Laboratory of Biology of the Cell Nucleus

Cell nucleus, gene expression, nucleoskeleton, nuclear actin, myosins and lipids, microscopy, ultrastructural methods

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Cell nucleus is a fascinating organelle, where some 6 x 109 base pairs of DNA fold as a nucleoprotein complex (i.e. chromatin) into higher-order arrays so as to fit in a structure measuring only 10 μm. The machineries for transcription of genes and processing of RNA products, for accurate DNA replication, repair and recombination are precisely regulated within the nucleus. Multiple protein-protein, protein-nucleic acid, and protein-lipid interactions take place in specific microenvironments forming functional domains. Recent evidence points strongly to structure-related regulation of nuclear functions – however, the mechanisms forming the 3D-structure of the nucleus are still mostly obscure. We therefore employ a multi-disciplinary approach in order to study nuclear functions in relation to the higher-order nuclear structures, e.g. nuclear bodies, the nucleolus, and the nucleoskeleton. Our research concentrates on: (1) the relationship between nuclear compartmentalization and regulation of gene expression (2) structure, dynamics, and function of the nucleoskeleton which contributes to the nuclear compartmentalization, (3) functions of nuclear myosins in transcription and gene expression, (4) functions of nuclear lipids, (5) development of new microscopy methods for ultrastructural studies.

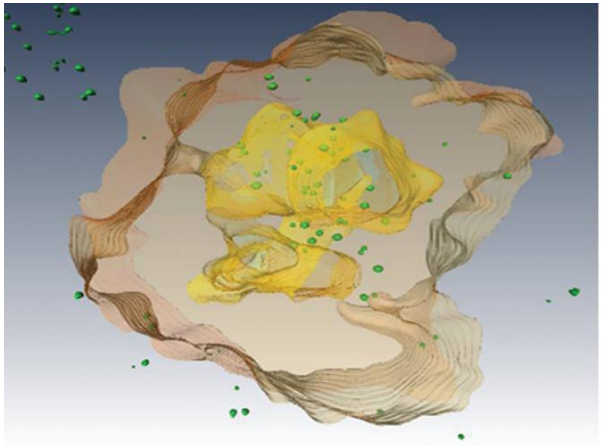

Fig. 1. PIP2 distribution in nucleolar subcompartments by TECNAI G2 20 LaB6 electron tomography. The fibrillar centre is pseudocoloured in yellow, the dense fibrillar component is in orange, and PIP2-containing areas are in green. (Yildirim et al., 2013)

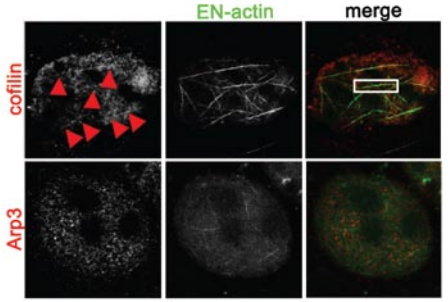

Fig. 2. Nuclear EN-actin (actin tagged with yellow fluorescent protein) filaments recruit Arp3 and cofilin. Co-localization of the nuclear EN-actin filaments with various actin-binding proteins was tested by indirect immunofluorescence microscopy in the U2OS cells. (Kalendova et al., 2014)

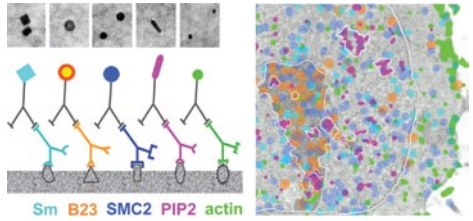

Fig. 3. Pathented method of simultaneous ultrastructural immunolabelling of five cellular antigens using metal nanoparticles of different shapes conjugated to secondary antibodies. The top panel: cubic palladium nanoparticles, silver-gold core-shell nanoparticles, 12-nm spherical gold nanoparticles, rod-like gold nanoparticles, 12-nm spherical gold nanoparticles. The right panel: mapping of labelled areas by respective antigens in the HeLa cell nucleus (Philimonenko et al., 2014)

- GACR, GAP305/11/2232 – Functions of myosin I and its binding partners in the cell nucleus, 2011-2015, P. Hozák
- MIT, FR-TI3/588 – Development of a kit for detection of mutations in structural proteins of a cell, 2011-2015, P. Hozák
- MIT, FR-TI4/660 – Multimodal holographic microscope, 2012-2014, P. Hozák
- TACR, TE01020118 – Electron microscopy, 2012-2019, P. Hozák
- MEYS, LD12063 LD-COST CZ – New nuclear functions of intermediate filaments, 2012-2014, P. Hozák
- MEYS, LH12143 LH-KONTAKT II – Cooperative contribution of actin- and myosin-families to the chromatin dynamics and tranion in the cell nucleus, 2012-2014, P. Hozák
- 1.07/2.3.00/30.0050 – Founding the expert platform for phenotyping and imaging technologies, 2013-2015, R. Sedláček, P. Hozák
- HFSP, RGP0017/2013 - Actin and actin-related proteins: probing their nuclear function, 2013-2016, P. Hozák
- FP7 EU, 262023 EURO-BIOIMAGING - Euro-BioImaging - Research infrastructure for imaging technologies in biological and biomedical sciences, 2010-2013, P. Hozák

1. Kalendová A, Kalasová I, Yamazaki S, Uličná L, Harata M, Hozák P: Nuclear actin filaments recruit cofilin and actin-related protein 3, and their formation is connected with a mitotic block.. **Histochem Cell Biol 2014** 142(2): 139-52.
2. Sobol M, Yildirim S, Philimonenko VV, Marášek P, Castaño E, Hozák P: UBF complexes with phosphatidylinositol 4,5-bisphosphate in nucleolar organizer regions regardless of ongoing RNA polymerase I activity. **Nucleus 2013** 4(6): 478-86.
3. Philimonenko VV, Philimonenko AA, Šloufová I, Hrubý M, Novotný F, Halbhuber Z, Krivjanská M, Nebesářová J, Šlouf M, Hozák P: Simultaneous detection of multiple targets for ultrastructural immunocytochemistry. **Histochem Cell Biol 2014** 141(3): 229-39.
4. Venit T, Dzijak R, Kalendová A, Kahle M, Rohožková J, Schmidt V, Rülicke T, Rathkolb B, Hans W, Bohla A, Eickelberg O, Stoeger T, Wolf E, Yildirim AÖ, Gailus-Durner V, Fuchs H, de Angelis MH, Hozák P: Mouse nuclear Myosin I knock-out shows interchangeability and redundancy of myosin isoforms in the cell nucleus. **PLoS One 2013** 8(4): e61406.
5. Yildirim S, Castano E, Sobol M, Philimonenko VV, Dzijak R, Venit T, Hozák P: Involvement of phosphatidylinositol 4,5-bisphosphate in RNA polymerase I transcription. **J Cell Sci 2013** 126(Pt 12): 2730-9.

First row from the left: Margaryta Sobol, PhD / Research Fellow, Vlada Philimonenko, PhD / Research Fellow, Prof Pavel Hozák, DSc / Head of Laboratory, Jindřiška Fišerová, PhD / Research Fellow, Lenka Pišlová / Secretary, Karel Janoušek / Technician
Second row from the left: Jana Fukalová, MSc / PhD Student, Ilona Kalasová, MSc / PhD Student, Lukáš Pastorek MA, Zuzana Lubovská / Technician, Ivana Nováková / Technician, Anatoly Philimonenko, MSc / Research Assistant
Third row from the left: Tomáš Vacík, PhD / Research Fellow, Pavel Kříž / Technician, Lívia Uličná, MSc / PhD Student, Pavel Marášek, MSc / PhD Student, Robert Havalda, MSc / PhD Student, Iva Jelínková
Not in the picture: Jana Rohožková, PhD / Research Fellow, Alžběta Kalendová, MSc / PhD Student, Tomáš Venit, MSc / PhD Student, Lenka Jarolímová, MSc / Research Assistant, Markéta Morská, MA (EuroBioImaging) / Project Manager, M., Irina Studenyak / Research Assistant, Ondřej Šmíd, PhD / Research Fellow, Magdalena Skalníková, PhD / Research Fellow, Robert Havalda, MSc / PhD Student, Petr Martin / Diploma Student, Sukriye Yildirim, MSc / PhD Student