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PRESS RELEASE

Biomimetic nano-objects: controlling their assembly

Researchers from CEA[1], CNRS[2] and the pharmaceutical laboratory Ipsen have recently shown, using the SOLEIL synchrotron, that it is possible to generate peptide nanotubes with precisely controlled diameters. Formed by the spontaneous assembly of a peptide, Lanreotide, the size of these nanotubes is controlled by the structure of this "building block". By the judicious modification of one of Lanreotide's amino acids, the researchers were able to obtain a range of 17 nanotubes, each perfectly regular and of a specific diameter. This is a first, which opens up numerous possibilities, notably in the nanotechnology field. These studies have been published online in the journal PNAS.

In the field of nanotechnology, it is important to control the size of nano-objects, since their size affects the physical properties of these materials. However, attempts reported in the literature at controlling the size of structures by modifying these building blocks have often failed. Using a biomimetic approach, researchers from CEA-iBiTec-S, CNRS and Ipsen have focused on a small molecule, an analogue of a natural hormone, somatostatin, and normally used as a drug, Lanreotide, a cyclic octapeptide[3]. This peptide, composed of eight amino acids, can self-assemble in water into dimers[4], which in turn associate to form nanotubes of a defined diameter. This type of self-assembled structure is an interesting approach in the synthesis of nanomaterials because, in these systems, their shape and size are mainly influenced by the structure of the building blocks.

Focusing on the structure of the walls of the nanotubes, the researchers then assumed that the amino acids, by ensuring contacts between peptides, governed the radius of curvature of the nanotubes. They developed a geometric model that explained why a change of a few angstroms to the basic structure of the peptide affected the size of the nanotubes, enabling them to rationalize or even predict the diameters of nanotubes thus created. Experimental verification of this model was done by synthesizing analogues of Lanreotide and the **whole strategy of this study was therefore based on the modification of an amino acid involved in the contact between peptides and showing that this mutation caused a controlled variation in the diameter of the nanotubes.**

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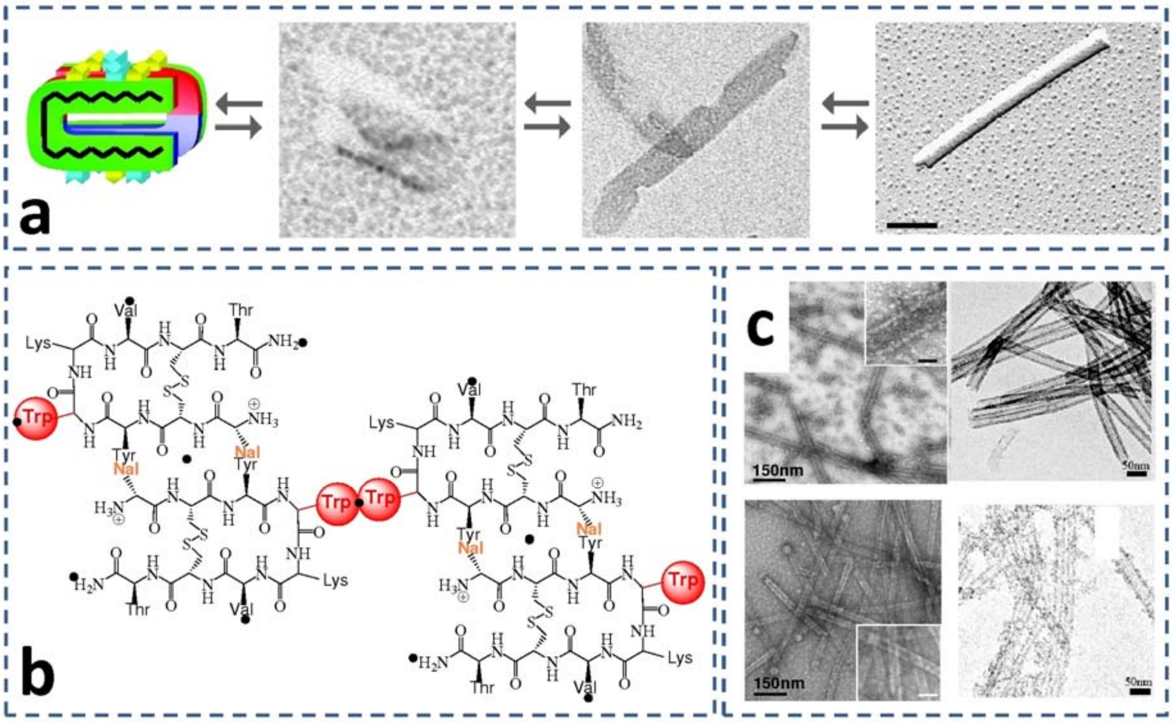
1 CEA-iBiTec-S: Institut de Biologie et de Technologies de Saclay, Direction des Sciences du vivant, CEA.
2 Among the involved laboratories: Institut de physique de Rennes (CNRS / université de Rennes 1), the group « Interactions cellulaires et moléculaires » (CNRS / université de Rennes 1) and the group « Systèmes membranaires, photobiologie, stress et détoxication » (CEA / CNRS).
3 Cyclic octapeptide: peptide composed of an 8 amino acid chain, forming a ring.
4 Dimer: molecule composed of two subunits.

The researchers synthetized analogues of Lanreotide by substituting one targeted amino acid for another. These peptides retained the assembly properties similar to those of Lanreotide and formed nanotubes. Characterization of these structures, done using electron microscopy and X-ray scattering at SOLEIL synchrotron, showed that the diameter of these nanotubes was effectively correlated with the size of amino acid introduced and that a given peptide spontaneously formed nanotubes of a specific diameter. **Seventeen nanotubes ranging from 10 to 36 nm in diameter were thus obtained depending on the amino acid incorporated.**

The use of these biomimetic self-assembly systems in nanotechnology depends on the possibility of using them as molds. Indeed, we find many examples in nature where organic templates are used to control the growth of inorganic phases (bone, teeth, shells, diatoms, etc.). **Thus, using these peptide nanotubes as molds, the researchers showed that it is possible to control the production of silica nanotubes of specific diameter, which opens up a wide range of applications in nanotechnology, e.g. optical fibers or nano filtration.**



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A: Stages of Lanreotide assembly into nanotubes: monomer<->dimer<-> 2-D bent crystal <-> nanotube
B: Lanreotide stacking on the inner surface of nanotubes: showing contact between peptides provided by the amino acid tryptophan modified to modulate the nanotube diameter.
C: Electron microscope images of nanotubes (peptide nanotubes on the left; peptide nanotubes mineralized with silica on the right)

Reference:
Control of peptide nanotube diameter by chemical modifications of an aromatic residue involved in a single close contact. Christophe Tarabout, Stéphane Roux, Frédéric Gobeaux, Nicolas Fay, Emilie Pouget, Cristelle Meriadec, Melinda Ligeti, Daniel Thomas, Maarten IJsselstijn, François Besselievre, David-Alexandre Buisson, Jean-Marc Verbavatz, Michel Petitjean, Céline Valéry, Lionel Perrin, Bernard Rousseau, Franck Artzner, Maité Paternostre, Jean-Christophe Cintrat. *Proc Natl Acad Sci U S A, **online**.*

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