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CYTOSKELETON AND CELL MOTILITY

Cytoskeleton, a complex intracellular network of polymeric filaments, plays an essential role in the maintenance of the cell shape, membrane dynamics, intracellular transport and distribution of the organelles, cell polarization, migration, and division.

Actin filaments (also called microfilaments), intermediate filaments and microtubules are the main components of the cytoskeleton. They are accompanied by numerous diverse proteins that regulate filaments nucleation, form a cap at the filament ends, stabilize filaments, interconnect them or cause their fragmentation, or function as motor proteins. Because microfilaments, intermediate filaments and microtubules are interconnected by the associated proteins, they act together as one network in response to external and internal stimuli. As a result, the cytoskeleton plays an essential role in cells and tissues differentiation and organs development, and in consequence in the maintenance of the homeostasis of the entire organism. Defects in the organization and function of the cytoskeleton lead to severe human disorders (e.g. epidermolysis bullosa, neurodegeneration, ciliopathies, and cancer).

The main cytoskeletal proteins, actin and α- and β-tubulin, are highly evolutionarily conserved in all Eukaryotes, and form polar polymers, microfilaments, and microtubules, respectively, with plus and minus ends that differ in their properties. Opposite to microfilaments and microtubules, intermediate filaments exist only in animal cells and are cell- and tissue-specific. Proteins that build intermediate filaments in different cell types differ in their amino acid composition, but have similar secondary structure and interact in a similar way to form apolar filaments. Although all three major cytoskeletal filaments interact with a number of associated proteins, only microfilaments and microtubules serve as tracks for the motor proteins.

Although the term “cytoskeleton” can be easily associated with term “skeleton” and thus considered as a solid and unchangeable structure, in fact the network of intracellular filaments is very dynamic and undergoes constant remodeling. It includes the exchange of subunits in the existing filaments as well as local or global reorganization of the entire network (involving depolymerization and polymerization of all filaments). Such dynamics of the cytoskeletal network enables not only the removal and replacement of the defective subunits or structures by the new ones but also the reorganization of the cytoskeleton in response to the intracellular and extracellular stimuli, e.g. during cell division or cell migration.

Not all components of the cytoskeletal are highly dynamic. The presence of the proteins that interact with main filamentous structures enables their bundling and formation of the more stable structures such as stress fibers composed of microfilaments or centrioles, basal bodies, and cilia, organelles with a stable microtubular scaffold.

Importantly, although in the cell, all microtubules, microfilaments and intermediate filaments are composed of the same subunits, specific for each type of filament, their properties differ not only in space (dif-

ferent cellular compartments) but also in time (depending on the stage of the cell cycle or cell differentiation). Such diversification is possible due to e.g. incorporation of different izotypes of α- and β-tubulin into microtubules, posttranslational modifications of tubulin, actin or subunits of the intermediate filaments as well as binding of the filaments associated proteins. Such differences in the properties of filaments are critical and enable participation in diverse cellular processes.

The following issue of KOSMOS was inspired by the 100th Anniversary of the Nencki Institute of Experimental Biology, Polish Academy of Sciences and was prepared by the former and present members of the Institute to commemorate the long-standing research conducted in the Institute, focused on the cytoskeleton, cell motility, and muscle contraction. The goal of this issue is to familiarize readers with these topics.

We are aware that many important problems from the field of the cytoskeleton and cell motility are not addressed in the articles presented in this issue, e.g. articles addressing intermediate filaments. The selection of the presented topics represents, however, the mainstream of research conducted in the Nencki Institute and by its alumni.

The preparation of this issue co-insides with 50th anniversary of the discovery of intermediate filaments by Howard Holtzer and co-workers celebrated this year as well as 50th anniversary of the discovery of tubulin by Gary Borisy and Ed Taylor, and 75th anniversary of experiments conducted by Albert Szent-Gyorgyi and co-workers leading to the discovery of actin that were celebrated last year. Moreover, next year we will celebrate the 60th anniversary of the discovery by Hugh E. Huxley and Jean Hanson of the basic mechanism of muscle contraction dependent on interactions between the actin and myosin filaments. More about the milestones in the research on cytoskeleton can be found on the following website: www.nature.com/milestones/cytoskeleton.

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