Molecular Robot Mimics the Ribosome

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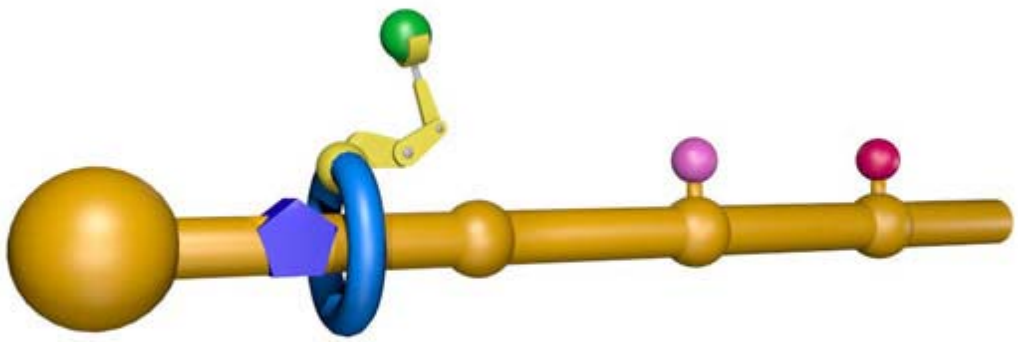
Technology



With molecules for moving parts, this nanorobot links together amino acids (colored balls) by attaching them to a moving ring (blue). Credit: Miriam Wilson

Scientists have invented a nanomachine that mimics the function of the ribosome, which is the molecular machine that translates the genetic code into the body's proteins.

Dave Leigh, a synthetic chemist at the University of Manchester, UK, and his team published their findings in the journal Science[1]. The machine is much simpler than the ribosome, and at about one-tenth of

the size and very slow. It destroys the code it reads and only produces short chunks of peptides, but some of these tactics could be used to make useful chemicals.

The machine built by Leigh and his team relies on a rotaxane, a large molecular ring threaded into another molecule that acts like an axle, which is lined with three amino acids. A chain of three amino acids hangs from the outer edge of the ring. One of these amino acids is cysteine, which contains a crucial sulfur-containing thiol group.

When the system is heated up, the thiol group plucks an amino acid from the axle and transfers it to the end of the chain. The ring moves along the axle and repeats this process again. Unthreading the ring and breaking off the newly-formed chain delivers a peptide made from all six amino acids.

Leigh's technique of sulfur-assisted amino acid transfer is found elsewhere in biology. Some bacteria use sulfur-assisted amino acid transfers to synthesize proteins. It's also commonly used in protein synthesis in the lab.

When 10^{18} of Leigh's molecular machines are run at once, tens of milligrams of the peptide are produced, but it is still a slow process, taking roughly 12 hours to attach each amino acid in the sequence. The ribosome, on the other hand, attaches 15 to 20 amino acids per second.

In its current form, the nanomachine requires the axle to be preloaded with amino acids in the correct sequence and can assemble just one peptide. In contrast, the ribosome grabs amino acids out of the liquid medium and assembles them in the right order according to a template. The team hopes to develop a molecular machine that does something similar in the future.

The goal is to move chemistry beyond its usual habit of making molecules using stepwise processes. These machines could eventually allow chemists to build materials with a specific sequence of molecules.

References

1. Lewandowski, B. *et al*. Science 339, 189–193. doi: 10.1126/science.1229753 (2013).