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Samarina O P, Lukanidin E M, Molnar J & Georgiev G P. Structural organization of nuclear complexes containing DNA-like RNA. *J. Mol. Biol.* 33:251-63, 1968.
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Nuclear ribonucleoprotein particles containing hnRNA are shown to have a "beads on a string" structure, i.e., the giant hnRNA is regularly wrapped on the surface of a series of homogeneous globular protein particles (called informofers). Mild RNAase treatment converts them into monomeric 30S particles. [The *SCI*® indicates that this paper has been cited in more than 470 publications.]

Structure of Nuclear hnRNA-Protein Particles

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In 1963, I was invited by Vladimir Englehardt to become the head of the department in the Institute of Molecular Biology. My first senior research associate was Olga P. Samarina, who began work with us on the DNA-like RNA (hnRNA), discovered recently in our group.[1,2] Samarina tried to isolate this RNA as a part of the nucleoprotein complex. She found that the bulk of hnRNA could be recovered in the form of heterogeneous 30S particles.[3] However, the small size of RNA in 30S particles, equal to approximately 700 nucleotides, was in contraversion with that of giant hnRNA.

The hypothetical explanation was that 30S particles represented the monomers of larger and more complex structures. In the spring of 1967, I was at the CIBA Symposium (my first trip to the West). One morning, looking through the recent journals in the library, I found a paper on "nuclear polysomes."[4] Looking through the pictures, I immediately realized that the described structures were not polysomes, but our hypothetical particles. The authors used the cytoplasmic RNAase inhibitor to protect "polysomes" from degradation, and I decided to try to use this inhibitor. After coming back, we discussed the idea with Samarina and her aspirant (postgraduate) Evgenii M. Lukanidin. He prepared inhibitor from rat liver cytoplasm and added it to the medium for hnRNP extraction. In three days, we received the nuclear particles of heterogeneous size (from 30S to approximately 200S). Mild RNAase treatment converted them into monomeric 30S particles. We suggested that hnRNPs were constituted of globular protein particles on which long hnRNA was wrapped in such a way that approximately 700 nucleotides were located on the surface of each particle. The globular protein particle was designated as "informofer." The postulated structure was proved by buoyant density analysis (1.4 g/cm^3 for particles of any size): sizing RNA in monomers, dimers, trimers, etc.; analysis of protein composition of 30S particles and oligomers; and, finally, by direct electron microscopy of different oligomers.

Thus, the main principle of hnRNP organization was determined. Later the location of hnRNA on the surface of protein particles was proved by Lukanidin et al.[5] in experiments where RNA was reversibly removed from the particles, while informofers remained in solution in the form of globular 30S protein particles.

The results were reproduced by several other authors only three to four years later, since the main experiment with quantitative conversion of oligomers into 30S particles required a precise RNAase concentration.

The paper was often cited, as it was the first work where the native hnRNPs could be isolated and where their structural organization was solved. Also, it was the first paper where the new principle of nucleoprotein organization (nucleic acid wrapped on the surface of protein particles) was described. Interestingly, a similar principle of organization was detected in 1973-1974, in the case of nucleosomes.

Very typically, all names suggested in the original papers ("informofers" for protein particles; "informatins"[5] for approximately 40 kD structural proteins constituting the 30S particles) were rejected by the authors who reproduced our original results and, of course, our "terminology war" was lost, as they wrote the papers in their own language.[6]

The work won the Lenin Prize in 1976.

1. **Georgiev G P & Mantieva V L.** The isolation of DNA-like RNA and ribosomal RNA from the nucleolo-chromosomal apparatus of mammalian cells. *Biochim. Biophys. Acta* 61:153-4, 1962. (Cited 235 times.)
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4. **Lawford G R, Sadowsky P & Schachter H.** Use of a ribonuclease inhibitor from rat liver supernatant fraction in the preparation of polyribosome-like particles from isolated rat liver nuclei. *J. Mol. Biol.* 23:81-7, 1967.
5. **Lukanidin E M, Zalmanzon E S, Komaromi L, Samarina O P & Georgiev G P.** The structure and function of informofers. *Nature (London) New Biol.* 238:193-7, 1972.
6. **Samarina O P & Krichevskaya A A.** Nuclear 30S RNP particles. (Busch H, ed.) *The cell nucleus. Nuclear particles.* New York: Academic Press, 1981. Vol. 9. p. 1-48.

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