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Nanomachine mimics nature's protein factory

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Nature is a clever chemist. Instead of bubbling reactants in a flask and hoping the right bonds form in the right places, nature uses cellular machines such as enzymes and ribosomes to build molecules step by step. Now, with the development of an artificial ribosome, human chemists are catching up on 2.5 billion years of evolution. The nanomachine could one day be used as a protein factory, assembling antibiotics such as penicillin.

Ribosomes join amino acids together: one part of the ribosome "reads" a chain of messenger RNA, which carries the code for the amino acid sequence to be built, while another section picks up the required amino acids. The ribosome then assembles these to make long proteins or smaller peptides.



Mimicking ribosomes could make drug manufacture much simpler (Image: Hybrid Medical animation/SPL)

To mimic this action, David Leigh at the University of Manchester, UK, and his colleagues used a ring-shaped molecule threaded onto a rigid track made up of a chain of small molecules. The track had three amino acids positioned along it, as well as a large inert chemical group at one end to act as a stop, preventing the ring slipping off.

Adding an acid to the system activates it, causing the ring to move along the track until its path is blocked by the first amino acid. A catalyst on the ring (the reactive "arm" in the video above) picks off the amino acid and attaches it to the ring, which then continues its journey.

Peptide bounty

The same thing happens when the ring encounters the second and third amino acids, only the catalyst places each amino acid on top of the previous one, forming a short peptide. With no amino acid obstacles remaining, the ring drops off the opposite end of the track to the stop, and releases its peptide bounty.

"It looks simple, but it's a lot more complicated than people have done before," says Leigh. Adding amino acids in such an ordered, autonomous way has proven difficult in the past.

However, the artificial ribosome is much slower than a real one, taking 12 hours to pick up one amino acid, compared to 20 per second that a ribosome can achieve.

"Yes, this is crude, but it's really elegant," says [Rachel O'Reilly](#) of the University of Warwick, UK, who was not part of the team.

Others have used [DNA "walkers"](#) moving along a track to build protein and peptide chains. But these processes are less well controlled than the one Leigh has exploited: if the walker hasn't picked the amino acid up within a certain time, it moves on, often missing out steps in the sequence. Leigh's machine cannot avoid gathering up its cargo.

Leigh says his small-molecule system could make ordered peptide and protein-like systems using building blocks other than amino acids. These substances could have exotic properties and be used to make new catalysts.

In the shorter term, he suggests that his machine could be used as an antibiotic production line for drugs like penicillin that are based on tripeptides, three linked amino acids. Building drugs in this way would be much more efficient than synthesising them using traditional laboratory techniques.

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