

FRONTIERS

TAKING SCIENCE WHERE NO MAN HAS GONE BEFORE. BY DANIEL WEISS

THE HIGH-CLIMBER DIET

The secret to reducing your weight may be increasing your altitude - so says a recent study conducted by researchers at Ludwig-Maximilians University in Munich, Germany. Obese subjects who spent just a week living high in the mountains, eating whatever they wanted and forbidden from exercising ended up losing weight - and keeping it off.

"The most interesting result was that after four weeks back at their normal altitude, the subjects still had the same body weight," says Dr Florian Lippl, the gastroenterologist who led the study.

During their week at 2,650 metres above sea level, the 20 middle-aged men in the study consumed on average 734 calories fewer per

day and lost 1.5 kilograms each. Lippl theorises the subjects' reduced appetite may have been due to increased levels of leptin, a hormone that reduces hunger. Participants' increased metabolic rates due to the high altitude also contributed to weight loss. Even after the subjects returned to their normal altitude, they continued to eat less and were significantly more active than before.

Lippl plans to conduct a follow-up study in which subjects will spend time in tents that mimic the low-oxygen levels found at high altitude, which he hopes will offer similar benefits. In the meantime, he advises those who need to lose weight to head for the hills. "I would recommend that obese people spend their holidays in the mountains," he says.

At a whopping 2,962 metres above sea level, this restaurant on the summit of Zugspitze, the highest peak in Germany, may be the ideal eating spot for weight-watchers and the obese.

PHOTO: GETTY IMAGES



CLEAN MACHINE

A newly developed device that sanitises hands with low-temperature plasma could help stop the spread of infections in hospitals. The plasma treatment takes a fraction of the time that washing with soap and water does and penetrates hard-to-reach areas.

"We have tested it against all sorts of bacteria, including those that are resistant to antibiotics, and they were all destroyed in about two seconds of plasma application," says Dr Gregor Morfill of Germany's Max Planck Institute for Extraterrestrial Physics, who developed the prototype sanitiser.

The treatment also wipes out viruses and fungi, without damaging human cells. Plasma, which is found in neon signs and large-screen televisions, is a gas in which a portion of the particles has been ionised. The plasma in the sanitiser is produced by passing electrical current through air, which transforms oxygen, nitrogen and water vapour into germ-killing compounds such as hydrogen peroxide and nitric oxide.

Morfill estimates that the plasma sanitisers could be mass-produced and then sold for under US\$100 apiece. The treatment has also shown promise in helping wounds to heal more quickly, although more study will be required before it is likely to be widely used for this purpose.

DENGUE LEVER

Dengue fever sickens 50 to 100 million people per year and threatens a quarter of the world's population, yet there is no effective vaccine or treatment. Now, scientists have developed a genetically altered strain of mosquitoes that could help reduce the impact of the disease.

The genetic modification renders the female *Aedes aegypti* mosquitoes that spread the disease flightless, but has no effect on males. Altered males would be released into affected areas, breed with local females and produce offspring incapable of flying and spreading dengue.

"It functions like an insecticide, but it does so in a very targeted and efficient way," says Dr Anthony James of

the University of California, Irvine, in the United States, who helped develop the new strain of mosquitoes. "We use the tendency of males going after females to do the job for us," he says.

James estimates that if a sufficient number of the modified males are released, they would – in theory – suppress the local population of dengue-spreading mosquitoes in six to nine months. The method has particular potential for fighting dengue in urban areas, which have been hard hit by the disease.

The method could be used to fight other mosquito-borne diseases such as malaria and West Nile fever, through the development of genetically modified strains of the various species that spread them.



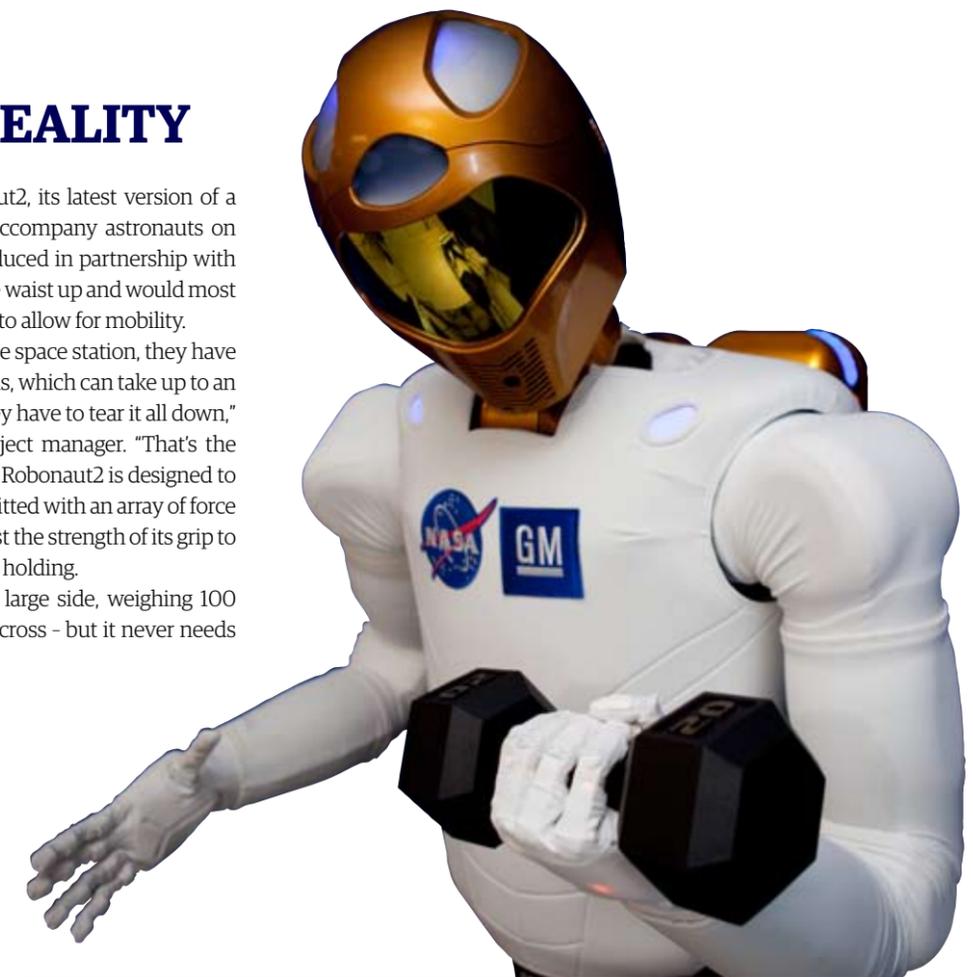
PHOTOS: COURTESY MAX PLANCK INSTITUTE FOR EXTRATERRESTRIAL PHYSICS (CLEAN MACHINE); PHOTO RESEARCHERS (DENGUE LEVER); NASA AND GENERAL MOTORS (SPACE ROBOT REALITY); PETER ADAMCZYK AND LISA LAU (BIONIC FOOT)

SPACE ROBOT REALITY

NASA recently unveiled Robonaut2, its latest version of a humanoid robot designed to accompany astronauts on space missions. The robot, produced in partnership with General Motors, is built from the waist up and would most likely be put on a wheeled base to allow for mobility.

"When the crew works on the space station, they have to go out and set up all their tools, which can take up to an hour and a half, and when they're done, they have to tear it all down," says Dr Ron Diftler, NASA's Robonaut project manager. "That's the kind of task a humanoid robot can do." The Robonaut2 is designed to carry out pre-programmed tasks and is outfitted with an array of force sensors, including ones that allow it to adjust the strength of its grip to accommodate the fragility of the object it is holding.

In human terms, Robonaut2 is on the large side, weighing 100 kilograms and measuring 78 centimetres across – but it never needs feeding, despite its size.



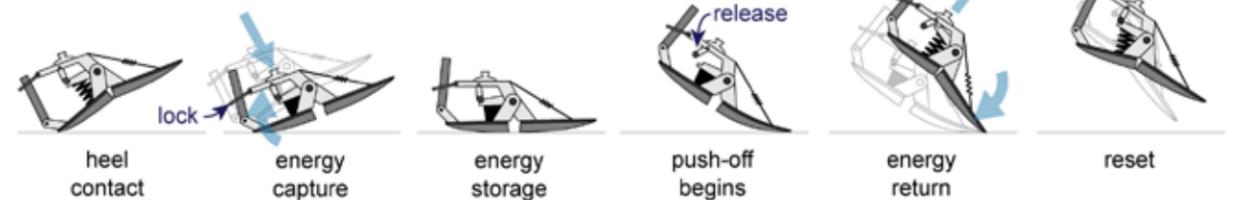
BIONIC FOOT

A newly designed artificial foot which recycles energy from step to step could help amputees walk a bit more free and easy. When you step down on the prosthetic's heel, a spring contracts and then latches. As your weight shifts forwards, a microprocessor determines when to release the stored energy to help the toe push off.

"We measure how much of your weight is on the toe, and when that crosses a threshold we release the spring," says Dr Steven Collins, a research fellow at Delft University of Technology in the Netherlands and co-designer of the prosthetic.

Conventional artificial feet require 23 percent more energy expenditure than normal walking, which is equivalent to carrying an extra 15 kilograms. The new foot shaves this added energy burden down to 14 percent, though Collins ultimately hopes to produce prosthetics so efficient that they allow amputees to outperform their "able-bodied" peers.

"There's nothing perfect about the human design for any particular task," Collins says. "We should be able to design a machine that performs certain functions better than a person can."



MOBILE MEMORY BOOSTER

Making calls on a mobile phone may improve one's recall in old age, says a new study on mice, in which long-term exposure to mobile phone radiation prevented and even reversed the progress of Alzheimer's.

"It surprised us to find that cell phone exposure, begun in early adulthood, protects the memory of mice otherwise destined to develop Alzheimer's symptoms," says study leader Dr Gary Arendash of the University of South Florida in the United States.

Mice were exposed to two hours of mobile phone radiation per day for seven to nine months. Mice with Alzheimer's had improved memory and reduced build-up of the beta amyloid protein associated with the disease in the brain, and young mice genetically predisposed to develop the disease had no memory loss or protein build-up.

Arendash theorises that the radiation increases blood flow to the brain, encourages development of new blood vessels and creates new connections among neurons. If applicable to humans, radiation treatment could reduce the impact of traumatic brain injury, in which the effects of a head injury are compounded by beta amyloid build-up.



SPACE ORGANICS

A new study finds that the Murchison meteorite which landed in Australia in 1969 contains millions of distinct organic compounds, at least as many - if not more - than exist on Earth.

Several dozen milligrams of the meteorite - which weighs over 100 kilograms - were subjected to high-resolution spectroscopy, which is capable of measuring a molecule's mass to within a single electron. The testing yielded more than 14,000 different elemental compositions. Adjusting for the various ways a set of elements can be combined in a molecule, the scientists estimate the sample contains millions of different organic compounds.

"We have done tests on substances from many different environments and we have never seen such a complex spectra as we did with the



Murchison meteorite," says the leader of the study Dr Philippe Schmitt-Kopplin, an analytic chemist at the German Research Center for Environmental Health in Munich, Germany.

As for whether the new results provide fresh evidence that the raw ingredients for life on Earth arrived via meteorite, Schmitt-Kopplin is non-committal. Research continues.

FLYING FISH

Billionaire Sir Richard Branson likes vehicles. He runs railways. He owns an airline. He is developing a space plane. Now, he has a new underwater vehicle at his Caribbean island.

The craft, dubbed the Necker Nymph, was designed and built by Hawkes Ocean Technologies in the United States as part of its DeepFlight line of winged submersibles. The Necker Nymph stands out with its open cockpit - its pilot and two passengers sit in the open water.

Unlike other submersibles, which use ballast to sink, the Hawkes models use wings to generate

negative lift. The craft is controlled with a joystick and manoeuvres with rudders and ailerons, just like a plane.

"You can stand it on its tail and pop out of the water or point it straight down so you're straining against your harness," says Karen Hawkes, marketing manager of Hawkes Ocean Technologies. "Or it can be really, really elegant where you're just skimming over a reef."

The craft can plunge as deep as a scuba diver, about 45 metres. And Branson isn't keeping it all to himself; you can rent it for the bargain price of US\$25,000 a week.



SOUND TOOTH

A new hearing aid called SoundBite uses the teeth, not the ear, to improve hearing. A microphone in the ear canal picks up sound, then digitises and sends it wirelessly to a device attached to the teeth. This device then translates the sound back into vibrations which pass to the inner ear via the jawbone.

"Unlike other hearing devices that use air conduction to transmit sound, our device uses a principal called bone conduction," explains

Jason Shelton, vice-president of marketing for Sonitus Medical, the US-based company that has developed the device. Other hearing aids using bone conduction are available, but they require surgery and are non-removable.

The company is currently seeking approval from US authorities for the device to be used in treating single-sided deafness. Sound would be captured from the deaf ear before being transmitted to the hearing side via the user's bones. Sounds like a good idea.



RICKETY ROYAL

Live slow and die young might as well have been the motto of King Tutankhamun, according to the findings of a recent study that subjected his mummy to genetic and radiological testing. The ancient Egyptian pharaoh, who ruled for just nine years and died at the young age of 19, suffered from a litany of maladies that would have rendered him unable to walk: a clubfoot, bone necrosis of the foot and a fractured shin.

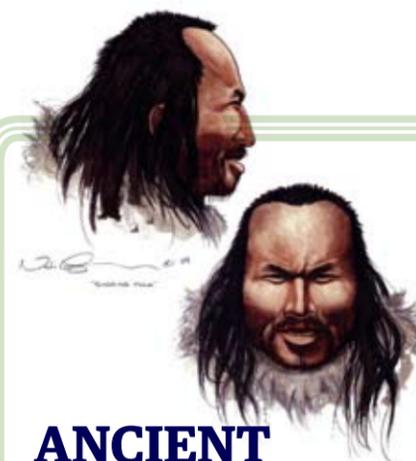
"He could not walk without sticks and was probably carried around to cover the fact that he could not walk," says Dr Carsten Pusch, a medical geneticist at the University of Tübingen in Germany, who participated in the research. "He was a poor boy hampered by many diseases and obstacles."

No evidence was found for the theory that King Tut was murdered, but genetic sequencing indicates that he was infected at least twice with virulent malaria tropica. In conjunction with an infection from the fractured shin, the disease may well have finished him off.



Howard Carter, the archaeologist who found King Tut's tomb, examines the pharaoh's sarcophagus.

PHOTOS: ERIC YOUNGHANS (MOBILE MEMORY BOOSTER); METEORITES AUSTRALIA (WWW.METEORITES.COM.AU) (SPACE ORGANICS); SONITUS MEDICAL (SOUND TOOTH); COURTESY NIJKA K. GODTFREDSSEN / SILA (ANCIENT GENOME); PHOTO RESEARCHERS (RICKETY ROYAL); COURTESY VIRGIN LIMITED EDITION (FLYING FISH)



ANCIENT GENOME

An international team of scientists has decoded the genome of an ancient human for the first time. The man, who lived 4,000 years ago in north-west Greenland, is known as Inuk, after the Greenlandic term for "man" or "person". But Inuk's not a Greenlandic by heritage.

"We believe that he comes from a previously undetected migration from the Old World (Siberia) to the New World about 5,500 years ago," says study leader Dr Eske Willerslev of the University of Copenhagen in Denmark. "His ancestors went to Alaska, then to Canada, then to Greenland where they died out without leaving any descendants."

Inuk's genetic material was isolated from a hair sample kept in the National Museum of Denmark since it was found at the Qeqertasussuk site in 1986. Having spent thousands of years in permafrost, the sample was in fairly good shape, but assembling a complete genetic code still took months of work.

The results also yielded some information on Inuk's traits. He was adapted to cold temperature, had brown eyes and skin and had thick, dark hair. "But he had a tendency to going bald," says Willerslev, "which probably means he died quite young because we found quite a lot of his hair."

LUMBERING GIANTS

If you ever have the misfortune of being charged by an elephant, you probably won't stop to wonder whether it's running or just walking very fast. Nonetheless, the question is a matter of some dispute among animal locomotion specialists.

In the latest attempt to answer it, Dr Norman Heglund of the Catholic University of Louvain in Belgium filmed 34 Asian elephants weighing up to 4 tonnes as they trod over plates that recorded the precise forces they exerted on the ground. The result was a mixed verdict. "At their highest speeds, elephants have a trot-like characteristic to their front legs and a walk-like characteristic to their back legs," says Heglund.

The elephants' front legs bounded off the ground with a spring-like motion, which is typical of running, while their rear legs remained rigid, which is typical of walking. However, unlike other land mammals, the elephants in the study always kept at least one foot on the ground even when reaching top speeds of almost 18 kilometres per hour.

The study also found that the elephants' centre of mass never rose or fell more than a centimetre at top speed. This remarkable steadiness helps spare the elephants' joints by never coming down on them too hard.



PHOTOS: PHOTOSHELTER (LUMBERING GIANTS); THOMAS ENDLEIN (ANT-SIZED POWER); ZEO INC. (SLEEPY HEADBAND)



ANT-SIZED POWER

Five hundred milligrams might not seem like much to a human, but it's a hundred times the body weight of the Asian weaver ant (*Oecophylla smaragdina*) in this photograph – the ant that's holding onto that weight with its jaws while clinging to a smooth surface and hanging upside down.

How does this tiny insect manage to stick so tightly when carrying a heavy weight, yet run freely when unburdened? This is the research topic of Dr Thomas Endlein, a zoologist at Glasgow University in Scotland, who captured the image to win the first annual photo competition of the Biotechnology and Biological Sciences Research Council.

When weaver ants want to cling to a surface, they drastically increase the size of the footpads that make contact with the surface. In addition, they secrete a fluid between pad and surface that helps them to stick more tightly. "Think of two microscope slides pushed together with a little bit of fluid between them," says Endlein. "It's quite difficult to pull them apart."

The ants live in the forest canopy and use their sticky feet to pull leaves together when constructing nests. As for getting the ant to demonstrate its strength on camera, Endlein says that was hardly a challenge. "Weaver ants are very aggressive," he says, "so they have a natural tendency to grab anything you bring close to them because they see it as an intruder." F-ant-astic.

SLEEPY HEAD(BAND)

How did you sleep last night? Chances are you know what time you went to bed and got up, but not much more. A new device called the Zeo Personal Sleep Coach aims to fill in the details and help you get a better night's rest.

The Zeo consists of a headband and bedside alarm clock which together analyse your brain activity so as to determine how much time you spend in light sleep, deep sleep and REM sleep. In the morning, you can upload the collected data to an online program and look for connections between your waking habits and sleep quality.

This kind of analysis is typically available only in a sleep lab, where multiple gel-smearing electrodes affixed to a subject's scalp record brain signals, which are then analysed by experts. Zeo's headband picks up activity with dry pads and relays it wirelessly to the bedside alarm clock, which analyses it with an algorithm. Though the Zeo Personal Sleep Coach is not intended to treat serious sleep disorders, its results have been impressive.

"If you take two human experts and allow them to score sleep on the same night, they will agree with each other 85 percent of the time," says Ben Rubin, Zeo co-founder and chief technology officer. "Our system agrees [with the experts] 75 percent of the time."

