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The natural movement of bacteria is used to propel micro-objects through water – the same trick might someday power tiny medical devices

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They have had a bad rap in recent years over fears of toxicity, but some nanoparticles are shown to protect nerve cells from damage

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A conductive coating of carbon nanotubes could clear ice from cars fast, and even provide a new way of heating homes

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A solution containing nanoparticles that absorb and then gradually release a drug could replace conventional eye drops, researchers say

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- **[Self-assembling gel stops bleeding in seconds](#)**

If the material works as well in humans as it does in animals, it could save thousands of lives and make surgery easier, experts say

Breaking News - 10 October 2006

- **[FDA too poor to test nano safety](#)**

Potentially dangerous nanomaterials could appear in medical devices and food packaging because the food and drug agency lacks resources

Technology - 07 October 2006

- **[Ancient Greeks invented 'quantum dot' dye](#)**

One of their hairdressers' dyes produced lead sulphide crystals just 5 nanometres wide, which could have useful quantum properties

News - 18 September 2006

- **[Brain cells and robotics make a connection](#)**^{NS}

The power to perform a wide range of tasks by using thought to control a computer or robotic arm has come a step closer, thanks to "artificial synapses"

Technology - 02 September 2006

Bacteria harnessed as micro propeller motors

- 16:45 26 January 2007
- NewScientist.com news service
- Belle Dumé

One of the main challenges in developing microscale robots lies in miniaturising their power and propulsion. Now, researchers in the US may have found a solution to this problem, by exploiting the natural movement of bacteria to propel micro-objects through water.

Many bacteria propel themselves along in a fluid by rotating their corkscrew-like tails, called flagella, at relatively high speeds. These flagella are only around 20 nanometres in diameter and are about 10,000 nm long.

Motors made from bacterial flagella have been used as novel "nano-actuators" before (see [Bacteria harnessed as miniature pumps](#)), but Metin Sitti and Bahareh Behkam of Carnegie Mellon University in Pennsylvania, US, have taken another approach. They use the entire microorganism as the motor and control its on/off motion with chemicals.

Sitti and Behkam began by sticking several *S. marcescens* – the kind of bacteria that cause pink stains on shower curtains – onto polystyrene beads 10 microns in diameter. These tiny "robots" were suspended in a solution containing water and glucose.

Outboard motoring

The bacteria themselves are only about one-fifth of the size of each bead and adhere to them via electrostatic, van der Waals forces and hydrophobic interactions. As the attached bacteria rotate their flagella, feeding on surrounding glucose, they push their bead forward at speeds of around 15 microns per second.

To stop the bacteria's motion, the researchers add copper sulphate to the solution. The copper ions bond to the rotor of the flagella motor and prevent it from moving. To restart the motion, another chemical called ethylenediaminetetraacetic acid (EDTA) is added. The EDTA traps the copper ions attached to the rotor, allowing it to move again. The rotors can be switched off in this way an unlimited number of times.

Using the entire microorganism as a motor has many advantages, the researchers say. Bacteria are robust machines that can easily be integrated with other microscopic components and do not need to be purified or reconstituted, as detached bacterial components must be.

Moreover, the bacteria motors work using simple nutrients such as glucose and are naturally sensitive to their environment. This means they can be precisely controlled.

"In the future, such hybrid swimming micro-robots could even be used to deliver drugs inside the liquid environments of the human body, such as the urinary tract, eyeball cavity, ear and cerebrospinal fluid," Sitti told **New Scientist**. "They could also be employed to monitor toxic or pathogenic biochemical agents in the environment as well for inspection and maintenance of liquid filled pipes in spacecraft and nuclear plants."

Journal reference: *Applied Physics Letters* (vol 90, p 023902)

Nanoparticles offer hope for frayed nerves

- 26 January 2007
- Peter Aldhous
- Magazine issue 2588

Nanoparticles have had a bad rap lately over fears about their toxicity. Now, though, it seems the particles also have a kinder side. Cerium oxide nanoparticles have been shown to protect nerve cells from damage and so might one day be used to treat patients with spinal injuries or stroke.

When the spinal cord is damaged, or part of the brain is starved of oxygen, the initial injury soon escalates and neighbouring cells begin to die. Many fall victim to oxidative damage from free radicals, which are released as the immune system goes into inflammatory overdrive to clear up the mess.

Last year, a team led by neurobiologist David Schubert of the Salk Institute for Biological Studies in La Jolla, California, showed that cerium oxide nanoparticles can protect cultures of mouse brain cells from oxidative damage (*Biochemical and Biophysical Research Communications*, vol 342, p 86). The researchers also found that the particles themselves were not toxic to the cells.

Now James Hickman and his colleagues at the University of Central Florida in Orlando have shown the nanoparticles can also protect spinal neurons. They tested similar particles, less than 5 nanometres in diameter, on cultures grown from neurons taken from the spinal cords of adult rats. The particles were able to protect the spinal neurons from hydrogen peroxide, a powerful oxidising agent (Biomaterials, DOI: 10.1016/j.biomaterials.2006.11.036).

The researchers found that in exerting its antioxidant effect, cerium is itself oxidised from a 3+ to a 4+ state, but reverts back over time, which means that a small dose of nanoparticles can keep working for weeks at a time. "If you can confine it to the site of injury," says Hickman, "you should be able to have a long-lasting neuroprotective effect."

Schubert adds that the nanoparticles seem to be taken up into nerve cells at the synapses, the junctions across which cells communicate with one another. This may give cerium oxide particles an advantage over other, more powerful, antioxidants that do not enter neurons in this way.

"In general, the antioxidant approach is a good one, and this is an elegant way of doing that," says Ravi Bellamkonda of the Laboratory for Neuroengineering in Atlanta, Georgia, which is run jointly by the Georgia Institute of Technology and Emory University.

However, Bellamkonda warns that the work is still at an early stage. The next test will be in demonstrating that the nanoparticles show similar neuroprotective benefits in live animals.

Nanotube coating promises ice-free windscreens

- 17:01 21 December 2006
- NewScientist.com news service
- Tom Simonite

A transparent lacquer containing carbon nanotubes could clear car windscreens or mirrors by acting as a heater. Thicker, opaque versions of the coating could turn entire floors of buildings into radiators, researchers claim.

The lacquer can be sprayed onto any surface and consists of a liquid base containing a mixture of nanotubes that conduct electricity. As the liquid dries, the nanotubes form a conducting network inside the lacquer. Passing a current through this network causes the layer to heat up.

In tests, a coating connected to a 12 volt power supply similar to car battery was able to clear ice from a plastic sheet in about 2 minutes although the test sheet was only the size of a paper back book.

"We can heat up the whole of any surface with a transparent coating," researcher Dominik Nemeč told **New Scientist**: "It could be used to clear windscreens or mirrors of water or ice." Nemeč is working on the coating with colleague Ivica Kolaric at the Fraunhofer Technology Development Group in Stuttgart, Germany.

Don't mind the gap

The team hopes the technology will replace the built-in wire filament heaters in car windscreens. As well providing more uniform heat than a filament heater, the nanotube film is more resistant to damage, says Nemeč. "If a filament is broken the whole heater won't work," he explains, "this new film can have gaps in – by accident or design – and still work."

Adding more nanotubes to the lacquer increases the heat the material can produce but also makes it opaque. "Anywhere you need heat, you could coat a surface in this material," says Nemeč.

He adds that the coating could also be used for under-floor heating. A square metre of film about 0.3 millimetres thick provides around 15 kilowatts of heat – enough to heat a good sized hall.

Secret's out for Saracen sabres

- 15 November 2006
- NewScientist.com news service

DURING the middle ages, the Muslims who fought crusaders with swords of Damascus steel had an edge - a very high-tech one. Their sabres contained carbon nanotubes.

From about AD 900 to AD 1750, Damascus sabres were forged from Indian steel called *wootz*. Peter Paufler of the Technical University of Dresden, Germany, and colleagues studied samples of a 17th-century sword under an electron microscope and found clear evidence of carbon nanotubes and even nanowires.

The researchers think that the sophisticated process of forging and annealing the steel formed the nanotubes and the nanowires, and could explain the amazing mechanical properties of the swords (*Nature*, vol 444, p 286).

Nanoparticles make for longer lasting eye drops

- 18:10 29 September 2006
- NewScientist.com news service
- Will Knight

The eye drops of the future may consist of a solution containing nanoparticles that absorb and then gradually release a drug, researchers say.

John Tsibouklis and colleagues at the University of Portsmouth in the UK have developed a solution containing polymer nanoparticles, 300 nanometres in diameter.

The drug is apparently physically bound to the nanoparticles in a two-stage chemical process. Once in the eye, the drug gradually becomes detached from the nanoparticles over a period of around 24 hours. "The idea is, you could take the eye drops once a day," Tsibouklis told **New Scientist**. "With luck we could push this up to once every 4 days. This would be very convenient."

Ongoing conditions

Because he has received commercial interest in the approach, Tsibouklis is unwilling to reveal the precise polymer material used or the mechanism by which it binds to a drug. But he says the nanoparticles are completely non-harmful and biodegradable and that animal tests have also shown the treatment to be effective.

Many eye conditions require the regular administration of eye drops. For ongoing eye conditions this can be unpleasant and inconvenient for a patient.

Tsibouklis says the nanoparticle solution could be used to deliver anti-bacterial or anti-viral treatments, to treat eye infections, or other drugs for more serious conditions such as glaucoma – a leading cause of blindness.

Implant alternative

Tsibouklis adds that it should also be more comfortable than using an implant, or modified contact lens to deliver a drug (see [Drug-delivering contact lenses revealed](#)).

Neville Osborne, an eye expert at the Nuffield Laboratory of Ophthalmology at the University of Oxford, UK, says time-release treatments hold great promise for treating serious eye conditions, especially those requiring drugs to be injected.

"If you can inject something into the eye that can then sit around and slow-release that would be marvellous," he says. But Osborne adds that any possible side effects on other parts of the eye must be examined carefully.

Journal reference: *Journal of Materials Chemistry* (vol 16, p 3439)

Nanotechnology - Learn more about all things nuclear in our explosive [special report](#).

Self-assembling gel stops bleeding in seconds

- 13:15 10 October 2006
- NewScientist.com news service
- Robert Adler

Swab a clear liquid onto a gaping wound and watch the bleeding stop in seconds. An international team of researchers has accomplished just that in animals, using a solution of protein molecules that self-organise on the nanoscale into a biodegradable gel that stops bleeding.

If the material works as well in humans, it could save thousands of lives and make surgery far easier in many cases, surgeons say.

Molecular biologist Shuguang Zhang, at the Massachusetts Institute of Technology in the US, began experimenting with peptides in 1991. Zhang and colleagues at MIT and the University of Hong Kong in China went on to design several materials that self-assemble into novel nano-structures, including a molecular scaffold that helps the regrowth of severed nerve cells in hamsters (see [Nano-scaffolds could help rebuild sight](#)).

Their work exploits the way certain peptide sequences can be made to self-assemble into mesh-like sheets of "nanofibres" when immersed in salt solutions.

In the course of that research they discovered one material's dramatic ability to stop bleeding in the brain and began testing it on a variety of other organs and tissues. When applied to a wound, the peptides form a gel that seals over the wound, without causing harm to any nearby cells.

Vessels and arteries

"In rodents it works in all the blood vessels and arteries, including the femoral artery, the portal vein, and in the liver," says MIT neuroscientist Rutledge Ellis-Behnke.

The peptides assemble into a gel that looks "like a hairy ribbon, but at the nanoscale" says Ellis-Behnke, although precisely how it stops bleeding is not yet clear. "It's critically important to understand the mechanism so we can rationally design new self-assembling materials," Zhang says.

Some surgeons are already excited about the material. "I see great potential in the eye field, the gastrointestinal field, and in neurosurgery," says Dimitri Azar, head of ophthalmology at the University of Illinois at Chicago, US.

Paradigm shift

"In the eye, even a drop of blood will blur your vision for a long time," Azar adds. "A material that would stop the bleeding could lead to a paradigm shift in how we practice surgery in the eye."

Ed Buchel, who teaches general and plastic surgery at the University of Manitoba, in Winnipeg, Canada, sees equal potential for treating trauma and burns. "If this works as well on humans as it does on rats, it's phenomenal," he says.

Still, they caution that extensive clinical trials are needed to make sure the materials work properly and are safe. The MIT researchers hope to see those crucial human trials within three to five years.

Their research will appear in the 10 October 2006 edition of online journal *Nanomedicine*.

FDA too poor to test nano safety

- 07 October 2006
- NewScientist.com news service

Potentially dangerous nanomaterials could appear in medical devices and food packaging because the US Food and Drug Administration lacks the resources to assess their safety.

So says a study published on 5 October by Washington think tank the Woodrow Wilson Center for Scholars. The report by former FDA deputy commissioner Michael Taylor warns that the agency's \$1.9 billion budget for 2007 is less than half what it needs to regulate conventional foods, drugs and medical devices, let alone nanotech.

As a result, he says, the FDA cannot afford to acquire the nanotech expertise it needs, so it may not spot problems, or may discover them too late. For instance, researchers are pushing for carbon nanotubes in medical treatments, but the jury is still out on whether they affect DNA.

From issue 2572 of New Scientist magazine, 07 October 2006, page 27

Ancient Greeks invented 'quantum dot' dye

- 18 September 2006
- From New Scientist Print Edition. [Subscribe](#) and get 4 free issues

Ancient Greek hairdressers could teach us a thing or two about nanotechnology.

When hair is dyed using a lead-based dye popular 2000 years ago, crystals of lead sulphide just 5 nanometres across form within the microstructure of the hair fibres, according to a team led by Phillippe Walter at the French Museums' Research and Restoration Centre in Paris.

A hair-like scaffold could be used to grow "quantum dots" - tiny crystals which confine a handful of electrons in a way that makes it possible to exploit their quantum properties, such as spin, for use in emerging quantum computing systems. Existing methods for producing quantum dots create defects. The work will be reported in *Nano Letters*.

From issue 2569 of New Scientist magazine, 18 September 2006, page 16

Brain cells and robotics make a connection

- 02 September 2006
- Mason Inman
- Magazine issue 2567

THE power to perform a wide range of tasks by using thought to control a computer or robotic arm has come a big step closer, thanks to "artificial synapses". These are rather like the links between brain cells but formed by connecting silicon nanowires to individual neurons.

Electrodes have already been implanted into the brains of some paralysed people, and have been used to control a computer cursor and robotic arm (*New Scientist*, 15 July, p 28). But these neural prostheses measure signals from groups of neurons, and can only sample a fraction of brain activity. "They're amazing advances, but it's still pretty crude," says Charles Lieber of Harvard University. "The electrodes are just poking in there, at the scale of the whole cell." Lieber's aim now is to communicate with neurons in the way the brain itself does. This would enable researchers to convert a wider range of thought ...

The complete article is 553 words long.