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Artificial evolution of RNA catalysts: Filling a gap between the RNA world and the next world

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An evolving life form must possess the ability to manipulate its own surroundings through chemical transformation in order to provide an environment conducive to metabolic function. It must also provide a hereditary record necessary to carry out critical functions for future generations. Central to this theme is the discovery of catalytic ribonucleic acids (ribozymes) in the early 80's in which certain RNA molecules possess catalytic function in addition to hereditary function. This discovery has led us to hypothesize that RNA molecules could have central roles in evolving primitive life. This notion is called "the RNA world". Unfortunately, the naturally occurring ribozymes thus far found in nature are able to catalyze only phosphoryl transfer reactions. Clearly, this is not enough evidence for persuading the RNA world hypothesis.

In vitro selection is a powerful method for probing the catalytic possibilities of nucleic acids. This method allows us to isolate rare catalytically active sequences of RNA from a combinatorial library containing approximately 100 trillion different RNA molecules. This procedure is considered to be an in vitro version of Darwinian evolution, which is the preferential survival and reproduction of the fittest variants in the population. My laboratory uses this technique to evolve novel ribozymes in vitro, in order to obtain evidence that RNA may have served as the evolutionary vehicle necessary for the development of present day DNA/protein-based life forms.

In last a half decade, my laboratory has attempted to isolate ribozymes that are able to charge amino acids on transfer RNA (tRNA) [*1–4*]. This work has aimed at discovering ribozymes that can bridge a missing link between RNA and protein world. In the lecture, I shall describe a hypothesis of how amino acids could have been involved in an early stage of the replication of RNA molecules in the RNA world, and how such amino acids could have begun being utilized in a prototypical translation system. Then, I shall discuss our effort in isolating ribozymes with tRNA aminoacylation function, and revisit the hypothesis how the RNA world can bridge to the pre-modern world consisting of RNA and protein.

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