

# New cancer-hunting 'nano-robots' to seek and destroy tumours

August 27 2014, by Jason Liu

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They have cancer in their sights. Credit: StephenMitchell/Flickr, CC BY-NC-ND

It sounds like a scene from a science fiction novel – an army of tiny weaponised robots travelling around a human body, hunting down malignant tumours and destroying them from within.

But research in [Nature Communications today](#) from the University of

California Davis Cancer Centre shows the prospect of that being a realistic scenario may not be far off. Promising progress is being made in the development of a multi-purpose anti-tumour nanoparticle called "nanoporphyrin" that can help diagnose *and* treat cancers.

Cancer is the world's biggest killer. In 2012, an estimated 14.1 million new cancer cases were diagnosed and around [8.2 million people](#) died from cancer worldwide.

This year, cancer [surpassed cardiovascular diseases](#) to become the leading cause of death in Australia; 40,000 Australians died as a result of cancer last year. It's no wonder that scientists explore every possible technology to efficiently and safely diagnose and treat the disease.

Nanotechnology is one such revolutionary cancer-fighting technology.

## **Nanotech: a big deal**

A nanometre is a very small unit of length, just one billionth of a metre. Nanotechnology looks at building up incredibly tiny, nano-level structures for different functions and applications.

One such nanoparticle-based application is the development of precise cancer diagnostic technology and safe, efficient tumour treatment. The only problem is nanoparticles must be tailored to specific jobs. They can be time-consuming and expensive to research and build.

So how do nanoparticles work? They can be made using inorganic or organic components. Each has different properties:

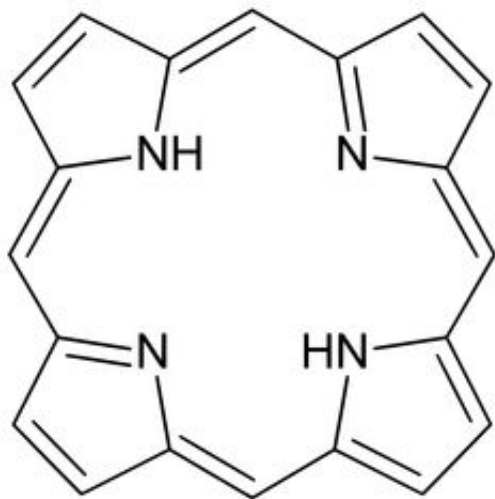
- Inorganic nanoparticles often have unique properties that make them useful in applications such as fluorescence probes and magnetic resonance imaging tumour diagnoses;

- "Soft" organic nanoparticles are the best drug-delivery carriers for tumour treatment, due to their biocompatibility, ability to be chemically modified and their drug-loading capacity. A few "soft" organic nanomedicines including Genexol-PM (paclitaxel-loaded polymeric micelles), Doxil (liposomal doxorubicin) and Abraxane (paclitaxel-loaded human serum albumin nanoaggregate) have been approved or are in clinical trials for the treatment of human cancers.

The new organic nanoparticle – nanoporphyrin – can do all this.

## Ins and outs of nanoporphyrin

Nanoporphyrin is only 20-30 nanometres in size. If you want to get technical, it's a self-assembled micelle consisting of cross-linkable amphiphilic dendrimer molecules containing four [porphyrins](#).



Structure of porphine, the simplest porphyrin. Credit: Wikimedia Commons

If you want to get less technical, it's a loosely bound group of molecules (or "micelle") with their hydrophilic ("water-loving") heads pointing outwards and their hydrophobic ("water-hating") tails pointing inwards. Each molecule contains organic compounds called porphyrins. Porphyrins can occur naturally, the best-known being heme, the pigment in red blood cells.

Nanoporphyrin's small size gives it an intrinsic advantage as it can be engulfed by and accumulate in [tumour cells](#), where it can act on two levels:

1. On the molecule level, nanoporphyrin can aid diagnosis by enhancing the contrast of [tumour tissue](#) in [magnetic resonance imaging](#) (MRI), positron emission tomography (PET) and dual modal PET-MRI. (Again, this is a bit technical, but if you're interested, porphyrin acts as a ligand, which chelates with imaging agent metal ions such as gadolinium (III) or <sup>64</sup>copper (II).)
2. on the micelle level, nanoporphyrin can be loaded with anti-tumour drugs to kill malignant tissue. When activated, for example, it can generate heat to "cook" the tumour tissue, and release lethal reactive oxygen species (ROS) at tumour sites.

## **Armed and dangerous (to tumours)**

Functional nanoparticle processes can be similar to those of an armed nano-robot. For example, when a tumour-recognition module is installed in a delivery nano-robot (organic particle), the armed drug-loaded nano-robot particles can target and deliver the drug into tumour tissue. They kill only those cells, while being harmless to surrounding healthy cells and tissues.

If a tumour-recognition module is installed in a probe nano-robot

(inorganic particle), the armed nano-robot particles can get into tumour tissue and activate a measurable signal to help doctors better diagnose tumours.

It has been a huge challenge to integrate these functions on the one nanoparticle. It's difficult to combine the imaging functions and light-absorbing ability for phototherapy in organic nanoparticles as drug carriers. This has, until now, hampered development of smart and versatile "all-in one" organic nanoparticles for tumour diagnosis and treatment.

The production of nanoporphyin is an efficient strategy in the development of multifunctional, integrated [nanoparticles](#). The same strategy could be used to guide further versatile nanoparticle platforms to reduce nanomedicine costs, develop personalised treatment plans and produce self-assessing nanomedicines.

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Source: The Conversation

Citation: New cancer-hunting 'nano-robots' to seek and destroy tumours (2014, August 27) retrieved 24 April 2024 from <https://phys.org/news/2014-08-cancer-hunting-nano-robots-tumours.html>

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