PROTEIN NANOSTRUCTURES

Two in the model

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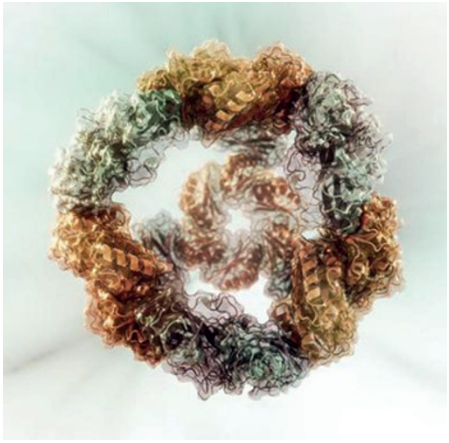

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Inspired by biological systems, researchers have sought to use proteins to create synthetic self-assembled nanostructures. Computational methods have, in particular, been developed that allow novel protein assemblies to be built with atomic-level precision, but the structures designed so far have been relatively basic and use only one type of building block. David Baker and colleagues at the University of Washington and the University of California, Los Angeles have now developed a computational method that allows nanostructures to be designed from two distinct subunits.

The approach is based on Rosetta software, which was originally developed by Baker and colleagues to predict the structure of naturally occurring proteins. First, the docking of protein building blocks on defined symmetry axes is systematically explored and used to identify large interfaces with high densities of contacting residues. Then, sequences of amino acids are designed to stabilize these interactions and drive co-assembly of the two components.

The team used the method to design five different cage-like nanostructures, which each contained 24 subunits. The structures were synthesized and, with the help of electron microscopy and X-ray crystallography, shown to closely resemble the computational models. *OV*

COATINGS

An enduring shine

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From the early Renaissance until around the nineteenth century, egg whites were used as a varnish to glossify the surface, saturate the colours and protect pieces of art. They were popular because they are very stable and they do not turn yellow or become brittle like oils and resins. Despite their popularity, however, little is known about why they are stable. Now, researchers at the Rensselaer Polytechnic Institute show that the native structure of egg whites adsorbed on hydrophobic surfaces changes from an α-helix to β-sheet structure, which protects paintings by acting as an oxygen barrier.

Georges Belfort and colleagues soaked hydrophobic polytetrafluoroethylene membranes, which acted as a model for the surface of fresh oil paintings, in ovalbumin (the main protein in chicken egg white) and studied the protein structure using attenuated total reflection Fourier transform infrared spectroscopy. Over 24 hours, the α-helix content of the ovalbumin coating decreased by 73% whereas the β-sheet content increased by about 44%. This suggests that after extended exposure to air, the protein coating contained mostly β-sheets, which are similar to those found in amyloid fibrils associated with neurodegenerative diseases. When the coated membrane was left in a two-compartment chamber with oxygen being fed in the bottom chamber and nitrogen in the top, the rate of oxygen diffusion across the membrane decreased over time and reached zero when four layers of ovalbumin were coated on the surface. It is suggested that the β-sheets trap and prevent oxygen from diffusing to the artwork. *ALC*

MOLECULAR TRANSPORT

Myosins stir it up

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Molecules in cells move following complex patterns, which operate on a range of different timescales: Brownian fluctuations typically dominate at short timescales whereas directed motion takes over at longer scales. Frederick MacKintosh, Christoph Schmidt and colleagues at Georg-August University, Rice University and Vrije University now report a study of intracellular dynamics that ranges over five orders of magnitude in time and identifies an intermediate regime of molecular transport.

The researchers follow the motion of kinesin proteins — molecular motors that move along microtubule tracks — by mapping the fluorescent signal from carbon nanotubes attached to the proteins. By acquiring the fluorescent signal at an intermediate rate of four frames per second, they show that, in addition to thermal diffusion and directed motor activity, kinesins exhibit a vigorous random motion, while still attached to the microtubules.

Schmidt and colleagues attribute this finding to the action of myosin proteins that indirectly agitate kinesin's tubulin tracks. Tubulin forms strong filaments that are embedded in a network of more flexible actin filaments. The myosins exert a mechanical stress on the actin network. This stress is then released in the form of random stirring of the whole filament network, including the microtubules. This random stirring, independently of the directed kinesin motion, enhances molecular transport at intermediate timescales. *AM*

METROLOGY

Reliable single-electron source

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Defining electrical units of measurement in terms of universal constants allows precise standards to be established. Both the unit of volt and ohm can be defined from the elementary charge *e* and the Planck constant by exploiting the Josephson effect and the quantum Hall effect, respectively. However, an equivalent, robust standard for the ampere is still lacking. One proposal is to use single-electron pumps — quantum devices that shuffle electrons one at a time with a certain frequency *f* — so that the standard of current can be defined from the product of the elementary charge and the frequency (*ef*). The drawback is that these devices operate in the tunnelling regime, whose stochastic nature results in fluctuations of the measured current from the value *ef*. Lukas Fricke, Frank Hohls and colleagues at the Physikalisch-Technische Bundesanstalt have now experimentally demonstrated a device configuration that can overcome this problem.

The researchers implemented a series of three single-electron pumps and two charge detectors, which monitor the flow of electrons across the pumps. Single electrons are shuffled across by applying voltage pulses to each pump in a certain sequence. Then, subsequent pulses allow the detection of pumping errors, that is, of events in which a pump fails to shuffle an electron. The knowledge of these errors allows, in turn, the current fluctuations to be determined from *ef*, and eventually to achieve a tenfold improvement in accuracy compared with the case of individual electron pumps. *ED*

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