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science max

issue 5 • 2003

Chocolate ... why it's good for you

The truth behind the Moon hoax

Sporty science

Make your own slime

Computer-controlled legs?

The science of ear wax

DR SCIENCE, COOL WEBSITES AND MORE!

contents

Cool websites	2
Short shots	3
Weird science: Up to your ears in wax?	4
That cheerful chocolatey feeling	5
Moonstruck: the <i>real</i> Moon hoax	6
Computer-controlled leg kicks a goal!	10
Try this at home: You've been slimed!	12
Science on display: Sporty science	13
Ask Dr Science	14
Puzzle page	15
That's a good idea	16

Congratulations

to the following students who each won a Hasbro® Beyblade® spinning top from *sciencemax* issue 4: Dayne Brookes, NSW; Damon Cuming, Vic; Chris Emary, Vic; Jake Lollback, NSW; David Salter, Qld; Glen Smith, NSW; Lawrence Smith, NSW; Thomas Smith, NSW; Liyala Tuckfield, Vic; Michael Zan, Vic.

Is your class doing something interesting in science?

If you are, we'd like to feature it in *sciencemax*!

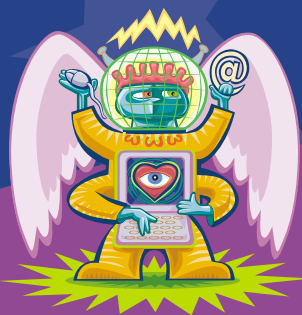
sciencemax is looking for exciting, unusual and fun activities in science classrooms around Australia and New Zealand. *sciencemax* will send a team to photograph your science event or class, and interview teachers and students. We'll devote a double page spread to your great science stuff!

---next issue

Cunning clocks, sharks on the loose and flying like the birds with hang-gliders!
sciencemax issue 5, out June 2003

Go to

www.hi.com.au/sciencemax for the *sciencemax* website! Ask Dr Science online, play with fun interactive games and find out what's on in science museums and centres around Australia.



Cool websites



Interactive spacewalk

http://www.discovery.com/stories/science/iss/i_spacewalk.html
Here's your chance to do some work on the International Space Station. A great interactive activity that lets you be a real, working astronaut!



The history of Pac-Man

http://videogames.gamespot.com/features/universal/hist_pacman/index.html
Wocka, wocka, wocka! One of the oldest and best video games has its own site. Find out all about Pac-Man and his descendents.



The ultimate ungulate page

<http://www.ultimateungulate.com>
Ungulates? Hoofed mammals! Find all about deer, antelope, tapirs, elephants, pigs, horses, camels, llamas, goats, giraffes and even Beecrof's Tree Hyrax!



A bamboo bike? You bet!

D P Mishra, professor at the Indian Institute of Technology, Kanpur, has developed a bamboo bicycle which weighs just 8 kg. His aim was to design a mode of transport that was cheap for rural people to construct, and easily made from material in their villages. According to the *Times of India*, most of the bicycle's body is made of bamboo, and it has 'a horn that blows like a flute'.



Eat your crusts!

Researchers at the German Research Center for Food Chemistry in Garching have found that bread crusts are truly more healthy than the bread they surround. Levels of a particular anti-oxidant (pronyl lysine) were eight times higher in the crust of bread than in the centre, the researchers reported. Anti-oxidants are well known for their cancer-fighting properties, so eating your crusts may not make your hair curly, but they may help to keep you healthy!

Drunk elephants

Beer-loving wild elephants are causing trouble in the north-eastern Indian state of Assam. The elephants have been trampling crops, breaking down fences and crushing huts in the search for their favourite drink. Rice beer is traditionally brewed in the tea garden areas of the state, and the elephants love it. No injuries have been reported, but local rangers say that the elephants have been very destructive both before and after getting drunk.



The lava lamp moon

NASA's Galileo spacecraft has spotted something interesting while orbiting Jupiter's moon Europa. The moon is acting like a giant lava lamp. Giant red spots are appearing and disappearing on the surface of the icy moon. Scientists suspect that this is the sign of warmer ice rising from below, perhaps carrying material from deep beneath the surface. They even wonder if organisms living in the deep warmth aren't hitching a ride to surface!

Weird Science

Up to your ears in wax?

Is yours dry, or goopy? Is it tan and flaky, or brown and sticky?

Humans only have two types of ear wax, and you're stuck with yours for life. What kind do you have? 'Rice-bran' ear wax is dry, flaky and a kind of grey tan colour. 'Honey' ear wax is goopy, gluey and brown. For those of us with honey ear wax, there's smelly news. Scientists have just linked wet and goopy ear wax to wild and smelly body odour.

Body odour is produced by bacteria. They chow down on your sweat, and produce some really foul-smelling waste. That's right—body odour is caused by bacteria poo! Your sweat doesn't smell at all!

Most of the thousands of sweat glands on your body produce clear salty sweat that bacteria don't like to eat. However, the sweat glands under your armpits produce a thick and milky sweat that bacteria just love to munch. These glands are called *apocrine glands*, and unless you wash pretty regularly, any place with apocrine glands can soon begin to stink.

Another place you'll find apocrine glands is in your ears. The apocrine glands in your ears help to produce ear wax. But what is ear wax exactly? Well, for a start it's not even wax. It's made up of dead skin, sweat, oil and stuff called *ceruman* that oozes from your apocrine glands. Scientists have discovered that people whose apocrine glands help to produce honey ear wax also seem to produce extra smelly sweat. Scientists are now using these links between your ear wax and your armpits to look for new ways to fight body odour.

But hang on!

If apocrine glands attract bacteria and bad smells, why don't your ears smell bad? Your ear wax is acidic, and bacteria don't like to grow in acidic places. Does this mean you can use ear wax instead of deodorant?!

WAX FACTS

- In Japan women with wet ear wax are more susceptible to breast cancer than those with dry wax, suggesting an association. In the future a swab of ear wax may be used to easily reveal a person's genetic susceptibility to breast cancer.
- Ear wax protects your ears by trapping dirt, bugs and bacteria in its stickiness.
- Ears clean themselves, and your ear wax will just drop out of your ear in little bits. If you remove your ear wax, your body just produces more and more to fill the gap.
- Some of the nerves that give you feeling in your throat are actually located in your ear canal. This means that excess ear wax can start to irritate the nerves, giving you a tickle in your throat, or even a cough!

... people whose apocrine glands help to produce honey ear wax also seem to produce extra smelly sweat



by Cristy Burne

A fascination for the magic of science led Cristy Burne to study biotechnology. She graduated from Murdoch University in Perth and now works as a science communicator for Questacon.

That cheerful chocolatey feeling

by L E Ohman

Charlie put the mug to his lips, and as the rich warm creamy chocolate ran down his throat into his empty tummy, his whole body from head to toe began to tingle with pleasure, and a feeling of intense happiness spread over him.

Charlie and the Chocolate Factory, Roald Dahl

Chocolate contains about 300 chemicals, some of which interact with the brain's 'feel good' systems.

Almost everyone likes chocolate. The average Australian eats about 7.5 kilograms a year. And when we want it, nothing else will do!

Why is chocolate so good?

It could be that luscious melt-in-your-mouth sensation. Cocoa butter, the main fat in chocolate, is solid at room temperature, but has a very low melting point. Chocolate is one of the few foods that melt in your mouth, giving it that delicious thick, silky texture.

Another reason chocolate is so appealing may be that it makes us feel good. Chocolate can increase pleasant feelings, reduce stress and give a sense of well-being—not bad for a sweet!

It's all in your head

The brain tells us when we feel good. It produces chemicals that make us happy and satisfied. Chocolate contains about 300 chemicals, some of which interact with the brain's 'feel good' systems.

But recent research has turned up a chemical made in the brain and found in chocolate that may hold the key to why we crave the sweet. It is called *anandamide*.

Chemical bliss

The name comes from the ancient Indian word *ananda*, meaning 'bliss'. Anandamide relieves pain, helps us relax and generally improves mood. Though the brain makes anandamide, we don't feel happy all the time because the chemical is broken down and inactivated very quickly. But chocolate not only contains anandamide, it also contains substances that slow the chemical's breakdown, so we can enjoy its mood-improving effect longer.

So go get yourself some chocolate and 'enjoy'!



L E Ohman is a psychologist and physiologist who writes about the brain and other topics in science.

Moonstruck: the *real* Moon hoax



by KEITH BURROWS

... radioactive testing has shown that the Moon rocks are older than any rocks on Earth



Moon rocks from Earth?

Did Neil Armstrong and Buzz Aldrin really land on the Moon in 1969? No way! It was all faked by NASA! That's the story according to people like Bill Kaysing, a 'Moon Hoax Investigator'. Several websites and even TV programs claim that it was all a clever plan by the USA to make it look as though they had won the race to the Moon. These 'investigators' ask us to question the evidence. Fair enough. All good scientists should question evidence, particularly when extraordinary claims are made. But of course this applies to the claims of Moon Hoax Investigators too!

Moon rocks

If we really wanted to question the Moon landings, where is the obvious place to start? The astronauts say they brought many kilograms of 'Moon rocks' back to Earth. If we had not gone to the Moon then these rocks *must* be fake. Hundreds of scientists from many nations have painstakingly examined these rocks in minute detail and not one has said that they were faked! In fact, the rocks have been found to be quite different from anything that exists on Earth. For example, all earthly rocks include minute traces of water in their minerals. The Moon rocks, however, show no evidence of water at all. This was a surprise to the geologists who studied the rocks and it would have been incredibly difficult to artificially manufacture such rocks. Besides, radioactive testing has shown that the Moon rocks are older than any rocks on Earth (since the Moon is smaller, it cooled and solidified more quickly).

HOAX

According to one scientist who examined the rocks: 'If you believe NASA has the technical ability to make fake Moon rocks, going to the Moon is a piece of cake in comparison.' Interestingly, the TV program did not even mention the rocks—surely the most obvious evidence to question if you really believe the whole story was a hoax!

What about that flag?

The 'investigators' are sure that the flag the astronauts planted on the Moon was actually fluttering in the breeze—something it definitely shouldn't do on the airless Moon. The flag is apparently shown waving immediately after the astronaut tried to plant its pole in the ground. In fact, this neatly demonstrates just the *opposite* of the claim made by the 'investigators'. The reason it continued to wave back and forth after the astronaut let go was that there was *no* air to slow it down. Galileo could have told the 'investigators' that in the absence of a force (*air friction* in this case) motion will continue! Unfortunately, this lack of understanding of basic scientific principles is common in the claims of the 'Moon Hoax Investigators'.

What about the dust?

'All right then', the 'investigators' argue, 'what about the dust?' They say there's no evidence of a blast crater, or of stirred-up dust, under the lunar lander. Sorry, wrong again, 'investigators'. They've ignored two obvious scientific facts: the Moon has no air, and the force of gravity is only one-sixth that on Earth. Because there is no air, the rocket exhaust streams out into a vacuum in all directions; it's not confined by the air pressure around it as it is on Earth. The much lower gravity, as well as the relatively light weight of the lander, also meant that the rocket engine was quite low powered—nothing at all like the rockets we are used to seeing blast off from Cape Canaveral. As for the lack of dust, again it's the lack of air! Any dust stirred up does not get caught in air currents and float to the ground; it simply flies straight off and lands a long way away.



Flapping flag?

What about the photos?

'Okay, what about the Moon photos?' the 'investigators' cry. 'They're obvious fakes.' Not likely! Many photographic experts have studied and verified the photos, giving them the thumbs up.

The photo here shows some of the details of the lander and the astronaut that are in the shade. The 'investigators' say that we shouldn't be able to see anything in the shade because there is only one light source on the Moon—the Sun—and there are no clouds or sky to provide 'fill-in' lighting. If you've ever walked on a sandy beach in bright sunlight you will realise how crazy that claim is. A lot of light is reflected off the sand. In just the same way, much light was reflected off the lunar surface to illuminate the parts of the picture that were not in direct sunlight. Anyway, careful processing of the images would have been used to enhance the dark portions of the photo. If that was faking, then it was done to improve the quality of the picture, not to deceive us!



Studio lighting or moonlighting?

radioactive testing

When rocks first form from molten material, traces of elements such as uranium are 'frozen' into place. Uranium very slowly decays, giving radioactive particles and 'daughter' products (new elements). By looking for these products and comparing them to the amount of uranium left, scientists can estimate the age of the rocks.

gravity

The force of gravity exists between any two masses, but it is only strong enough to affect things if one of them is very big—like the Earth. The force of gravity not only holds us to the Earth, it holds the Moon in orbit around the Earth. Because the Moon is so much smaller than the Earth, the force of gravity between an astronaut and the Moon is only one-sixth that on the Earth.



The 'investigators' hold up other pictures showing shadows that were not parallel, as you might expect from the Sun. They're absolutely convinced that studio conditions would have been needed to create the effect of a black sky. They extend the lines of the shadows back towards the light source to suggest that the light source was actually close to the set. But hold on a second! Have you noticed that if you look at a photo of a tall building taken from ground level the sides of the building are not parallel? As in any picture, the rules of perspective mean that parallel lines often do not look parallel in a photo. This is particularly true if the lines are shadows on sloping ground, as was the case in the Moon photos!



A simple photo using models, showing the apparently different directions of shadows on sloping ground.

Our 'investigators' have dozens of points that they say proves that NASA faked the Moon landings. All of them can be *disproved* with some clear thinking and good science. Still, lots of people were convinced of the claims. What do *you* think we can learn from all this?

Computer-controlled leg kicks a goal!

by Elaine Downie

Imagine waking with a painful leg on Monday morning, being X-rayed the same afternoon, and having your whole leg amputated by Thursday night! Sounds like a nightmare? This is just the nightmare that Paul Stoney experienced in real life when a deadly tumour was found in his right leg 20 years ago when he was only 19.

... the leg just fine-tunes itself as the person walks.

If the loss of a leg wasn't bad enough, within 6 months he was involved in a car accident, smashing up his other leg,

arms, spine, ribs and head. Instead of studying for his chosen career, he spent those 4 years in and out of hospitals, recovering from 27 operations.

Not surprisingly, Paul became very interested in medicine, healing and prosthetics.



In the knee joint of the C-LEG is a powerful microprocessor (computer chip). Four sensors in the knee and ankle joint measure movement and angle changes. The sensors send these measurements to two microprocessors and the hydraulic knee joint makes adjustments via valves, controlled by a software program built into the computer chip. Readings are taken every 0.2 seconds. The leg is powered by a rechargeable lithium-ion battery, which can provide up to 35 hours of energy. The leg needs to be recharged each night.

What is prosthetics?

Prosthetics is the science of creating artificial spare parts for our bodies. Paul Stoney is a prosthetist—an artistic engineer who makes legs and arms for people who, just like him, have had a limb amputated through accident or disease.

Paul has been making his own artificial legs for the past 10 years, until just recently when he acquired the 'Rolls Royce' of legs—the C-LEG.

Latest leg

Gone are the days when artificial legs looked like wooden pirate peg legs. The C-LEG is a sophisticated, computer-controlled prosthetic leg made in Germany.

'The C-LEG is fantastic,' says Paul, 'I can walk much faster and smoother. I can speed up and slow down much quicker than with my old leg.'

The key to the smoothness and faster responses is that the C-LEG fine-tunes itself as it is used. This ability to quickly adapt to a particular person's way of walking represents a huge advance in artificial legs.

Most people with a full prosthetic leg find it very difficult to go up and down stairs or along ramps without losing their balance. The knee joint, which is a bit like a door-closer, cannot adjust quickly enough to sudden changes in speed and direction. There is every chance that the person will stumble.

With the C-LEG, however, the changes needed for walking on different surfaces are programmed in for each individual. From then on the leg just fine-tunes itself as the person walks.

How the leg works

As the leg 'walks', powerful sensors measure huge numbers of angles and forces on the leg and foot, and compare them to a data bank of values stored in the computer chip. It then adjusts itself accordingly.

Artificial legs can come with a cover of soft foam material of skin colour, but this is just for cosmetic purposes. It is the strength and design of the main structure inside that is really important.

Autoclaved carbon fibre is used in the main part of the C-LEG. This is the same material used to build Formula One racing cars. And the price is not much different from buying a car either—at least \$45 000!

At school, before his amputation, Paul had been a keen runner and cyclist. Today he still rides 100 km a week. However, when riding, he chooses to either not wear the leg or turn it off. This is because it makes it more difficult to balance.

'If the leg had to do all the work of riding, its little microprocessor and knee joints would probably wear out too fast ... then I'd need to find another \$45 000 for a new one,' says Paul. 'And, besides, it wouldn't do to have a blow-out on the freeway!'

He's talking about the leg, not the bike.



Paul Stoney teaches in the National Centre for Prosthetics and Orthotics at La Trobe University in Melbourne. This is the main training place for prosthetists in the Southern Hemisphere. The course takes 4 years to complete.

sciwords

gait Pattern of walking.

lithium-ion battery Small battery suitable for computers, which produces more electricity than other batteries of its size. Can be rechargeable.

microprocessor Tiny computer chip 2 cm x 1.5 cm that runs software programs.

autoclaved Sterilised in steam.

hydraulic Transmission of energy in machines by fluids like water or oil.

carbon fibre New material, similar to fibreglass but stronger. Contains a carbon 'mesh' embedded in a thick fluid that can be moulded, but will set on contact with air.

Elaine Downey has been a science teacher for 15 years. She is crazy about medical science, microbes and music.

try this at home

by Samantha Lucia



You've been slimed!

Snails slide around on it, it dribbles out of your nose when you have a cold and it lines your stomach to stop gastric acids dissolving your insides. SLIME ... gooey, grungy and gross! What is it, and how can you make your own?

What you need:

- 2 cups cornflour
- 1 cup water
- food colouring (if you like)
- bowl
- wooden spoon

What to do:

Place cornflour in the bowl!

1



2



Add 2 or 3 drops of food colouring.

3



Slowly stir in water, mixing well with the wooden spoon.

First, what is slime?

Place your spoon in the slime mix and scoop some of it onto your spoon.

Then lift the spoon, with its slime, about 20 cm above the bowl and let it fall back into the bowl.

The slime should flow back into the bowl, without any real shape. It doesn't flow in squares or triangles; it pretty much just falls in a stream. Once it's back in the bowl, the slime takes on the bowl's shape. So, like tomato sauce and honey, slime is a liquid.

Now what?

Place the slime-filled bowl on a table, or get a friend to hold it for you (tightly).

Pretending you're a boxer, give the slime a quick punch. Quickly hit the slime and then pull your hand out as fast as you can (be careful not to hurt yourself). You'll find that your hand is perfectly clean; the slime hasn't stuck to your hand.

Now, pretend you're a boxer in slow motion, and punch the slime really slowly all the way to the bottom of the bowl, then slowly out again. This time the slime has stuck to your hand and it's probably dripping from your fingers to the floor.

By hitting the slime really quickly, the cornflour in the slime hasn't got time to travel through the water and stick to your finger. It's a little like running on wet sand—your feet stay fairly clean, as the sand can't travel through the water fast enough to stick to you.

When you slowly hit the slime, the cornflour in the mixture has enough time to travel to your hand and stick to you. Just like when you stand on wet sand, the sand has time to travel through the water and stick to your feet.

Try this:

Place your spoon in the slime, making sure the spoon reaches the bottom of the bowl.

Pretending you are in slow motion, mix the slime as slowly as possible.

Now, keep stirring, except this time pretend you are in fast motion and stir the slime as quickly as you can. You'll find that it's almost impossible.

That's because slime is a stir-thickening fluid. The faster you stir it, the thicker and harder it becomes.

Presto, you've got slime! Now what to do with it, other than throw it at your little sister? You can always experiment with it, and work out its weird properties.

Hints

- Do this outside, as it can be quite messy.
- You may need a little more water if it's a really hot, dry day, as the cornflour naturally dries out. If it's a really humid day you may need a little less water. Add the water slowly until you have a thick pasty mixture a little thicker than cake mix.
- If the slime gets into the carpet, let it dry and vacuum it out.

Facts

- Unlike slime, water and toothpaste are stir-thinning fluids. So, the faster you stir or mix them the thinner they become. Imagine if toothpaste were a stir-thickening fluid, like slime—you'd end up with your toothbrush stuck on your teeth all day!
- Liquid—a substance that flows and takes on the shape of the container that holds it.

Sporty science

Before starting any form of exercise, your heart is pumping 5–6 litres of blood around your body every minute. But as you start exercising, your exercising muscles become hungry for more oxygen. To cope with the greater demand for blood, your body increases its blood flow from 5–6 litres/minute to a whopping 30–40 litres/minute! So how does it manage to do this?

The amount of blood pumped around our bodies depends on how fast our heart can pump blood (heart rate) and how much blood can be pumped with each heartbeat. We are all aware that our heart rate increases with exercise, but the speed at which our hearts can do this is amazing. Just 1–2 seconds into your daily exercise routine, your heart rate jumps from its resting value (around 60–70 beats/minute) to 100 beats/minute. It then takes just another 10–20 seconds for your heart rate to jump up to top speed (see box).

Top speed or maximal heart rate can be calculated as (220 minus your age) beats/minute.

Combined with this increase in heart rate is a boost in the volume of blood pumped with each heartbeat. To 'pump up the volume' our heart muscle not only pumps harder but it also receives more blood to pump. A greater volume of blood is returned to our heart by the squeezing action of our breathing and running muscles. In other words, each time we take a step and a breath we are helping to return more blood to the heart. So keep in mind that with every breath you take and every move you make, you are helping your heart, which in turn is helping your body to keep on going!

Sports Quest exhibits are a feature of the Earth, Body and Beyond display at the Investigator Science Centre, Adelaide, until the end of January 2003.



What's on

Awesome Earth and **Sideshow** are currently featuring at Questacon, Canberra.

Space and the **A to Z of Collecting** are running at Scienceworks, Melbourne.

Speed: Science in Motion is the highlight exhibition at the SciTech Discovery Centre in Perth.

The Queensland Sciencecentre is moving to exciting new premises, opening August 2003!

Lucy Andrew is the Project Coordinator at the Investigator Science and Technology Centre in Adelaide.

ask dr science



Got some science stuff that has you stumped? Ask Dr Science!

Dear Dr Science,
Some days I can see the Sun and the Moon in the sky at the same time.
Why?

Jaime Walsh, VIC

Dear Jaime,
Whoa, another two-part question here! You guys are really getting value out of Dr S!

First, you really want to know why you can see the Moon in the daylight sky when the Sun is so bright. The second part is what's the Moon doing there at all? Doesn't it belong in the night sky? Okay, here we go ...

Number one—have you ever gone outside on a clear night when the full moon is shining? Notice how light the landscape is? That tells us that the Moon is REALLY BRIGHT! Even though the Moon is just shining because it reflects the Sun's light, it's still brighter than anything else in the sky. Apart from the Sun, of course. So, if it's in the daytime sky, it stands out fairly well.

Number two—what's the Moon doing up there in daytime? It's got a lot to do with the way it moves around the sky. It takes about 29 days for the Moon to move around the sky. Around full moon time, the Moon is just about directly opposite the Sun, so it's rising at the time the Sun is setting. So it's not in the sky at the same time. After that, the Moon gradually moves eastwards, night after night, until it looks like it's quite close to the Sun—around new moon time. That's the time when you can see it in the daytime sky—when it's rising close to the Sun. Gradually, day after day, it moves apart from the Sun again until it's rising in the night-time sky again.



Dear Dr Science,
Which is colder, the North Pole or the South Pole?
Anthea Hammond, WA

Dear Anthea,
The South Pole rules. Not many people realise that there's no land at the North Pole. It's just a giant chunk of ice. In fact, submarines can sail right under the North Pole. The South Pole, on the other hand, is a real continent. It even has mountains. 'Why is this important?', I hear you ask. Just stick with Dr S, and all will be revealed. You see, because the South Pole has mountains and is higher, more elevated, it's basically colder. The North Pole, being mainly ice, is mostly at sea level, and just that little bit warmer. The lowest temperature ever recorded was -89.2°C at Vostok, Antarctica, in 1983. Some cold snap!

Dear Dr Science,
What does geothermal mean and what are its uses?
Leonie McCarron

Dear Leonie,
It's Latin, Leonie. Geo means 'earth', and thermal basically means 'heat'. Geothermal = earth heat, right? And geothermal energy is one of the—excuse me—hot topics in low-pollution power at the moment.

You see, the temperature at the Earth's core is about 7000°C . Luckily for us, this drops off closer to the Earth's surface. But in some places, the heat is close enough to use in some really clever ways. Where there are underground hot springs, this water can be piped up to heat buildings. If there's no water, pipes are laid through the hot rock and water is pumped through. The result is a flow of good, hot water. Sometimes, this water can be hot enough to make steam, which can then be used with turbines to generate electricity.

Geothermal energy is very kind to the environment. No CO_2 , no smoke, no fuss—and it's not going to run out soon, either. Not like the hot water at my place...

Computer-controlled leg kicks a goal!



Spot the difference

Can you find ten differences between these pictures?



hydraulic

autoclaved

battery

carbon

gait

microprocessor

lithium

medicine

Germany

prosthetics

sensors

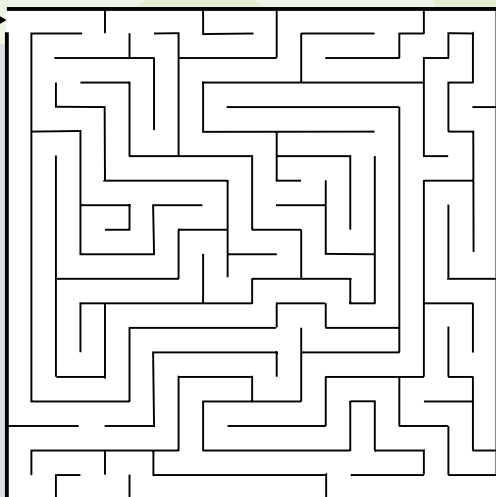
artificial



True science stuff

Help Albert find his way home!

Albert Einstein loved to think while he was out walking. The trouble was, he often thought so deeply that he could get lost even in his own neighbourhood. His usual response was to walk up to someone and say, 'My name is Albert Einstein. Can you tell me which house is mine?'





THAT'S A GOOD IDEA!

with Professor Tess Tube!

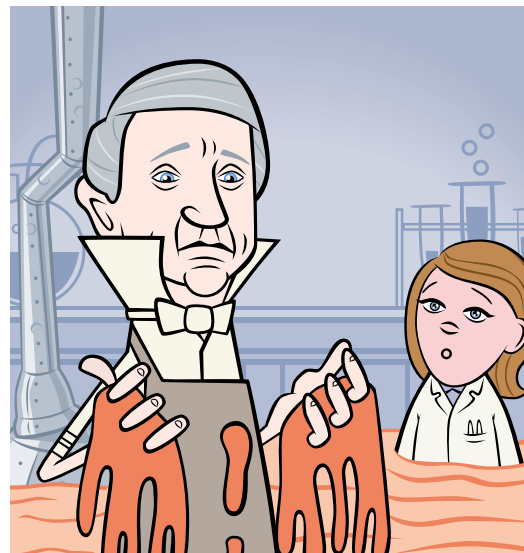
BOUNCING INTO RUBBER



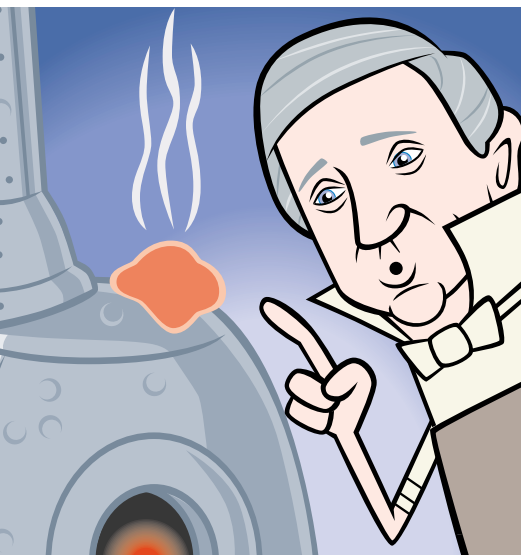
1 In the 1830s, natural rubber was brought to America and Europe. It quickly became a hot item and everyone wanted it for its bouncy, waterproof qualities.



2 But natural rubber melts easily in hot weather, and goes hard and brittle in cold weather. In the USA, Charles Goodyear set out to change this by adding substances to raw rubber.



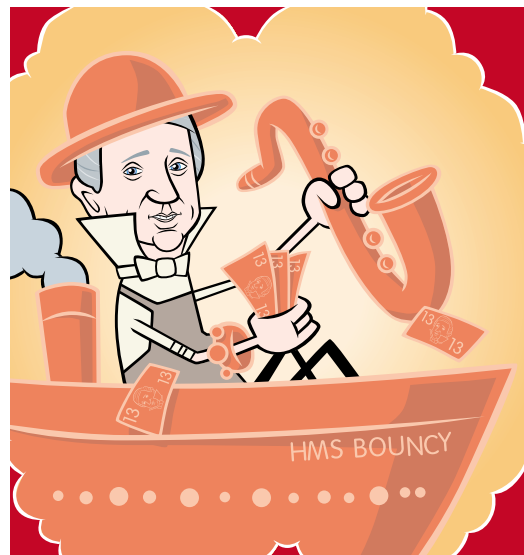
3 After adding nitric acid, Goodyear improved the texture of rubber. However, his first contract for mailbags for the US Post Office was a disaster and hot weather left him with 150 melted mailbags.



4 Goodyear battled on, and was jailed several times for owing money. The turning point came after he added sulfur to his rubber compound. When demonstrating this to potential customers in a store, a glob landed on a hot stove.



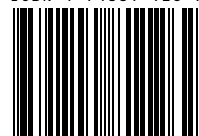
5 Goodyear noted that the rubber with sulfur 'cooked' but was still springy. After months of experimenting he worked out that adding sulfur, then steaming the rubber under pressure for 4-6 hours at a temperature of 120-150°C gave the perfect result. He had invented vulcanised rubber.



6 Goodyear didn't stop there. He imagined many uses for rubber, such as hats, bank notes, musical instruments, jewellery and ships! He even had his portrait painted on rubber.

Vulcanisation (heating and adding sulfur) makes rubber more stable because the long molecule chains in rubber are made stronger by sulfur cross-linking the chains. Because they're linked, they don't flow past or around each other when the rubber gets hot. And the rubber doesn't get hard and brittle when cold because the molecules can't be broken apart easily.

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- Move your elbow joint in as many directions as possible. How does it compare with the shoulder joint? With a knee joint? Examine the skeleton again and draw the bones being connected at the elbow in the arm, and at the knee in the leg.
- Now compare ankle and wrist joints for range of movement. Have another look at these joints on the skeleton. Why do you think these two joints are able to make such a variety of different movements?

Find out the names of the bones in the arm and the leg.

Plaster and paint

Before a prosthetist can make a new body part, they make plaster casts to get an accurate fit. Then, if it is for something like a nose or ear, the colour must be carefully matched.

Mix up plaster of Paris and make a cast of the top of a friend's hand. Make sure the plaster goes down the sides of the fingers so that this will be a record of the size and shape of the hand at this age.

When the plaster is dry, paint the hand and nails with water or oil paints to make it look like a prosthetic hand.

- How does the colour of the hand compare with the original?
- What surprised you most about matching colour?

Research

Prosthetic body parts

Apart from prosthetic arms and legs, what other types of prostheses can be made today?

- Investigate one of the following: eyes, ears, noses, fingers, heart valves, hips.
- What types of new materials are used for these?
 - How is the material coloured to match the person (if it needs to be)?
 - What kind of artistic training is involved?
 - What is the process used to design a prosthesis to match the one that has been lost or damaged?
 - What kinds of accidents or diseases can cause a person to need the prosthesis?

The history of amputation

Investigate one of the following changes to surgery over the past 200 years and how it has helped with improving the surgery of amputation. Make sure you give a good definition of the topic chosen:

- Antiseptics
- Anaesthetics
- Development of antibiotics
- Microsurgery



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SHORT SHOTS

sciencemax • page 3

Curriculum area

- Biological science/Living world
- Chemical science/Natural and processed materials
- Earth and space science/Earth and beyond, Working scientifically
- Level 4–5/Stage 4

Activities

- 1 Much work has been done lately in providing low-cost, environmentally friendly technologies for developing countries.
 - a Research the following:
 - Clockwork radios
 - Semi-permeable water filters
 - Solar ovens
 - b Design a car by using low-cost, environmentally friendly technologies like bamboo.
- 2 For more information on Asian (Indian) elephants—including their working lives—go to:
 - www.thebigzoo.com/Animals/Indian_Elephant.asp
 - www.bbc.co.uk/nature/wildfacts/factfiles/178.shtml
 - www.india-emb.org/Section17E/Engl2E.html
- 3 Why not try a lunchbox survey? All class members should note the contents of their lunches for one week. At the end of the week, pool these results and graph them via a spreadsheet display using presentation software like PowerPoint. Alternatively, present it as a poster.
- 4 A good background article on Europa is available at the home of the Galileo spacecraft:
 - <http://galileo.jpl.nasa.gov/moons/europa.html>
 Terrific animations and pictures of Europa can be found at: www.solarviews.com/eng/europa.htm

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Contents

Short shots	1
Weird science: Up to your ears in wax?	2
That cheerful chocolatey feeling	3
Moonstruck: The real Moon hoax	5
Computer-controlled leg kicks a goal!	7

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Weird Science

Up to your ears in wax? **sciencemax**

Curriculum area

- Biological science/
Living world, Working scientifically
- Level 6/Stage 5

Background information: Mendelian inheritance

Ear wax is inherited in a classically Mendelian style. This means that:

- A single gene controls your ear wax type.
- This gene is made up of two parts, called alleles; one allele comes from your mother and one from your father.
- Each allele can only code for one type of ear wax, either 'honey' or 'rice-bran'.
- One allele is dominant (honey) and one is recessive (rice-bran).

Every person has two alleles that make up their ear wax gene. If just one parent contributes the dominant 'honey' allele, you will inherit honey ear wax. This is because the 'honey' allele overrides the 'rice-bran' allele.

Even if you have one rice-bran allele on your ear wax gene, you'll still have honey ear wax. The only way you can inherit the recessive rice-bran ear wax is if both of your parents contribute rice-bran coding to your ear wax gene.

For example, consider two parents who each have one honey (H) allele, and one rice-bran (h) allele. Both parents have honey ear wax because the honey allele overrides the rice-bran allele. The grid below shows the possible allele combinations their children could inherit, and the type of ear wax they could have.

	Father H	Father h
Mother H	HH (honey)	Hh (honey)
Mother h	hH (honey)	hh (rice-bran)

Activity

- 1 Draw up a grid to show the allele combinations a child could inherit if:
 - One parent has two rice-bran alleles and one parent has one honey and one rice-bran allele.
 - One parent has two rice-bran alleles and one parent has two honey alleles.

- 2 Tongue rolling is a classically Mendelian trait. The 'can roll' allele is dominant. The 'can't roll' allele is recessive. Draw up a grid to show the possible allele combinations, and your ability to roll your tongue if:
 - One parent has one 'can roll' and one 'can't roll' allele, and the other parent has two 'can't roll' alleles.
 - Both parents have one 'can roll' and one 'can't roll' allele each.

Research

What are some other characteristics that are inherited in this way? Who was Gregor Mendel? What did he study?

Survey

Design and carry out an ear wax survey. You could survey your family's ear wax type. At no time place anything in anyone's ear. Permanent damage can result if you do. Are there any patterns in ear wax type inheritance?

Resources

For some student-friendly information on ear wax and its benefits go to <http://kidshealth.org/kid/talk/yucky/earwax.html>

For more teacher-oriented facts on the ear wax link to apocrine glands go to http://www.eurekalert.org/pub_releases/2002-06/l-log053102.php

Some great lesson plans on Mendelian inheritance can be found at http://web.clas.ufl.edu/users/rhatch/pages/05-SecondaryTeaching/NSF-PLANS/4-5_SCIENTIF.htm

This research was conducted by Dr Hiroaki Tomita and team at the University of California Irvine. The relevant paper is: Mapping of the wet/dry earwax locus to the pericentromeric region of chromosome 16. *The Lancet* 359(9322), 8 June 2002, 2000–2002.

Computer-controlled leg kicks a goal

Curriculum area

- Physical science/Energy and change
- Biological science/Living world
- Chemical science/Natural and processed materials, Working scientifically
- Level 4–5/Stage 4

Activities

Walking patterns

You need a video camera for this activity.

- 1 Look at the diagram, which shows how we walk.
- 2 Work with a partner and video about five steps of their gait (walking pattern) from the side view.
- 3 Take still photos with the video camera at each of the three stages, showing how the person walks.

- 4 Repeat for the other person and compare each other's gait.
- 5 If time permits, video each other (including stills) again to find the stages used in running.
- 6 Draw up a diagram for running similar to the one for walking.

Joints

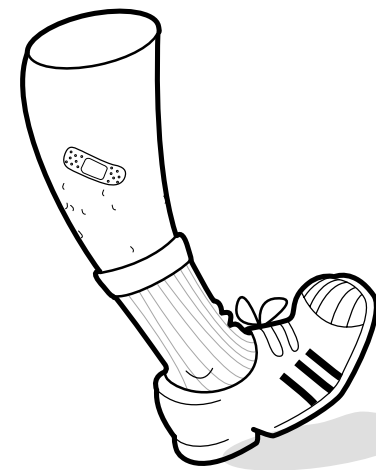
Joints give the body specific movements. You will need the school skeleton to complete this activity.

- Swing one of your arms around in as many directions as possible. Go to the skeleton and repeat the action. Describe and draw the kind of joint that will allow this large range of movement. What is this type of joint called?

Walking patterns (gait)

As a person walks, there are three main stages:

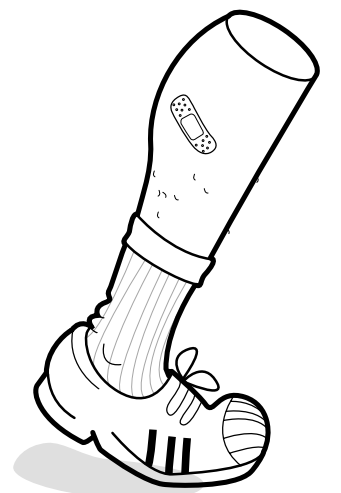
- 1 First the foot hits the ground with the heel ('heel strike').
- 2 Then the foot takes the full weight of the person ('foot flat').
- 3 The last stage is when the heel comes off and the ball of the foot pushes on the ground to lift the leg up to take a forward step ('propulsion').



1 heel strike



2 foot flat



3 propulsion

continued ... p. 8

That cheerful chocolatey feeling



Curriculum area

- Biological science/Living world
- Chemical science/Natural and processed materials, Working scientifically
- Level 4–5/Stage 4

Background information

The Swiss are the biggest chocolate consumers in the world, enjoying 10.1 kg per person a year (in 2000). A recent Dutch study found that Switzerland was the happiest country in the world—you have to wonder...

In 2000, the top five chocolate-consuming countries in the world were Switzerland, Austria (9.1 kg/person), Ireland (8.8 kg/person), Germany (8.2 kg/person) and Norway (8.1 kg/person).

Over the years chocolate has developed a bad reputation. It has been associated with a number of evils such as acne and tooth decay, but there is no evidence to back these claims. Chocolate neither causes nor aggravates acne. Studies of students with mild to moderate acne showed that eating chocolate had no effect on their acne condition. In fact, acne may not even be linked to diet. The sugar in chocolate does contribute to the development of cavities, but no more than the sugar from other foods. Poor dental hygiene is the primary cause of tooth decay.

Chocolate may actually help prevent cavities. Cocoa butter coats the teeth and may protect them from plaque formation.

Chocolate may also help us stay healthy. Cocoa beans are rich in antioxidants called flavonoids. Consumption of other flavonoid-containing foods such as red wine and tea is correlated with a reduction in cardiovascular disease.

To learn more about anandamide, its effects on the brain, and the brain–chocolate link see www.sciencenews.org/sn_arch/10_12_96/food.htm

Experiments using chocolate to demonstrate volume, mass and density, changes of state and kinetic theory, and forms of matter can be found on www.flash.net/~wx3o/chp/lab1.htm

The experiments look fairly basic, but may give you further ideas.

Experiment

Hey, what's that white stuff on my chocolate? Find out why bloom, that white mould-like stuff, appears on chocolate.

What you need:

- 6 pieces of the same kind of chocolate or chocolate chips divided into two groups (fat bloom and sugar bloom).
- plastic bag
- small bowl
- plastic container (with a top) that is big enough to hold the small bowl
- water
- paper and pencil

What you do:

Draw a line down the centre of your piece of paper. Label one side 'Fat bloom' and the other 'Sugar bloom'. Then divide each group into two columns and label the columns 'Before' and 'After'.

- In the 'Before' column for each group record:
- the colour and appearance of the chocolate
 - what it smells like
 - how it feels when you run your finger over it

Eat a piece of the chocolate from each group and describe the taste. Describe how it feels in your mouth as you eat it.

Place one piece of chocolate from the 'Fat bloom' group in the plastic bag; this is your experimental chocolate. Place the other piece of chocolate in a cool dry place.

Set the plastic bag in the sun for a few minutes or in a warm place where the chocolate will become soft. Take care that it doesn't melt into a runny liquid.

Move the bag to a cool place where it can sit overnight.

Place a piece of chocolate from the 'Sugar bloom' group in the small bowl and set the bowl in the plastic container. This is the 'Sugar bloom' experimental chocolate.

Pour enough water into the plastic container to cover the bottom, taking care not to get water in the small bowl. Put the top on the container, making sure it is tight, and set the plastic container aside in a cool place.

Place the other piece of chocolate from 'Sugar bloom' group in a cool, dry place.

In the next day or two examine the two pieces of experimental chocolate.

continued ... p. 4

The light in the shadows

This hardly even needs a photo to make the point. Simply place a suitable person-like model on a piece of black paper and light it with a single strong light source. This is preferably done in an otherwise dark room. Look at it, or photograph it, from the shadow side. Now replace the surface by light-coloured paper or similar and look/photograph again. Not surprisingly, the detail in the shadow area is much brighter this time. One has to wonder what the hoaxers were thinking with this so-called revelation!

The waving flag

If the appropriate vacuum equipment is available, it would not be difficult to set up a simulation of this situation. Simply hang something very light from a horizontal support in such a way that it is free to oscillate. Show that it quickly comes to rest. Now repeat the experiment in a vacuum and watch the difference. (You need to be able to shake the container to get the flag waving.) The difficulty is arranging a low-friction support. A piece of tissue paper supported by thin cotton threads is suitable. This can be a good introduction to Galileo's principle of inertia—an object will continue to move unless there is an unbalanced force. The force of friction, or air resistance, is the usual reason for the apparent non-compliance of the real world with Galileo's ideal!

Activity

The assumptions we make

A major theme of the TV program was the lack of a blast crater under the lunar lander and the lack of moon dust. Again, this example can be used to illustrate the problem of the assumptions we tend to make. We are used to seeing the huge exhaust plumes from rockets taking off and imagine the hole they would put in the ground underneath. There are a number of very large differences in the lander situation, however, as pointed out in the article. When considering a new situation we need to be very careful about the assumptions we are unconsciously making!

Students could be given the task of thinking about the unconscious assumptions we make every day. For example, what assumptions do we make about the safety of driving compared to the safety of flying? Are these assumptions backed up by the facts? Astrology is a contentious area. What assumptions are we making when we give opinions about it? Have we tested them? In the western world we make many

assumptions about the way society should work. How justified are they? What are some assumptions that other people make that we would not? What assumptions do we make when watching various TV programs? Are they justified? Perhaps the experience of the TV program in question here has helped us answer that question!

Websites

A search on 'Moon hoax' or similar will produce many sites, most of them not worth a glance! Here are some sites that are worth a look:
http://science.nasa.gov/headlines/y2001/ast23feb_2.htm?list45245

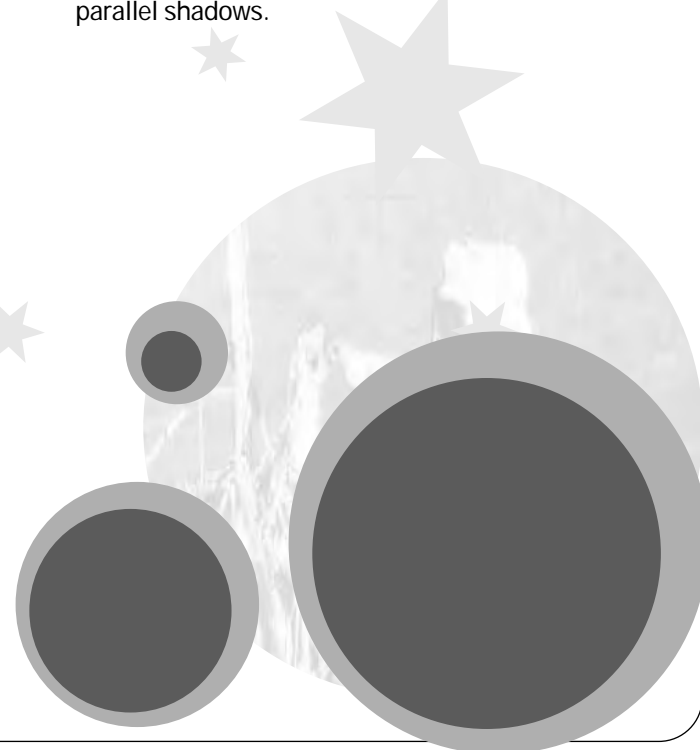
This is NASA's site, which contains both effective rebuttals and links to other good sites.
www.badastronomy.com/bad/misc/apollohoax.html

This site has a list of links to other sites that either support or refute the hoax theory. There is a link to the author's own very detailed site.
www.uwgb.edu/dutchs/PSEUDOSC/ConspiracyTheoryDidWeGototheMoon.htm

This is a good clear site refuting the conspiracy theory. It has a good description of the evidence from the rocks along with microphotographs of the Moon rocks.
http://pirlwww.lpl.arizona.edu/~jscotti/NOT_faked/

A very good rebuttal by an expert. It contains many photographs and links to other sites.
<http://users.erols.com/igoddard/moon01.htm>

This site has good photographs illustrating the arguments about the reflected light and non-parallel shadows.



Moonstruck: The *real* Moon hoax

Curriculum area

- Earth and space science/Earth and beyond
- Physical science/Energy and change, Working scientifically
- Level 4–5/Stage 4

Background

Many students will have seen the Moon Hoax TV program, or perhaps web sites making similar claims. Many of them might have been convinced by such arguments. It is unfortunate, but true, that one of our tasks as science educators has become unscrambling the bad or misleading science that students get from various media sources. This particular issue may be one that we can use to help students understand the importance of not accepting everything they see on TV, or even read in newspapers, and particularly on the Internet.

Activities

Debate: Did NASA reach the Moon?

One of the functions of a debate is to encourage all participants to look at both sides of the case. Although it might seem 'dangerous' to encourage students to question what we believe to be the 'truth', our role is to encourage them to question with openness, not blindly as is all too often the case. We can, in fact, have confidence that the truth will win out in the end! There is no need to find students who actually believe the hoax stories to take the negative side—in fact the reverse could be preferred. All students should be encouraged to look at the evidence on both sides and present it fairly and honestly, that is, in a way which puts the case but doesn't attempt to deceive.

The ideal of a scientific approach is total objectivity. In practice this is extremely difficult; we all have our innate biases towards one point of view or another. The purpose of a debate such as this should be to try to identify our biases, as well as those of the other side, and come to terms with them. If these points are put to the class a debate can be a very constructive experience.

Ideally, it would be a great cross-discipline activity. The participation of the English or Communication teachers would help to dispel the idea that scientists mock these sorts of stories because they are sceptical of everything. Unfortunately you may even find some of your fellow teachers who are prepared to put the other side in this debate!

The hoax photos

The angle of the shadows

It is not hard to take photos that can clearly expose the hoaxers' claims as nonsense. Simply build a model surface on sand, or similar, that includes hills and dales, and place some vertical objects on different parts of the slopes. The photo below was taken this way. Make sure to take a photograph from directly above to show that the shadows are in fact parallel when viewed appropriately. Those with digital cameras or video equipment would be able to do this exercise 'live'. Indeed, simply looking at a scene such as the ones in these photos through a rectangular frame is enough to convince most people of the point.



continued ... p. 6

Compare them to the chocolate pieces you stored in the cool, dry place. Record your observations in the 'After' column. What happened? Compare the experimental chocolates to the ones you stored in a cool place.

- Do they look the same?
- Has the smell changed?
- Has the taste changed?
- Do they feel the same in your mouth?
- Do the chocolates feel the same when you touch them?

Describe the differences between the chocolate in the fat bloom and sugar bloom groups.

Accompanying notes for the experiment

There are two types of bloom, fat bloom and sugar bloom. Both have a white or grey appearance and spoil the look of the chocolate.

Fat bloom

Fat bloom is easy to produce as directed in the experiment. Sugar bloom takes longer to develop. When placed in a moist environment, as described in the experiment, moisture forms on the chocolate overnight, but the white-grey bloom does not develop. However, the moisture on the chocolate is viscous, sticky and tastes sweet, an indication that the moisture has drawn the sugar to the surface. The surface of the chocolate is rough when it has dried, duller than properly stored chocolate, and it feels a bit grainy when eaten.

Fat bloom is easily removed when touched and has a slightly greasy feel. As unappealing as it looks, fat bloom does not significantly alter the taste of the chocolate.

Cocoa butter, a major component of chocolate, is polymorphic, meaning that it crystallises in different forms. These forms vary in melting point and stability. The least stable forms have the lowest melting point.

Bloom forms as the lower melting, unstable fats separate from the body of the chocolate, migrate to the surface and form larger, more stable crystals. Fat bloom occurs when the chocolate is allowed to soften and reharden.

Tempering, an important part of the chocolate-making process, makes the chocolate more resistant to fat bloom. During tempering, the chocolate is slowly heated then slowly cooled with stirring. In this way, the fat crystals become more uniform and solidify in a thermodynamically stable crystal form.

Sugar bloom

Sugar bloom looks similar to fat bloom, but it is not easily removed when touched and has a rough, grainy rather than greasy feel.

Sugar bloom is most often caused by surface moisture. The moisture can be the result of storing the chocolate in a humid environment or by removal from cold storage to a warm place, causing condensation.

The moisture causes the sugar in the chocolate to dissolve. When the moisture evaporates, sugar is left on the surface. The texture of chocolate that has sugar bloom tends to be grainy, but the chocolate is still fit to eat.

Proper storage of chocolate

This should not be an issue, as chocolate should be eaten promptly for immediate gratification. However, should the need arise, store chocolate tightly wrapped and away from pungent odours, as it absorbs flavours and odours from other foods. The ideal storage temperature is 18–20°C with no more than 50–55% relative humidity.

