Origin of genomic DNA: Discussion from reverse-transcription and expansion of repetitive oligonucleotides

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ゲノム DNA の起源：短鎖反復核酸の逆転写および伸長合成からの考察

[Abstract]

Genetic information of organisms is preserved within sequences of nucleotides in genomic DNAs, which are possible to be replicated by DNA polymerase semiconservatively. The sequences of the DNA molecules in organisms are variant, but long. Even the DNA of *Mycoplasma genitalium*, which has a smallest DNA among all types of organisms, is of 580-kilobase pairs in length. However, the long DNA can be synthesized with neither some prebiotic experiments nor the present DNA synthesizing techniques. Only oligoribonucleotides 55mer are possible to be synthesized in the presence of a montmollironite clay under prebiotic conditions. How is the long DNA synthesized in the primordial environment? Ohno proposed the model that genes of the present organisms emerged from short repetitive oligoribonucleotides. Several types of DNA polymerase are capable to synthesize long repetitive DNAs with more than 50-kilobase pairs in length from short oligonucleotides such as $(TA)_n$, $(TG)_n$, $(CAG)_n$, $(TAGG)_n$, $(TTAGGG)_n$, $(TACATGTA)_n$, and $(AGATATCT)_n$ by conventional enzymatic reactions. Furthermore, telomerase, which catalyzes the synthesis of the telomere of eucaryotic genome ends, can synthesize the complementary repetitive DNA $(TTGGGG)_n$, in the presence of a RNA template by the reverse-transcriptional activity. There are various repetitive sequences such as $(GT)_n$, $(CAG)_n$, $(GGAAT)_n$, and $(TTAGGC)_n$ in the genomic DNA of different organisms containing Bacteria and Eucarya. Based on these examples, it is deduced that short repetitive DNA should have been synthesized from short RNA in the presence of oligopeptides catalysts or ribozymes, which have primordial reverse transcriptase-like actlvity; genomic DNA should have emerged from long repetitive DNAs elongated from the short repetitive DNA in the presence of primordial DNA polymerase-like oligopeptides or ribozymes. I discuss the plausibility of these ideas, proposing a model for the origin of genomic DNA from the reverse-transcription and expansion of repetitive oligonucleotides.