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Self-assembled tripeptide fibers as prebiotic RNA binders

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Before the emergence of the first RNA polymerase ribozyme, sustained non-enzymatic replication of RNA was crucial to the development of early life. To that end, cationic peptides have been hypothesized to be able to assist in template-directed non-enzymatic RNA polymerization by binding to and selectively inhibiting the annealing of long, complementary RNA strands. These strands can then act as templates for free primer strands, resulting in progressive replicative turnovers. However, the geochemical scenarios that would allow for the accumulation of high concentrations of long, cationic peptide oligomers are not likely. Recently, it has been discovered that certain tripeptide systems can spontaneously self-assemble into hydrogels and fibrillar macrostructures. As the accumulation of high concentrations of peptide trimers is much more likely than longer oligopeptides on the early earth, we probed the self-assembly properties and RNA-binding affinities of six tripeptides, each containing a cationic residue in the N-terminal position followed by an aromatic or hydrophobic dyad. KYF and RFF showed the best fibrillar self-assembly propensity-RFF is the first purely-peptidic arginine-containing tripeptide to self-assemble and microscopy and binding assays show that RNA indeed binds to the structures generated by these tripeptides. In fact, binding of a fluorescent RNA to cationic fibrillar macrostructures resulted in a direct label-free method of visualizing the kinetics of nanostructure assembly in real time. As these tripeptide assemblies are also reasonably heat-stable and do not prohibitively inhibit nonenzymatic RNA replication, our studies suggest that cationic tripeptide nanostructures could have been prebiotically-plausible RNA-binders, potentially possessing the ability to assist in the replication and eventual evolution of early genetic systems.

Biography

Tony Z Jia is a Researcher of the Earth-Life Science Institute at the Tokyo Institute of Technology in Tokyo, Japan. His research interests include prebiotic and ancient biopolymer formation and evolution.

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