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Abstractions

LAST AUTHOR

Brown fat tissue, which burns energy stores to generate heat, is relatively scarce in adult humans. By contrast, white fat cells are abundant, and store energy for use elsewhere in the body. Last year, Bruce Spiegelman of the Dana-Farber Cancer Institute in Boston, Massachusetts, and his colleagues showed that the protein PRDM16 can induce muscle precursor cells to differentiate into brown fat cells (*Nature* **454,** 961–967; 2008). On page 1154, Spiegelman and his colleagues now report that connective tissue cells called fibroblasts can also be so induced with a PRDM16 complex. When transplanted into mice, the cells produce fat pads that look and behave like brown fat tissue. Spiegelman spoke to *Nature* about the cells and their potential for treating metabolic disorders such as type-2 diabetes and obesity.

What did you hope to learn from transplanting induced fibroblasts?

We wanted to know whether the transplants had the physiological characteristics of brown fat in terms of functioning as hot spots for glucose uptake, which they did. Going forwards, we plan to look at questions such as: how many brown fat cells does it take to significantly affect metabolism? What optimizes the cells' survival times? And where should they be implanted?

Why is the location of transplantation important?

To survive and function well, fat pads need blood vessels, and probably nerves. One day, we hope to use the pads therapeutically, to soak up glucose and convert it into heat instead of stored fat. We would want that to work optimally — and anatomy probably matters for optimum function.

How did you get started on this line of research?

It goes back to my postdoctoral work at the Massachusetts Institute of Technology with Howard Green, who pioneered the study of fat-cell differentiation. In the 1980s and 1990s my group was working exclusively on white-fat-cell development, and identified the master gene, *PPARG*. But there was this other kind of fat cell — the brown one — that I was also interested in. It wasn't until 2004 that we started to identify what controls brown-fat function and identity.

Are you using fat to combat fat?

Brown fat is a kind of fat, but we now appreciate that it comes from muscle-like precursors. It provides a way to control energy expenditure. The popular press loves this idea of 'fat fighting fat' — among all the silly phrases out there, at least this one is fairly accurate. ■

MAKING THE PAPER

Mikhail Noginov

Scientists build the smallest laser ever using a hybrid nanoparticle.

In today's nano-age, lasers are just so micro. To generate their trademark focused beam, lasers must contain a cavity in which to resonate and stimulate atoms. But even with an efficient resonance-promoting medium, light cannot resonate in cavities smaller than half its wavelength. This means that even the smallest optical laser would occupy a chunky 100–200 nanometres, a problem for engineers who need resonating cavities to be even smaller than this to design light-activated medical therapeutics and to build speedier nanometre-scale electronics.

Now, Mikhail Noginov of Norfolk State University in Virginia and his colleagues have followed up on hints that nanoparticles, which measure 2–100 nanometres in diameter, might serve as nanometre-scale resonators working at visible wavelengths. The researchers used visible light to excite free electrons in nanoparticles. The vibrating electrons form oscillations called surface plasmons, which, like a traditional laser cavity, can support stimulated emission, but do so using much less space (see page 1110).

The idea of surface-plasmon-based lasers, or 'spasers', was first proposed in *Physical Review Letters* by another group in 2003. Several years later, Noginov and his colleagues began brainstorming about the best way to build the right resonating cavity. That "very important part of the work", Noginov says, helped them to target certain metal nanoparticles for their planned spaser. Pure metals are prone to losing some of the incoming energy, preventing the stimulated emission that is needed to produce a spaser. To get around this, co-author Ulrich Wiesner and his team at Cornell University in Ithaca, New York, fabricated hybrid nanoparticles with a 14-nanometre gold core surrounded by a 15-nanometre-thick silica shell

embedded with dye molecules, making a 44-nanometre-diameter sphere. By combining gold with the dye, the team took advantage of the two materials' electrical properties: the gold provided the free electrons needed to create a surface plasmon; and the dye molecules transferred incoming energy to the surface plasmons.

Next, the researchers tested their creation using standard optical equipment. They sent light into water containing the nanoparticles, and detected the amplified light that emerged when the spaser began working. Noginov anticipated plenty of technical issues. "In real experiments, potential glitches are everywhere, like bugs in the swamp," he says. At first, his team was seeing "nothing", but eventually a sharp line appeared at 531 nanometres — the wavelength of the light emitted by the surface plasmons, and the first evidence of an optical spaser.

Noginov also drew on the expertise of co-authors Vladimir Shalaev and Evgenii Narimanov at Purdue University in West Lafayette, Indiana, who work with metamaterials — man-made materials with optical properties that do not occur in nature. These metamaterials demonstrate, "absolutely crazy phenomena" says Noginov, including optical invisibility cloaking like something straight out of *Harry Potter*. Shalaev's team measured the emission kinetics of the spaser using a sophisticated microscope.

The next step will be to shrink the resonator even further. How low will they go? "Theoretically," says Noginov, "you can go as low as you want" until the metal atoms stop behaving collectively like a metal, which researchers predict occurs at diameters of about 1 or 2 nanometres. In future nanocircuits, such tiny spasers could fulfil the gatekeeping role that transistors held in the microelectronics era. ■

FROM THE BLOGOSPHERE

If you didn't make it to the autumn 2009 meeting of the American Chemical Society in Washington DC last week, you can get the highlights from the Sceptical Chymist blog (http://tinyurl.com/mg8q83). *Nature Chemistry* associate editor Stephen Davey and Andrew Mitchinson, a senior editor at *Nature*, share their impressions from pleasantly overcrowded lecture rooms.

Mitchinson gives high ratings to several 'nano' talks, including work on metal-lined nanocages and the creation of nanoparticles that can carry DNA plasmids into cells. He writes, "the science was great ... with lots of interest in each talk" and declares it his "favourite session of the meeting so far".

Davey writes about a lively couple of sessions on work by young investigators and winners of the Arthur C. Cope Award — which centred on the use of pyridines in natural-product synthesis and modern alchemy using "cheaper and abundant metals for catalysis", respectively.

And if you've ever wondered how quickly chemists can evacuate during a fire drill or how the Declaration of Independence is stored, those answers are in the blog too. ■

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