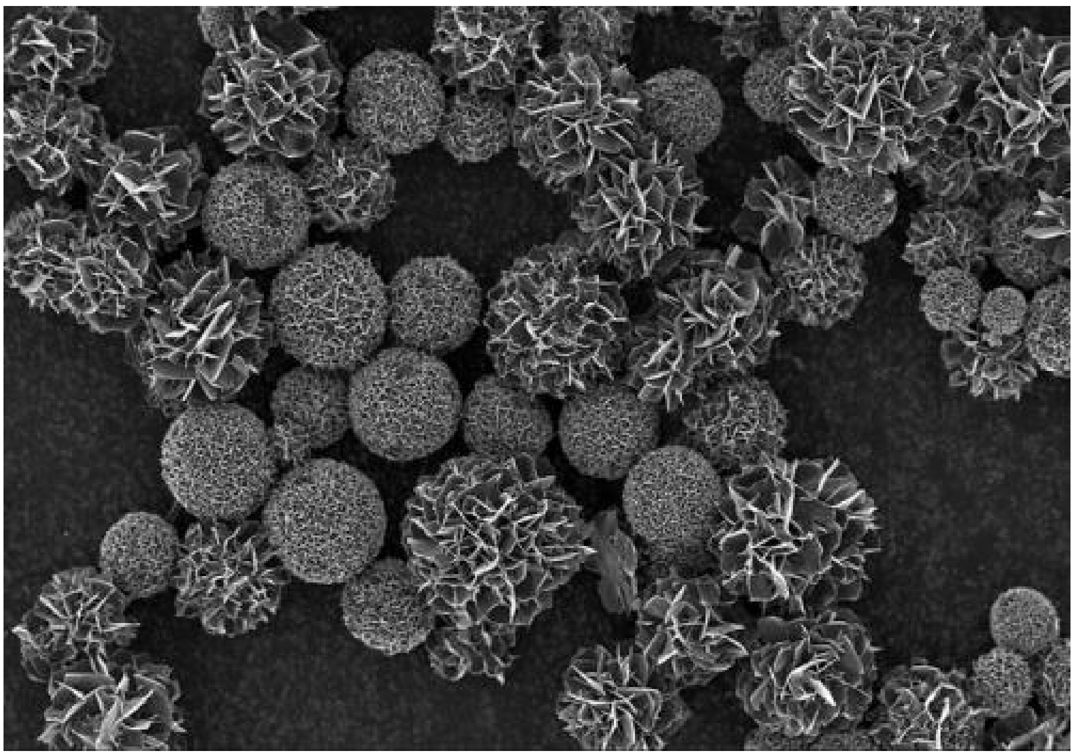
What exactly is Google's 'cancer nanodetector'?

November 11 2014, by Henry Scowcroft



Octacalcium phosphate nanoparticles, seen under an electron microscope

Last week, US tech giants Google made a splash in the media, announcing plans to develop new 'disease-detecting magnetic nanoparticles'. This was almost universally welcomed – after all, trying to detect diseases earlier is something that's a focus of many research organisations, including ours.

But when we tried to dig deeper into the detail behind the story, things remained pretty light on actual context and detail. So we spoke to Professor Duncan Graham – a UK-based nanoscientist from University of Strathclyde and expert advisor to Cancer Research UK – to get his take on the announcement.

What is a nanoparticle?

"The technical definition is that a nanoparticle is an object that is less than 100 nanometres wide along one of its edges," Professor Graham told us. A nanometre is a thousandth of a thousandth of a millimetre. In other words, it's tiny.

At that scale, things behave differently. "You get a different biology, chemistry and physics than you do with bigger things. And that's really attractive to scientists."

"Nanoparticles can be made of anything – they can be metallic, organic, or inorganic, and they come in all manner of different shapes and sizes," he said.

As a result they have a variety of origins. Some are naturally occurring – in soot for example – whereas others can be made in the lab, sometimes from complex biological molecules.

Are they new?

"No," says Graham. "Nanoparticles have been around for centuries. Ancient art has used nanoparticles. They're in stained glass windows. The Lycurgus Cup in the British Museum looks so magical because it's made of glass containing gold nanoparticles.

"And more immediately, they're already used in medical detectors – for example, the pregnancy tests you buy over-the-counter work use gold nanoparticles attached to antibodies. They're really nothing new, although they're incredibly interesting to researchers."

Another ubiquitous use is in antimicrobial products, which can contain suspensions of silver nanoparticles (but don't drink them – you'll go blue).

Why are they good for medical detection?

"Nanoparticles have an extremely high surface area in relation to their volume. This means they can carry a lot of 'stuff' on their surface – proteins from blood, for example. And this means they're good for detecting things, because they can really boost a signal"

For example, a protein that's relatively scarce in the blood – and therefore difficult to measure – can collect on some nanoparticles in amounts large enough to detect. But how does this work in practice?

"That's difficult to give a single answer to," says Graham. "There's a bewildering amount of modification that researchers around the world are adding to the surface of nanoparticles. You can attach biomolecules like proteins or DNA to them, and make them change properties so they produce optical, magnetic or electrochemical signals. There are a lot of applications because there's so much chemistry you can do on their surface."

So what's Google up to?

Professor Graham is somewhat perplexed by the recent media hubub. "It's been quite challenging to work out what Google are actually planning, apart from getting a lot of coverage in the media," he says.

"There are no concrete proposals, no peer-reviewed references, no research strategy – all the things that we in the science community normally take as given." But then they're Google, he says. They do things differently.

"The way traditional science works is to map out all the possible risks, demonstrate you've accounted for them, and then ask for funding based on your robust, well-discussed ideas. Google are doing the opposite – they're saying 'we want to get to here, we'll worry about the details later'.

"One thing my colleagues and I – who are also relatively sceptical about this – did note was the fact that they've pulled together a pretty high-powered team who all have excellent track records. So there's probably something exciting in the pipeline – its actually quite a refreshing approach, but very different from how you'd traditionally go about developing a diagnostic."

Google have been similarly vague about the precise form of nanotechnology they aim to use, Graham points out: "On a technical level, they're talking about magnetic particles, so you'd assume that'd be something made of iron or cobalt – although this is pure speculation."

How does all this fit into the wider field of nanotechnology and diagnostics?

This isn't all about Google, says Graham. "It's worth pointing out that Google are far from being the only show in town. There are loads of different research groups looking into what is collectively called 'biosensing' – continuous monitoring of what your body's doing in the hope of spotting problems early".

There are two main ways researchers are trying to do this, he says – either using optical (light-based) detection – where nanoparticles are used to either emit light directly or change the optical properties of their surroundings – or magnetic systems.

"One of the top people in this field, as far as cancer goes, is a guy called Sanjiv Gambhir at Stanford University in the US. His team are doing some really interesting stuff with regards imaging using nanoparticles," says Graham.

(Edit: it seems, according to this article in Wired, that Gambhir originally advised Google about nanotechnology).

What are the current challenges facing nanodetectors?

In Professor Graham's view, there are "two serious hurdles" for nanotechnologists to overcome before particle-based biosensing becomes a reality:

"The first is that, when you put nanoparticles into the body, they tend to get removed from the body in the urine via the kidneys. So for Google's biomonitor, they need to work out how to keep the particles in the body if their system is to be able to continuously monitor your health.

"But then you run into problem number two – known as 'bio-fouling'. This is where random, non-specific molecules stick to the nanoparticles and clog them up or deactivate them."

"The key thing to emphasise is that there's so much research that needs to be done before we can say 'this is a disease-specific diagnostic'," says Graham.

And, of course, any biosensor needs to be accurate. "You need to know the numbers. Is it 100% accurate? 90%? What's acceptable? What's the false-positive rate? Or, worse, false negatives? And that's not to mention all the regulatory and ethical hurdles to get past once you've worked it all out…"

"I'd also worry about how these things are ever used", says Graham. "We must be really careful when we use the word 'diagnose' – its doctors, not instruments, that actually diagnose patients. An instrument can only ever highlight a set of conditions to a clinician – it's always going to be the doctor who makes a call as to whether someone has a disease."

"There is of course a wider issue here. What utility does the information you're producing actually have? If I'm wearing a gadget that suddenly tells me I have a form of brain cancer that's incurable, what practical use is that to me? How has that helped my life?"

Who owns the data?

"This is something Google really seem to have ducked in their announcement. We don't need to dwell on it too much, but there's been a lot in the press in the last year about who has access to Google's data, and under what circumstances," says Graham, referring to reports of Government agencies accessing user data from tech companies like Google and Facebook.

Are there any other applications of nanotechnology in the field of cancer?

Of course it's not all about diagnostics. There are other ways nanotechnology is being explored by cancer researchers.

"The other big focus of nanotech in cancer is to deliver treatments," says Graham. "This is a field that's in its infancy – lots of basic research in animals, some of it promising, but much of it plagued with small numbers and less-than-robust statistical analyses.

"One group who have caught my eye is a US company called Nanospectra. They've developed a technology that uses gold particles, which travel to a tumour, and then get heated up by a beam of light to destroy the cancer cells. This now has got as far as human trials for head and neck cancers and lung cancer… it will be incredibly exciting to see what this approach yields. It's great to see it actually being done."

Professor Graham's 'take-home' message is that it's a mistake to see Google as the only organisation focusing on nanotechnology to detect disease – it's a vibrant, active field with incredible potential but still in its early days.

"There were a few raised eyebrows last week when the news broke – it seemed more light than heat given the amount of info available. But it's an interesting approach, and with their financial clout it will undoubtedly take the field somewhere new."

Provided by Cancer Research UK