Young Tall Poppy Science HEROES

TALL POPPIES IN FLIGHT PROJECT
TALL POPPY CAMPAIGN

AUSTRALIAN INSTITUTE OF POLITICAL SCIENCE

The Tall Poppies in Flight is a national science education project for children in upper primary schools.

The project is part of the Tall Poppy Campaign which aims to promote Australia's science heroes, both past and present, to inspire young people in the pursuit of intellectual excellence by promoting a greater appreciation of the achievements of all our Tall Poppies and to encourage younger Australians to follow in their footsteps.

The Tall Poppy Campaign is an inititative of the Australian Institute of Political Science. The Institute is an independent non-partisan organisation which was established in 1932 to promote broader understanding of political, economic and social issues in Australia.

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AIPS

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Preface

The chapters in this book are based on the work and experiments of 9 outstanding young Australian researchers, winners of the Young Tall Poppy Science Awards across different States.

The Young Tall Poppy Science Awards recognise outstanding scholarship and achievements from young scientific researchers with up to 10 years post-doctoral experience.

The Young Tall Poppy Science Award recipients share their passion for their work, their intrigue with science and their latest research with primary and secondary school students and teachers across the country.

The Young Tall Poppies who have contributed to this book come from NSW, Victoria, South Australia and Queensland. They have devised experiments and investigations to allow children to explore the wonderful world of science – from studies on hearts, lungs, bones, hearing and allergies – to exciting engineering and environmental activities. Always, the scientists are asking questions, making observations, creating hypotheses and suggesting further ideas for learning and understanding.

We would like to take this opportunity to thank the Young Tall Poppy Award recipients who have contributed to this book for their fantastic efforts!

John Beale has worked with the material provided by the Young Tall Poppies on their work to ensure that it can be used safely, productively and enthusiastically by young students. John Beale believes passionately in the value of teaching science to anyone who will listen, particularly young people. He currently teaches psychology and statistics at university, has a PHD in Nuclear Physics and is working on a second PHD in Psychology.

The activities are written to allow students to carry out independant or group investigations. It is important that we recognise that scientists often work collaboratively – not only with colleagues from the same institution, but also with other scientists who share the same interest and curiosity from all over the world.

Kim Bennell, PhD

I am an Associate Professor at the University of Melbourne where I head up the Centre for Health, Exercise and Sports Medicine. The Centre conducts research into how exercise can be used to prevent and treat diseases such as osteoporosis and arthritis as well as how we can prevent and treat sports injuries. The Centre's staff and students are from a range of backgrounds such as physiotherapy, medicine and exercise science.

I attended the local primary school before going onto the local high school in Mount Waverley. I was always interested in sport and exercise having been a gymnast since I was six. When I finished high school, I did a year of Physical Education at University then transferred to Physiotherapy.

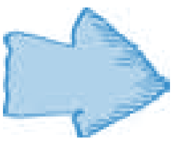
After becoming a physiotherapist, I worked at Box Hill Hospital (Melbourne) and a sports medicine clinic before taking a year off to travel the world in an old camper van. When I returned home, I commenced work as a tutor at La Trobe University and completed a research PhD. For my research I studied why track and field athletes get stress fractures in their bones.

On completion of my PhD I then took up a position at the University of Melbourne. I also continue to work as a physiotherapist and have my own private practice in a gym where I treat patients with sports injuries as well as advise people how they can exercise to strengthen their bones and prevent osteoporosis.

The skeleton and bone health

INVESTIGATION ONE

Critical thinking exercise on the skeleton



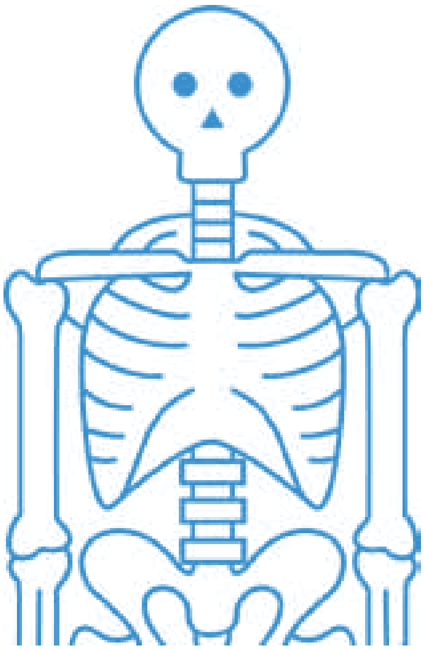
You will need

A skeleton if possible or

A picture of a skeleton on an overhead projector or

A drawing of a skeleton on the black or whiteboard. Great detail is not needed, eg. leave out details of hand and foot bones.

This investigation is best done as a class group.



The aim of this investigation is to introduce students to the skeleton, to teach them the names of major bones and to have them think critically about our skeletons.

Procedure

Discuss with the class the skeleton or picture of a skeleton, pointing out the major bones such as the ribs, skull, pelvis, femur.

Brainstorm with the class the following questions:

Question 1: Why do humans have bones?

Answer 1: Possible answers include those related to operating in our environment, such as to help us walk around, so we can reach things, to support our bodies, to enable us to carry objects. Others related to protecting our organs include to protect our hearts (ribs), our brain (skull). Also, the bones contain important minerals (eg. calcium) that the body needs so they act as a reservoir for these. Write on the board all suggestions. Encourage original ideas and elaboration of ideas already on the board. Once all ideas are on the board, ask the class for suggestions about grouping them: what criteria should be used to group ideas? Grouping them by their different functions is possible as is grouping by importance; is it more important to protect organs than to be able to walk?

Question 2: Are bones essential?

Answer 1: This is a hard question. The facts are that evolution has equipped animals with bones but insects and some sea creatures have alternatives such as squid, sharks, grasshoppers and beetles. Some creatures have no equivalent at all, eg. jellyfish. When students voice an opinion, get them to defend it and write the defence on the board. Group these items with the help of the class. Can the class decide whether the answer is "yes" or "no"?

The following questions require written answers; they can be answered individually or in small groups:

Question 3: Compare and contrast a human with a creature that does not have bones.

Question 4: Compare and contrast the human skeleton with a tower crane (as seen on building sites), emphasising similarities and differences.

Question 5: Make a list of questions an octopus might ask a human about bones.

Answer 5: Questions should include the advantages and disadvantages of having bones and may mention

- Do bones break and how do they heal?
- How flexible are bones?
- Do they float?
- Are they heavy to carry around?
- Can you grow another arm if one is lost in an accident?

INVESTIGATION TWO

Understanding osteoporosis

You will need

A skeleton if possible or

A picture of a skeleton on an overhead projector or

A drawing of a skeleton on the black or whiteboard. Great detail is not needed, eg. leave out details of hand and foot bones.

This investigation is best done as a class group.

The aim of this investigation is to generate understanding of osteoporosis, its causes and prevention.

Procedure

Teachers may decide to brainstorm these questions with the class, providing hints as necessary or teach the material more traditionally.

Question 1: Are bones dead or alive? Get opinions from the class and have students explain their opinions. Write statements in defence of opinions on the board. These may include:

- Alive because they grow
- Alive because they mend themselves
- Dead because they are hard, don't bleed (in normal experience)
- Dead because they last for a long time out of the body.

Answer 1:

- Bone is a living, growing tissue that changes all the time.
- Throughout life old bone is removed and new bone is added to the skeleton
- The outside of bone is hard and dense, the inside is less dense and is like honeycomb, the innermost part is the bone marrow, which is a fluid and makes blood cells.
- Bone stores vitamins and minerals especially calcium which is important for bone strength.

Question 2: Has anyone heard of the "Bone Bank"? Probably not. Ask students for ideas on what it could be and write these on the board.

Answer 2: "Bone Bank"

- Think of bone as a bank account where your bones represent the account and you make "deposits" and "withdrawals" of calcium instead of money

- Each day you make deposits and withdrawals. It is important to save for your future when you may need to make large withdrawals of calcium. So the sooner you start saving and the more you deposit the longer it will last as you get older, and so will help prevent osteoporosis.
- In childhood and the teenage years much more bone is deposited than withdrawn as the skeleton grows in size and density
- The amount of bone tissue in the skeleton (known as bone mass) continues to increase until the early-mid 20's. At this point they reach their maximum strength or peak bone mass.
- At about age 35 years more bone is withdrawn than is being deposited so bones slowly start to lose bone mass
- That's why the younger years are really important to maximise peak bone mass or bone deposited so that there is a large amount for when you need to make withdrawals.

Question 3: What is osteoporosis? Get ideas from the class and write on the board.

- Do you know anyone with osteoporosis, eg. mother, father, grandparents, neighbour?

Answer 3: Osteoporosis

- Osteoporosis is a condition in which bones lose calcium and bone tissue, become weak and more likely to break
- It often develops silently and is not found until an adult breaks a bone
- Fractures most often occur at the hip, spine, or wrist
- When a great deal of bone tissue is lost even sneezing or bending over to tie a shoe can cause a bone in the spine to break.
- People can become bent over if the bones in their spines squash down or get shorter

Question 4: Who gets osteoporosis? Class discussion. Record answers on the board and refer back to these when going through the suggested answers below.

- Is it only older people who get osteoporosis?
- What things do you think affect your bone strength eg. nutrition and exercise?
- Which things do you think are good for bone and make deposits to your 'Bone Bank'?
- Which things do you think may be bad for bone/ make withdrawals from your 'Bone Bank'?
- Are women more likely or less likely than men to get osteoporosis? Justify your answer.

Answer 4: Who gets osteoporosis?

- The older you are, the greater your risk of developing osteoporosis but it can also occur in young and middle-aged adults.
- Both men and women but women are at greater risk
- In Australia one in two women and one in three men over the age of 60 develop osteoporosis

- Those with a family history of osteoporosis- i.e. a mother/ father or grandparent with osteoporosis or who had fractures development or had very stooped posture, or significant loss of height.
- Caucasian (i.e. fair skinned) and Asian women are more likely to develop osteoporosis
- Female dancers or elite athletes who's menstrual cycle ceases.
- Older people with osteoporosis who fall are more likely to break a bone and falling is a problem in people over the age of 65 years

Question 5: What things affect your bone strength? Class discussion with any ideas on the board for later discussion.

Answer 5: Things that affect bone strength:

- Cigarette smoking, excessive alcohol intake, high caffeine intake (>4 cups of coffee per day), not consuming enough calcium, or getting little or no weight-bearing exercise may increase your chances of getting osteoporosis
- Some medications may increase your risk of developing osteoporosis
- People with a small, thin body frame are more at risk of developing osteoporosis, so it is important to have a healthy weight (not overweight)
- A healthy diet, high in calcium, is important to keep bones healthy and strong
- Weight-bearing exercise is also good for bones

Question 6: Why do you think exercise is good for bones?

Answer 6: Why is exercise good for bones?

- Bone responds to exercise by becoming stronger
- Bone responds best to exercise when you are younger so right now is a really important time to exercise to stop you getting osteoporosis when you get older
- A lack of exercise may contribute to lower bone mass

Question 7: What types of exercise do you think would be good for bone?

Answer 7: What sort of exercise?

- Weight-bearing
  - Running, stair climbing
  - Walking is not enough
  - Bone responds best to a variety of loading exercises, where you change direction all the time, things such as jumping (up and down and from side-to-side), dancing, gymnastics, basketball, netball, tennis, hockey, soccer
- Resistance exercise
  - Using muscle strength to lift weights, eg. hand weights or machine weights

ACTIVITY ONE:

Bone quiz

You will need

The following collection of skeletal parts made out of cardboard for each team

A foot

A shin as one piece but with two bones shown

A femur

A pelvis

A spine

A skull

Two humerus or upper arm bones

Two forearms plus hands.

Each of these bones or groups of bones needs to be labelled with a number, starting at 1 and rising to 10 in any order.

For this activity divide the class into teams with a maximum of 10 students per team. Give each team a name. Suggestions for names are:

- Bone busters
- Bone builders
- Jumping Joeys

The aim of this activity is to help remember the facts learnt in the investigations done previously.

Procedure

1. The idea of the game is to be the first team to complete assembly of their skeleton. Each team has a collection of 10 pieces of cardboard representing parts of the skeleton.
2. Select a student to answer the first question. A correct answer means that student can put the foot in the skeleton assembling position after having done a number of jumps equal to the number written on the body part.
3. Choose the next student and repeat the process with the second question and the shinbone piece of cardboard.
4. Repeat until the skeleton is assembled.
5. If any student gets an answer wrong they have to do 10 jumps before the question is asked again.

Questions

1. Name the longest bone in your body? Femur
2. What do you call the part of the skeleton that protects your brain? Skull
3. Which parts of the skeleton protect the heart and lungs? Ribs
4. What mineral is needed for healthy bones? Calcium
5. Give an example of a food that has lots of this mineral in it? Milk
6. Give an example of exercise that is good for bone health? Jumping, running etc
7. Is swimming good for bone health? No
8. Osteoporosis affects all people equally, true or false? False
9. Someone with osteoporosis may not have obvious symptoms, true or false? True
10. Name an activity that is bad for bone strength. Smoking, heavy drinking, high caffeine intake.

Link to SOSE

Draw a map of the world, using an atlas as a guide. It is important to include the major landmasses but shape is not that important. Identify significant population groups; for instance, North Americans, Inuit of Northern Canada, Mexicans, South Americans. For each population group indicate using a scale from 0 – 10 (where 0 = osteoporosis does not occur to 10 = osteoporosis a big problem) how bad you think osteoporosis may be and the reasons for your belief remembering the causal factors of osteoporosis you have just learnt about. If your map is large enough you can write your judgements and reasons on the map in the place that particular group of people lives. If not, indicate where that group lives and put your judgements and reasons on a separate sheet of paper.

There is plenty of material on the web about osteoporosis, just type in “osteoporosis” into your search engine. You will find a lot of information and some personal stories from people who have had osteoporosis. Use this research to answer the question “Is prevention of osteoporosis important?”. Give reasons for your answer.

Describe some of the problems you would encounter if you had osteoporosis and how you might feel as a result. Use your initiative to present your work in the best manner possible.

Levon Khachigian, PhD

I am of Armenian descent. My parents, who were Christian missionaries working in the Middle East, migrated to Australia in 1965 with me in tow at 18 months old. I attended Naremburn Public School, on Sydney's lower north shore, until Year 6 and then went onto Crow's Nest Boys' High School till Year 12. I studied Science at the University of New South Wales majoring in Biochemistry and Microbiology, and graduated with First Class Honours in 1986. I was awarded a PhD in medical biochemistry by the University in 1993. I then studied at Harvard Medical School for three years before returning to the University in 1996 and completing my studies in 2004.

As a molecular biologist, my research has helped increase our understanding of the processes that lead to the appearance of harmful genes in cells of the artery wall. This has led to the generation of novel DNA-based drugs that block arterial re-narrowing after some forms of arterial surgery. More recently, I have been unravelling the mechanisms behind tumour growth control by inhibiting the growth of blood vessels supplying the tumour.

I am a National Health and Medical Research Council Principal Research Fellow and Head of the Signalling and Transcription Laboratory at the Centre for Vascular Research at the University of New South Wales. I am also an Associate Professor of Pathology at the University.

Artery Health

The process in which plaque builds up in the wall of an artery is known as atherosclerosis. Plaque is made up of fats, cholesterol and other substances and deposits can grow large enough to significantly reduce the blood's flow through an artery.

INVESTIGATION ONE

Demonstration of a siphon

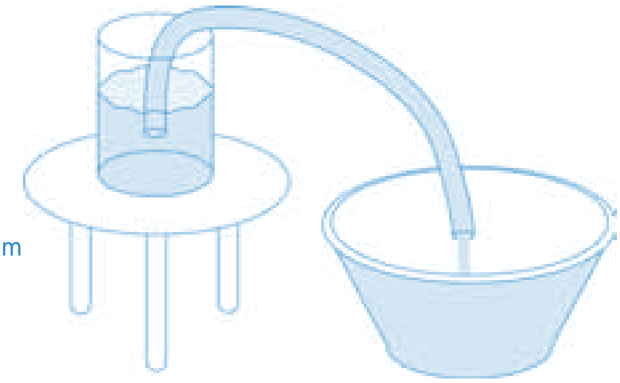
You will need

A length of clear plastic hose

A beaker or 2 litre plastic milk bottle

A bucket

A chair or lab stool



This investigation is best done with the whole class.

The aim of this investigation is to demonstrate a siphon and solve the problem of why it works.

Procedure

1. Place the stool on a bench.
2. Fill the beaker with water, place it on the stool.
3. Fill the hose with water and hold it in with a finger on each end.
4. Place one end of the hose in the beaker; make sure the other end is always over the bucket, which should be on the bench.
5. Vary the height of the end of the hose not in the beaker and by removing the finger at various heights, show that water runs out faster the lower the open end is.
6. By keeping the open end of the hose at the same level as the water in the beaker, show that water won't flow out unless the end of the hose (more accurately the lower surface of the water in the hose) is below the water level in the beaker.
7. Show that if the hose is empty the siphon doesn't work.

Brainstorm with the class:

Question 1: What makes the water run up the hose, out of the beaker and down the hose into the beaker?

Answer 1: The pressure at the low end of the hose is lower than the pressure in the beaker, caused by the weight of water in the hose.

Question 2: Why won't the siphon work if the hose is empty?

Answer 2: Without any water in the hose, the pressure at all points in the hose is the same (closely so anyway).

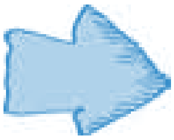
Question 3: Why won't the siphon work if the open end of the hose is level with the water in the beaker?

Answer 3: Because the pressure at the surface of the water in the beaker is the same as that at the end of the hose.

Everybody should draw the circumstances where the siphon will and won't work. Make sure that students show the water in the hose appropriately.

INVESTIGATION TWO

As arteries clog up, flow rate diminishes



You will need

Three clear lengths of plastic hose with different internal diameters, small, medium and large. The large should not be greater in diameter than about 1.5cms.

A beaker or 2 litre plastic milk bottle

A bucket

A stopwatch

A chair or lab stool

Pen and pad to record results.

This investigation is best done with the whole class.

The aim of this investigation is to demonstrate that for constant pressure, less liquid flows through a small pipe than a large pipe.

Procedure

1. Cut the three pieces of plastic hose so that they are all as close as possible to the same length. A longer length will be needed if a stool is used rather than a chair, but aim for 1-1½ metres long.
2. Place a mark on each hose to identify it.
3. Place the stool on a bench or table.
4. Fill one of the beakers with water and place it on the stool with the other empty beaker (or bucket) on the bench close to the stool.
5. Fill one of the plastic hoses with water and hold a finger on each end to keep it full.
6. Place one end of the hose in the beaker of water; push that end close to the bottom but not close enough to obstruct the flow.
7. Hold the other end over the bucket, close to but inside the rim of the bucket.
8. Remove the finger from that end of the hose and start the stopwatch. When the beaker is empty stop the stopwatch.
9. Have an appointed student record the time on the board along with the hose identifier.
10. Repeat with the other two hoses, emptying the bucket between each recording.

Have the class examine the results.

Question 1: Does the time to drain the beaker diminish, as the hoses get larger in diameter?

Answer 1: Hopefully yes.

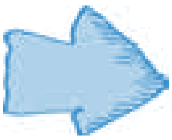
Question 2: Is the pressure drawing the water out of the beaker constant for the three different hoses?

Answer 2: Yes, provided the beaker was full and the open end of the hose at the bucket rim every time.

Draw the analogy between this investigation and the heart pumping blood through our bodies. If the heart pumps at constant pressure, the more clogged our arteries become, the less blood will flow through them. This can lead to oxygen starvation of our muscles and brain. It can also cause our heart to pump harder to boost the pressure and make more blood flow leading to heart problems.

INVESTIGATION THREE

Presenting the results of Investigation Two



You will need

Pen and paper for plotting a graph

This investigation is best done with the mathematically able students in the class.

The aim of this investigation is to demonstrate a better way of looking at the results of investigation two.

Background

Flow rate was measured in investigation two by having a constant volume of water (a full beaker) pass through the hose in a measured time. Flow rate is then calculated by using the formula:

Flow rate = Volume of water/time to empty beaker

= k1/time

Therefore, as long as volume is constant, time is inversely related to flow rate (k1 is a constant).

Flow rate through the plastic hose is proportional to the cross-sectional area of the hose, the pressure difference between its ends and its length.

The formula connecting these four variables is:

Flow rate = k2*cross-sectional area*pressure/length

where k2 is a constant.

In investigation two we did a scientific experiment by varying only one of these parameters and measuring the effect on flow rate. We held the pressure difference and the length of the hose constant. This allows us to rewrite the last equation as:

Flow rate = k3*cross-sectional area

where k3 is another constant.

Combining the first and last equation, we end up with:

1/time = k4*cross-section

where k4 is another constant.

This equation tells us that if we plot 1/time on the y-axis and cross-section on the x-axis, we should get a straight line.

Procedure

We have three data points from investigation two that we can plot on a piece of graph paper to test this idea. Set up a table as follows:

Results	Time	1/Time	Hose internal diameter	Cross-section
Small hose				
Medium hose				
Large hose				

1. Insert the times measured in the Time column and the hose internal diameters in that column.

2. Calculate 1/Time using a calculator.

3. To calculate the cross-section, divide the hose internal diameter by two, square the result and multiply by π (3.14159).

4. Plot the three numbers in column 3 on the y-axis against those in column 5 on the x-axis.

5. Test for straightness by trying to rule a straight line through the points.

Question 1: Is the graph a straight line? If not, why not?

Answer 1: The graph should be roughly straight only, because of errors of measurement. All scientific work needs to think about errors and either accommodate them or try and minimise them.

FURTHER WORK

Make a list of the likely errors in Investigation Two that caused your line in Investigation Three not to be straight.

Make an artificial heart from a plastic petrol siphon bought from a local car accessories shop. By connecting this artificial heart to plastic hoses of different diameters, you should be able to demonstrate that you need to squeeze the plastic bulb harder for smaller pipes to maintain the same flow rate, just as a heart has to work harder in people with atherosclerosis.

Research the causes of artery clogging using the Internet and your school library. Use your research to make a poster advising people about ways to avoid atherosclerosis. Can you see any difficulties in having your advice heeded?

People in some countries eat a lot of animal fat, e.g. the Inuit of Northern Canada, the Masai of Africa and many people in Mongolia. Compare and contrast death rates or average life span in one of these populations with that in Australia. What could be done to help these people live longer? Do you think comparing death rates or life span is a fair measure of the effects of dietary differences between these two groups. Why or why not?

Holger Maier, PhD

I was born in Germany and came to Australia with my parents and sister as a 14 year old. My family settled in Adelaide where I completed Year 12 at Modbury High School studying mainly science subjects including Physics, Chemistry and Mathematics I and II.

After High School I went to the University of Adelaide to study Civil Engineering. At University I learnt how to design and build roads and bridges, large buildings, water supply and water treatment systems as well as how to manage and protect our environment and natural resources, such as rivers, lakes and oceans. After graduating from university I worked for a consulting engineering company for two years where my main task was to design large commercial and industrial buildings.

At this point in my life two wonderful things happened. Firstly, I married my fiancée, Krista, and secondly I decided to pursue a research career. I commenced my studies for my second degree, a Doctor of Philosophy, or PhD, in Water Resources Engineering at the University of Adelaide.

During my PhD studies I developed innovative methods of predicting salinity and blue-green algal blooms in the River Murray, which are used to better manage our environment and improve the quality of the water supplied to cities and townships that rely on the River Murray for their water supply. The experience of conducting research as part of my PhD inspired me to pursue an academic career, which has enabled me to continue to find new and better ways of managing our environment and natural resources.

To broaden my experience and to put my skill and knowledge to good use I spent 18 months as an Australian Volunteer Abroad on the Pacific island of Samoa, where I worked with engineers and scientists at the local water authority to improve the quality and reliability of the water supply to villages. I also spent 12 months as a researcher at the University of British Columbia, Vancouver, Canada before returning to the University of Adelaide in 1999.

A career in academia has also provided me with the opportunity to help educate a new generation of Civil and Environmental engineers whose task it is to improve the world we live in. In my role, as a Senior Lecturer at the University of Adelaide, I teach a number of courses related to water and environmental engineering. I also supervise a number of PhD students, as well as my two children, Lani who is five years old and Ben, who is three.

Our water supply

The class activities are centred around water supply. Students are encouraged to think about where the water they drink comes from, how it gets from where it is stored into the tap in their kitchen and the issues involved with moving water through pipes.

INVESTIGATION ONE

Where does water come from?

You will need

Bottle of soft drink

Teaspoon of salt

Paper and pencils for drawing

The investigation is best done in small groups of about 4 students.

The aim of this investigation is to make students think about where tap water comes from.

Procedure

Students may brainstorm these questions.

Question 1: When you turn on the tap at home or at school, where does the water come from? (i.e. what is the source of the water?)

Answer 1: Rainfall.

Question 2: Where does the water that falls as rain come from?

Answer 2:

1. To answer this question we need to consider the whole water cycle or "hydrological cycle". Let's start with the water in the oceans.
2. Water evaporates from the oceans under the influence of the sun and wind. The evaporated water or water vapour blows around in the wind, rising and cooling as it gets higher.
3. Once it gets to a certain height which depends on barometric pressure (students will be familiar with this if they watch the weather on TV) and air temperature, it is ready to

condense from vapour back into water droplets. To do this it uses small particles of dust that are floating nearby in the air. Once the vapour has condensed it goes from being invisible back to being visible; we see it as clouds.

4. When the conditions are right, the small water droplets in clouds join together to form larger drops which the atmosphere can no longer support. These large drops fall as rain.

Each group should draw a picture showing the hydrological cycle. Be sure to show the ocean, some land with rain falling and make sure the wind is blowing the water vapour from the ocean onto the land. The teacher should collect each group's drawing for display to the class. Discuss as necessary to make sure all students understand the hydrological cycle.

To illustrate the process of water drops condensing on dust particles, you will use your bottle of soft drink. When the bottle is unopened, the carbon dioxide which makes the drink fizzy is invisible, just like water vapour in the atmosphere. Carefully open the can/bottle without shaking it. Some fizz will be visible immediately. This is carbon dioxide which is changing from being dissolved in the drink back into a gas.

Question 3: Why does the carbon dioxide turn back into a gas when you take the lid off?

Answer 3: By removing the lid you have caused the pressure in the bottle to drop. Just like the water vapour in the atmosphere, the dissolved gas finds a small solid particle (a tiny grain of sugar or colouring for instance) and uses it to "come out of solution". This is exactly like the water vapour coming out of solution in the atmosphere and forming a raindrop.

Pour some of your teaspoon of salt into the soft drink.

Question 4: What happened?

Answer 4: The drink bubbled furiously, probably flowing out the top of the bottle.

Question 5: Why?

Answer 5: Adding the salt creates many more condensation centres, making it easier for the dissolved carbon dioxide to turn into a gas.

Each group should produce a report of their observations in this investigation. These reports can be passed to other groups for constructive elaboration finally ending up back with the authoring group. Be sure to include: aim, method, equipment, results, conclusion.

INVESTIGATION TWO

Collecting and treating water

You will need

Pen and paper for drawing

A handful of dirt

A bucket or large tin with a hole in the bottom

Some clean sand

Two buckets

Water

Two labels

Two glasses about the same size

This investigation is best done as a whole class.

The aim of this investigation is to demonstrate how water may be filtered using a sand bed.

Procedure

The class should brainstorm these questions.

Question 1: What happens to rain after it has fallen?

Answer 1:

1. Rainfall either sinks into the ground and ends up as groundwater or runs over the ground and ends up in rivers and lakes. Some of it evaporates back into the atmosphere and the roots of plants absorb some.
2. The water that ends up coming out of your tap is surface water that is held in lakes or runs down rivers, although groundwater is also used.
3. Water is delivered from rivers or lakes to users (e.g. houses, factories) using a system of pipes, sometimes hundreds of kilometers long. In many instances, water is also stored in large reservoirs and tanks, to make sure we do not run out of water during periods of high water demand and little rainfall (e.g. in summer or when we get up in the morning).
4. In many instances, the water also has to be treated before it can be delivered to consumers, as it may contain harmful bacteria or may be "dirty". Water is filtered to remove dirt and other material we do not want to drink.

You are about to build and test a water filter.

1. Put some water in a bucket, add dirt and stir until it is brown and muddy looking.
2. Fill one of the glasses with the muddy water. Stick a label on this with "Muddy water" on it.

3. Put the clean sand in the bucket with the hole in the bottom, make sure that the sand can't run out (a rock over the hole is good for this). Sit the bucket full of sand on top of the third bucket.
4. Pour the muddy water into the bucket with the sand in it and collect the filtered water in the bottom bucket.
5. Fill the second glass with the filtered water and stick a label with "Filtered water" on it.
6. Compare the muddy water with the filtered water by holding the two glasses together at eye level. Involve the whole class in judging which glass holds the clearer water, especially if the difference is not great.
7. The following table may be filled in to include everyone in the investigation

Name of student	Is filtered water clearer?
Bruce	Yes
Mary	Yes
Fiona	No

If two thirds or more of the class reply "Yes" then it is safe to conclude the filtered water is clearer. If less than two thirds reply "Yes" more sand would need to be used in the filter.

Question 2: Where did the mud end up?

Answer 2: It adheres to the sand in the filter or fills the gaps between the grains of sand and is removed from the water.

This is similar to the process that filters the water that comes out of your tap. Some parts of Australia use water that has soaked into the ground.

Question 3: What is that water called?

Answer 3: Groundwater

Groundwater often needs extensive treatment before it is nice enough to drink.

Design and draw a picture of a water filter, showing where the dirty water would enter and the clean water leave. Show it to a classmate and listen to their constructive criticism. Then give your criticism of their picture.

INVESTIGATION THREE

How does the water get to your tap?

You will need

Paper and pencils for drawing

4 metres of clear plastic pipe

Each student should draw a picture. The demonstration should be done as a class activity.

The aim of this investigation is to foster problem solving and to teach some basic principles of water engineering, such as "water does not flow uphill" and conservation of energy (depending on desired level of complexity).

Question 1: What do you think is the best way to get water from the reservoir to the factory? In your picture, clearly show the water storage, the pipes (if you decide this is the best way to transport the water), a local reservoir and the pipes between that reservoir and a tap.

Answer 1: Water does not flow uphill, so we either need to dig a tunnel through a mountain and convey water through pipes or we can put pipeline over the mountain and pump water.

Each student should draw a picture of a lake and show how water may be piped into a nearby town. Some students will have drawn pictures where the water would not flow through the pipes into the town. All drawings should be collected and those that won't work shown to the class for a discussion of the problems. If drawings are anonymous, embarrassment will be avoided. If no pumps are drawn in a picture, the lake needs to be higher than the town and any intervening mountains would have to be tunnelled through. If the lake is lower than the town or the pipes go over intervening mountains, a pump would be needed. The pump should be close to the water storage. Some students may show water being carted in trucks.

Procedure

Half fill the clear plastic pipe with water. Hold the pipe in a "U" shape.

Question 2: Why is the water the same height on both sides of the U?

Answer 2: The water adopts the lowest potential energy state available. This is called the Principle of Conservation of Energy and is a fundamental law of Physics. In this case the state of lowest potential energy occurs when the water is the same height on both sides of the "U".

Hold the pipe with one end higher than the other so the water runs towards but not out the lower end. Close the high end of the pipe with a hand and return the pipe to the "U" shape. The water should now not be level in the pipe.

Question 3: Why is the water not at the same level on both sides of the U?

Answer 3: Air pressure between the hand over the end of the pipe and the water on that side of the U is preventing the levels becoming the same. This demonstrates that pressure can cause water to run uphill.

Remove the hand closing the pipe end to show that the water now resumes a level position. The air pressure is now equal at both ends of the pipe. Now fill the pipe to nearly full holding it in the U shape. Have a student close the end of the pipe that is distant from the tap with their hand and tell them to hold it there as tightly as they can. Move the pipe into a more vertical position with the student's hand still closing one end. The student should be able to feel the pressure of water as it tries to adopt the position of lowest potential energy (which is on the floor!). Other students will also want to experience this pressure. Lower the pipe to a more horizontal position and students should feel the pressure on their hands decrease. Students can think of this as: by exerting more pressure on a column of water, it can be forced to greater heights. Students should now see why a pump (which puts the water under pressure) is needed to get water to flow up a pipe over a mountain.

FURTHER WORK

Make a poster or pamphlet on one of the following topics. Use your school library or the Internet for research.

1. Rather than talking about where water comes from, discuss the question "where does the water go?" (e.g. once you flush your toilet or after your bath or shower).
2. How do we make sure that we do not run out of water?
3. How do we make sure that there is not too much water (e.g. flooding)?
4. How do we make sure water is clean and safe to drink (e.g. some of the water treatment aspects have been covered above (i.e. filtration), but you could look at other water treatment processes such as disinfection and how we ensure there is no bacterial regrowth in the pipes)
5. How do pumps work? Consider not only modern pumps but also ancient pumps as used by the Romans and other civilisations.
6. What is the impact of global warming on water supply?

Here is a link to a website with information on the water cycle:
http://www-k12.atmos.washington.edu/k12/pilot/water_cycle/teacherpage.html

The principle of conservation of energy was mentioned in Investigation Three. This principle is fundamentally important in Physics: do some research to see if you can find at least one application not related to water usage.

The health of Australia's rivers is always a hot topic. In your opinion, how much of the water in rivers should be used for human consumption, and how much should be left for the environment? Explain your choice.

China has built a huge dam on the Yellow River. This was covered in the press at the time, but there will be information on the Internet as well. Find out as much as you can about the project and make up a list of 10 questions you would like answered by the chief engineer who built the dam. Have a friend help you in a role-play: the friend should ask the questions and you should be the engineer and provide the answers.

Imagine living in a world where water flowed uphill. How would this be different and what would be the consequences?

Gus Nathan, PhD

I was born in Adelaide in 1962 and christened Graham by my parents. I grew up in Happy Valley (Adelaide) as the middle of five children playing footy and tennis and riding home-made go-carts down local hills. I went to Reynella Primary School and then onto Seacombe High School where I earned the nickname "Gus", which has somehow stuck.

I was very close to my grandmother who taught me to love music and play the piano. My love of music led me to becoming a semi-professional musician. I also learnt to play the fiddle, electric bass, and didgeridoo and taught myself to play the double-bass and the saw. I have played rock, folk and world music in Rundle Mall (Adelaide), folk clubs in Oxford (England), the Adelaide Casino and in various pubs and clubs around town.

My love of the wilderness started with catching lizards and yabbies in the local creeks and blossomed when a friend took me backpacking into the Gammon Ranges when I was 15. This was the first of many trips into the North Flinders Ranges and beyond. When I was 25, three friends and I walked across the Simpson Desert carrying our own supplies in a buggy which we pulled behind us. We had designed and built the buggy ourselves. I also started caving, rock-climbing and high-altitude mountaineering, and I have climbed Mt Denali, in Alaska, the highest mountain in North America at 6200m.

Today I live in Ironbank (Adelaide), with my partner Jasmin, on a bush property which we share with bandicoots, kangaroos and koalas. We also have bats, which live in the walls of our cottage. We love spending time looking after the bush and working with our neighbours to strengthen the vegetation corridors. We are having fun developing our property to minimise environmental impact which includes designing our own independent water system and doing our own renovations with recycled materials. We both cycle to work to keep fit and minimise pollution.

I chose Mechanical Engineering as a career because I enjoyed designing things and tinkering under the bonnet of a car. Later, my enjoyment of making things was to combine with my love of nature through a career in sustainable energy which involves developing technologies to reduce energy consumption and air pollution. My postgraduate studies and research has been in the field of combustion. The research for my PhD formed the basis for the Gyro-Therve burner which is used in cement kilns around the world to reduce air pollution and increase efficiency. I was also a joint inventor of the combustion system used in the Sydney Olympic Torch and was the joint leader of the chief design team that designed the 2000 Olympic flame at Stadium Australia.

I am also a joint inventor of a flow control device that can be mounted to a combine harvester to assist in organic wheat farming by killing weed seeds using the waste heat from a tractor's exhaust.

I am an Associate Professor at the School of Mechanical Engineering's Turbulence Energy and Combustion Group at the University of Adelaide.

How does the Olympic Torch stay alight?

These experiments with candles have been chosen because they combine the science of asking the question 'how does it work?' with the engineering challenge of 'how can it be applied to meet the specified task?'. Candles are one of the oldest inventions that are still in use today. In the experiments students will both learn how a candle works, and try to develop a mini-Olympic torch flame using a candle for the flame, and try and keep it alight in a wind. The idea for this challenge came from Gus' development work on the Sydney Olympic torch.

These investigations use readily available items. A candle is chosen to provide the flame because it is low cost and reasonably safe. It is important to address the safety issues of handling candles as some students may not have experience with them. The key risks are burning if they touch the flame or from molten wax.

INVESTIGATION ONE

Safety with candles

You will need

A candle

A cigarette lighter or a box of matches

There should be sufficient supervision with preparation for any emergency, e.g. a damp woollen blanket on standby to smother any student or flame. This investigation is best done in small groups of about 4 students.

The aim of this investigation is to familiarise you with safe ways to handle lit candles, without burning yourself or setting fire to the room you are in.

Procedure

The teacher obviously needs to plan where this investigation is done. However, students should be encouraged to take responsibility for the environment as well. These instructions are aimed at them.

1. Make sure you are not working on a flammable floor. Good non-flammable floors include wood, concrete, tiles but not carpet. You should not be wearing flammable clothing (cotton and wool are safe, nylon is not). Have a look around you. What items close by could easily catch fire?
2. Make a rough list of all flammable items around you. Try and reorder this list so that the most flammable items appear up the top and least flammable down the bottom. To help decide on the final order of your group's list, discuss your initial rough version with those in your group. When you are happy with your list hand it in to your teacher.
3. Your teacher will compare the lists from all groups and write on the board the best list.
4. Under the teacher's supervision, move the more flammable materials at least one metre from where you plan to light the candle.
5. Decide who in your group is to light the candle and have them light it. Pass the lit candle around the members of your group making sure that nobody gets burnt or has hot wax dropped on them.

INVESTIGATION TWO

Making a candle

You will need for each group:

A long thin tin such as an asparagus tin from the supermarket, open at one end and empty

Material for the wick from a craft shop

Paraffin or other wax suitable for melting to make the candle

Each group should use different materials and tins to the other groups if possible

Gloves and safety glasses to use when pouring hot wax

This investigation is best done in small groups of about 4 students.

The aim of this investigation is to make a candle.

Procedure

1. Teacher needs to heat the paraffin wax in a pot until it is melted. Students should take note of the wax as it melts.
2. Whilst the wax is melting, tie one end of your wick around the middle of a pen or pencil and place it over the open end of your tin, making sure it is in the middle the whole way down to the bottom of the tin.
3. Your teacher will come around to your group and carefully pour the hot wax into your tin. Take care to avoid getting hot wax on you. Place your tin in a safe place to cool down.
4. Next science class when the candle has set use a hair dryer to heat the outside of the tin so the candle can be removed. Put your candle with all the candles made by the other groups.
5. Make sure there is no flammable material around and light your candle. Measure the length of the flame with a ruler, taking care not to get burnt.
6. Find out which candle burns with the longest flame, which with the shortest flame. Record your results in the class table.

Class table of results for Investigation Two.

Group number	Type of wax	Wick material	Length of flame
1			
2			
3			

Why would the flames be of different lengths? Could it be that some wax burns faster than others or is it something to do with the wick? If you decide it is the wick, what could it be about the wick?

INVESTIGATION THREE

How does a candle work?

You will need

For each student (individual or small group):

A candle (The "Taper" type – about 20cm long and 1.5cm diameter)

A candle-stick holder

A glass / glass-jar

A length of wick approximately the same length as the glass jar

Warm water, detergent, instant coffee and teaspoon to stir it.

A pencil or pen for the experiment

Pen and paper for the students to write and draw with

This investigation is best done in small groups of about 4 students but can be done as a class.

Each class will need

Matches / cigarette lighter

A thermocouple to measure temperature (See if you can borrow one of these)

The aim of investigation three is to encourage students to question how familiar objects work and to discover ways of finding out. It will also encourage them to take inventive steps to adapt and develop an object for a purpose.

Procedure

Step 1: We all know what a candle is – but how does it work? To discover this, we need firstly to find out how each component works.

Question 1: What are the individual components of a candle? Draw a diagram and label the components.

Answer 1: Wax and a wick

Step 2: For any flame we need fuel, air and a source of ignition

Question 2: Which of the components is the fuel? Add label to your diagram

Answer 2: Wax

Step 3: Why do we need a wick? To find out, try lighting the wrong end of the candle (the wick doesn't work because it is covered by wax)

Question 3a: Can the wax be lit without the wick?

Answer 3a: No

Question 3b: What happens when we try to light the wrong end?

Answer 3b: It simply melts the wax

Step 4: What does the wick do? To find out perform the following steps with the spare wick, the water, the coffee, detergent and the pen.

- Half fill the jar with warm water
- Add 3 teaspoons of instant coffee
- Add a half teaspoon of detergent
- Stir together
- Tie one-end of the wick to the middle of the pencil/pen
- Suspend the wick into the water from the pencil - the pencil should be resting on the top of the glass like a bridge.

Question 4: How high does the coffee climb up the wick?

Answer 4: The dye climbs up the wick about 1cm – depending on the type of wick and the amount of detergent

Note: The climbing of a fluid against gravity in the wick is called capillary motion. The coffee is simply there to make the fluid dark so that you can see it. The detergent is a wetting agent to allow the fluid to penetrate the wick.

Step 5: Why does the fuel not burn without the wick? To find out perform the following steps:

- Put the candle in the candle-stick holder
- Light it

Question 5: What happens to the wax at the base of the wick?

Answer 5: It melts and forms a pool of molten wax

Step 6: Wait for a pool of molten wax to develop at the base of the wick. Measure the temperature of the molten wax with the thermocouple.

Question 6: What is the temperature of the molten wax?

Answer 6: About 120°C – this will depend on the type of wax

Step 7: There is a minimum temperature for each substance which must be reached before it will ignite, called the auto-ignition temperature. The auto-ignition temperature of wax is about 450°C – again depending upon the type of wax.

Question 7: Why does the candle wax in the pool of molten wax not ignite?

Answer 7: Because the pool of molten wax is a long way below its ignition temperature

Step 8: Place the tip of the thermocouple as close to the wick within the flame as possible and measure the temperature there.

Question 8: What is the temperature of the wick? Is it above or below the ignition temperature of the wax?

Answer 8: The temperature of the burning wick is around 650°C (depending upon how you measure it!), but it is well above the ignition temperature of the wax, ensuring that it will burn.

In summary, during ignition, the burning match heats the wax and melts it, the molten wax moves up the wick by capillary motion. The molten wax within the wick is heated further by the flame to its ignition temperature so that it can burn in the surrounding air. The burning wax radiates heats to the wax and continues the process.

Now that you know all of the processes, draw the candle and the flame. Try and write down all the steps involved in how a candle burns, showing them on your drawing.

Note that for advanced students who may ask why the wax in the pool stays much cooler than it does in the wick, the answer is as follows. The pool of molten wax can never get much higher than the melting temperature of the wax. This is because as its temperature begins to rise, this causes more of the solid candle to melt. This ongoing melting process absorbs a lot of heat, keeping the temperature of the wax near to its melting temperature. Hence it is only within the wick that the temperature of the molten wax can increase sufficiently for the candle to burn – unless, of course, there is a very big flame.

INVESTIGATION FOUR

Design your own mini Olympic torch

Prior to this experiment it is necessary to warn the students that the top of the tin will become hot. (However from experience, it does not become sufficiently hot to be of significant concern because the metal conducts heat very readily and it is very thin so that it cools quickly).

You will need

For each student (individual or small group)

A candle

A tin can (preferably taller than it is wide – a 400ml size is ideal – but it will work for a wide range of can sizes). The can should be open at both ends with no sharp edges.

Pen and paper for the students to write and draw with.

This investigation is best done in small groups of about 4 students.

Each class will need

Matches / cigarette lighter

A few household electric fans oriented to blow horizontally. The fans will probably be the critical item, so the more the merrier.

A wet cloth to place under each fan and extending in front to catch dripping wax.

Optional additional items include a roll of metal fly-wire and scissors to cut it.

The aim of Investigation Four is to have students explore the possibility of making a mini Olympic torch and to experiment and find a way to make the torch flame harder to blow out in windy conditions.

For the students:

An Olympic torch must be stable in the wind. We all know that it is easy to blow a candle out. Your challenge is to use the tin as an outside of the torch to try and make the flame as stable as possible.

Step 1: Place the candle inside the tin, with both oriented vertically. Hold the can with one hand and the candle with the other. Place both in the stream of the wind produced by the fan. Slowly move the candle around within the tin wherever you like, watching closely to what happens to the flame.

Question 1: What is the best location for the candle within the tin to keep the flame the most stable? Illustrate your answer with a sketch.

Answer 1: The flame is most stable when the candle is pressed directly against the front wall (i.e. closest to the fan). It is also most stable when the tip of the candle is about in halfway between the top and bottom of the can.

An Olympic torch must also be visible above the top of the torch! When the flame is within the can it cannot be seen. Your next challenge is to find a way of keeping the flame stable, whilst also making it visible to the outside world!

Step 2: Start with the candle in its most stable position – this is with the candle pressed against the front of the can and about halfway up. Slowly move the candle upwards within the can (keeping the can still) until the flame is just emerging from the top of the can.

Question 2: What is the best location for the candle within the tin to keep the flame stable while still being visible? Illustrate your answer with a sketch.

Answer 2: The flame can be stable when the candle is directly against the front wall but also with the flame emerging above the tin if the base of the wick is still below the top of the can.

Step 3: Start with the candle in its most stable position with the flame most visible. Slowly tilt the candle and tin forwards and backward. Observe the flame.

Question 3: What is the most stable orientation of the candle and tin relative to the wind? Is it possible to push the candle further out from the can? Illustrate your answer with a sketch.

Answer 3: The flame is most stable when the tin and the candle are oriented slightly backwards away from the vertical. Under this condition the candle can be pushed further upwards.

An Olympic torch must be stable with the torch oriented in any direction relative to the wind. This is because the wind can blow from any direction and people may point the torch in funny directions!

Question 4: What happens when you point the torch into the wind? Can you make it stable?

Answer 4: The flame goes out.

Don't be disappointed if you can't make a flame that is stable in every condition. After all, it took our team several years of design work to develop a system which is stable under all these conditions.

FURTHER WORK

Try using the wire mesh wrapped around the top of the candle to make the flame more stable and more visible. You can also try punching small holes into the side of the can.

Visit the ABC website at http://www.abc.net.au/torch/ to research the route taken by the Olympic torch around Australia before the 2000 Olympics.

Research the origin of the Olympic torch relay. You may use the Internet (for instance at http://www.herald-mail.com/news/1996/olympics/july14herald.html) or get hold of David C Young's book "The Modern Olympics: A Struggle for Revival," published by The Johns Hopkins University Press in 1996.

You are the Olympic Torch. Describe your journey around Australia before the 2000 Olympics, telling your reader of one unusual or exciting happening on that trip and how you felt having completed the trip.

Imagine you are Gus Nathan. Describe the necessary characteristics of the Olympic torch and some of the problems you encountered designing it.

Find out the cost of staging the Olympics (using your school library or the internet). Defend the Olympics against the charge of being a huge waste of money compared to the benefits of spending that amount on a charity such as Save the Children Foundation.

Gus Nathan's story and the work he has done show that being a scientist is not only interesting but something you could do. What is your opinion on this statement? Discuss, using points for and against the statement to illustrate your discussion.

What would happen if fire was not hot? Make a list of how your life would change or be different.

Stephen O'Leary, PhD

I was born in Dubbo, country New South Wales, and moved to Sydney with my parents when I was 4 years old where I went to Lindfield East Primary School.

It was while I was at primary school that my scientific interest was sparked by the manned Apollo lunar missions – particularly the idea of BIG rockets. Through Apollo I felt the intense excitement of scientific discovery and learnt that humans could achieve wonderful things if they work together towards a common goal. I was in year three at primary school and in the classroom when I watched the first man set foot on the moon. Later when the astronauts visited Sydney, I got to see them as they paraded through the city streets.

From space exploration I became interested in astronomy. This was fostered by a club run by the Powerhouse Museum in Sydney (then the Museum of Applied Arts and Sciences). The club helped me learn about the night sky because we went to the planetarium every month during our meetings. It was through astronomy that I started to actually do amateur science – including making a telescope.

When I was a child, computers were HUGE and took up an entire room. There were no computer games, and you had to write your own computer programs to do just about anything! Again through the Museum of Applied Arts and Sciences I was given the opportunity to learn how to program a computer, and then to test my programs. This was the catalyst for my interest in computer programming, which has been a huge advantage to my scientific career.

By now I was in high school and I was interested in just about how everything worked. Astronomy had taught me that being good at maths was really necessary if you wanted to know how things worked. I was still interested in astronomy, but got progressively more interested in girls!

When I finished school I was faced with a major LIFE CHOICE: I wanted to do something at university that would qualify me to help people, but I was really torn between doing science - and helping people through research – or learning to become a doctor and treating their ill-health. However, it was pointed out to me that by doing medicine, it was possible to treat sick people and do research to improve their treatment. So I set out to achieve just that!

During my medical course I did a year of research on the Bionic Ear, which I found exceptionally interesting and challenging. I was present when the first Bionic Ear made by Cochlear in Australia was surgically implanted into a patient – real history in the making. This showed me how exciting and rewarding science could be.

After a few years of working as a young doctor, I had the opportunity to do my PhD. This meant leaving clinical work behind for a few years, but it was really one of the best times of my life – focused, dedicated time to do some Real Science!

Most people want to travel and see the world, but the best way to do it is with your work, that is to actually live overseas. Young scientists will often travel to work in overseas laboratories, so that they can become more skilled – young doctors will do the same. I had the opportunity to do research in Oxford (England), and then later to work as a doctor in the United Kingdom. This was an outstanding experience – freedom, the excitement of seeing the world, living off a shoestring. My wife and I were there for 3 years, and over that time we saw much of Europe and came home with a son.

To fulfil my dream of being able to help people by treating their illness and to do science, I needed further training to become a Surgeon Scientist. Young doctors turn into surgeons by doing special training courses, and I was lucky enough to earn a place in the Ear, Nose and Throat surgical training program in Sydney in 1994. The scientific training is really about developing communication skills i.e. talking to fellow doctors and researchers about your ideas and findings and writing about your research work so it can be published in journals and books so that other researchers and doctors can learn about your research. The other important scientific skill is to learn to 'look carefully' at the 'evidence' i.e. the results of your research to improve patient treatment.

How did I put it All Together?

Through more travel: this time to Holland where I worked as both a surgeon and a scientist in the University Hospital at Utrecht. The purpose of this trip was to work with colleagues from a different part of the world and a different culture, and to learn more skills. Scientists and surgeons are always acquiring more skills.

Today, I have a great job which gives me the opportunity to practice what I had originally set out to do when I left school: to treat people but also to do research into their medical problems and come up with better treatments. I am a Surgeon Scientist working at The University of Melbourne and the Royal Victorian Eye and Ear Hospital, a teaching hospital.

On a typical day I would:

- see the patients who have been staying in the Hospital overnight;
- do an operation;
- attend to my research: do experiments/ talk with my research team/ write articles for publication/ get funding for more research/ talk to people in the community or at conferences here and abroad; and
- see patients who are visiting the Hospital clinics.

My research interests are:

Firstly, restoring hearing to the hearing impaired through:

- improving the Bionic Ear; and
- regrowth (regeneration) of the hearing nerve.

Secondly, Virtual Surgery through:

- teaching surgery in a 3-D "virtual" environment; and
- teaching surgery across the Internet.

Hearing Impairment

Teacher to initiate a discussion with the class on the problems with hearing impairment or deafness. How do people cope with being deaf? Students will know deaf people and may wish to discuss their experiences with these people.

INVESTIGATION ONE

Critical thinking about being hearing impaired

You will need

Pen and paper for writing down ideas

This investigation is best done in small groups.

The aims of this investigation are:

- To raise awareness of hearing impairment, and its effects upon the individual and family.
- To demonstrate how to communicate with a hearing impaired person.
- To highlight that people in the child's immediate family might have a hearing loss (i.e. older relatives) and help the child to understand how poor hearing might influence that individual's communication strategies.
- The child should be able to understand the significance of the cochlear implant, once they are aware of the impact of hearing loss upon people and their families.

Procedure

Divide class into small groups and have them brainstorm answers to the following questions. When all groups have worked out their best answers to the questions, go through their answers with the whole class using the answers below. It may be easier for students if the seven questions are worked on in three groups of two, two and three.

Question 1: Why is hearing important?

Answer 1:

- To communicate with others.
- Environmental awareness – especially to signal danger, e.g. hearing a car approach when you are crossing the road.

Question 2: What would it be like if you lost your hearing?

Answer 2:

- Communication with other hearing people becomes much more difficult.
- Following conversations between groups of people is especially difficult.
- When there is background noise, it is often impossible to understand anyone.
- These factors make it much more difficult to engage socially

Question 3: What might it be like for *your family* if you lost your hearing

Answer 3:

- Day-to-day organisation of the family activities becomes more demanding, because of the difficulties with communication.
- It is more difficult for the hearing impaired person to participate in conversation during family gatherings.

Question 4: Who in your family might have a hearing impairment?

Answer 4:

- The main point is to realise that older relatives often have a hearing impairment, because hearing gradually deteriorates after the age of 40. Hearing impairment is usually most noticeable in the oldest generation of the family.
- Hearing impairment is a major factor contributing to the difficulty that some older relatives have communicating at family social engagements. Many children do not appreciate that this is the main reason why older relatives may not be joining in with the conversation at family celebrations, etc.

Question 5: **What can be done about hearing impairment?**

Answer 5:

- Lip reading. Most people with a hearing impairment learn to lip read – either intuitively or by taking formal instruction.
- Hearing aides.
- Cochlear implants.
- Neither hearing aides nor cochlear implants completely overcome the difficulties of hearing in the presence of background noise.

Question 6: How do you communicate with a hearing impaired person?

Answer 6:

- Get their attention before you start to speak.
- Face them – so that they can lip-read you.
- Speak clearly - don't mumble. There is no need to raise your voice.
- If possible, conduct your conversation in a place where there is no background noise.
- Make the point that adopting this strategy will help them communicate with their older relatives!

Question 7: How do people that have never heard communicate?

Answer 7:

- This depends upon the type of education that the person has had.
- Some people use sign language.
- Other people have learnt to lip read.
- Others have had cochlear implants, and use this in conjunction with lip-reading.

INVESTIGATION TWO

Critical thinking about being hearing impaired

You will need

Pen and paper for writing essays

Video Camera, VCR & TV

Earmuffs

This investigation is best done with the whole class.

Aim: To demonstrate to the class the importance of lip reading when communicating with a hearing impaired person.

Procedure

Part A

1. Set up a video camera.
2. Have a member of the class make a short speech (e.g. 2-3 sentences into the camera) – without the rest of the class present. The camera should focus upon the student's head only. The teacher might want to limit the scope of the speech, to ensure that the context is not too far removed from the class's experience (e.g. "My favourite football team is xxxx.")
3. Play back the video to the class WITHOUT sound, asking the class to concentrate upon the movement of the student's lips. This will simulate a profound hearing loss. See if anyone can follow any of the conversation.
4. Re-play the video, this time with the sound turned down very low – to simulate a severe hearing loss – and see if the speech is any clearer to follow.
5. Re-play the video at full volume so that all students can understand.
6. Now, turn off the sound again, and the students should be able to at least partly follow the conversation by lip-reading alone.

Part B

1. Place either headphones, or earmuffs on a student, and have them face a classmate.
2. See if the student can follow a simple conversation with their classmate. It is helpful to limit the scope of the conversation (i.e. to provide a "closed-set" of possibilities) to assist with the communication.

Part C

In debriefing the class, re-enforce:

1. The importance of facing a hearing-impaired individual when you communicate with them (to facilitate lip-reading).
2. The benefit of any extra sound in helping with communication – i.e. why hearing aides and cochlear implants are so important.

Question 1: Make a list of all pairs of methods that humans use to communicate with each other, e.g. talking and listening

Answer 1: Students should be able to list:

- Talking and listening
- Sign language and vision
- Facial expression and vision
- Body language and vision
- Touching and feeling

FURTHER WORK

Imagine how it would feel to be totally hearing impaired from birth. Why do you think you would feel that way? Make up a poster showing these feelings and the reasons for them.

Collaborate with two other students to think up a list of questions you would like answered by someone who had been totally hearing impaired from birth. Would that list be different if the person had lost their hearing at age 10? Students should be encouraged to adapt and add to the ideas thought up by other group members. Each group should also defend the choice of questions and take notes during the group stage of the project. Each student should then, by themselves, write up the lists of questions and discuss the reasons for each question having been chosen.

Make up a poster showing how we can better include our older relatives in our family gatherings, particularly making them feel welcome in our conversations.

Using the Internet or your school library, research one of the following topics.

1. How does the Bionic Ear work?
2. Which famous Australian invented the Bionic Ear, and why did that person get interested in the treatment of hearing?
3. The Bionic ear was the world's first bionic implant. Researchers around the world are now developing new bionic devices to help the blind to see and people with paralysed limbs to move. What can you find out about these new developments?
4. Increasingly doctors, health professionals, scientists, engineers and managers have to work together to solve complex health problems. When have you worked in a team? What has made those teams successful? What has working with a team taught you about being a "team player"?
5. Bionic ears are not generally available to people in third world countries. Why? Does this seem fair to you? What would you do about it? Explain your answer.

Write up the results of your research in a way that would be understood and interesting to a year 4 student.

Sandra Orgeig, PhD

I was born in Cape Town, South Africa in 1966 to German speaking parents. I went to the German School in Cape Town for 13 years, matriculating in 1984 with German, English, Afrikaans, Mathematics, Applied Mathematics, Physics/Chemistry and Biology.

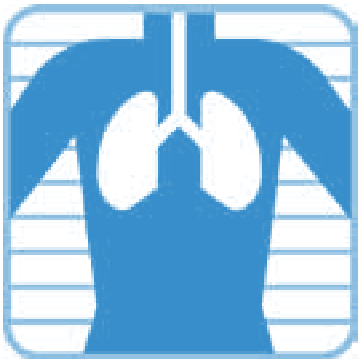
As I was uncertain of what I wanted to do with the rest of my life, I decided to follow my interests, which lay in Biology and Chemistry. Hence, I enrolled in a Bachelor of Science course at the University of Cape Town, majoring in Biochemistry (the study of biological molecules) in 1987. As I was still uncertain which career I wanted to follow, I enrolled in a Bachelor of Science Honours course in Biochemistry and studied the structure and interactions of the proteins that are responsible for packing our DNA into our chromosomes.

My Honours year, while one of the toughest of my life, was also one of my most enjoyable and stimulating. For the first time I tasted the 'Thrill of Discovery', and found it gave me a tremendous feeling of excitement, achievement and purpose – it was a very addictive feeling. It was this experience that convinced me to follow a research career. However, the question was where, and in what field?

I decided to take an extended break and do some travelling, and ended up coming to Australia for six months. I worked for a few months in a completely unknown field to me about how the Lung works. I also travelled around Australia, falling in love with the country. I was extremely fortunate to gain an Overseas Postgraduate Research Scholarship, which enabled me to live and study in Australia in order to complete my PhD. in a new and interesting area - Lung Physiology and the evolution of air breathing at Flinders University in South Australia.

Since completing my PhD in 1994, I have worked at the University of Adelaide as a Research Fellow, continuing on from my work on the evolution of lungs and air-breathing, and how lungs can cope with dramatic changes in temperature, as is experienced by reptiles, and also some mammals, that go into torpor or hibernation. The specific aspect of lung function that I research is called the Pulmonary Surfactant System. My colleagues and I have discovered that cholesterol is a crucial ingredient of pulmonary surfactant that varies with temperature and enables the surfactant system to remain in a fluid and spreadable state even at low body temperatures. Other major discoveries that we have made is that the Pulmonary Surfactant System exists in all animals that possess lungs, it has remained remarkably unchanged throughout 400 million years of evolution, and in fact the system evolved first, before the first lungs appeared.

The Pulmonary Surfactant System



The Pulmonary Surfactant System is a mixture that consists of lipids (fats) and proteins that coat the inside of the tiny air sacs, called alveoli, which is where gas exchange (i.e. uptake of oxygen, excretion of carbon dioxide) takes place.

Because the inside of our lungs are wet, this creates certain physical problems.

Water has a very high surface tension, which is caused by the fact that water molecules are more attracted to each other, than to the air, or other molecules, around them. Therefore, water forms droplets. It also causes other physical phenomena such as being able to float a needle on a water surface, or water drawing up a thin capillary tube by itself, or making it very hard to separate two sheets of glass which have a layer of water between them.

Lipids or detergents can overcome this high surface tension. This can be seen when you spray some detergent on a glass plate (e.g. shower glass) and run water over it – it no longer forms droplets, but sheets.

In the lung, the lipid molecules of the pulmonary surfactant system are able to line up at the water surface (i.e. air-water interface) where they can reduce the surface tension, in a manner similar to a detergent.

Temperature and the surfactant system

The natural composition of surfactant is quite complex consisting of many different types of phospholipids, and other lipids (including cholesterol) and 4 different proteins.

Lipids characteristically go hard when it is cold (e.g. butter in the fridge), but become fluid when the temperature increases (e.g. butter melting in the sun). The temperature at which this change from a solid form to a liquid one occurs will vary with the type of lipid.

Animal fats (butter and lard) contain saturated fatty acids, which are hard at quite high temperatures. Unsaturated fats (like cooking oils) are liquid at low temperatures. Cholesterol keeps the lipids which reduce surface tension in our lungs from becoming hard.

For more details and pictures see my website:
http://www.ees.adelaide.edu.au/research/enviro/evol_physiology/

INVESTIGATION ONE

Demonstration of Boyle's law

= Pressure is inversely proportional to volume

i.e. $P = 1/V$. $P = k/V$ where k is a constant.

BOYLE'S LAW

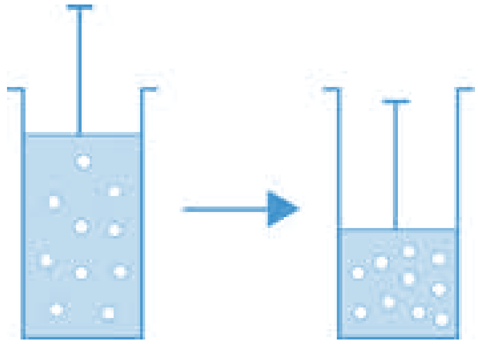
The physical law that applies to all lungs

Pressure is inversely proportional to volume

- i.e. if volume goes up, pressure goes down and air flows from high pressure to low pressure

E.g. a bicycle pump or a syringe

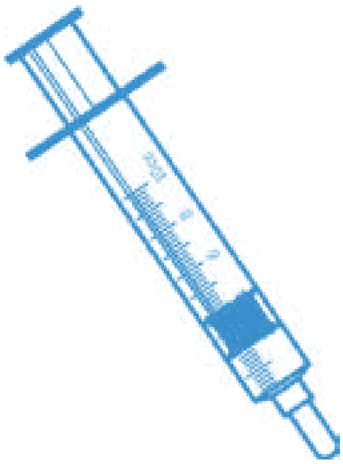
- Volume has decreased
- Molecules closer together
- Increased pressure



You will need

Plastic syringes

This can be done as a class demonstration or in small groups.



BACKGROUND

Lungs are encased within the body. In order to take air into the lungs, the lung has to increase in volume. This occurs because when we breathe in, our ribs move out (aided by the intercostal muscles) and our diaphragm (muscle separating chest cavity from abdomen) moves down. This increases the size of the chest cavity and hence the volume of the lung. This causes a decrease in pressure inside the lung and air flows from an area of high pressure (outside the mouth) to an area of low pressure (inside lung). On expiration, the opposite occurs. Our muscles contract, causing the chest cavity and the lungs to compress. This increases the pressure of the air inside the lungs, causing the air to move from an area of high pressure (inside the lungs) to an area of low pressure (outside the mouth).

Procedure

Take some plastic syringes, place a finger over the opening at the front, pull out the plunger to increase the volume of air inside the syringe barrel. This will cause a decrease in pressure inside the syringe because the same number of gas molecules are now occupying a larger space i.e. they are further apart. Take your finger off the opening and hear the sound of air rushing from an area of high pressure (outside syringe) to an area of low pressure (inside syringe). This is how air moves into and out of the lung.

INVESTIGATION TWO

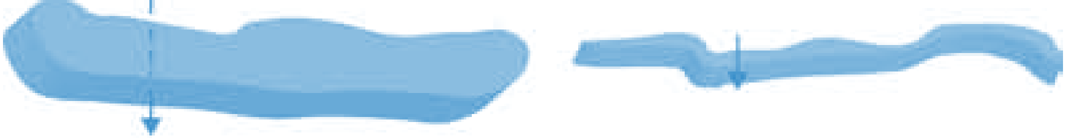
Demonstration of Fick's law

= Diffusion is directly proportional to the area and indirectly proportional to the thickness of the membrane

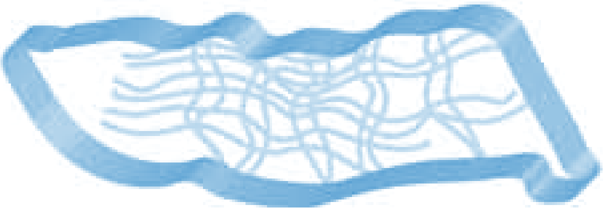
FEATURES OF GAS EXCHANGE ORGANS

1. A large surface area

2. A thin membrane



3. Many blood vessels close to the surface



= More diffusion

You will need

One small jar (a vegemite jar will do)

One larger jar that the smaller jar will fit into leaving space around the smaller jar

Gauze of three different thicknesses

Coloured dye

A bucket

A rubber band that fits tightly around the top of the small jar

A stopwatch

Pencil and paper for recording times and plotting

This can be done as a class demonstration or in small groups.

BACKGROUND

In order for lungs to function efficiently, they have to have a large surface area (e.g. the surface area of the 300 million alveoli of the human lung is approximately the size of a tennis court). This provides greater opportunity for molecules to diffuse across the membrane. Moreover, the membrane has to be very thin, so that molecules are not impeded as they pass from the lung into the blood vessels (oxygen) or from the blood vessels into the lung (carbon dioxide). This demonstration shows that thicker membranes slow the rate of diffusion from one side to the other.

Procedure

1. Mix up the dye in the bucket so it is quite concentrated.
2. Fill the small jar to the top with the dye from the bucket and, using a rubber band close the top of the jar with the thinnest gauze.
3. Fill the larger jar with water and place the small jar upright inside it. Immediately start the stopwatch.
4. Observe the diffusion of dye from the small into the large jar and stop the stopwatch when the water inside and outside of the small jar is the same colour. This may be easier to judge if the small jar is close to one side of the large jar.
5. You may need to carefully stir the water in the large jar but do not create large currents.
6. Record the time taken in the table.
7. Repeat the experiment with the two thicker pieces of gauze.
8. Your table will now have three times recorded.

Gauze thickness	Time until colours the same
Thin	
Medium	
Thick	

9. Plot your three values to make a graph that looks like the one below.
10. Choose three positions along the bottom (the x axis); the leftmost for the thin gauze and the rightmost for the thick gauze.
11. On the y-axis draw a scale so that your longest time is covered; start with zero. The points now may be plotted on your graph.

12. Don't worry if your line is not straight like the one below.

Question 1: Think of things that might cause your graph not to be straight. Make a list of these.

Answer 1: List of possible causes for graph not being straight:

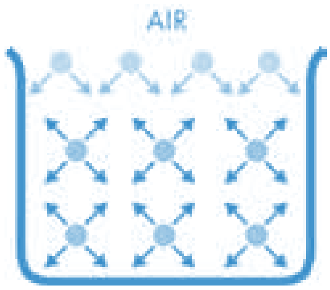
- The gauze thicknesses were not linearly related, e.g. the thick was not 3 times thicker than the thin
- Errors in measuring the time taken for the colours to become the same
- Dye seeping around the rubber band rather than through the gauze
- Differences in the water temperature as the investigation was done
- Careless stirring of the water in the large jar

As long as the graph is roughly straight and slopes upwards from left to right, Fick's law has been demonstrated.

INVESTIGATION THREE

Demonstration of surface tension

Cohesion of water molecules causes surface molecules to experience a net force of attraction to the interior **surface tension** therefore water appears to have a skin



You will need

A beaker or jar that is very clean

Distilled or deionised water

A fine pin or needle

Dishwashing liquid

This may be done as an activity for the whole class or in small groups.

BACKGROUND

Water has the highest surface tension of any biological fluid. This is caused by the fact that water molecules are more attracted to each other, than to the air, or other molecules, around them. This causes water droplets to take on a spherical shape and makes it appear as if the surface of the water has a skin (e.g. see water strider standing on the surface of the water). Detergents can lower the surface tension of water.

Procedure

1. Take a very clean beaker (i.e. rinse several times in pure distilled or deionised water) and fill it to the top with distilled or deionised water. This can also be done with tap water if it is very clean but the demonstration works better with distilled water.

2. Take a fine pin or needle and place very gently onto the surface of the water, being careful not to break the surface with the point of the pin. A good way of doing this is to hold the pin carefully on two matches and lower it gently onto the surface.

3. Observe that it can rest on the surface of the water. The surface tension is strong enough to support it.

4. Detergent lowers surface tension. Squeeze a small amount of dishwashing liquid onto your finger and rub it on the rim of the beaker so that the detergent runs into the water.

Question 1: What did you observe?

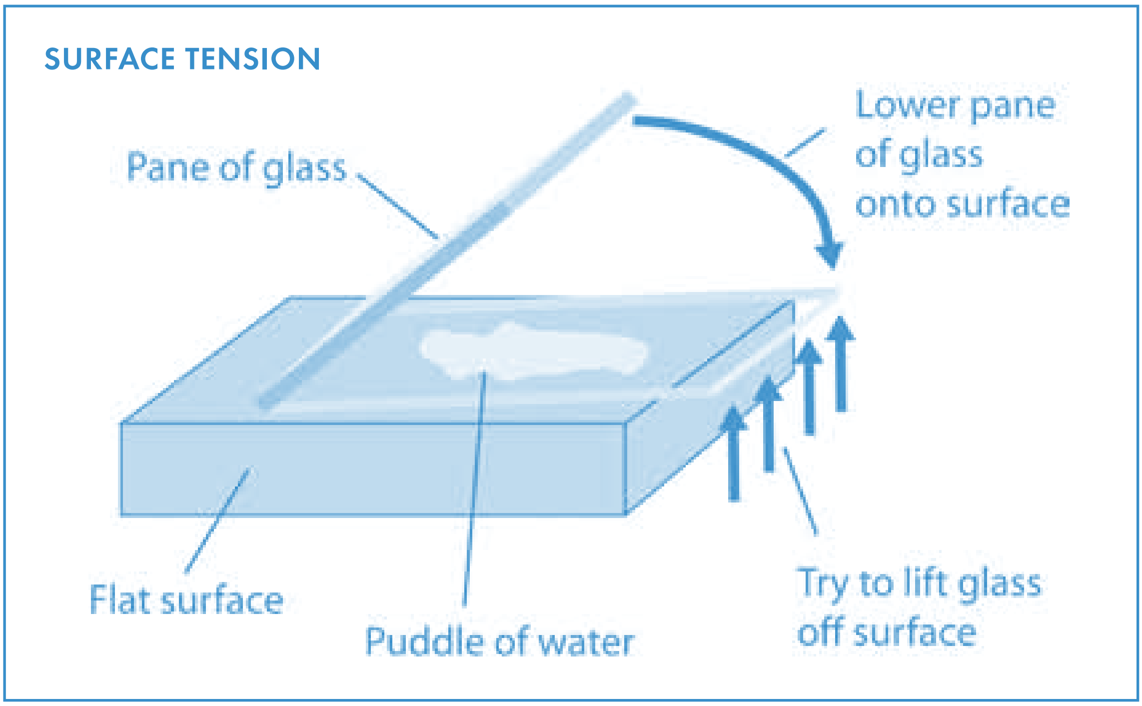
Answer 1: The pin moved quite violently away from the blob of detergent.

Question 2: Why?

Answer 2: The detergent lowered the surface tension closest to where you rubbed your finger and the higher surface tension over the rest of the surface pulled the pin away.

INVESTIGATION FOUR

Demonstration of the effect of detergent on surface tension



You will need

Two sheets of safety glass about 20cm square with round edges

Distilled or deionised water

Dishwashing liquid

A laminex or very flat benchtop

This may be done as a whole-class activity with every student given an opportunity to participate.

Procedure

1. Make a puddle of deionised/distilled water on the laminex and some distance away a puddle with detergent mixed with water. Make sure the puddles don't meet.
2. Place a pane of glass on top of each, squeezing the layer of fluid to the edges and leaving part of the pane over the edge of the benchtop for students to grasp.
3. All students should try lifting the panes of glass and compare the difficulty between the two solutions.

Question 1: Which pane is the hardest to lift?

Answer 1: The pane on top of the deionised/distilled water.

Question 2: Why?

Answer 2: Surface tension in the mixture of detergent and water is only about 40% of that in distilled water.

FURTHER WORK

Exercise 1

Partitioning air and water breathing in a bimodal breather: What can these differences tell us about the physical conditions promoting the evolution of airbreathing? (for very capable students only)

Aim: To demonstrate the effect of changes in oxygen level and temperature on the breathing rate of amphibians or fish.

Rationale: Axolotls (or Mexican walking fish) are salamanders, which remain permanently in the juvenile, or larval stage. They remain in the water, breathing with gills all their life, and do not turn into the adult stage, which lives on land. However, axolotls are also able to breathe air with their lungs, which makes them bimodal breathers, i.e. they use two modes of breathing: 1. waterbreathing via the gills; 2. airbreathing via the lungs. This provides a great advantage to the animal, as in situations where there is not sufficient oxygen dissolved in the water to extract with the gills, the animal is able to come to the surface and gulp oxygen-rich air to force into its lungs. This experiment can also be performed with an air breathing fish–the gourami.

Experiment: Place axolotls (or gouramis) in water containing either different levels of oxygen or different temperatures (e.g. 15, 20, 25, 30, 35°C) and observe over a given time period the number of times the animal comes to the surface to breathe air. The number of times they beat their external gills correlates with gas exchange stress in the water. Note also where, and for how long, the animal rests (at the surface or at the bottom). Note any other changes in behaviour. A reduction in the oxygen level should increase the number of airbreathing events, gill "beats" and time that the animal spends at the surface. Similarly, an increase in the temperature of the water will reduce the amount of oxygen that is dissolved, and also raises the metabolic rate of the animal, such that it requires more oxygen to fuel its cellular processes. Both factors should lead to an increase in the number of airbreathing events, gill beats and time spent at the surface.

Method: In order to reduce the amount of oxygen in the water, boil the water first (WITHOUT THE ANIMALS IN IT) for different periods of time e.g. 5, 10 or 20min, then allow the water to cool to room temperature (~22°C), before placing the animals into the water. The greater the boiling time, the more oxygen will be removed from the water. In order to increase the oxygen to the water, bubble air through it (e.g. as in a fish tank).

Results: Present your results using either tables or graphs with an appropriate explanation. Discuss your results.

Exercise 2

The sport of holding your breath for long periods underwater has become popular in recent times, as has diving to great depths without breathing equipment. Using the Internet or your school library, research this emerging sport. Write a paragraph explaining it to a year 4 student, giving your opinion on how risky you think it is and telling that student why you think people engage in it.

Exercise 3

Current dietary advice tells us to minimise the amount of cholesterol in our blood but from what you have just learnt, it seems that cholesterol is essential in enabling our breathing. Without attempting to distinguish between good and bad cholesterol, write a paragraph discussing why it is good for breathing but bad when we have too much in our blood. Discuss how we might resolve the conflict between needing cholesterol and too much of it being bad for us. Make a list of other things that are good for us on one hand and bad for us on the other. Discuss one item on your list and how we should resolve the conflict for that item.

Ideas for teachers: Current dietary advice is to reduce cholesterol in our blood as too much leads to the deposit of plaque on the walls of our blood vessels. This plaque not only increases blood pressure but also can break off in clots and block other blood vessels leading to severe health problems. Even if cholesterol is eliminated in diets, our bodies make enough of it for the needs of our lungs (and some times too much for the health of our circulatory systems). Other things which are good for us in small quantities include salt and alcohol. Food is a classic example of something which is essential for us in the correct quantity and bad for us in excess.

Exercise 4

Make up a list of 10 questions you would like to ask Sandra Orgeig about how and why she became interested in science. Pick another student in your class and ask them to pretend to be Sandra. Ask them your questions and take notes of their answers. Write a report listing your questions, "Sandra's" answers and any comments "she" made about your questions. If "she" was critical of a question, be sure to write a defence of why you chose it.

Alfio Parisi, PhD

My parents migrated to Australia and I was born in 1959 at Mossman, in North Queensland. I attended primary school in Mossman, which was a small sugar town, where my family lived close to the local sugar mill. A vivid memory of those days living in the tropics was the carefree and barefoot times, with the soot from the sugar mill covering anything that was stationary.

During secondary school at Trinity Bay State High School in Cairns, I was interested in how and why technology works. I was always keen to pull apart anything that was not working with the aim of seeing the 'insides'. Studying science provided me with the avenues to explore these interests. In senior high school, the physics classes provided explanation of the basic laws and principles of science that underlie modern science and technology.

Combining this with the ethics of hard work, provided by my family, gave me the motivation to study physics at James Cook University and to continue work as a Physicist. Following graduation, my first employment was in Canberra as a marine geophysicist exploring for oil and gas hidden below the seas off Australia.

I now work as a physics lecturer at a university and research solar ultraviolet radiation. I became interested in solar ultraviolet radiation as a research field in order to understand the laws of physics that influence solar ultraviolet radiation. The motivation was to understand the factors that influence ultraviolet radiation exposure to humans during normal daily activities. The risks of skin cancers and sun-related eye problems like cataracts are increased by ultraviolet exposure and in order to reduce these risks, an understanding of the solar ultraviolet radiation is essential.

During my career as a Physicist and scientist, I have been an author on a book, written my research findings in scientific journals, travelled to overseas scientific conferences and never lost my interest and excitement for science and physics in particular.

Ultraviolet Radiation

The risk of developing skin cancer or sun-related eye disorders may be lowered by the reduction of human exposures to solar ultraviolet (UV) radiation. There are also other determining factors such as genetic factors, however, both the total amount of sun received over the years, and over exposure resulting in sunburn increase the risk of skin cancer.

There is a need to balance harmful UV exposure against the benefits of exposure which include the production of vitamin D. This requires an understanding of the solar UV environment.

The solar UV that reaches the earth's atmosphere is made up of wavelengths shorter than 400 nanometres or nm (where 1 nm is one thousand millionth of a meter). These wavelengths are shorter and carry more energy than the wavelengths of visible light. The UV is divided into the categories of UVC (shorter than 280 nm), UVB (280 to 320 nm) and UVA (320 to 400 nm).

At the surface of the earth, there is no solar UVC present and only part of the solar UVB. This reduction of the solar UV is due to the earth's atmosphere absorbing and scattering the radiation. Absorption by ozone and oxygen molecules in the atmosphere removes all the UVC. Part of the UVB is absorbed by ozone. It is the UVB that will increase if there are any reductions in the amount of ozone in the atmosphere. At the longer UVA wavelengths, there is very little absorption by ozone, so that changes in ozone are of no consequence for the UVA.

Cloud cover significantly affects the amount of UV reaching the surface of the earth. This amount also depends on how far the UV from the sun must travel through the earth's atmosphere and this depends on the angle of the sun above the horizon. This varies with time of day and with season. The scattering of UV in the atmosphere is the result of the interaction with molecules and particles suspended in the air. Any particle in the UV radiation's path causes redirection of the UV. This scattering of the UV means that even in shade there is a percentage of UV present.

INVESTIGATION ONE

Degradation caused by UV

You will need

Page of newspaper
Board
Tape
Access to the Internet
Best done as a class

Procedure

Pick a period, preferably in summer where the weather forecast is for several days without rain. Cut the page of a newspaper in half. Tape one piece to the board and place it on an unshaded outdoor surface. Keep the other piece indoors in a cupboard drawer.

At the end of the first day compare the colour of the two sheets of paper. What has happened to the sheet placed outdoors? Repeat the process for a second day and again compare the sheet that has been outdoors to the sheet that has been indoors.

Write a brief report describing what happened to the newspaper and why you think it happened.

INVESTIGATION TWO
UV index

You will need

Access to the Internet

This can be done individually or in small groups

Procedure

1. The UV index is provided by the Bureau of Meteorology to describe the daily levels of solar UV radiation. It is a forecast value that indicates the forecast maximum for the day.
2. Visit the Bureau's website and find the map of Australia with the forecast clear sky UV index for local noon marked on it. The web address is: http://www.bom.gov.au/info/about_uvb.shtml
3. What is the forecast clear sky index for your area today?
4. On that same web page there is a table describing the danger category for the relevant UV index. What is the danger category for the UV index for today?
5. On this web page, follow the link "See UV Index Forecast Graphs for Capital Cities and Alice Springs."
6. Find the graph for the capital city closest to your location.
7. What is the UV index two hours either side of midday and three hours either side of midday?
8. How does it compare with midday and how does the danger category compare with midday?
9. Display your results in a table.

INVESTIGATION THREE
UV in tree shade

You will need

The Ultra-Violet Sensometer. This is a small index card that undergoes a colour change to provide a reading of the UV levels in the three categories of weak, medium and strong. It is available through the South Seas Trading Company, Maui, Hawaii for $4.95US plus postage and handling at the web address: http://www.maui.net/~southsky/uvcard2.html

Best done in small groups.

Procedure

1. Take the card outside and obtain a reading on a horizontal plane of the UV level at 9 am. What is the reading?
2. Repeat this at approximately noon.

3. At noon, take the card into tree shade and take a reading on a horizontal plane.
4. How does this compare with that in full sun?
5. The reading in the tree shade should be less than in full sun, however there may have still been some UV in the tree shade due to the UV that has been scattered by the molecules and particles in the atmosphere and that is reaching us from all directions.

INVESTIGATION FOUR

Ozone hole

You will need

Access to the Internet

Best done in small groups.

Procedure

One of the methods of measuring the ozone levels in the atmosphere is by satellite. The data is available on the web site below: http://jwocky.gsfc.nasa.gov/

1. On this site, on the left hand column, click on ozone. When this next page has loaded, select south pole image – GIF (640 x 480) and select a date at the start of any year and press request to obtain an image of the ozone levels over the south pole and southern hemisphere.
2. If there is a blank patch over the South Pole, select another date. What is the average ozone level over the South Pole?
3. Select a date in the middle of the year. What is the average ozone level over the South Pole.
4. Select a date in September or October and what is the average ozone level over the South Pole.
5. You may have found that the ozone levels are lower over the South Pole in spring. This is because in winter the temperatures over Antarctica are extremely cold and trigger a series of chemical reactions that lead to the rapid destruction of ozone and the low levels of ozone in spring.
6. Make a table of your results.

FURTHER WORK

Using the school library and the Internet, research the causes of the hole in the ozone layer. Prepare a set of about 10 questions you would use to interview the president of the United States on the measures his country is taking to limit the size of the hole in the ozone layer. Write a report of the results of your research, listing your questions and saying why each question is important.

Prepare a poster showing the methods we should all adopt to minimise the damage to our bodies from too much ultraviolet radiation.

Ranjeny Thomas, PhD

"Imagination is more important than knowledge.
Knowledge is limited.
Imagination encircles the world." - Albert Einstein

I was born in Perth, Western Australia in 1961. My father emigrated from Kerala, in Southern India, to Melbourne in 1952 as a medical student, and went on to become a plastic surgeon. During his training he met my mother, an Australian nurse, and they made the decision for my father to settle in Australia.

Like many immigrants to Australia in the 1950's, it was a tough and competitive road. I am one of four sisters. We were all imbued with a strong work ethic, encouraged to perform academically, to participate in sport, and to extend ourselves creatively through such activities as music, art and craft, and creative writing.

I attended the local state primary school and then an all-girls independent school. At school, I excelled academically with a good all-round ability. I was not talented at sport, but I played violin and piano, loved writing, languages, reading and finding answers to things. I was not very interested in science at school. It was poorly taught and really did not inspire me. At a recent school reunion, I was sorry to note that no other girl from my year had become a scientist, although many had entered the health professions. I had no idea what to do when I left school, so I studied Medicine, with the idea that it had great career flexibility (so I could leave the decision-making till later!).

At University I did OK but was not a top student. I continued learning French at university and loved this. I started work, and began training as a physician, enjoying the detective work involved in diagnosis of patients presenting with rare diseases. Soon though, the challenge ran out. Moreover, the creative side of me was all but suppressed. I had stopped playing the piano towards the end of medical school to give myself more time to study, and once I started working and studying to be a specialist, time got even shorter.

When studying for my specialist physician exams, some of my friends and I formed a weekly study group to discuss various exam topics. One of these was Immunology – the study of how the Immune system decides what is self or non-self, how it fights infection, and how things go wrong in autoimmune diseases like rheumatoid arthritis. One of the group invited a visiting Immunology Fellow to come along to the study sessions and help us out with questions we had in this difficult subject. He had studied in one of the top laboratories in the United States of America and was on a year's Fellowship in Perth.

Suddenly, through his insights in Immunology, a whole new world opened up for me. Indeed the whole group got fired-up on the subject, and three of the five of us are still researching in related areas today! My first mentor.

Soon afterwards, I passed my exams and began training as a specialist in arthritis – known as a rheumatologist. Rheumatologists deal with autoimmune diseases of the immune system, like rheumatoid arthritis, lupus and vasculitis. Not only are these diseases interesting to diagnose and treat, but the reason people get them has been a big black-box mystery

At this stage I met my second mentor – Graeme Carroll who is a Perth rheumatologist. He was supervising my specialist training and responded to my request to do a research project with a nice question about what the drug methotrexate - which had just started to be used to treat rheumatoid arthritis - did to the immune response in the joints in these patients. With Graeme I learnt to organise myself to do research – to write small research proposals, to tabulate and analyse data in a database, to put figures together for publication, and how to network with individuals who could help me get my research done. The latter is an essential skill for those people who need to get research done in their "spare time".

By the time I had rotated through the Immunology Department and done a few more research projects, I was well and truly hooked.

My husband, a musician and architect, and I were keen to travel overseas as soon as my training would allow. We made plans to go to the United States and I sought advice from my first mentor on top laboratories in Immunology in United States of America. I wrote to all the laboratory directors on his list – looking back it was a real who's who – and got an answer from nearly all of them.

Peter Lipsky actually offered me money to come! As a combined rheumatologist/immunologist he was the perfect choice for my next mentor. I had no idea whether I would like basic research (as opposed to clinical research on patients), but I thought I would try it for a year or so. I got to the laboratory and immediately found my vocation. I loved designing and doing experiments, I still loved to write, and I enjoyed speaking with others about it.

The excitement of being the first to discover something new was electrifying then, and continues to stimulate me 14 years later. When there is a research question in my head which is puzzling me, it is difficult for me to concentrate on anything else.

What are the things I love about research?

- *The joy and freedom of using my imagination as part of my work.* The practice of medicine does not require a large amount of imagination, so it becomes boring for many naturally imaginative and creative people. In Science, highly developed mental flexibility and creativity in thinking are real advantages.
- *Design.* An important part of me is a designer, and I love to design experiments that are elegant in the way they demonstrate a new concept or finding.
- *Interacting with others.* Research productivity is enhanced exponentially by working with other imaginative people who can bring different perspectives. The need for interaction is tremendously intellectually satisfying, because one has the privilege to work and become friends with some amazing individuals all over the world. Travelling is integral to Science, and this is one of the most fun parts, particularly if you can dine, have fun and talk with your colleagues in exotic places. I have met some of my greatest friends through both Science and music in this way.
- *Making a difference to society today and in the future.* All Science stands on the shoulders of those who have gone before. What a wonderful thought that without Galileo or the Curies or Burnett I would not be where I am today, and so what I discover today shapes the thinking of the world today and in the next generations. What an amazing family tree to belong to, and to contribute products (my students and trainees) of my teaching!

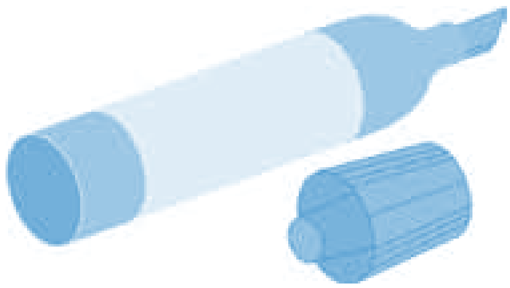
My research goal is to develop an antigen-specific immunotherapeutic for autoimmune disease and allergy. In plain English, that means I want to work out how to treat diseases like rheumatoid arthritis and asthma with a vaccine after the disease has already started. This vaccine would suppress just the bit of the immune system (response to a specific antigen) that has gone wrong, without turning off a master switch and risking shutting down the entire system. We have developed a prototype vaccine that works in animals and we are ready to start testing in humans. Meanwhile, we are continuing to refine our research strategy in animals.

INVESTIGATION ONE

Form design and data collection.

You will need

Markers, butcher's paper, pens and paper for designing the form.



This investigation is best done individually for the first stage, in small groups for the second stage and as a class for the third stage.

The aim of this investigation is to design and use two forms. Firstly, a survey form for finding out how many students in this class have allergies, asthma, diabetes and arthritis and what triggers the allergies and asthma. Secondly, a form for presenting the results of the research. This is an essential skill in many areas of scientific research, eg. psychology.

Procedure

Stage 1. This is a creative thinking exercise, designing forms for collecting and presenting scientific data.

1. When designing a survey form, the first question that has to be answered is "what data should be collected to answer the research question?".
2. The specific question that needs an answer in this case is "how many students in this class have allergies, asthma, diabetes or arthritis and what allergen sets off the allergies and asthma?". This should be briefly discussed with the class.
3. They may want to draw on their experience from the class on epidemiology where they used forms similar to those needed here, but the teacher should not lead them to do this.
4. The teacher needs to introduce the idea of anonymity for participants in the survey and ask students to consider it in their designs (reason is that having any of these diseases may be embarrassing for students but if respondent's names are not on the form their responses cannot be identified).
5. The form for presenting the results should be designed at the same time as the survey form. Students need to consider how to best present the answers to their research question.
6. After the brief class discussion, students should individually attempt to design both forms. This is most important; the teacher should check that everybody has had a try.

Stage 2 involves moving the students into small groups (of about three) to brainstorm their designs.

1. The teacher should circulate between groups encouraging students to be flexible and consider different possible reply formats such as putting a cross in a table as opposed to writing "yes" or "no" in response to a question.
2. Students should also be encouraged to adapt each other's ideas to improve their group's design.
3. Once each group is happy with their product they should write their designs on the butcher's paper.
4. If there are a large number of groups, the next step can be merging pairs of groups and iterating this brainstorming in the combined groups. This may be repeated again until there are only approximately three groups remaining.

Stage 3 begins with the remaining groups sticking their designs up so they are visible to all members of the class.

1. Each group needs to present their designs to the class, listening to and accepting or rejecting the constructive criticism of members of other groups.
2. When each group has had a turn, the teacher should introduce another idea: "wouldn't it be nice to see if allergy rates, etc differ between boys and girls?".
3. The class should readily decide how to gather this extra piece of information and how to present it on the results form.
4. Once all are in agreement, the survey form should be adopted, written or typed and 10 photocopies made for some of the class to use in a pilot run. The latter run is done as a precaution to make sure the form works when put into use. For instance, if a tabular form has been adopted for the survey form, is there a position for a "don't know" response regarding the allergy and asthma trigger?
5. Once the form has passed the pilot run, conduct the survey by having everybody fill out a copy.

Finish the investigation by completing tables 1 and 2. Discuss the results with the class.

Here are designs for presenting the results.

Table 1.

Ailment	Number of Boys	Number of Girls	Total number of students
Allergies			
Asthma			
Diabetes			
Arthritis			
Totals			

Table 2.

Ailment	Number of students with this trigger		
	Pollen	Mould	Exercise
Allergies			
Asthma			

The categories of allergens causing allergies and asthma need consideration in the design stage. However, students may not have much understanding of these categories before the data is collected, although research using the Internet will help. Alternatively, the number of columns and headings in Table 2 can be decided upon when the data has been collected.

Question 1: There are other methods of presenting data that make it easier to understand, other than using tables. What is one such method? Use it to present the data in Tables 1 and 2.

Answer 1: A bar graph reveals any trends in the data more readily than a table. For table 1 use the row headings as categories on the x-axis and plot number of boys alongside number of girls for each category on the y-axis. Similarly for table 2.

INVESTIGATION TWO

Are more people affected by allergies and asthma from year to year?

You will need

Both forms from Investigation One.

Permission to survey students from a class in each year at the school.

Pens and paper for writing a report on the survey.

The aim of this investigation is to find out if more people are affected by allergies and asthma from year to year?

Procedure

1. Brainstorm with the class the idea of using the forms from Investigation One to gather and present results for this investigation. Some small modifications will likely be thought necessary.
2. The survey form may need a class identifier and will need the age of the respondent.
3. Students may decide to split results on gender as they did in Investigation One, this is their decision.
4. The results form will need some thought; teachers can decide whether to go through a design process similar to that in Investigation One or to use the design suggested in Table 3, adjusting the number of columns as necessary.

Table 3.

Ailment	Number of students					
	Age = 6	Age=7	Age=8	Age=9	Age=10	Age=11
Allergies						
Asthma						
Total students						
% with allergies/ asthma						

5. Once the survey and results forms are satisfactory, the data collection stage begins.
6. The recommended method of collecting data is to approach one class in each year at the school, hand out the survey forms to all students in that class and collect them once they have been filled out. This should take less than 15 minutes per class.
7. When the data has been collected, the class may be divided into teams as follows: a team to divide the forms up into different age groups, one team per age group to count the number with asthma, number with allergies, number without either in their age group.
8. Someone should be delegated to fill out Table 3. In the bottom row of that table is the answer to the research question.

Discuss the results of the survey with the class. The percentage of combined asthma and allergies sufferers will probably not be shown to increase in these results. Reasons for this include:

- Each percentage has an error associated with it and the errors are likely to be larger than the increase (if any) over a year.
- The small range of years available to be surveyed is not large enough to reveal longer-term trends.

As the next step, every student should write a report of the research conducted, including any forms used, who was surveyed and how, the method used to derive the results and the results obtained. This may be done individually or in small groups.

The penultimate stage of this investigation is evaluation of the reports.

1. Once these have been written, they can be collected and handed out to the class but not to their authors.
2. Students should evaluate the report they have been handed using the criteria in the preceding paragraph which could be written on the board. Evaluators can be encouraged to write comments on the reports, defending any criticisms they make.

Finally, the evaluated reports can be recollected and used as the basis of a class discussion of what was learnt from Investigation Two.

FURTHER WORK

Case study.

Use the Internet to research asthma or an allergy of your choice. Use your newfound knowledge to think up a set of questions you could ask a sufferer of your chosen ailment. Find such a person, obtain answers to your questions and write a case study report. This report should list the questions you used, a summary of your subject's answers including their answer to the question: "What does your subject do to treat or prevent their condition?".

Model construction

Phagocytic cells ingest bacteria or viruses and display fragments of these allergens to other cells of the immune system. The result is "inflammation" of the body part infected with the bacteria or virus. Make a model using your choice of materials (eg. plasticine, jelly and lollies, fuzzy felt, etc) of a phagocyte ingesting bacteria and alerting the body to infection. Reference: Time Australia, February 23, 2004: pp42-50 (at National Library).

Further reading and web activities

Frank MacFarlane Burnet, Father of Immunology. The Helix (CSIRO), February/March 1999: pp. 19-22 (at National Library).

David Whiteman, PhD

I was born in Brisbane in 1966, and spent most of my childhood in that city (except for a few periods overseas, which I will get to shortly). In those days, Brisbane was just like a big country town, and it was common for kids to explore creeks and bushland after school and on weekends. The lazy days spent riding my BMX bike through the scrub and playing "armies" with friends in the suburban bush near my home probably sparked my early interest in plants and animals.

School was mostly fun, although I don't think it gave me the passion for Science that I now have. Looking back, I would say that my love of Science was always a part of me and was not something that I learned. I was a naturally a curious kid who would happily spend a few hours reading a book about monkeys (still my favourite mammals) or the solar system or whatever else caught my interest. My family background was also conducive to pursuing knowledge: both my Mum and Dad worked at the University and encouraged me to find the answers to my questions by looking up books.

Although I didn't consider myself a nerd, my love of Science must have been pretty obvious to those around me, as I do remember that a relative once gave me a "junior chemistry set" for Christmas. This may or may not have been a good thing, for the chemistry set came with a small burner, and I devoted a great deal of time to concocting various explosive potions. Eventually, the chemistry set was confiscated.

When I was about nine or ten years old, my family and I travelled to England for a year. Actually, we only spent eight months in England, and the rest of the year was spent travelling through Asia and Africa to get there, and then through the West Indies and various Pacific Islands to get back. This was a wonderful period of my life, for it was the first time that I had ever seen exotic animals and plants. Brisbane didn't have any fancy zoos when I was a kid. I was fascinated by all sorts of critters, and became a particular expert on monkeys.

It was about this time that I first developed an interest in medicine, probably because I endured numerous painful injections before leaving Australia. I wanted to know more about the deadly diseases, such as yellow fever, cholera and typhoid, that my parents were determined I would avoid. While visiting some countries, I also had to swallow some very large and extremely bitter pills to prevent malaria. I was never very good at swallowing, so I had to chew the tablets, and the memory of their taste makes me gag to this day!

Nevertheless, through asking questions about that disease, I came to understand that malaria was transmitted by certain types of mosquitoes, and that it can be prevented either by avoiding being bitten by mosquitoes or by killing the parasite that lives inside the mosquitoes. If you want to be really sure not to get malaria, you can do both. On another occasion while visiting a small island in the Pacific, I was horrified to see a person suffering from a parasitic disease known as "elephantiasis", in which their legs swelled literally to the size of an elephant. Experiences like these prompted my curiosity into the causes of diseases, and probably laid the foundation for my later career.

From reading the above, you might think that I always wanted to be a doctor or scientist, but it never really became my plan until I was considerably older. By the time I finished primary school, my major interests were BMX bikes, making bombs, swimming, surfing and "mucking about". Nevertheless, I enjoyed schoolwork; especially Maths and Science, I always worked hard and did well in exams, so I must have kept my brain active all the while.

I kept myself busy through high school, and again enjoyed my studies. By about grade 11, I settled on the idea of studying medicine at university, since it gave such a wonderful breadth of Science subjects and led to an extremely interesting job at the end of it all.

It was a fantastic decision, and I revelled in the amount of information that I could cram into my brain. As medical students, we learned all about the human body and how it works, and then learned about the numerous diseases that afflict mankind. We learned how to distinguish various diseases from each other, and then how to treat people to make them better.

Perhaps most importantly, we also learned that all of this vast amount of medical knowledge has come about simply because some people have asked simple questions such as "why did that person get sick, but not that other person?" or "how can I treat this disease better?". I especially enjoyed this side of medicine – that is, asking questions that don't yet have answers, and then designing research studies to provide the answer. Eventually, I gave up seeing patients, and devoted myself completely to medical research.

I am a National Health and Medical Research Council Senior Research Fellow working at a large medical research institute. I am researching the causes of certain types of cancer and in particular cancers of the skin and the oesophagus. This work is immensely satisfying, although there are always plenty of challenges to overcome. I am looking forward to a long career in medical research, and hope one day to "make a difference".

INVESTIGATION ONE

Critical thinking exercise on Epidemiology

You will need

Pen and paper for writing ideas.

This investigation is best done as a class group.

The aim of this investigation is to introduce students to the concept of epidemiology

Procedure

1. Display this paragraph to the class: Epidemiology is the study of diseases. More specifically, it is the study of diseases as they affect whole populations, as opposed to individual people. To illustrate, whereas a doctor may ask, "What is making this patient ill?", an epidemiologist asks, "What is making *all of these people* in my community ill". Thus, **epidemiology** is the study of diseases as they affect whole groups of people, or populations.
2. Discuss this paragraph with the class making sure all students are comfortable with the concept.
3. Brainstorm Question 1 with the class, writing on the board all suggestions. Encourage original ideas and elaboration of ideas already on the board.

4. Once all ideas are on the board, ask the class for suggestions about grouping them, guiding the class if necessary into the four categories below.

Question 1: Using the information in this paragraph, what sort of questions would an epidemiologist ask?

Answer 1: The main questions an epidemiologist asks are WHO? WHEN? WHY? HOW?

WHO?	Who gets this disease? Old people or young people? Men or women? People living in the city or people living in the country? People who smoke or people who don't smoke?
WHEN?	When did this disease first appear? Has it always occurred at the same rate? Has the disease become more or less common over time?
WHY?	Why is the disease occurring in this group of people? What is it about the people who become ill that makes them different from the people who are not ill? Do they eat different foods? Do they work in different jobs? Do they live in different houses? Do they have access to good health care?
HOW?	How is this disease caused? Is it spread by germs? Is it contagious?

5. Move on to question 2. Try a different approach by having students attempt the question themselves before class discussion. Each student should produce up to 8 dot points in answer to Question 2. Once everyone has finished their dot points, invite students to read them out: teacher should write them on the board.
6. Discuss duplications with the class and student presenting his/her answers. Encourage elaboration of points already on the board and flexibility in the wording of answers.
7. Once everybody's' answers have been included, facilitate class discussion.
8. Have class rank answers in order of importance: this should bring out opinions which students should be fostered to defend.

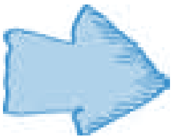
Question 2: Is epidemiology important? If so, why?

Answer 2: Reasons may include:

- To allow medical services to be targeted at groups at risk of particular diseases
- For reasons of equality, namely prevention of suffering in at-risk groups
- Preventing the spread of disease
- Prevention of epidemics by timely intervention
- To enable cures to be developed for new diseases, eg. SARS
- Provision of advice so people can avoid harmful behaviour, eg. Smoking
- To allow governments to make adequate funds available for spending on hospitals, doctors and nurses
- For quarantine purposes
- To provide geographical information on diseases, eg. Melanoma, kidney failure.

INVESTIGATION TWO

Using the Internet to compare rates of disease



You will need

Pen and paper for taking notes.

This investigation is best done individually, computer numbers being adequate. Alternatively, it can be done is small groups.

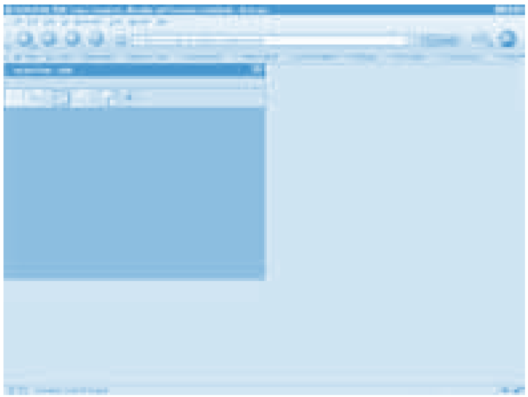
The aim of this investigation is to introduce students to epidemiological data

BACKGROUND

"Cancer" is the name given to a large number of diseases of different organs of the body. All of these diseases share one feature in common: the cells in the organ have lost the normal control mechanisms that govern their reproduction. Instead "cancerous" organs develop tumours that can spread to different parts of the body.

Cancer occurs at different rates in different populations around the world. This often gives epidemiologists a clue as to what is causing the disease. This exercise uses data available on the Internet to look at rates of different types of cancer.

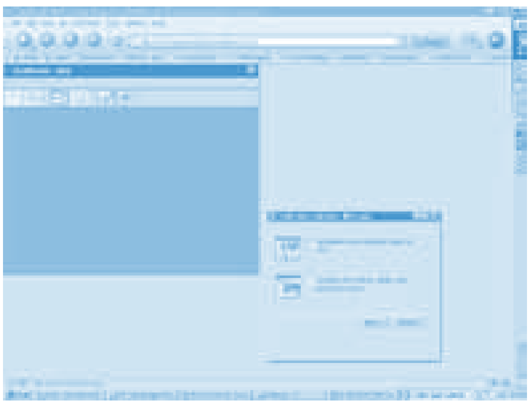
We will use the Internet site GLOBOCAN, operated by the International Association for Research on Cancer (IARC)



Procedure

1. Go to http://www.depdb.iarc.fr/globocan/GLOBOframe.htm

You will see a webpage with a sidebar. Familiarise yourself with this page.

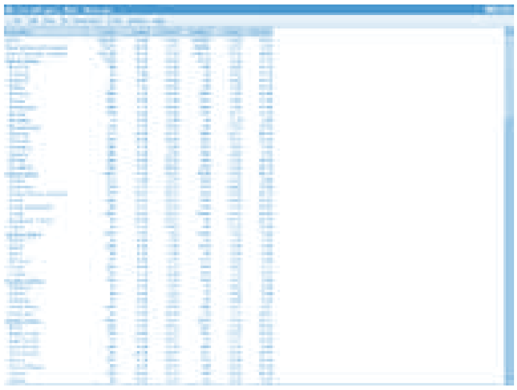


2. Click on the Tab marked with Tables and then click the dropdown list by "Cancer"

3. Select "Liver" from the list of cancers and "Male" on the radio buttons under "Sex". Select "Area" first, then by "Name" under "Country presented by".

4. Click on the "Execute" button.

5. A page will appear, listing the rates of LIVER CANCER in males for all the different countries in the world.



7. The table has EIGHT columns, as follows
   1. Cases, i.e. number of people who develop liver cancer
   2. Crude, i.e. the crude rate of liver cancer in each population where rate is the number of people per thousand
   3. ASR (w), i.e. the adjusted rate of liver cancer, adjusted to the age- and sex-distribution of the World population. An ADJUSTED rate is necessary to make sure that the comparisons are fair and take account of different age-structures in each population
   4. Deaths, i.e. number of people who DIE from liver cancer
   5. Crude, i.e. the crude DEATH rate of liver cancer in each population
   6. ASR (w), i.e. the adjusted DEATH rate of liver cancer, adjusted to the age- and sex-distribution of the World population

   We are not interested in the last two columns.

Look at the FIRST THREE ROWS, marked "World", "More developed countries", "Less developed countries".

Question 1: Do more males get liver cancer in More developed countries or Less developed countries?

Question 2: Now look at the CRUDE RATE of liver cancer in More developed countries and Less developed countries. Are they very different or quite similar?

Question 3: Now look at the ADJUSTED RATE of liver cancer (ASR) in More developed countries and Less developed countries. Are they very different or quite similar? How do they differ from the CRUDE RATES of liver cancer? Why might there be a difference?

Now we'll look at the whole table.

Question 4: Which male population has the HIGHEST NUMBER OF CASES in the world? Does this country also have the highest CRUDE rate of DISEASE (column 2)?

Question 5: Which male population has the LOWEST NUMBER OF CASES in the world? Does this country also have the LOWEST CRUDE rate of DISEASE (column 2)?

Question 6: What is the CRUDE RATE of liver cancer in Australia?

Question 7: What is the CRUDE RATE of liver cancer in New Zealand?

Question 8: What is the CRUDE RATE of liver cancer in China?

Question 9: What is the CRUDE RATE of liver cancer in Canada?

We will repeat the above exercise for MELANOMA of SKIN, to see if we find the same patterns of disease. At step 3 of the procedure above select MELANOMA of SKIN rather than LIVER and click "Execute". This will bring up a table similar to that at step 5, but this time for Melanoma.

Look at the FIRST THREE ROWS, marked "World", "More developed countries", "Less developed countries".

Question 10: Do more males get melanoma in More developed countries or less developed countries?

Question 11: Now look at the CRUDE RATE of melanoma in More developed countries and Less developed countries. Are they very different or quite similar?

Question 12: Now look at the ADJUSTED RATE of melanoma (ASR) in More developed countries and Less developed countries. Are they very different or quite similar?

Now we'll look at the whole table.

Question 13: Which male population has the HIGHEST NUMBER OF MELANOMA CASES in the world? Does this country also have the highest CRUDE rate of DISEASE (column 2)?

Question 14: Which population has the LOWEST NUMBER OF CASES in the world? Does this country also have the LOWEST CRUDE rate of DISEASE (column 2)?

Question 15: What is the CRUDE RATE of melanoma in Australia?

Question 16: What is the CRUDE RATE of melanoma in New Zealand?

Question 17: What is the CRUDE RATE of melanoma in China?

Question 18: What is the CRUDE RATE of melanoma in Canada?

Conclusions:

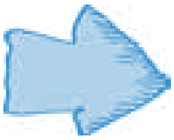
You have now studied TWO different types of cancer. You can see that they occur at very different rates in different populations. This is because the two types of cancer have different causes. Liver cancer is caused most commonly by a virus (the hepatitis B virus) which is very common in some parts of the world. Melanoma is caused by exposure to sunlight, but really only affects people with fair skin. The highest rates are found in sunny countries with many fair-skinned people (such as Australia and New Zealand).

FURTHER WORK

You might wish to repeat Investigation Two for females rather than males. Find a way to report your results for both genders.

INVESTIGATION THREE

Collecting and analysing information in a field survey



You will need

Data collection form

This investigation is best done in pairs.

The aim of this investigation is to look at how EPIDEMIOLOGISTS collect and analyse information to learn more about people. Suppose we want to protect people from the harmful burning effects of the sun. Before we can plan our health campaign, we have to know more about the types of people in our population, since different people react to the sun in different ways.

So, we want to know more about the numbers of people in our population who have different types of hair colour, eye colour and freckling. We are going to undertake a **field survey** to gather this information.

Part 1: Data collection

All students should have a **data collection form** for the field survey. Each member of a pair of students will then "score" their partner for hair colour, eye colour and freckles. If classifying any of the three characteristics is difficult, students should just do their best. Once finished, teacher needs to collect all forms.

Part 2: Sorting and collating your data

This activity can be undertaken by different groups in the class. Division into groups depends on how evenly distributed hair colour is in the class. It may be feasible to divide the class into five teams, one to divide up all the forms into the hair colour groups, and four teams to handle the four categories of hair colour.

If this is so, Team 1 needs to group the data on HAIR COLOUR by sorting the forms into 4 piles based on the categories of hair colour:

1. dark brown/black
2. light brown/sandy
3. blonde or white
4. red or orange

Now, Team 1 fills in the cells in the Table 1.

TABLE 1: Number of boys and girls in each group of hair colour

Hair colour	Number of Boys	Number of Girls	Total number of students
dark brown/black			
light brown/sandy			
blonde or white			
red or orange			
Totals			

Question 1: How many students in the class were in each of the groups of hair colour?

Question 2: What FRACTION of students in the class was in each of the groups of hair colour?

Team 1 should hand the forms grouped on hair colour to Teams 2-5. Teams 2-5 need to sort the data forms into those that have "freckles" and those that have "no freckles" and fill out Table 2.

TABLE 2: Number of students in each group of hair colour, by numbers of freckles

Hair colour	No freckles	Some freckles	Total number of students
dark brown/black			
light brown/sandy			
blonde or white			
red or orange			

Question 3: How many students in each of the groups of hair colour had SOME FRECKLES?

Question 4: What FRACTION of students in each of the groups of hair colour had SOME FRECKLES?

Teams 2-5 should now sort the data forms into those that have "blue eyes" and those that have "other colour eyes" and fill in the cells in Table 3.

TABLE 3: Number of students in each group of hair colour, by eye colour

Hair colour	Blue eyes	Other colour eyes	Total number of students	Fraction with blue eyes
dark brown/black				
light brown/sandy				
blonde or white				
red or orange				

Question 5: How many students in each of the groups of hair colour had BLUE EYES?

Question 6: What FRACTION of students in each of the groups of hair colour had BLUE EYES?

Question 7: Which group of students had the HIGHEST FRACTION of BLUE EYES?

Question 8: Which group of students had the LOWEST FRACTION of BLUE EYES?

This is how epidemiologists go about their work. By collecting and analysing information about people, we understand more about what makes people different, and what factors might cause disease.

DATA COLLECTION FORM

TODAY'S DATE: ____/____/____

FILLED IN BY:

CLASS:

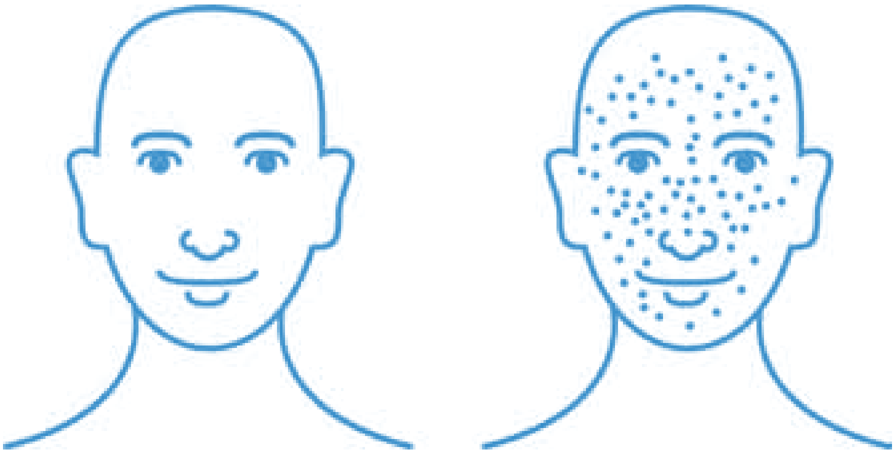
Instructions: Please look closely at your partner. For each of the next three questions, please tick only ONE box! Do your best....

1. What colour is your partner's **HAIR**? *Please tick one box*

❍ Black or Dark brown ❍ Light brown or Sandy

❍ Blond or White ❍ Red or Orange

2. Look at your partner's face. Does your partner have any FRECKLES?



❍ No freckles (or just a few) ❍ Some or Many freckles

3. What colour are your partner's eyes?

❍ Blue ❍ Not blue

SOSE connections

- What would happen if there were no epidemiologists?
- Make a list of questions you would like to ask an epidemiologist who works on mosquito-borne disease. (You may need to consult the internet to find out what diseases are carried by mosquitoes).
- Imagine you are a new disease. What symptoms would you cause in people, how would you spread and what techniques would you use to avoid epidemiologists tracking you down?