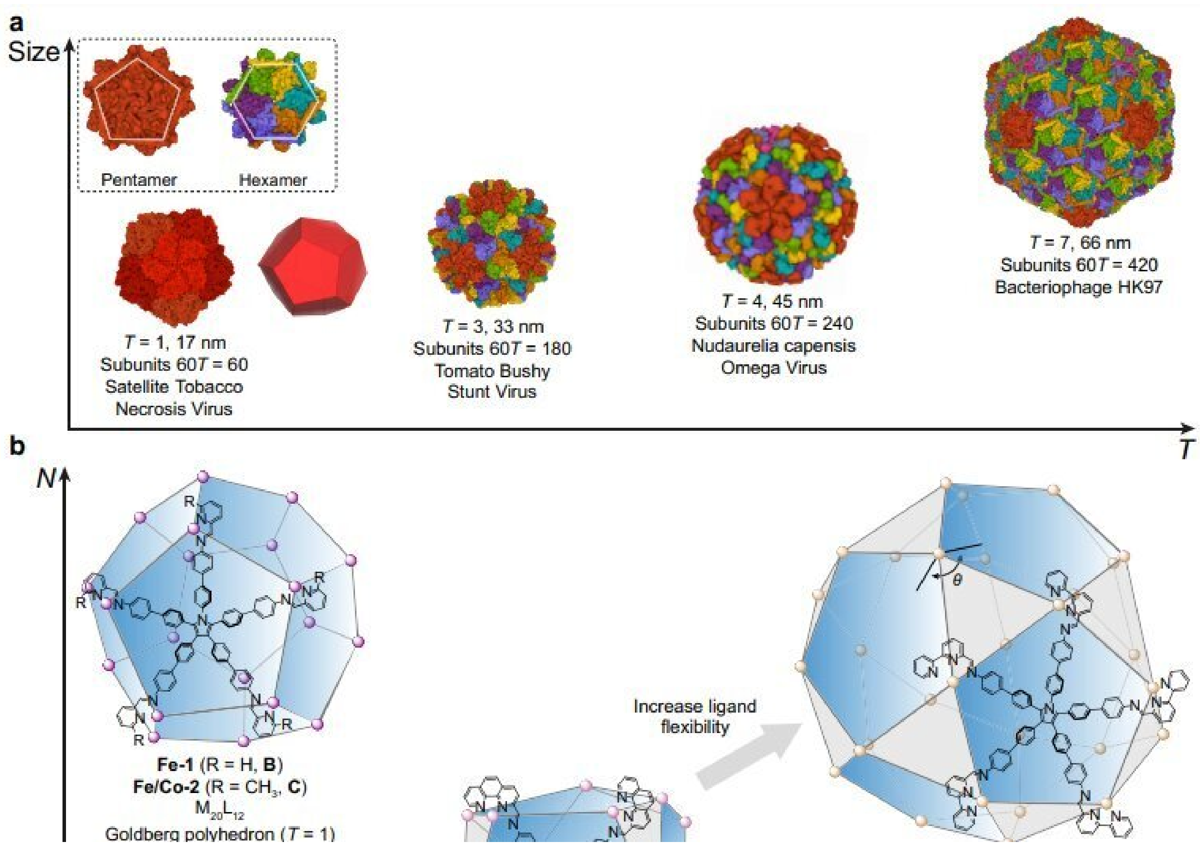
Super-sized nanocage could deliver bigger drug cargoes

April 6 2023



Schematic representation of the cages assembled from pentatopic pyrrole-based subcomponent A. a, Progressively larger viral capsids with icosahedral symmetry are constructed from pentagonal and hexagonal subunits by increasing the "triangulation number" T. Inset shows the pentamer and hexamer of virus with T = 7. b, Progressive increase in the number of metal vertices, i.e. the nuclearity (N), of the $M_{5n}L_{2n}$ cages assembled from subcomponent A as the dihedral angle between pentagonal faces at vertices (θ) increases; gray arrows highlight changes to the system that brought about an increase in both θ and N. Dodecahedra 1 and

2 correspond to the Goldberg structure with T = 1. The inset box shows organic subcomponents A–E and the metal ions used to construct the cages shown. Credit: *ChemRxiv* (2022). DOI: 10.26434/chemrxiv-2022-p836x

Think about how frustrating it is to try to fit a gift into a box that is too small. Sometimes you just need a bigger box.

Nanocages are tiny artificial containers that can be used to deliver therapeutics to a target destination in the body. But some drug molecules are like gifts that are too big for a standard-sized nanocage "box." Now, in an article published today (April 6) in *Nature Synthesis*, researchers from the University of Cambridge describe how they have built a super-sized nanocage that could be used to deliver larger drug cargoes.

Simple building blocks

Rational control over the self-assembly of these types of cages generally poses considerable challenges. So instead of following traditional self-assembly methods, the team decided to use a simple building block process inspired by natural biological systems. Using the new method, they were able to build progressively larger artificial nanocages, with the largest cage having an enclosed volume greater than 92 cubic nanometers—the largest ligand-enclosed inner cavity volume ever made.

Larger cages have been reported, but they have more open ligand frameworks, which are not as useful because these cages have not been able to bind cargoes. Prospective "guest" molecules slip out between the widely-spaced bars, unless they are covalently tethered to the "host" framework.

First author Dr. Kai Wu, a postdoctoral researcher in the Nitschke lab in the Yusuf Hamied Department of Chemistry, said, "The findings of this study are important because they demonstrate how we are able to create ever-larger complex, functional structures using simple building blocks."

Larger cargoes

The super-sized nanocages have potential applications in fields such as drug delivery and biotechnology, where they could be used to deliver larger therapeutic biomolecules to specific parts of the body.

The researchers also note that the large internal cavities of the nanocages could serve as a platform for the binding of large biomolecules, such as hydrophobic membrane proteins or proteases, which could be useful in drug discovery and development.

Wu said, "Overall, this research expands our understanding of how to create nanoscale structures and may have practical implications in a variety of fields."

Professor Jonathan Nitschke, who led the research, said, "This work, sponsored in part by Astex Pharmaceuticals under its Sustaining Innovation Postdoctoral Program, aims to have real-world impact in the field of new drug development."

More information: Jonathan Nitschke, Systematic construction of progressively larger capsules from a fivefold linking pyrrole-based subcomponent, *Nature Synthesis* (2023). DOI: 10.1038/s44160-023-00276-9.
www.nature.com/articles/s44160-023-00276-9

Provided by University of Cambridge