and can maintain their structure without the need for scaffolding made from foreign materials, a feature of some other engineered tissues.

"It is a very elegant and clever way to deliver cells," says Philippe Menasché, a cardiac surgeon at the Georges Pompidou European Hospital in Paris, who has also experimented with making tissue sheets.

Pharmacologist Wolfram-Hubertus Zimmermann at the University Medical Centre Göttingen in Germany, who is also developing an iPS treatment for heart disease, says that the latest trial is based on work conducted by Sawa and other colleagues in Japan over the past 15 years.

Once Sawa's team has treated its three patients, it will apply to conduct a clinical trial involving a further seven to ten people. If the treatment proves to be safe, and shows some signs of working, it can be approved for sale under the accelerated system. This allows researchers to bypass expensive large-scale clinical trials aimed at proving efficacy, and instead to use small pilot trials to show that the therapy is safe and shows an indication of efficacy.

But some researchers say the bar for approving therapies for commercial use is too low. Even if the cells are found to be safe, there are risks associated with any surgery, and patients could give up other therapies for a treatment that might not work. Ethicists and regulators say the benefits of any new therapy must outweigh the risks.

Yoshiki Yui, a cardiologist at Kyoto University, says that, as well as meeting the requirements for safety, researchers should show that their treatment is effective, which would require testing it in larger numbers of people than are currently required. The evaluation process should also use randomized, controlled clinical trials, the gold standard for demonstrating efficacy in medical research, he says.

The iPS-cell therapy has potential, Yui adds, but under the current approval system, "we won't know if it works or not" because it won't have been tested in a controlled trial. "The biggest problem is there's no adequate system of evaluation in Japan," he says.

A spokesperson for the health ministry told *Nature* that the current approval system is sufficient because researchers must still show that a treatment works even if it has been approved for commercial use.

Sawa agrees that a control group is important for proving efficacy, but notes that he is abiding by Japan's rules, which don't require this before a treatment is made commercially available.

He says the health ministry's approval is an acknowledgement that the therapy "is scientifically and ethically justified" to be tested in patients. "Whether it really works, [we] have to find out now," he adds. ■ SEE EDITORIAL P.611

PHYSICS

Muography makes its mark

Little-known particles called muons are helping to map the insides of pyramids, and to spot missing nuclear waste.

BY ELIZABETH GIBNEY

The muon is going mainstream. The particle, a heavy version of the electron that constantly rains down on every square centimetre of Earth, is little known outside particle physics — but last year it helped archaeologists to make a stunning discovery of a previously unknown chamber in Egypt's Great Pyramid.

Volcanologists and nuclear engineers are also finding new uses for muography, which harnesses muons to probe the innards of dense structures. The first companies are looking to cash in.

"The discovery in the pyramids last year has really put muography on the map," says David Mahon, a physicist at the University of Glasgow, UK, who co-organized an international meeting called Cosmic-ray Muography, sponsored by the Royal Society and held on 14–15 May in Newport Pagnell, UK.

MUONS ARE EVERYWHERE

Muons have the same negative charge as electrons but 200 times the mass. They are made when high-energy particles called cosmic rays slam into atoms in Earth's atmosphere. Travelling at close to the speed of light, muons shower Earth from all angles. Every hand-sized area of the planet is hit by roughly one muon per second, and the particles can pass through hundreds of metres of solid material before they are absorbed.

Their omnipresence and penetrating power makes muons perfect for imaging large, dense objects without damaging them, says Cristina Cârloganu, a physicist at the Clermont-Ferrand Physics Laboratory in France. The denser materials are, the more energy they absorb from the particles, so physicists can track how often muons of different energies reach detectors placed around a target, and compare that with the expected rate without an obstacle, to build up a 3D profile of the density of the interior.

Physicists have been experimenting with the technique since the 1950s, including an unsuccessful search for hidden chambers in the second-largest pyramid at Giza (L. W. Alvarez *et al. Science* **167**, 832–839; 1970). But the room-sized detectors were expensive and impractical, says Raffaello D'Alessandro, a particle physicist at the University of Florence, Italy, and a co-organizer of the muography meeting. They could weigh more than 10 tonnes and relied on muons' ability to ionize particles of sometimes explosive gases.

CHANGE OF TACK

Ways to track the paths of charged particles more precisely — developed at facilities such as CERN, Europe's particle-physics laboratory near Geneva, Switzerland — have made for safer, smaller and more-sensitive muon detectors. They can now be as compact as a few square metres and can run on solar panels, making it possible to take them to remote field sites.

Volcanoes have become a popular target for the technique, thanks to pioneering work by researchers in Japan. Mapping lava channels, which absorb less energy from muons than does the dense surrounding rock, could one day help to predict eruptions, says Cârloganu. This year, researchers will try to image the solidified plug of lava inside Italy's Mount Vesuvius.

"It's a new, very specialist technique that comes from the high-energy-physics world."

Smaller devices are also being used in archaeology, says Giulio Saracino, a physicist at the University of Naples Federico II in Italy. He and his team have mapped cavities and tunnels under Mount Echia, a settlement in Naples that has been occupied since the eighth century BC. They also plan to look for a rumoured aqueduct beneath the nearby ancient city of Cumae.

A spate of commercial applications for muography — five were presented at the conference — probe smaller samples, such as drums of nuclear waste. These applications often use a slightly different technique, which tracks how muons change direction when they hit atomic nuclei in a material.

By placing detectors on both sides of a sample, physicists can recreate a particle's trajectory. And because the angle of deflection correlates with the density of the substance the muon hits, studying these paths can help to create a density map of the material being


Muon detectors are now small enough to take to field sites such at the Great Pyramid of Giza in Egypt.

probed. Engineers can use this method to spot stray fragments of uranium inside containers of nuclear waste, even if it is encapsulated in concrete or steel.

"To get information about what is deep in the centre, muons are pretty much the only thing that can do that," says Mahon. He directs a firm called Lynkeos Technology based in Glasgow, which will start imaging nuclear-waste samples next month at the UK National Nuclear Laboratory at Sellafield.

In the United States, trials at the Los Alamos National Laboratory in New Mexico have found that similar technology can spot where fuel rods have been removed from casks of spent fuel. Just four stolen fuel rods would provide enough plutonium to build a primitive nuclear weapon, Los Alamos physicist Christopher Morris told the conference.

Israeli firm Lingacom, based in Tel Aviv, is also investigating using the technique in security screening, for example at border crossings, to inspect containers for smuggled nuclear material. Other firms plan to use muography to track the wear of oil-industry pipelines and search for minerals in old mines.

But in many academic fields, the technology is still greeted with shrugs and quizzical looks. Despite finds such as the Great Pyramid's hidden chamber, the technology is still relatively unproven. "It's a new, very specialist technique that comes from the high-energy-physics world," says Saracino. "The first time I say to geologists that we have muon technology, they say, 'What are muons?' They are fascinated, but also a little bit wary." ■

DIVERSITY

Fewer African American men going into medicine

Diversity advocates seek strategies to correct alarming decrease.

BY GIORGIA GUGLIELMI

Even as US diversity initiatives try to increase the representation of minority ethnic groups in science and medicine, the proportion of black men pursuing such careers is reaching historic lows. In 1986, 57% of African American medical-school graduates were men — but by 2015 that share had dropped to just 35%, even as the total number of black graduates had increased.

Given the extent of racism and discrimination, "it's difficult for black males to be able to progress", says Cato Laurencin, a surgeon-scientist at the University of Connecticut in Farmington. Laurencin chaired a workshop on the issue that was convened last November by the US National Academies of Sciences, Engineering, and Medicine and the Cobb Institute, a non-profit group in Washington DC that studies health disparities and racism in medicine.

A report from the workshop, released on 18 May, examines factors that contribute to the growing absence of black men in science and medicine, as well as current models and strategies for boosting participation (see go.nature.com/2lo4p3b).

Although more African American students attend medical schools today than 30 years ago, the increase is due to greater numbers of ▸