Tiny 'Lego' blocks build Janus nanotubes with potential for new drugs and water purification

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Researchers have created tiny protein tubes named after the Roman god Janus which may offer a new way to accurately channel drugs into the body's cells.

Using a process which they liken to molecular Lego, scientists from the University of Warwick and the University of Sydney have created what they have named 'Janus nanotubes' – very small tubes with two distinct faces. The study is published in the journal *Nature Communications*.

They are named after the Roman god Janus who is usually depicted as having two faces, since he looks to the future and the past.

The Janus nanotubes have a tubular structure based on the stacking of cyclic peptides, which provide a tube with a channel of around 1nm (around one millionth of a mm) – the right size to allow small molecules and ions to pass through.

Attached to each of the cyclic peptides are two different types of polymers, which tend to de-mix and form a shell for the tube with two faces – hence the name Janus nanotubes.

The faces provide two remarkable properties – in the solid state, they could be used to make solid state membranes which can act as molecular 'sieves' to separate liquids and gases one molecule at a time.

This property is promising for applications such as water purification, water desalination and gas storage.

In a solution, they assemble in lipids bilayers, the structure that forms the membrane of cells, and they organise themselves to form pores which allow the passage of molecules of precise sizes. In this state they could be used for the development of new drug systems, by controlling the transport of small molecules or ions inside cells.

Sebastien Perrier of the University of Warwick said: "There is an extraordinary amount of activity inside the body to move the right chemicals in the right amounts both into and out of cells.

"Much of this work is done by channel proteins, for example in our nervous system where they modulate electrical signals by gating the flow of ions across the cell membrane.

"As ion channels are a key component of a wide variety of biological process, for example in cardiac, skeletal and muscle contraction, T-cell activation and pancreatic beta-cell insulin release, they are a frequent target in the search for new drugs.

"Our work has created a new type of material – nanotubes – which can be used to replace these channel processes and can be controlled with a much higher level of accuracy than natural channel proteins.

"Through a process of molecular engineering - a bit like molecular Lego – we have assembled the nanotubes from two types of building blocks – cyclic peptides and polymers.

"Janus nanotubes are a versatile platform for the design of exciting materials which have a wide range of application, from membranes – for instance for the purification of water, to therapeutic uses, for the

development of new drug systems."

More information: The study, Janus cyclic peptide–polymer nanotubes, was authored by Maarten Danial, Carmen My-Nhi Tran, Philip G. Young, Sebastien Perrier, & Katrina A. Jolliffe

Provided by University of Warwick