Researchers show RNA ribozymes able to cooperate to reassemble themselves

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(Phys.org)—A team of chemistry and applied sciences researchers from several universities in the United States has shown that RNA fragments torn apart in the lab work together to reassemble themselves. This finding, the team claims in their paper published in the journal *Nature* suggests that early life may have started with cooperative efforts between RNA molecules eventually leading to cooperative replication.

The team based its work on mathematical theories proposed by Manfred Eigen, a chemist who suggested that because early RNA wouldn't be able to successfully evolve from short stranded molecules, they must have had help. That help, he said, may have come in the form of cooperative efforts between molecules.

In earlier work team lead Niles Lehman had found that if long RNA molecules known as ribozymes were cut into fragments and then placed together in a Petri dish, they would over time reassemble themselves into their original configuration. In this new research, Lehman et al altered three ribozyme samples so that they were identical save for one letter that allowed for distinguishing among them. Each was cut into two pieces and placed in a Petri dish. The team found that if the ribozymes were placed together in a Petri dish, they reassembled themselves faster than if they were put in the dish alone. This occurred, they report, because one of the ribozymes helped another reassemble, who then helped a third reassemble who in turn helped the first reassemble, which formed a closed loop network.

To see if the same result might be possible in a more chaotic environment, the researchers placed 48 cut ribozymenes in a test tube with millions of other RNA molecules and found that the original 48 found a way to locate their other parts and each other and helped one another reassemble; again much faster than any of them would have alone.

The team suggests that a similar type of cooperation among short RNA molecules in Earth's primordial soup may have allowed them to replicate in a way that avoided the problem of building up mistakes when making copies that mathematical models have suggested would have led to evolutionary death. That would have allowed them to evolve into longer more complex RNA molecules and eventually into all the other molecules that exist today.

More information: Spontaneous network formation among cooperative RNA replicators, *Nature* (2012) doi:10.1038/nature11549

Abstract
The origins of life on Earth required the establishment of self-replicating chemical systems capable of maintaining and evolving biological information. In an RNA world, single self-replicating RNAs would have faced the extreme challenge of possessing a mutation rate low enough both to sustain their own information and to compete successfully against molecular parasites with limited evolvability. Thus theoretical analyses suggest that networks of interacting molecules were more likely to develop and sustain life-like behaviour. Here we show that mixtures of RNA fragments that self-assemble into self-replicating ribozymes spontaneously form cooperative catalytic cycles and networks. We find that a specific three-membered network has highly cooperative growth dynamics. When such cooperative networks are competed directly against selfish autocatalytic cycles, the former grow faster, indicating an intrinsic ability of RNA populations to evolve greater complexity

through cooperation. We can observe the evolvability of networks through in vitro selection. Our experiments highlight the advantages of cooperative behaviour even at the molecular stages of nascent life.