## ABSTRACT

Nucleoli are formed on the basis of genes of ribosomal DNA (rDNA) clusters called Nucleolus Organizer Regions (NORs). The essential structural components of the nucleoli, Fibrillar Centers (FC) and Dense Fibrillar Components (DFC), together compose FC/DFC units. These units are centers of rDNA transcription by RNA polymerase I (pol I), as well as the early processing events, in which an essential role belongs to fibrillarin. Each FC/DFC unit probably corresponds to a single transcriptionally active gene. In our work we study changes of FC/DFC units in the course of cell cycle. Correlative light and electron microscopy analysis showed that the pol I and fibrillarin positive nucleolar beads correspond to individual FC/DFC units. *In vivo* observations showed that at early S phase, when transcriptionally active ribosomal genes were replicated, the number of the units in each cell increased by 60 to 80 %. During that period the units transiently lost pol I, but not fibrillarin. Then, until the end of interphase, number of the units did not change, and their duplication was completed only after the cell division, by mid G1 phase. This peculiar mode of reproduction suggests that a considerable subset of ribosomal genes remain transcriptionally silent from mid S phase to mitosis but become again active in the postmitotic daughter cells. In our research we continued the study of the FC/DFC units and examined kinetics of their most important proteins, polymerase I and fibrillarin. Following changes of the fluorescent signals in individual FC/DFC units, we found two kinds of kinetics: the rapid fluctuations with periods of 2-3 minutes and slow fluctuations with periods of 10 to 60 min. Our data indicate that a complex pulsing activity of transcription as well as early processing are common for ribosomal genes. In first theoretical work focused on the nucleolar DNA, which is closely linked to our experimental data about FC/DFC units we discuss the characteristics of ribosomal DNA. In second theoretical work we focused on the discontinuous transcription, and thus directly connected to the data of our second experimental study, which indicate that ribosomal genes in mammalian cells are also transcribed discontinuously. Both theoretical works are the basis of theoretical introduction of thesis.



**Key words:** Nucleolus, FC/DFC unit, rDNA, polymerase I, fibrillarin, cell cycle, transcription, replication, fluctuation.