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Molecular machine mimics cellular production line

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Manchester scientists have developed a tiny molecular machine that mirrors the function of the ribosome, which builds the proteins in our body's cells.

Just a few millionths of a millimetre in size, the minute machine resembles a ring threaded on a rod.

As this ring moves along the rod, it picks chemical units and assembles them into chains, just as ribosomes join up the building blocks of proteins.

The ultimate goal is to synthesize new drug molecules or new types of plastic.

"Just as robots are used to assemble cars in factories in the big world, one day we hope we will be able to use artificial machines like these in molecular factories to construct new things with great efficiency," said Prof David Leigh from the school of chemistry at Manchester University, UK.

"Ribosomes make proteins, which are just one type of polymer used by nature. In fact, all of biology is based on just four sorts of so-called information polymers - proteins, DNA, RNA and also carbohydrates.

"But with our artificial machines, we're not limited by the same building blocks of nature. So, we should be able to make new materials with other types of building blocks - new types of plastics, new types of catalysts, pharmaceuticals and so on".

The ribosome is one of nature's true marvels. This giant molecule concerns itself with the business of translating and acting on our genetic code. That code, held in the cell's DNA, is delivered to the ribosome by the "messenger" molecule RNA.

The ribosome reads the code and assembles long polymer chains out of amino acids. These chains then fold to form proteins, and it is the proteins that go on to build and maintain our bodies.

An artificial ribosome, like the one developed in Manchester, functions in a similar way.

The machine's chemical structure is based on a rotaxane, a molecular ring threaded on to a rod. A "reactive arm" is attached to the ring and works its way down the rod, removing and stacking the amino acid units bound to the rod.

A key point is that the sequence for a new polymer chain comes from the scientists. It is controlled by the chemical groups placed along the rod structure.

"The degree of control we have in this is exquisite," said Prof Leigh.

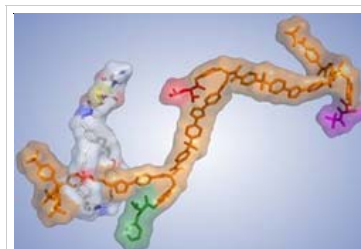
At the moment, the team is only producing small molecules, or peptides, that comprise chains of just a few units in length. This will have to be scaled up to the many tens of units achieved by ribosomes.

But just as insulin for diabetics today is produced in vast vats by engineered microbes, so in the future the Manchester team envisages containers carrying millions upon millions of their artificial machines all churning out the programmed molecules.

"Even though each machine is producing one molecule at a time, if you have a million, million, million of them, all acting to produce the same molecule, then you can produce quantities of the molecule that you can see in a reasonable period of time," said Prof Leigh.

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The machine gives the scientists a high degree of control over the assembly sequence.
 Image Credit: Guillaume De Bo.

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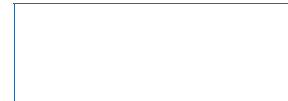
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