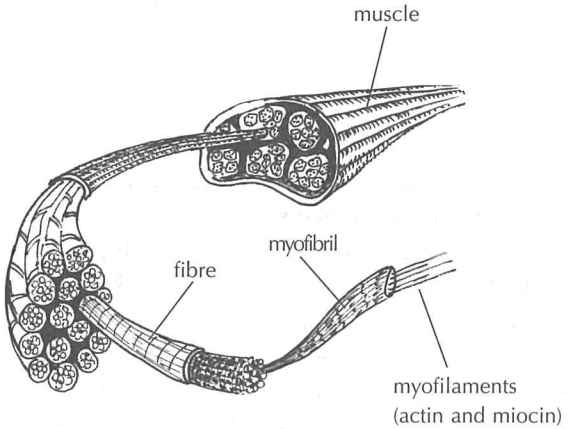
The percentage of each type of muscle fibre is genetic and remains constant throughout an athlete's entire life. The relative percentages of the muscles can indicate whether the athlete is more suited to sports where endurance is a factor or sports where short bursts of energy are essential. Endurance sports include long distance running, long distance swimming, mountain climbing, trekking, cycling, etc. Sports which require spurts of energy include weightlifting, sprinting, pole vaulting, etc. While the number and type of muscle fibres cannot be altered during a lifetime, the size of the fibres can be increased by training. Unfortunately illegal drugs such as anabolic steroids have a similar effect.

Energy

Energy in the human body comes from a special molecule called adenosine triphosphate, or ATP for short. This molecule comes from three different sources.

1 **ATP is stored in the cells.** It is instantly available, so is useful for short bursts of energy such as those required for somersaults, twisting dives and scoring in basketball.

2 **ATP is produced in anaerobic muscle fibres.** Energy produced from the breakdown of glucose and glycogen allows for the formation of ATP from adenosine diphosphate (ADP). ATP produced in this way is available for longer bursts of energy, such as 100 metre sprints.



Cross-section of muscle tissue

3 **ATP is produced in the aerobic muscle fibres.** This process uses a combination of enzymes and oxygen to break down carbohydrates, proteins and fats to produce ATP. The big advantage of this system to endurance athletes such as marathon runners is that it can be accessed for long periods of time and produces large quantities of ATP.

As you train and perform, your body automatically uses a mixture of these energy sources to provide for its needs.

Lactic acid exists at a low level in the muscles at all times. The level increases if the body goes from rest to a low level of exercise but will not inhibit muscle performance. If a high level of exercise is maintained, the level of lactic acid begins to increase till it reaches a point called the individual anaerobic threshold (IAT). This is the point of maximum efficiency for the performing athlete. When the lactic acid level has passed the IAT it can reach a maximum level where the athlete's performance will deteriorate, he or she will feel weak, perhaps even nauseous and disorientated, and severe muscle pain will develop. Some athletes call this 'hitting the wall'. The resulting pain and exhaustion indicates that there is a required recovery time for the fatigued muscles. The pain is a warning to athletes that they have reached their maximum effort point.

The level of lactic acid in the blood can easily be identified by blood monitoring.

The concentration of lactic acid in the muscles is measured in millimols/litre (mmol/L). At rest an athlete's lactic acid will be less than 1 mmol/L. Well-trained athletes such as marathon runners can tolerate a level as high as 8 mmol/l over a long period of time. Sprinters may reach levels three times as high but can only cope with this for very short periods of time.

After exhausting performances, athletes can increase the speed of lactic acid removal from their muscles by exercising at a low level. This can be done, for example, by running a slow lap, swimming a little before getting out of the pool, or undertaking cool-down exercises.

Oxygen

Aerobic capacity is constantly monitored by top coaches and athletes and is known as **VO_2 max**. It is a measure of the maximum rate at which an athlete's body will utilise oxygen and indicates how much energy the athlete can draw on from aerobic muscle action. Athletes aim to improve their VO_2 max to the highest possible level to give maximum aerobic energy availability. VO_2 max is measured in millilitres/kilogram/minute and tells us the volume of oxygen utilised every minute per kilogram of the athlete's body weight.

An athlete's anaerobic threshold is the percentage of VO_2 max that can be sustained for extended periods of exercise. He or she will be able to swim, run, cycle faster, jump higher and throw further as his or her IAT becomes closer to his or her aerobic capacity or VO_2 max.

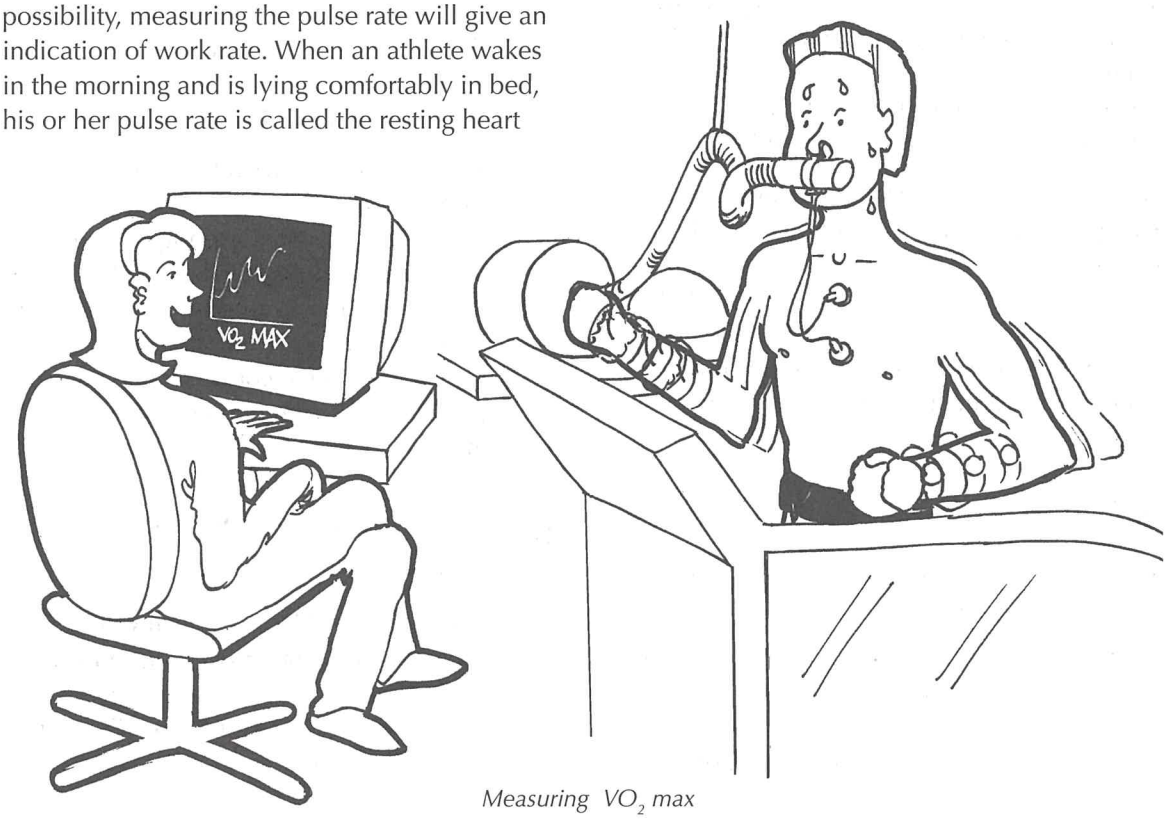
The **heart** is the muscle responsible for pumping blood and fuel to the working muscles. With training the heart muscle becomes stronger and more efficient, supplying the muscles with more blood and therefore more oxygen.

How hard an athlete is working can be determined by using an ergometer. If this is not a possibility, measuring the pulse rate will give an indication of work rate. When an athlete wakes in the morning and is lying comfortably in bed, his or her pulse rate is called the resting heart rate. This is the lowest heart rate. As the athlete's movement and then intensity of exercise increases, so does his or her heart rate.

The athlete's heart rate at IAT is called the individual anaerobic threshold heart rate. This is the pulse rate at the maximum level of exercise an athlete can sustain for long periods of time. It can be determined by taking the athlete's pulse in the middle of a continuous training session and should be given as a narrow range rather than an exact value.

An athlete's maximum heart rate is experienced during periods of intense energy. It should be equal to 220 minus the athlete's age, plus or minus 10 beats. You can determine your own maximum heart rate by taking your pulse after running up and down stairs for five minutes.

As an athlete trains, his or her resting heart rate becomes lower because the heart is beating more efficiently, and the individual anaerobic threshold heart rate increases. For the average person the IAT heart rate is less than 70% of the maximum heart rate. Training can increase the IAT heart rate to as high as 90% of the maximum heart rate.



Measuring VO_2 max

Student activities

Some of the following ideas are appropriate and adaptable for primary and some for secondary. It is recommended that teachers select, adapt, simplify or extend those that best suit the needs and level of their students.

Note: In secondary schools, teachers may like to involve health and physical education teachers in activities. Any suitable fitness tests, such as the cardiovascular endurance shuttle run test, can be used.

Big feet and big hands

How would you discover if big feet run fastest? We all have individual running ability. A great number of factors contribute to these individual differences. This investigation looks at the possibility of a link between foot size and fastest running speed. Foot size can be found by tracing each food on squared paper and counting the squares. Younger students could colour the squares. Every day during National Science Week, each student could run the length of the school sporting field and have his or her time measured with a stopwatch. The times could be averaged and a class table and/or graph drawn up showing the relationship between foot size and running times. Do big feet run faster? The class could make a big book with their colourful feet, appropriate pictures, results and conclusion.

How could you discover if big hands are strongest? For this investigation, use the above process to find hand size and collate results. For the investigation use a water-filled plastic bottle with a nozzle. Measure how high students can squirt water using one hand without lifting the bottle from a particular surface. Are big hands stronger?

Pulse rates

This activity must only be done under close qualified supervision.

What is your pulse rate? Your pulse rate can be measured by carefully and accurately placing several fingers together on either side of the neck, as demonstrated by your teacher, or on the inside of the wrist. Do not use your thumb as it has a pulse of its own. Count the number of beats that you feel over an accurately measured ten-second interval. Repeat this twice and take an average of the three counts. Now multiply this by six to get your pulse rate per minute.

Is your pulse rate different when you are resting and when you are active? Plan an investigation where you measure your pulse rate while resting and then again after three minutes of physical activity. Compare your results with those of your classmates. What conclusions can you draw?

If you rest after a period of exercise, how long does it take your pulse rate to go back to your resting rate? Does this time vary between individuals and is it significant? If you had heard that the time it takes for your pulse rate to return to normal is an indication of your fitness level, how would you test this hypothesis? Design and carry out an experiment with your classmates and record all your results in a table. What conclusions can you draw?

What are your resting pulse rate, individual anaerobic threshold pulse rate and maximum pulse rate? For athletes, monitoring these three pulse rates is extremely important. What are they and why are they important? (See the teachers' notes.) What are yours? Compare yours to those of other class members. Find the class range and average for each. Interpret your results.

Are any of your heart rates affected by your fitness level? If you increased your fitness level, how would these pulse rates change? Spend three weeks training to improve your fitness and measure your heart rates on a weekly basis. Map the changes that occur. What variables could affect your results? What conclusion, if any, can you draw? How could you improve this experiment?

Looking at personal physical fitness

How far can you run? How fast can you run? How high can you jump? How long can you jump? How would you discover if exercise makes you more fit? How would you discover if exercise makes you stronger? How would you discover if exercise makes you more eat more?

Student activities

The following simple investigations involve doing and measuring. Design simple investigations for both individuals and groups.

Which of your present physical activities contribute to your level of physical fitness? Make a list of the physical activities that you do on a weekly basis and highlight those that contribute to your level of fitness. Beside each write the time that you are involved in that activity. How physically fit are you? How could you measure your current physical fitness? Who could you seek help from?

How could you improve your personal fitness? What changes would you make to increase your level of fitness? Make a list of these. Do you think that an increase in your level of fitness would be desirable? How could you bring this about? What other organised activities in the community could you participate in? Plan and carry out a three-week fitness program. Design a checklist to measure your progress and evaluate the success of your plan and describe how you feel. Include factors such as happiness, energy and confidence.

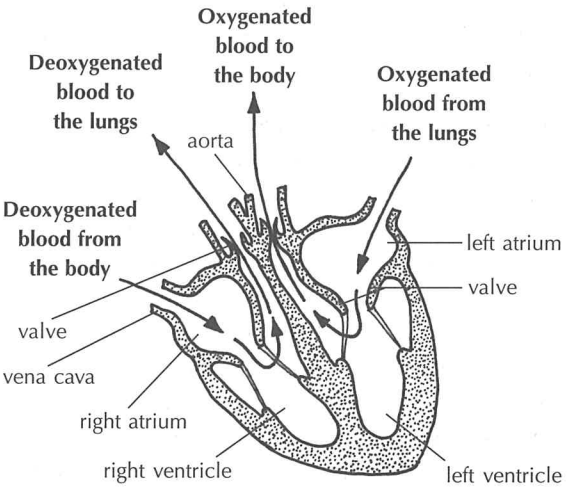
How could you improve your stamina, suppleness and strength? Improving *stamina* involves cardiorespiratory or aerobic training. Improving *suppleness* involves flexibility training, stretching of muscles and tendons. Improving *strength* involves muscle training.

After thorough research, map out a plan of attack to increase stamina, suppleness and strength. Before commencing the activity plan, make sure that your health is good and that your plan has been checked and will be supervised by someone who is qualified. Design activity and progress sheets for each of the three types of training. Decide how you will evaluate your activities and progress.

Examining a sheep's heart

What does a sheep's heart look like and how does it work? A heart consists of chambers and valves and is the pump that moves blood around an organism. This activity may best be done as a teacher demonstration.

Using your powers of observation and basic dissecting equipment, examine a sheep's heart from your local butcher. Look carefully at its structure and determine how it functions. Use the diagram to help you as you dissect.



Sheep's heart, showing direction of blood

Looking at muscle

What is muscle? Muscle is made of fibres and is attached to bone. Muscles contract to move the bones and allow movement. Take a piece of veal or beef steak and examine it carefully. Identify the fibres. Cut a cross-section of the steak and examine it with a magnifying glass or a stereoscopic microscope. If you have the correct equipment, make a proper microscope slide and examine it under a monocular microscope. Use references to help you understand the nature and function of muscles. You could also examine prepared microscope slides.

Breathing rates

How many breaths do you take in a minute? Working with a partner find out how many breaths you take in a minute. Sit down comfortably for this activity. Will the number of breaths vary from minute to minute? Repeat the experiment several times. This is a good investigation for learning to take averages. What is your average number of breaths per minute in a sitting position? Change roles and determine

Student activities

how many breaths per minute your partner takes. Make a result chart for the whole class.

Does exercise cause your breathing rate to change? After three minutes of running, repeat the procedure above and find your average breathing rate and complete another result chart for the class. What do your results mean? Why does exercise alter breathing rate?

How much air can you breathe out? How much air you can breath out is called your vital capacity. There is always some air left in your lungs after exhaling and this is called residual volume. Design an experiment to measure your vital capacity. One method could be to invert a large plastic water-filled container in a tray of water with a rubber tube extending from your mouth to inside the bottle. The container could be calibrated or you could mark the side of the container to show how much air you breathed out. If a group of students are doing this activity, make sure that you clean the rubber tube thoroughly each time.

Looking at how muscle is attached to bone

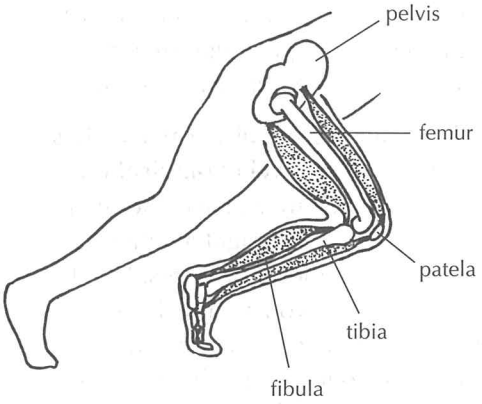
How is muscle attached to the bone? Examine a thigh and leg section of a chicken, by first removing the skin and examining the muscle below. Look at how the muscle is attached to the bone in the leg. What enabled the chicken to walk? Similarly, you could look at a chicken wing. What enabled the chicken to flap its wings?

Making a model forearm

First research the muscle structure and function of the forearm and then, using any materials you choose, make a working model.

Legs

How does a leg move? This is a challenge for those students who want to know how things work. Devise a plan to find what factors contribute to how a leg moves and how these factors work together.



The following information may help.

- Muscles that contract to bend body joints are called **flexor muscles**.
- Muscles that contract to straighten body joints are called **extensor muscles**.
- The leg has **levers** of many different orders. Find and identify them.
- Common body joints include **ball and socket joints** and **hinge joints**.

Look at and compare the basic leg shape of different athletes such as a rugby league player, a diver, a marathon runner and a weightlifter. How is the basic shape different? What are the demands on these sportspeople that have shaped their leg muscles?

Improving sporting performance

How could you improve you performance in your favourite sport? In this activity you will take a close look at your performance in your favourite sport. To begin with, write out your major goal in this sport. How will you go about achieving this goal? If your goal is to improve in that sport, you might like to approach the teacher who is most knowledgable about that sport. What will you ask?

Making a model heart

How can a model show the structure of a human heart? First research the structure of the heart and then, using any materials you choose, make either a static model of the heart or, if you like a challenge, a working model of the heart.

Student activities

Shooting more baskets

How can you shoot more baskets? For this activity you will need a basketball and a basketball hoop.

Mark the floor in front of the basketball hoop at a distance from it that you feel comfortable. Think about your stance, your clothing, your shoes, the extent to which you are thinking positively, the position of your head, how you are holding the ball prior to throwing, your concentration level, your eye–ball coordination, etc. These things you will keep constant throughout the investigation. Then taking your own time, and always throwing from a stationary position at the mark on the floor, attempt to throw forty baskets. Count the number of times the ball passes through the basket. Analyse your performance. Have a friend observe you carefully and also analyse your performance.

Also asking your observer for an opinion, think about how you could improve your performance. Make a list of the things which you can do over the next twenty-four hours to improve your performance at the same task tomorrow. Pick one of these only. Try to keep everything else the same so that you have only one controlled variable. There will be variables that cannot be controlled, such as the day temperature, your diet over the previous twenty-four hours, etc. All these factors will make the findings less reliable. Make a list of all the things that you need to keep constant. Now devise and carry out an appropriate plan of action which will allow you to improve this one variable over the next twenty-four hours, using your selected controlled variable.

Devise and carry out a plan to improve your performance. Twenty-four hours later, repeat the performance task taking care to keep the desired constants as identical as possible to the previous day. Evaluate your repeat performance. How well did your plan work? Name your controlled variable and then list the factors which were constant during the two sessions of performance testing, such as throwing distance, ball, shoes, arm action and feet position.

Information search

Individual students, groups of students or classes as a whole can use the following focus questions to stimulate interest or for further investigation, class discussion and debate, or class presentations with demonstrations. Students could explore the relevance of each question to sports science.

Can you answer the following? Using any sources available to you, including magazine articles, reference texts, libraries, people with appropriate expertise and the Internet, find the answers to the following questions.

- How do humans move?
- What is the effect of athletic training on muscle systems?
- How does the heart muscle work?
- How does the heart muscle change over time when an athlete begins to train?
- What is the structure of a muscle?
- How does oxygen enter your body and travel to muscle tissue?
- When and why does lactic acid build up in your bloodstream?
- What is your VO_2 max?
- What is your individual anaerobic threshold (IAT)?
- What is the anaerobic threshold heart rate and how can an athlete improve this?
- What is a resting pulse rate?
- What is the maximum heart rate?
- Who in your community could tell you more about physiology and fitness?

2: Nutrition

Food is the fuel for the human body. Good fuel serves the body well. Poor fuel can prevent the body functioning at its best. All good diets include foods from each of the major food groups. The diets of individual athletes will vary in the recommended quantities of foods from each of these groups.

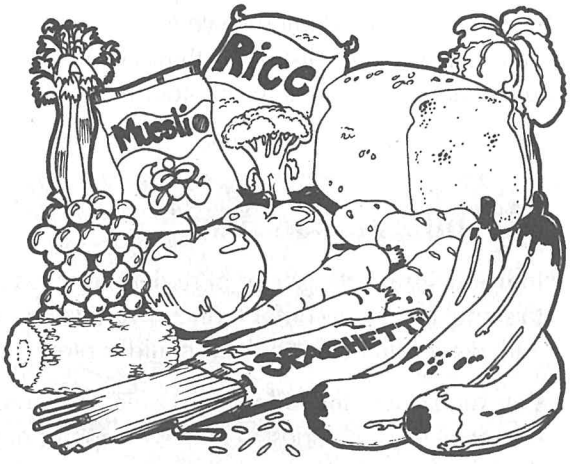
Food for athletes

A good diet for athletes and active people is a diet:

- high in nutritious carbohydrate
- with adequate protein
- low in fats and oils
- with lots of water and quality fluids
- with essential vitamins and nutrients, especially calcium and iron.

Carbohydrates are energy-giving foods that make up a large part of our diet. They are readily available and generally not too expensive. Plants produce carbohydrates by photosynthesis. This process uses carbon dioxide from the air and energy from the sun to produce carbohydrate in the form of sugar. Once ingested, carbohydrate is digested and absorbed into the bloodstream and may then be converted to glycogen that is stored in the muscle and used by the body to produce energy, water and carbon dioxide.

For sportspeople, carbohydrates are even more important because available energy and energy output need to be high. Endurance sports such as football, tennis, hockey, etc. are very dependent on constant energy availability. For endurance sports more than half a sportsperson's energy intake should be carbohydrate. For maximum energy availability, 7–10 grams of carbohydrate per kilogram of body weight per day is advisable. A 70 kilogram sportsperson would therefore need a daily carbohydrate intake of 490–700 grams.



Carbohydrate foods

Types of carbohydrates. Some carbohydrate-rich foods contain fat and some are more nutritious than others. Dividing them into the following three groups helps to determine the best possible diet for an athlete.

1 **Nutritious carbohydrates** provide high-quality carbohydrate combined with other nutrients and include bread, rice, pasta and potato.

2 **Refined carbohydrates** are almost entirely carbohydrate and include sugar, cordial, sports drinks, honey and sugar-rich sweets.

3 **Carbohydrate-rich foods that include fats** are a significant part of many diets. The fats are often not obvious, so a high level of awareness of these foods is necessary if a low-fat diet is preferred. Foods in this group include chocolate, crisps, potato chips, full-cream milk, pies, pastries and most cakes.

To perform at your best on and off the sporting field, a diet in which nutritious carbohydrates feature prominently will serve you best.

Fats and oils are essential for a healthy diet and are very efficient sources of energy. However, fat can be stored in the body, leading to an increase in body weight. In some people this leads to obesity and associated health problems. In an athlete this can lead to extra body weight which may decrease performance. It can also cause a decrease in the carbohydrate consumption. Decreasing fats and oils in the diet of most athletes is essential.

Proteins are essential for growth and tissue repair. Excess protein can also be used to provide energy if carbohydrates are depleted, but will also be stored as fat in the body if intake exceeds requirements. The intake of protein therefore needs to be monitored closely. The recommended daily intake is 1.2–1.6 grams of protein per kilogram of body weight. A 70 kilogram physically active person would therefore require 84–112 grams per day. Foods high in protein include red meat, chicken, fish, eggs and cheese.

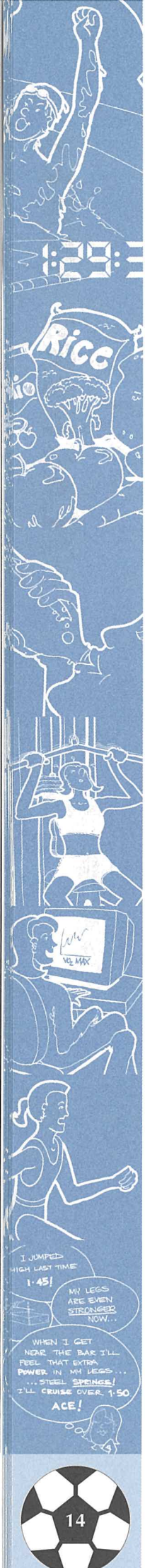
Vitamins and minerals are essential for good health. A balanced healthy diet including fruits and vegetables will meet our needs for most of these. For a physically active person two essential minerals are iron and calcium.

Iron is needed by haemoglobin and helps transport oxygen around the body. Lack of iron can lead to anaemia, tiredness and lower energy. Iron is present in many foods, including red meat, chicken, fish, spinach, lentils, kidney beans and bread. An iron-deficient athlete may need to seek advice on the best way of absorbing iron from these foods into the body. A physically active person requires 7–17.5 milligrams of iron daily. A menstruating female physically active person will require more, up to 23 milligrams per day.

Calcium is needed for bone growth and repair and maintaining good bone density. The best source is low-fat dairy products such as milk, cheese, yoghurt and ice-cream.

Fluid intake is essential to replace fluid lost from the body. If fluids aren't replaced at the rate they are lost, the result is dehydration. This reduces performance and increases health risks. Exercise increases body fluid loss in the form of sweat and the need for more fluid immediately increases. A physically active person needs to plan an adequate and continuous fluid intake throughout the day. Relying on thirst is not sufficient. Carrying a water bottle at all times and rehydrating after training sessions are good strategies.

Carbohydrate loading before competition is a practice that assists endurance athletes and team players. For three days prior to competition, athletes will benefit from eating 10 grams of carbohydrate per kilogram of body weight per day. This increases the stored glycogen in the muscles. The final meal before competition or play should be taken 3–4 hours earlier, with only a high carbohydrate snack taken 1–2 hours before. Carbohydrate loading does not cause faster running or higher jumping, but allows an athlete a longer sustained effort and performance.



Student activities

Some of the following ideas are appropriate and adaptable for primary and some for secondary. It is recommended that teachers select, adapt, simplify or extend those that best suit the needs and level of their students.

Discovering foods — a simple investigation

How would you discover which foods are most nutritious? How would you discover which foods are high in sugar? How would you discover which foods are high in fats? How would you discover which foods are high in starch? Our diets affect our health. A good diet can give us better health and prevent many health problems occurring. Primary classes could make a big book to highlight good diet and health. Finding which foods are high in sugar can be done at a primary level by looking at ingredients listed on the packet. Finding which foods are high in fat can be done by placing small quantities of foods on brown paper and checking for a transparent greasy spot. Finding which foods contain starch can be done by adding drops of iodine to each. If starch is present a dark blue–black coloration will appear. It is fun to do this with small pieces of everyone's individual lunches.

Identifying foods — a bigger challenge

Which foods contain sugars, starches, proteins, fats and oils? This is a bigger challenge. Research how to test for each food group listed above, then list at least five of your most commonly eaten foods, and carry out investigations to analyse these foods. Are you surprised by the results? What balance between food groups should we have in our diet? Have you a good diet? Which foods could be reduced or increased to improve your diet?

How would you record your findings? Are tables, graphs or diagrams appropriate?

Organising a guest speaker or an excursion

Why is a good diet important to an athlete? Who could you invite to your school to talk to you about good diet or where could we go on an excursion to learn about good diet? Our community includes many people interested in helping students learn more about their area of expertise. Those who work in health and nutrition areas are no exception. Find out who in your community would be willing and competent to come to your school and speak to your class. Make contact and arrange a date. Don't be deterred if your first choice is unable to come. Make sure that your speaker has all the equipment he or she needs and don't forget to ask questions. Your class could compile a list of interesting questions before the day of the talk.

Essential carbohydrates

Which foods are

- ***nutritious carbohydrates* that provide high-quality carbohydrate combined with other nutrients?**
- ***refined carbohydrates* that are almost entirely carbohydrate?**
- ***carbohydrate-rich foods that include fats* as well as carbohydrates?**

For maximum energy, athletes need a high energy and high carbohydrate diet. However, not all carbohydrate products are pure, not all are nutritious and some are not fat free. In this activity you will investigate the different types of carbohydrate foods. The investigation can involve a visit to a supermarket or having class members investigate their pantries at home. Plan and carry out an investigation to make a recommended shopping list for a high energy, high carbohydrate diet. Use tables for recording results. Make a chart listing examples of the three types of carbohydrate foods. What are the advantages and/or limitations of each? For each food list the grams of carbohydrate/100 grams of food; the grams of protein /100 grams of food; the grams of fat/100 grams of food; the grams of fibre/100 grams of food; the grams of water/100 grams of food; vitamins and minerals present; and kilojoules of energy/100 grams of food.

Student activities

Eating for energy

What will I eat to give me maximum energy? Some foods provide the body with more energy than others. The wrong foods or too much food can reduce your available energy. After adequate research and a class discussion plan a seven-day diet to give you maximum energy.

Essential minerals — iron and calcium

How can we be guaranteed sufficient iron and calcium in our daily diet? Iron and calcium are two extremely important essential minerals. Lack of them can affect our energy level, haemoglobin function and bone density. How much iron and calcium do you need? What would you include in your daily diet to ensure that you are getting sufficient of each? Why should we avoid a deficiency of these minerals?

Enjoying eating

What would you cook for dinner to give your family a meal high in nutritious carbohydrates and low in fat? Where would you start? Where would you get information? How do you know which foods are high in fat? How do you know which foods are nutritious carbohydrates? You could browse through cooking books to plan the dinner. Prepare the meal and serve it to your family.

Would you consider including
(a) fried foods?
(b) pasta?
(c) sweet desserts?
(d) pastries?
(e) bread?
Give reasons for your answers.

Instead of, or as well as, a family dinner, this activity could be done as a school lunch. **What would you prepare if you were required to provide a plate of finger food, high in nutritious carbohydrate and low in fat, for a class lunch**? Plan a day for the lunch, plan your food contribution, along with your classmates prepare your food, bring it to school and arrange it nicely. Enjoy.

A personal school lunch

What do you eat for lunch? What we eat affects our health and our feeling of wellbeing. Analyse your lunch. List each separate item and determine which foods make it up. If you can, determine the number of grams of protein, carbohydrate, protein, fibre and fat. Also calculate the energy value in kilojoules. Evaluate your lunch. Could you have a better lunch? Plan a lunch that is high in carbohydrate and low in fat. Prepare, pack and eat it in the near future. Can we eat too much? Can we eat too little?

Information search

Individual students, groups of students or classes as a whole can use the following focus questions to stimulate interest, further investigation, class discussion and debate, or class presentations with demonstrations. Students could explore the relevance of each question to sports science.

Can you answer the following? Using any sources available to you, including magazine articles, reference texts, libraries, people with appropriate expertise and the Internet, research the following.

- What are the major food groups?
- What are proteins and why are they important?
- Why is a high carbohydrate diet good for sportspersons?
- Why is a low fat diet good for sportspersons?
- What would you eat and drink in the day of an afternoon sporting event?
- What foods serve a marathon runner best?

3: Sports psychology

Sports science recognises the athlete as a whole person, with the physical and mental aspects of the athlete both contributing to peak performance. The mind and its contribution to peak performance is addressed in a scientific manner by sports psychology. It includes positive thinking, goal setting, focusing and self-talk.

Positive thinking

Our minds and our bodies are a team. They do not and cannot act independently. What we think affects all our actions, what we do and how we do it. Thinking and acting positively can improve health, happiness, effective learning, academic achievement and sporting performances. A positive thought in any situation will serve you best, allow you to make the most of the situation and make you feel good about yourself. Negative thoughts on the other hand are self-destructive and, like handicaps, they are limiting and prevent us from feeling and performing at our best. They reduce our chances of achieving at a high level and reduce our enjoyment in a particular situation.

All of us need positive influences in our lives. If the positive input comes from ourselves we do not need to rely on positive input from others which may or may not be available to us. All of us have a choice between thinking positively and thinking negatively. There are simple exercises and strategies which can help us change ingrained negative thinking habits into positive thinking habits.

A high jumper about to make a jump can choose to think negatively 'I can't do this' or positively 'I can do this'. Positive thinking will not overcome a lack of preparation, but if the necessary preparation has been done it will enable you to perform better at the time.

An important part of positive thinking is to avoid focusing on perceived problems. Rather than problems, see challenges. Many of us know athletes who have overcome profound disabilities to swim or run, or stroke victims who

have learned to speak or use useless limbs. The paralympics and the transplant games provide countless stories of athletes who have addressed difficult challenges and have succeeded. Even though some see these people as having immense problems, they themselves see challenges and with courage and determination often achieve incredible things.

Goal setting

Setting clear achievable goals and then planning and working to achieve those goals is important to all sportspeople. Goals can be long term (for a sporting career), mid term (for a season) or short term (for an individual performance or training session). In fact, setting goals for the following day is a strategy many people find extremely useful.

We have many different aspects to our lives, including family life, work or school, leisure, sport, spirituality, etc. When setting sporting, academic or any other kinds of goal it is important to remember to keep all aspects of our life in perspective and to maintain a balance.

Goals do not need to be winning oriented. In fact, this often sets sportspeople up for disappointment and a sense of failure. Goals such as reaching a personal best, or competing well, or reaching a certain score, as in the case of a gymnast, are goals which are less likely to cause damaging disappointment. Goals set in terms of the sportsperson's own personal performances are more easily achievable than goals based on other people's performances.

Goals need to be realistic. Setting unrealistically high goals sets us up for disappointment and possibly negative feelings and experiences. Setting yourself up for failure can reduce or destroy self-esteem and self-confidence, and increase the risk of quitting. More realistic goals set us up for success and the positive feelings, thoughts and benefits which are associated with success. This can lead to more self-confidence, improved self-esteem and the achievement of higher goals.

Goals do not need to be performance orientated. Equally important and valid goals for sportspeople might be, for example, learning to think more positively, focusing better, enjoying sport and training more, being a better member of a team, being more responsible, increasing commitment, becoming more self-confident, reducing stress, improving mental toughness, or exploring a new resource or technique.

When setting goals it is important to make them positive rather than negative goals. For example, a sprinter may have a positive goal such as 'I want to get off the blocks cleanly and quickly' or a negative goal such as 'I don't want to leave the block before the gun fires'. Negative goals can be self-defeating in that they can cause the person to focus on the thing which they wish to avoid. In the above example it can cause the sprinter to focus on the possibility of making a false start.

Setting goals can help us focus on positive outcomes rather than focusing on our fears, mistakes or previous disappointments. Positive thinking can help us see our mistakes not as failures but as positive learning experiences.

Finally, goals are usually more effective when they are combined with a timeline or timeframe. Goals with a definite timeline can help us stay focused and on course.

Focusing

As we rush through our busy days, lots of varied thoughts constantly pass through our minds. For example, while doing a warm-up routine your mind may be thinking about a conversation you just had, what you would like to eat for lunch, a test coming up at school, making time to take the dog for a walk, or telephone calls you want to make. Our thoughts can randomly jump from one thing to another. Random thoughts, which occur as our mind wanders, are a problem to many athletes. It can be a particular problem in sporting events that take a longer time to complete, for example football games or golf tournaments. Athletes who allow these random thoughts to pass through their mind while competing rarely reach their peak performance. On the other hand, an athlete who focuses totally on the performance, with no irrelevant thoughts occurring, is much more likely to reach peak performance. The ability to focus our thoughts does not come easily to any of us and is a skill that needs to be learned and practised. The ability to mentally focus totally on the task at hand is a great benefit in almost everything we do and is by no means a tool useful only to athletes. Focusing can help us play the piano, perform in tests, write essays or play scrabble. Performance suffers when our minds wander or we lose focus.

If any person gives everything they've got to a performance or a task, if they are totally focused, use all their expertise, strength and energy, then they are winners, regardless of medals, place or times. In team sport, being a good team player, being totally prepared, playing as well as you can, making the most of every opportunity that comes your way and staying totally focused also makes you a winner. Whether your team has won or not is a totally different question.

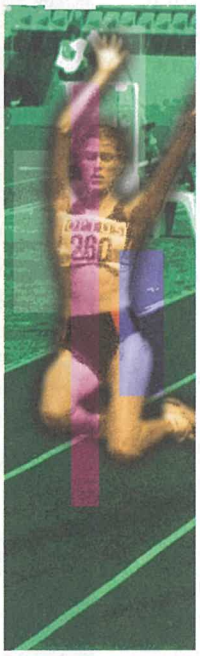
Focusing helps control fear, self-doubt, negativity and anxiety by channelling thought processes in more productive directions.

MEASUREMENT in SPORT

Wouldn't it be great if there was a science teaching resource that students loved to use?

There is. It's called Measurement in Sport – a practical science teaching resource, that brings science alive.

Developed by the National Standards Commission, this 48 page booklet presents up-to-date and relevant scientific material by posing problems requiring practical solutions.



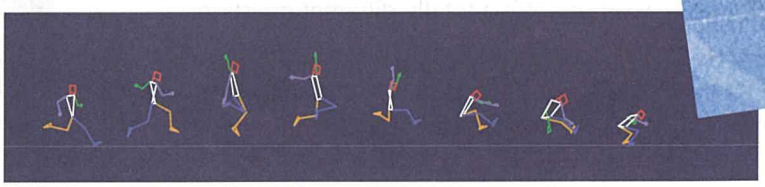
The idea behind Measurement in Sport is to centre the learning process around students doing activities that are linked to their lives. Students enjoy the challenge of thinking more deeply about science and arriving at their own solutions.

Here's what some students have said about Measurement in Sport

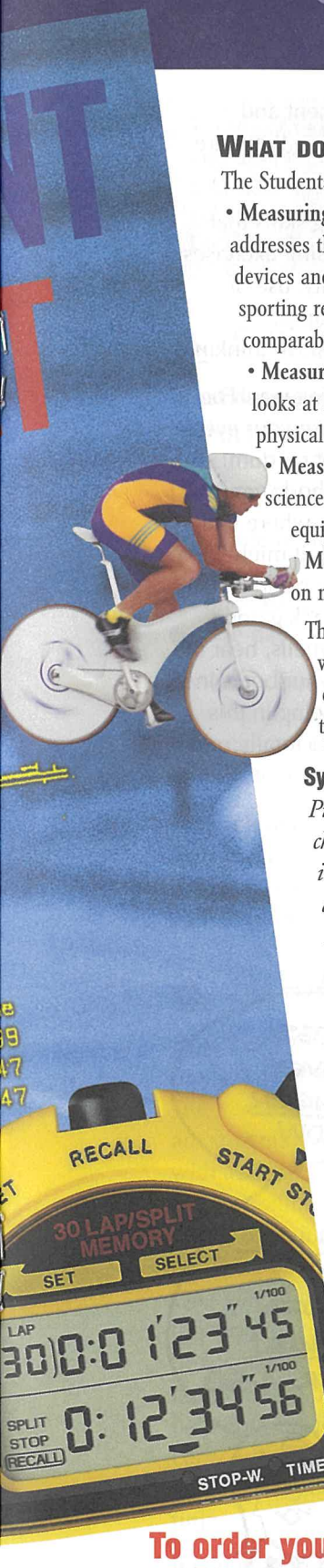
"The Measurement in Sport book was really fun. The way sport was related to physics made physics easier to understand and much more enjoyable."

"Measurement in Sport was the most exciting, fun and extremely educational topic I've done in science in my whole life! It makes you enjoy science."

"I thoroughly enjoyed our topic in physics. Measurement in Sport was fun, and I learned a lot from it. The knowledge I have gained from this topic will help me throughout my whole life. I recommend every student to read the book. It is definitely very enjoyable."



brings Science Alive!



What does Measurement in Sport cover?

The Students Booklet is divided into four main areas:

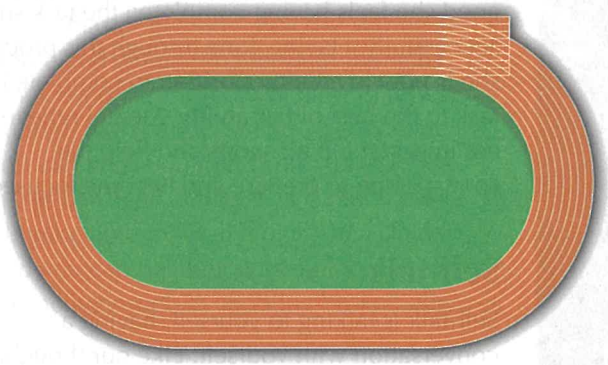
- **Measuring for Competition** – addresses the limitations of measuring devices and the need for accuracy in sporting records to maintain comparability.
- **Measuring for Improved Performance** – looks at human physiology including physical fitness, nutrition, drug abuse and training.
- **Measuring for Innovation** – focuses on the impact of science and technology on sport such as design of new equipment and communication systems.
- **Measurement Fundamentals** – gives background on measurement standards.

These sections are also outlined in the Teachers Manual which gives additional information, syllabus links, equipment lists and hints. Here's a preview of typical sections.

Drugs in Sport

Few issues in sport are as controversial as the use of performance enhancing drugs. Students look at how drugs affect physical performance, the dangers of drug use and why artificial stimulants are banned.

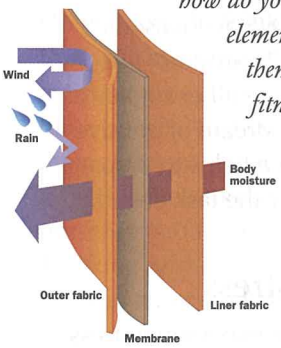
They also analyse and measure the effects of the commonest stimulant of all – caffeine.



Sydney 2000

Picking up on Olympic awareness, this section challenges students to solve problems involved in designing the Olympic pool, athletics track and netball court.

For instance, how did the builders of Sydney's Olympic track determine its length? Activities include calculating track tolerance, designing an Olympic arena and accurately measuring court dimensions.



Physical Fitness

Fitness is a topic often discussed in the media, but how do you measure it? Students learn the key elements of physical fitness and how to measure them. For example, what are the differences in fitness ratings between males and females?

Using three fun activities they measure cardiorespiratory endurance, flexibility and body composition.

Athletic Clothing

Why do companies such as Nike spend millions of dollars developing fabrics like DRI-FIT for athletes? Issues such as wind resistance, low air resistance and weight are developed.

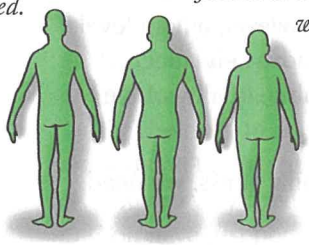
Students measure the relative thermal properties of fibres, learn about advanced textile technology and protection from UV radiation.

Talent Scouts

How do experts determine which physical attributes will produce optimal results in an athlete?

What is the difference between an ectomorph and a mesomorph? Students discover some of the key factors in athlete talent scouting and identify talent within their own class.

Areas covered are somatotypes (body types), twitching muscle fibres and approaches to determining athletic potential.



To order your copies of Measurement in Sport send your school order form to:

National Standards Commission
PO Box 282, North Ryde, NSW 1670
Phone (02) 9888 3922
Fax (02) 9888 3033
E-mail mhaire@nsc.gov.au
ABN 87 902 882 824

❑ 1 to 9 Students Booklets $6 ea

❑ 10 or more Students Booklets $5 ea
(Free Teachers Manual with each 20 Students Booklets)

❑ Teachers Kit $15
(Teachers Manual and Students Booklet)

Teachers Manual is available on **www.nsw.gov.au**

Teachers' notes

Imagery and mental rehearsals

Some sportspeople mentally rehearse perfect performances before beginning them. For example, a female gymnast about to execute a vault might imagine herself standing ready to begin, becoming focused, beginning and following the run-up, taking off, executing the somersault and landing perfectly. She might imagine the cheering of the crowd and how good she feels having completed the task so successfully. Having gone through this process she is now in a better position to complete the task to the best of her ability. Mental rehearsals are important in all sports and help the sportsperson to prepare and become focused.

Self-talk

Self-talk is talking to yourself, having a conversation with yourself. Like our thoughts it can be positive or negative and to be useful self-talk needs to be positive. Positive self-talk can empower us and help improve performance. 'I can do it', 'I can go faster', 'Stay focused', 'I will do a perfect routine', 'I can shoot this goal', 'I'm totally prepared' are all examples of positive self-talk. A constant stream of positive self-talk before a performance helps to prepare the sportsperson mentally for the task ahead.

Controlling excess stress

In our modern society we all experience stress most of the time. A little stress can be useful, indeed desirable, and can be used to our advantage. A little stress over an imminent sporting event can improve our concentration and performance. Mostly, however, a high level of stress is crippling. It can adversely affect sporting performance, learning, quality of life and health.

To effectively manage personal stress, we need to know:

- what causes our personal stress
- what are the effects of the stress we experience
- how much particular stress we are experiencing at any particular point in time
- what particular stress management and relaxation methods work for us — these are called coping skills.

Stress management involves coping skills that include: relaxation exercises, focusing exercises, breathing exercises, physical activity, use of imagery, music, use of relaxation tapes, meditation, muscle flexing and positive thinking.

Imagery can be used in the following way. For example, lie or sit comfortably, close your eyes, relax your body, clear your mind of random thoughts and keep your mind and body very still. Then in your mind travel to a place where you feel completely happy and relaxed. It might be a favourite room, on the beach, lying beside a stream or on a sun lounge in the back garden. Imagine yourself there, smell the smells, hear the sounds, feel the sun or breeze on your body. In your mind live the experience of being in this relaxing place and allow yourself to totally relax and de-stress.

Student activities

Some of the following ideas are appropriate and adaptable for primary and some for secondary. It is recommended that teachers select, adapt, simplify or extend those that best suit the needs and level of their students.

Setting goals

What do you want to achieve in the future? Setting goals helps us clarify our thinking and set directions for the future. They can have different timeframes such as:

- whole-of-life goals
- five-year goals
- one-year goals
- one-day goals.

For each of the time spans above, list your sporting, health or fitness goals in order of importance. The goal setting process can be applied to any aspect of your life.

For each of the lists write out a plan that will help you achieve your goals. How did writing out your goals and your plans help you clarify your thinking?

Staying focused

How can you keep your mind totally focused on one task and eliminate all irrelevant thought? The human brain is an intricate organ capable of amazing things. All our waking hours are filled with activity, noise, stimulation, experiences and responsibilities all needing our attention. Our minds often jump from one thing to another, reducing our concentration on the task at hand. One way to improve our concentration and therefore our sporting performances is to learn to be focused. This is not easy and will take considerable practice. Work out a plan that will help you stay focused on one task. Design and carry out a further experiment which will help you learn to focus effectively for long periods of time.

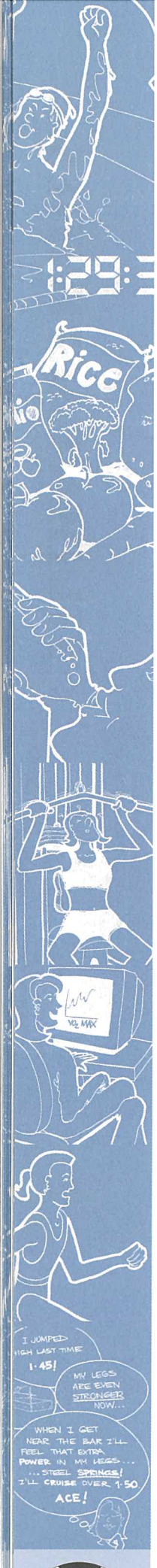
If you need some ideas, perhaps the following simple activity will help. Sit very still in a comfortable position and watch a candle flame for several minutes. At the end of that time, reflect on all the thoughts that passed through your mind. The human mind can be likened to a pond, and the thoughts that pass through it can be likened to stones being thrown into that pond. Each thought or stone causes ripples, movement or disturbance on the surface of the pond. Before being able to focus totally on any task, it is important to be able to control these random thoughts and make our minds like a still pond with a totally flat surface. It takes time and practice to master this skill. Practise staring at the candle and eliminating random thoughts until your mind is still. You will have to repeat this exercise many times to increase the time that you can keep you mind still and inactive. When this has been achieved it is much easier for you to be able to totally focus on a single task and you can begin practising focusing on a sporting activity such as shooting basketballs.

Are you are a positive thinker?

Do you tend to think positive or negative thoughts in your day-to-day life? Sport psychologists constantly encourage athletes to think positively about themselves, their ability, their performance and their sport. All of us at times have performed badly. Rather than seeing ourselves as failures, we can think positively. Thinking positively improves self-esteem and gives us a better chance of performing at our personal best. How do you know if you are a positive thinker?

Imagine that you are faced with the following challenging situations.

- You think you did something wrong.
- You feel lonely.
- You have broken some sporting equipment that belongs to someone else.
- You can't concentrate on the task at hand.
- You are very tired but have to go to training.
- You have just performed at less than your best.
- You haven't mastered a sporting skill even though you have tried hard.
- You have to compete in a race but you don't want to.
- You don't want to get out of bed but you have to.



Student activities

- Someone in your sporting team is annoying you.

Write down the first thought that would pop into your mind. After you have completed writing your thoughts for these ten situations, decide whether your thought was positive or negative. Were you thinking positively or negatively? Design an investigation of your own to determine if you are a positive or a negative thinker.

How can you become a positive thinker?

Changing negative thought patterns

How can you change your negative thought patterns? First, listen to your thoughts and identify them as positive or negative. Now devise a strategy to stop you when you have a negative thought and change it into a positive thought. Why do you think this strategy will work? Monitor your thought processes over a period of two weeks. Can you measure and/or evaluate any changes in your thinking patterns that have occurred? How does increased positive thinking affect how you feel?

Identifying individual stress

What causes your stress and how does it affect you? Stress affects all of us. Too much stress reduces our quality of life and causes us to function less effectively both on and off the sporting field. Does stress cause you to function less effectively? What causes your stress? After a detailed information search on stress, its causes and effects, design an experiment or procedure that will enable you to list all the ways in which you are affected by stress. How could it affect your body, your mind, your actions and your feeling of wellbeing? Now design a further experiment or procedure to determine your personal causes of stress. List these in order of significance in your life. This experiment can help you tune into your body and better understand your feelings and actions. How can you reduce your stress?

Reducing stress

What reduces your stress? There are many methods of stress reduction available to us. They include music, breathing exercises, meditation, relaxation tapes, exercise and imagery. Design an investigation to determine which method works for you.

Does imagery reduce your stress? Get comfortable and close your eyes. In your mind, escape to a place where you always feel relaxed and at peace. Imagine the place in detail and how you would feel if you were there. Experiment with this process until you have a process that works effectively for you.

Information search

Individual students, groups of students or classes as a whole can use the following focus questions to stimulate interest or for further investigation, class discussion and debate, or class presentations with demonstrations. Students could explore the relevance of each question to sports science.

Can you answer the following? Using any sources available to you, including magazine articles, reference texts, libraries, people with appropriate expertise and the Internet, research the following questions.

- Why is sports psychology an essential part of sports science?
- What kinds of things would you expect a sports psychologist to do with a football team immediately before a game?
- If you were a top athlete, what kind of support would you expect from your sports psychologist?
- What is imagery and how does it help athletes?
- Why is it helpful for athletes to set goals?

4: Biomechanics

Biomechanics is the part of sports science that looks at the movement of sportspersons and applies the laws of physics to this movement so that it becomes the best possible technique for the particular requirements of each individual athlete. A complete scientific study and analysis of a sportsperson's technique and movement can lead to specific technique modifications and improvements, helping the athlete reach his or her maximum peak performance. In the case of a sprinter, for example, stride length, stride frequency, distance the feet lift off the ground, arm movement, etc. could be monitored and analysed.

The human body

The human body is a versatile biological machine, which like most machines can work with varying degrees of efficiency. Biomechanics helps increase efficiency. Much biomechanical analysis of athletes and team players is done with high-speed cameras, which take a series of photographs during sporting action. Using a computer, key parts of the body are pinpointed and the computer then produces a series of stick figures based on the movement of these key parts. This shows the action and technique of the person filmed. Technique faults can be highlighted and corrected. Comparisons can also be made between the techniques of different athletes in the same sport.

Movement

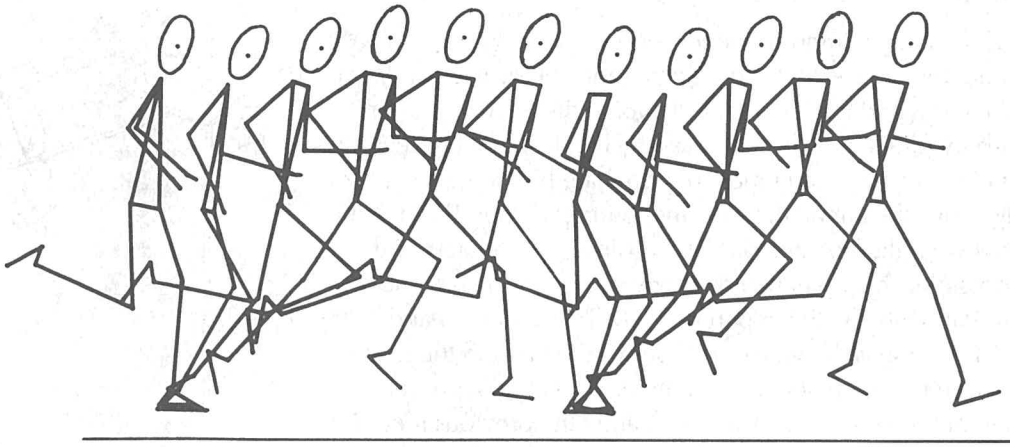
Movement occurs when an unbalanced force is applied. Movement from a stationary position involves acceleration when a force is applied. The greater the force applied, the greater is the acceleration and the greater the resulting velocity.

Forces

Forces affecting a sportsperson come from two sources. They can come from within the body or can be external to the body.

Forces generated by the athlete. Our bodies generate and apply force constantly. Every human body has an energy intake and distribution system, which makes chemical energy available inside the body. This allows muscles to produce forces that act on the skeletal system causing movement. During periods of intense activity, energy conversion is increased in our bodies.

Internal forces within the body come from muscles throughout the entire body working together. A tennis player, for example, uses force when hitting the ball. Muscles from the legs,



Biomechanics series as printed out by a computer

Teachers' notes

hips, body trunk, shoulders and arms working together generate this force. Increasing body strength during training increases the force that an athlete can produce.

Forces external to the athlete. There are many external forces provided by the environment which affect sporting performance.

Gravity affects everyone all the time and acts directly downwards to the centre of the Earth. Sometimes it needs to be overcome, such as in the case of a high jumper, and sometimes it can be used to advantage.

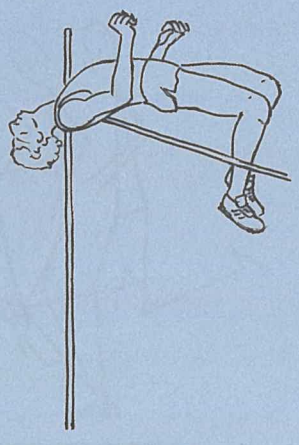
Friction is a force that can help or hinder a sportsperson. Friction between the soles of shoes and a playing surface can enable the person to be more sure footed and prevent slipping and injuries. Therefore the soles of sports shoes are extremely important. However, because different sports require different movements and are played on different surfaces, there is a need for different shoes and different soles. Over recent decades an entire industry has been set up to design and supply specialised shoes for particular sports. Ice dancers, skaters, skiers, bike racers and surf skiers, on the other hand, need to reduce friction. An ice skater has boots with long thin blades. This provides little resistance to the skater moving forward, while preventing the skate from slipping sideways. Skiers ensure that the base of their skis is smooth to reduce friction as they pass over the snow. Friction can also be important when gripping sports equipment with the hands in such sports as weightlifting, gymnastics and javelin throwing.

Drag can be a problem whenever an obstacle such as an athlete's body or a ball impedes the flow of air or water. Air or water changes direction to move around an object and then, after passing it, comes in behind it in a less streamlined and more turbulent manner. Where the air or water first hits the object an area of high pressure is built up. The area immediately behind becomes an area of lower pressure. The object tends to be pushed back by the high pressure and sucked back by the low pressure or drag. Drag reduces velocity and distance in the case of, for example, ski jumpers. Streamlining helps to reduce drag. A speed skier will arrange his or her body in such a way to make the airflow over the body as laminar as possible, and the turbulence and drag as little as possible. Slip streaming occurs in car racing and bike racing. A car travelling directly and closely behind another car is travelling in the lower pressure area created by the first car and as a result tends to be pulled along by the car in front.

Rough surfaces can disturb air and water flow and set up surface turbulence and drag. Some swimmers shave their heads before competition

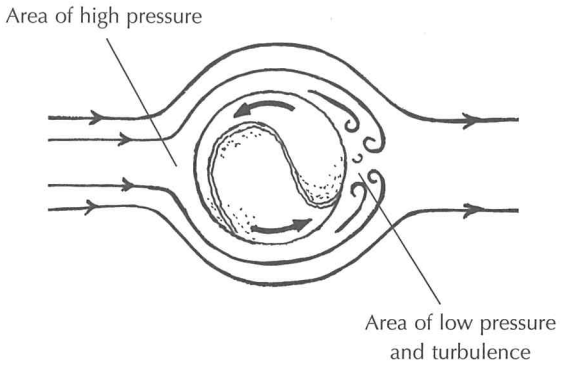
The high jump and Dick Fosbury

How high an athlete jumps depends mostly on the spring, which must come from a take-off from a single foot. The spring is a direct result of the run and the take-off. In 1968, in the Mexico Olympics, Dick Fosbury jumped backwards over the bar, keeping his centre of gravity below the bar at all times. This enabled him to have parts of his body above the bar at all times and to jump higher. The style is achieved by a right foot take-off with a spin so that a backward leap is possible. The top half of the body goes over the bar and begins to fall while the lower part of the body is going up and over the bar. At no time is the entire body above the bar and the centre of gravity can remain below the bar. In 1968 Dick Fosbury set a new Olympic record of 2.24 metres, beating the previous record of 2.18 metres.



Fosbury flop

to reduce turbulence and the resulting surface drag. Swimming costumes made of low friction or smooth materials also help.



Drag and a tennis ball

Angular momentum

Angular momentum affects many sports but is best illustrated by a spinning ice skater. Tucking in the arms causes the rate of spinning to increase. Extending the arms causes the rate of spinning to decrease.

This can be explained by the following relationship.

Angular momentum = angular velocity X *moment of inertia*

When a skater enters a spin the angular momentum is fixed and remains constant. Decreasing the moment of inertia can then increase the angular velocity that determines the spin rate. The moment of inertia depends on the mass and its distance from the axis of rotation. As the mass is brought in towards the centre of rotation, the moment of inertia is decreased and the spin rate increases.

The centre of gravity of a sportsperson is the single point through which the whole mass of the body can be seen to act. The position of the centre of gravity can affect the balance of an athlete. Gymnasts whose centre of gravity is off centre at inappropriate times can lose their balance and divers with the same problem will have trouble executing a high-scoring dive. Weightlifters stand with their feet apart to lower their centre of gravity and give them greater stability.

Physics and sport

The laws of physics apply to all movement and all sport.

Newton's laws can be used to demonstrate this.

Newton's first law states that any object will remain in a state of rest or uniform speed in a straight line unless acted on by a force.
A football will remain stationary on the ground

The physical fitness industry

Physical fitness is the ability that allows the human body to perform physical activities. It is possible to have a low level or a high level of physical fitness. As the level of fitness increases it is possible to perform more difficult tasks and a greater number of tasks. The more physically fit a person is, the more difficult are the tasks that can be performed and the greater is the number of tasks that can be performed.

The fitness industry began and grew in the twentieth century, as leisure time increased. At the same time there was a decrease ion the number of physically demanding occupations and a dramatic increase in the number of occupations which involved sitting at a desk. At the end of a hard working day in previous centuries, most workers needed to physically rest. Many people in our current workforce at the end of the day feel the need for a walk, jog or workout in the gym. This has given rise to many new occupations and areas of research.

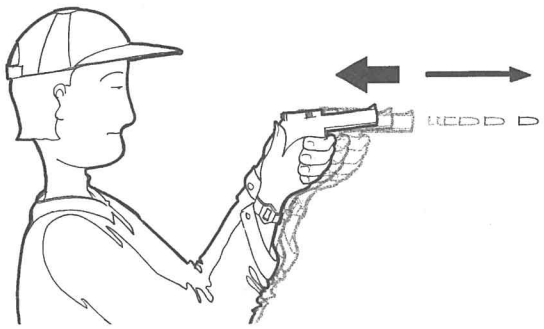
unless kicked or picked up or subjected to a force in some way.

Newton's second law states that when a force is applied to a mass, acceleration can result and that acceleration will be in direct proportion to the force applied.

Force (in newtons) = mass (in kilograms) X acceleration (in metres/second^2)

The more force you apply with a golf club, the greater is the acceleration of the golf ball, assuming of course that it is hit correctly.

Newton's third law states that for every action there is an equal and opposite reaction. A pistol shooter shoots a bullet at high speed. This action causes a reaction in the gun which will move backwards into the hand of the shooter.



Pistol shooting and Newton's third law

Energy

Energy is measured in terms of the work it can do and is measured in the same units (joules). Energy as applied to athletes can be described as either potential energy or kinetic energy. Potential energy is energy due to position and kinetic energy is energy due to movement. If potential energy is due to the position of an athlete or object above the ground surface it is a special kind called gravitational potential energy.

PE (in joules) = mass (in kilograms) X acceleration due to gravity (in metres/second^2) X height (in metres)

KE (in joules) = 0.5 X mass (in kilograms) X velocity^2 (in metres/second)

Momentum

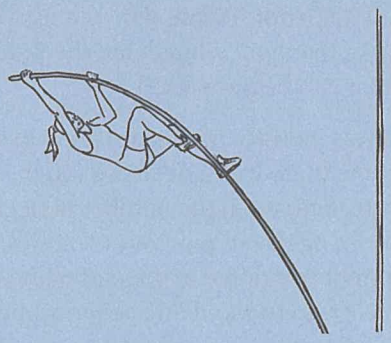
Momentum of an athlete is an important factor if the athlete is moving. Momentum is defined as the product of mass and velocity. The greater the mass or the greater the velocity, the greater is the momentum produced. A pitcher in baseball gives the ball as much momentum as possible to ensure a fast delivery. To do this the force on the baseball is maintained by the pitcher for as long as possible and the follow-through results.

In an isolated system, momentum is conserved. This is called the law of conservation of momentum. When a tennis player serves, the momentum of the racquet and arm of the athlete is transferred to the ball. The momentum before striking the ball is the same as the momentum after striking the ball. Momentum is conserved, but in this case transferred.

The pole vault — an upside-down event

Why upside down? The athlete is definitely upside down just before going over the bar, but also it is an event where instead of the athlete propelling his equipment, the equipment propels the athlete. In this case the equipment is a fibreglass pole reinforced with graphite.

When the pole is planted, linear motion is converted into angular motion as the athlete swings and the pole pivots around its base. The speed of the linear motion is critical and determines the height the athlete will reach. This event, like many others, is affected by altitude. At high altitudes vaulters will reach greater heights.



Student activities

Some of the following ideas are appropriate and adaptable for primary and some for secondary. It is recommended that teachers select, adapt, simplify or extend those that best suit the needs and level of their students.

Measuring running speed

How can you determine your running speed using stride length and frequency? This investigation involves accurate measurement, record keeping and simple calculations. Design an experiment that will enable you to determine your average stride length when running at your maximum speed, and your stride frequency. Use this information to calculate your running speed:

Running speed = stride length X *frequency*

Primary students could wet the soles of their shoes and run on a non-grass surface so that the wet spots show. Using water soluble paint is good fun but messy to clean up after.

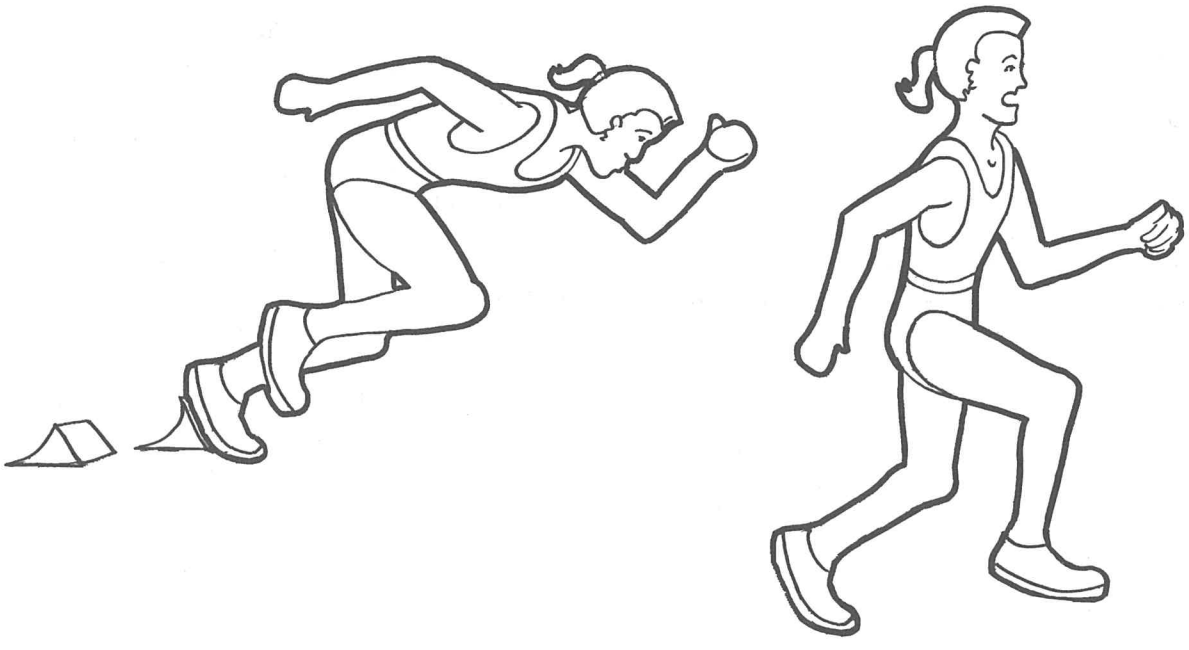
What limitations did your investigation have? What variables could not be controlled? How could your investigation and the accuracy of your results be improved?

Variation in stride length

Does your running stride length vary with your running speed? What is the best way to answer this question? Do you think there is a connection between stride length and running speed? Plan your investigation thoroughly before carrying it through, collecting your results and answering the question. Carry out the same investigation with some of your friends to see whether they have the same relationship between stride length and running speed. What are the limitations and sources of error in this investigation?

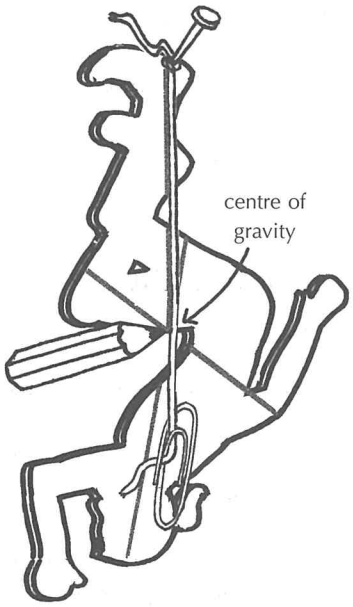
Determining the centre of gravity

How does the centre of gravity affect stability? The centre of gravity of an athlete or any object is the point through which the whole gravity acting on the body can be seen to act. A running athlete will often have a centre of gravity well away from the contact point with the ground. If he or she tried to hold this position when stationary he or she would be unstable and would topple over. One possible investigation is to determine the centre of gravity for the following two athletes.



Student activities

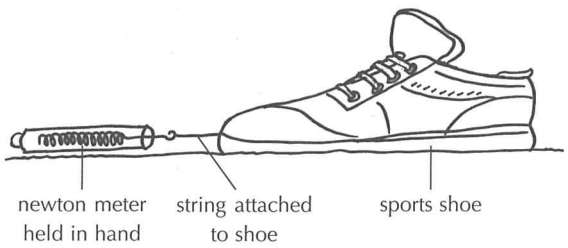
Magnify and cut out the athlete outlines and suspend each in turn by a string with an attached paperclip. Draw a vertical line through the athlete and the paperclip. Reattach the paperclip in two different positions on each athlete and again draw vertical lines.



The point where the three lines cross is the centre of gravity. Which of the two athletes is in the most stable position? When is an athlete in a state of equilibrium? Why doesn't the sprinter fall?

Shoes and friction

How much friction exists between your shoe and a particular flat surface? Investigate how the force of friction can be indicated, then design an experiment to make the necessary measurements. One possibility is using the method indicated below and measuring the force needed to cause the shoe to begin to move.



Compare the friction of your shoe sole to those of your friends.

In lower primary a big book could be made with each shoe being drawn and the force measured in newtons needed to move it written beside each shoe. Shoes could be ranked or grouped according to their grip. Compare the different sole surfaces. Prints of shoe soles could also be made in the big book.

How would you explain the differences in the forces required to move each shoe over the surface? What are the limitations of this investigation?

Friction and playing surfaces

In what order would you list the friction of the common playing surfaces available to you? Some surfaces are easy to slip on and others are not. Slipping on sporting surfaces causes injury. A surface with low friction is easy to slip on. One example is a highly polished wooden floor.

Design an experiment to determine the friction of common playing surfaces using your own shoe. Pulling your shoe horizontally with a newton meter will indicate how much force is required to move the shoe. The more force that is needed to move the shoe, the more friction there is between it and the playing surface. Why is it important to use the same shoe for each playing surface? How reliable are your results? Repeat the experiment using someone else's shoe. Explain the similarities or differences in the results.

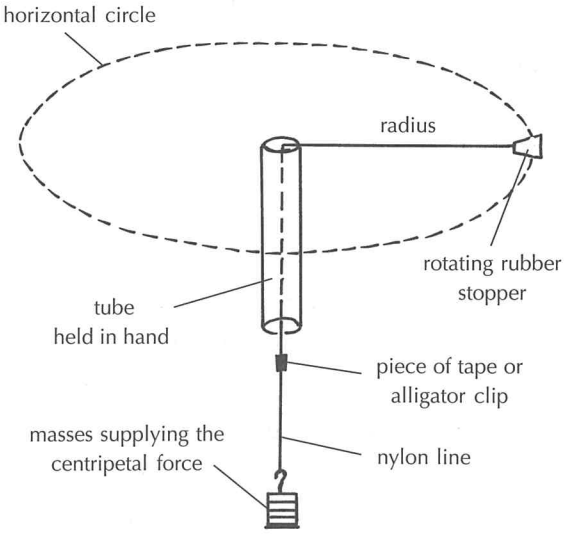
Student activities

Designing a sports shoe

What is your ideal sport shoe? Professor Cavanagh, head of the Biomechanics faculty at Pennsylvania State University in the early 1980s, carried out tests on running shoes. He looked at flexibility, weight, waterproof qualities, support, bounce, traction, comfort, grip and wear. One interesting fact that was revealed by his investigation was that a good pair of running shoes covers 750 kilometres in their lifetime. It is important therefore to have comfortable, suitable shoes. List those things that you require in a sports shoe. Design a shoe that meets all your requirements. You might like to add style and colour to meet your aesthetic needs as well.

Circular motion

What is circular motion, what sports does it affect and how does it affect them? Investigation of circular motion is a good reason to make and play with toys. Make the following toy and play with it.



What can you learn from it? What forces apply? How can the velocity of the rotating mass be changed? What sports make use of circular motion? What other toys could you make which involved circular motion?

Conservation of energy

What sporting examples demonstrate the conservation of energy? This is a more difficult challenge. Here is one example to get you started. A stationary diver on a high board has potential energy but no kinetic energy. On takeoff the potential energy is converted to kinetic energy. This occurs as height decreases and velocity increases. Halfway down, the total energy, which hasn't changed, is half potential energy and half kinetic energy. On hitting the water the energy is all kinetic. As the diver enters the water much of this energy is transferred into the water causing movement. Some is converted into heat and sound energy. List and describe as above as many sports examples of conservation of energy as you can.

Forces acting

What forces are acting in the following situations? Whether stationary or moving with a resultant force, sportspersons are acted on by forces. Draw sketch diagrams of the following and use arrows and labels to show the forces acting on each. For example, gravity is force acting directly downwards, so the arrow will point to the bottom of the page.

1 A netballer shooting a goal
2 A runner stationary in starting blocks
3 A runner leaving the starting blocks
4 A rifle shooter firing a gun
5 A footballer kicking for goal
6 A golfer hitting off a tee

Newton's first law

What sporting examples illustrate Newton's first law? A mass will stay at rest or moving with constant speed in a straight line unless acted on by some external force. A golfer applies force to a stationary ball and causes it to move. Starting with this example, make a list of sporting situations that demonstrate Newton's first law. Plan and carry out three demonstrations that illustrate this law.

Student activities

Newton's second law

What sporting examples illustrate Newton's second law? Force applied is proportional to the acceleration produced. In a sporting situation we are assuming that the technique used is correct and successful and that the force is applied as it is meant to be. Here is one example to get you started. When a football is kicked, the force with which it is kicked determines its acceleration. The greater the force, the greater is the acceleration and the further the football will travel if it is kicked at the correct angle. Now make a list of your own examples demonstrating Newton's second law. Plan and carry out three demonstrations which illustrate this law.

Newton's third law

What sporting examples illustrate Newton's third law? For every action there is an equal and opposite reaction. When a golfer hits a ball, the ball accelerates and the golf club decelerates due to the equal and opposite force acting. List as many sporting examples as you can to illustrate this. Plan and carry out three demonstrations that illustrate Newton's third law.

Angular momentum

What sports make use of angular momentum? Investigate as many as you can and explain to yourself what use each sport makes of angular momentum.

Moment of inertia and angular momentum

How do high divers use the moment of inertia to produce complex twists and turns? Complex twists and turns are executed in gymnastics, ski jumping and diving. The challenge in this investigation is to find out how this occurs. Take a wooden rod or straight stick and load the ends with equal lumps of modelling plastic. Holding the rod in the centre try to twist it. Move the modelling plastic masses halfway to the centre of the rod or stick. Again holding the rod in the centre try to twist it. What difference did you notice in the way the stick handled in the two situations? What happens when the mass comes closer to the turning axis? What would happen if one mass was brought in and one was not? How do you think a diver could distribute his or her mass (move his or her body) to perform twists and somersaults?

Hint: Angular momentum depends on spin rate and moment of inertia.

Information search

Individual students, groups of students or classes as a whole can use the following focus questions to stimulate interest or for further investigation, class discussion and debate, or class presentations with demonstrations. Students could explore the relevance of each question to sports science.

Can you answer the following? Using any sources available to you, including magazine articles, reference texts, libraries, people with appropriate expertise and the Internet, research the following questions.

- How can computer analysis of an athlete's technique benefit the athlete?
- What enables the human body to move?
- How can the human body generate force?
- What factors affect the acceleration of an athlete?
- How does drag affect a bike rider and how can it be reduced?
- How does an ice skater use angular momentum to vary spin rate?
- In what sports is friction an advantage?
- In what sports is friction a disadvantage?

5: Sports medicine

The human body is a machine that needs to be maintained and repaired when necessary like any other machine. Correct care, use and treatment help athletes and sportspeople maintain peak performance and enjoy a long sporting career.

Sports medicine is simply the application of medical knowledge and treatment to people who are involved in sport in any of its forms. It involves all the normal branches of medical science and differs only in the people who are treated and the types of treatments they require. A good sports medicine practitioner needs to be a good doctor and have an understanding of the way in which a wide variety of sports affect the people involved in those sports. Sports medicine addresses

- physiology and maintaining fitness
- the treatment of injuries
- the treatment of illness.

Physiology and maintaining fitness

Sports physiology aims to help the athlete train as hard as is possible to reach maximum effectiveness without suffering from overuse or other injuries. Knowing how to improve the function of body organs and parts through training without overstressing them is important for training programs. Sport physiology has provided a wealth of knowledge about how to achieve and maintain maximum strength, fitness and stamina. Maintaining fitness and returning to full fitness after injuries is also an important area of sports medicine.

The treatment of injuries

Injuries can be traumatic or accidental and can occur at any time. These injuries can be severe, particularly if they occur during periods of intense effort or activity. Injuries can also be the result of overuse or overtraining. Too much speed, overuse of one set of muscles, and excessively long training sessions can all contribute to an injury. Quick diagnosis, treatment and healing of injuries are high priorities with all athletes. Not only can injuries prevent participation in sporting events, but can interrupt training schedules, fitness levels and damage entire sporting careers.

The treatment of illness

Illness affects everybody, including athletes. However, even a simple infection can be a major problem during competition. Quick effective treatment of non-sport related illnesses is therefore of great importance.

Injury prevention

Common sense can prevent many injuries and illnesses. Sportspeople or athletes should:

- Be fit. Conditioning is essential if injuries are to be minimised.
- Wear appropriate well-fitting clothing and use the correct equipment.
- Play or perform under correct supervision.
- Train, play or perform only in reasonable conditions. Training in extreme heat, for example, can lead to heat illnesses.
- Replace fluids regularly by drinking water or sports drinks. This will prevent dehydration.

First aid

Injury prevention does not always work, so it is essential to be prepared. A well-equipped and up-to-date first aid kit should always be close at hand and should include phone numbers of emergency services and a person with first aid qualifications.

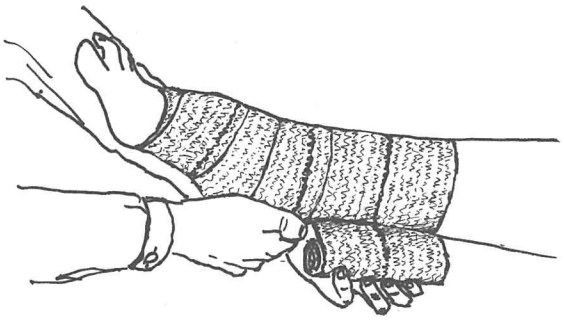
Immediate treatment

Immediate treatment for common injuries or conditions can decrease the damage to the athlete and decrease the recovery time.

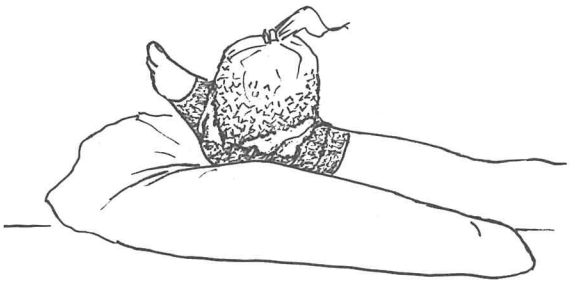
Strain injuries. Immediate strain injury treatment can be summarised by the word RICE:

Teachers' notes

- **R**est for both the athlete and the injured body part. The athlete should cease all activity immediately.
- **I**ce packs should be applied to the injured site.
- **C**ompression should be applied in the form of an elastic bandage.
- **E**levation of the injured area should occur as soon as possible.



Compressing injury with elastic bandage



Elevated bandaged leg with ice pack

Bleeding. Using rubber gloves, apply sterile gauze and then hold firmly to apply pressure and control the bleeding. Elevate the body part, apply ice and a compression bandage for extra pressure if appropriate.

Heat illnesses (heat exhaustion and heat stroke). Heat injuries are very serious and should be treated as such. They involve an elevated core temperature of the body. Symptoms include dizziness, rapid pulse, nausea, lack of energy, not sweating and red, dry skin. An athlete can collapse and become unconscious. Keep the person cool, remove excess clothing, give water, monitor carefully and call for help. A coach or adult might need to administer cardiopulmonary resuscitation (CPR).

Head, neck or back injuries. Do not move the person, keep him or her calm and call an ambulance.

Correct medical diagnosis and treatment must follow up all immediate initial treatments.

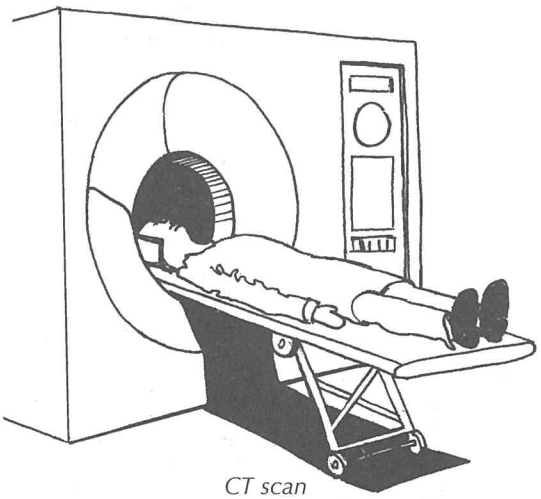
Diagnosis

Diagnosis of sporting injuries needs to be quick and accurate, so treatment can be immediate. Sports medicine teams have many diagnostic tools available for their use. Some of the more common ones are listed below.

- **Physical examination.** This is the first procedure and may be the only one available on the sporting field.
- **X-rays.** These help identify bone and joint injuries, and involve X-rays being directed at the injured site to give an image of the bone structure.
- **Ultrasounds.** These identify problems with soft tissue such as muscle and tendon. In this case sound waves are used to produce an image not only of the muscle structure but

also muscle movement. This extremely safe technique allows instant observation of the images produced.

- **CT scans (computer tomograph scans).** These investigate both bone and soft tissue. The procedure gives a very detailed image and simply involves the patient lying in a chamber for a few minutes.

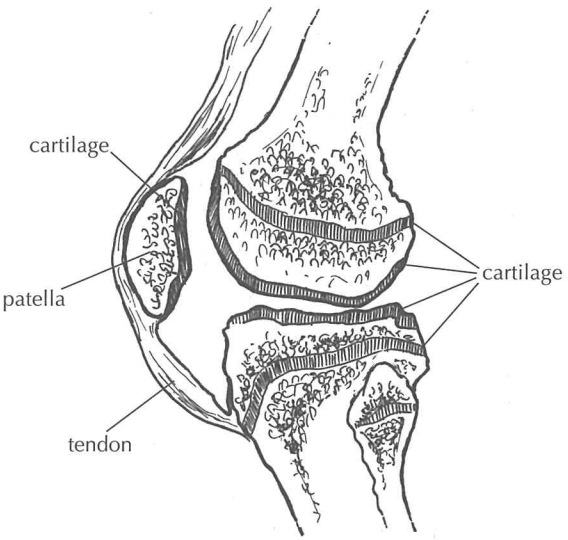


CT scan

- **MRI (magnetic resonance imaging).** This investigates soft tissues using a magnetic field while the patient is lying in an enclosed chamber.
- **Blood tests.** There are many different blood tests that give different information. They give invaluable help in diagnosing an athlete's health profile.

Blood test

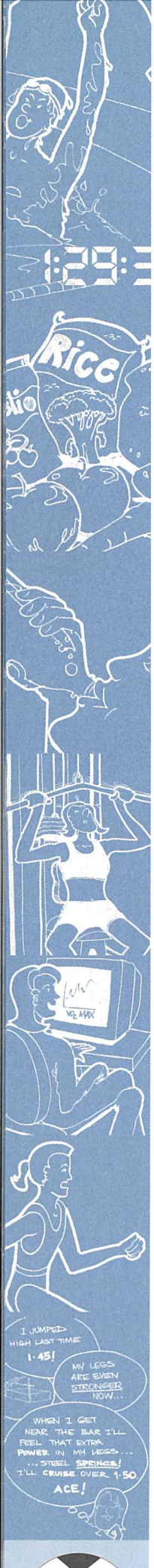
- **Bone scans.** These involve nuclear medicine in that a radioactive fluid or dye is injected into the patient several hours before the procedure. New bone cells that are repairing damage absorb the dye, allowing them to be seen and evaluated. The radiation leaves the patient's body within eight hours. This procedure is used in sports medicine to identify stress fractures and other bone or joint damage. It is also used with cancer patients to determine whether the cancer has spread to the bone.
- **Arthroscopes.** These allow direct inspection and assessment of the inside of a joint, giving direct feedback instantaneously. Joint injuries, in particular knee injuries, are a common sporting problem that can be accurately diagnosed using this method. Knee joints are amazing intricate structures which allow humans to manoeuvre and move in a wide variety of ways. Arthroscopy has made an immense difference to diagnosis and treatment of joint injuries.



Knee joint

Drugs and sport

Legal drugs used in sports medicine are many and varied. Two commonly used groups of drugs are the non-steroid anti-inflammatory drugs and painkillers. Inflammation often follows sporting



Teachers' notes

injury and can be reduced by anti-inflammatory drugs. They are not painkillers but can reduce pain by reducing the problem causing the pain and can also reduce damage and recovery time. Pain relief for severe injuries improves the level of comfort of the athlete but does not treat the injury.

Illegal drugs in sport is an increasing problem. The taking of illegal drugs to enhance performance is called doping. Over recent years many athletes have succumbed to the temptation to improve performance by this method and have had to pay the price of public humiliation and banishment from their sport. Inadvertent doping is when a drug is taken for medical purposes but also falls into a banned category. Athletes must check any medication taken thoroughly as inadvertent doping still leads to disqualification and banning.

Some illegal drugs in sport are listed below.

- **Beta-blockers.** These regulate the heart beat and are taken to reduce tremor and palpitations. A pistol shooter could use such a drug to reduce the frequency of heartbeats and therefore shoot between beats to reduce trembling.
- **Narcotic analgesics.** These are morphine-like analgesics. They cause the athlete to feel good, can be addictive and can reduce anxiety, nervousness or fear. They are sometimes taken to reduce pain so that a sportsperson can participate.
- **Diuretics.** These increase urination, leading people to think it is making it harder for other drugs to be detected. They also play a role in reducing weight due to water loss.
- **Stimulants.** These are commonly called uppers or amphetamines and include drugs such as cocaine. These were more commonly used in the past to reduce pain, give a false sense of wellbeing and improve self-confidence. They needed to be taken just before competition and are now easily detectable.
- **Anabolic agents.** Synthetic hormones such as anabolic steroids are made in a laboratory. They are similar to testosterone, the male hormone, and increase the muscular mass of the athlete. Anabolic steroids allow longer and more frequent training and better performance. They also have a wide range of undesirable side effects. They are used legally in some medical procedures such as the treatment of cancer patients.
- **Peptide hormones and analogues.** These have similar benefits to anabolic steroids but have dangerous side effects.

Illegal drug use should be avoided for many reasons, including the long-term health damage to the athlete.

Student activities

Some of the following ideas are appropriate and adaptable for primary and some for secondary. It is recommended that teachers select, adapt, simplify or extend those that best suit the needs and level of their students.

What's inside us?

What bones can an X-ray see? What organs can an ultrasound see? This fun activity can be adapted for primary students of any age. X-rays allow us to view bones and ultrasounds allow us to view organs.

Younger students could cut out and colour diagrams of:

(a) the bones of the skeleton, and/or
(b) organs such as the heart, brain, lungs, kidneys, stomach and intestines.

They could then pin them to their body in the positions where they think they should go.

Performing a play in National Science Week

What happens after an athlete is injured both at the site where the injury occurred and at a sports medicine centre or hospital? To help you understand the importance of sports medicine, write and perform a play that both answers the above question and highlights the career opportunities involved in first aid and sports medicine. The topic lends itself to humour and the play could be performed in National Science Week.

Family medical experiences

What medical procedures have your family members experienced? Many sports medicine procedures are normal medical procedures used for a specific purpose. To help you understand these procedures, why they are done, when they are done, and what the possible benefits are, carry out a survey. Design a survey sheet including questions you will ask members of your family. Older family members including grandparents and great-grandparents are ideal people to ask because they have lived longer and usually have needed more medical support. As some people do not like to share their medical experiences it is important to ask their permission first. You could ask about blood tests, X-rays, ultrasounds, CT scans, MRI, bone scans, physiotherapy and surgery. If you are unsure what questions you could ask, the following examples might help you get started. What procedures have you experienced? What was done to you? Why was it done? How did it feel, before, after and now? How did it help you?

What's inside us?

What does an X-ray machine do? Write a creative short story entitled 'My life as an X-ray machine'. Thinking about what an X-ray machine 'sees' may help to get you started. You could choose your own title for your story. The same activity could involve a CT scan or an ultrasound.

Thinking critically

What should we do as a country about the illegal use of drugs in sport? What pressures cause athletes to consider illegal drugs? Who should decide which drugs are legal under what circumstances? How should they do it? In this activity you will have an opportunity to think critically and constructively, and to address socially relevant questions. These are excellent questions for a class discussion or debate. Many other questions posed in this book could be used in the same way.

A sprained ankle

What would you do if your friend sprained his or her ankle? Sprain injuries on the sporting field are common and it is possible that all of us may be required to help at some time. Research the correct procedure to apply to a sprained ankle. Prepare a demonstration for your class using a friend or model.

What would you do if your friend broke his or her leg? Injuries treated correctly at the time heal more quickly and keep athletes from their sport for a shorter period of time. Again, prepare a demonstration for your class using a friend or model.

Student activities

A class presentation

How could you best teach your class about one aspect of sports medicine? By telling others about a particular procedure you will come to understand it yourself. Plan your presentation and map out what you will do. What material would you cover? How would you research the topic? If you could attend a local hospital or sports medicine centre to observe the procedure this would help. How would you present the information? What computer technology do you have available to you? Can you use computer software to design or enhance your class presentation? Do you have a video camera available? Can you use it to make an entire presentation or perhaps include in your presentations such things as interviews with appropriate community members?

Careers in sports medicine

If you decided to follow a career path in sports medicine, what particular career path would you follow, and why? There are an increasing number of career paths in sports medicine. Primary classes could make a list of these and say what each one involves. This could lead to posters depicting each which could be made into a mural or display. Secondary students could pursue to a greater extent what each career path entailed and give reasons for their choice.

This topic could be performed as a play written by students and presented at a school assembly during Science Week. Alternatively, each student could research one sports medicine career path and deliver a five-minute presentation to the class.

Information search

Individual students, groups of students or classes as a whole can use the following focus questions to stimulate interest or for further investigation, class discussion and debate, or class presentations with demonstrations. Students could explore the relevance of each question to sports science.

Can you answer the following? Using any sources available to you, including magazine articles, reference texts, libraries, people with appropriate expertise and the Internet, research the following questions.

- What injuries does warming up before physical activity help prevent?
- What is an X-ray and what is it used for?
- What is a CT scan and what is it used for?
- What is an ultrasound and what is it used for?
- What is MRI and what is it used for?
- What is a bone scan and what is it used for?
- What should be in a first aid kit for a sporting event?
- How would you treat a sprain injury during a sporting match?
- How would you recognise heat illnesses?
- How would you treat heat illnesses?
- What would you do in the case of suspected neck or back injuries?

Over the past five years, Philip Pain and Margaret McIver (Mitchell) have written this series of booklets. Unfortunately, during that time Phil developed a brain tumour and after a long struggle died in October 1999. He was an excellent science communicator and educator with a flair for original and creative thinking. He contributed greatly to science during his too short lifetime and will be greatly missed by the science community.

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