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EDITORIAL

Editorial

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Scientific breakthroughs happen when new technology enables us to explore previously inaccessible places. With recent advances in biophysical and microscopic techniques, we have reached that point with cytoplasmic nanospaces. Nanospaces are the intracellular domains found in all eukaryotes and prokaryotes at which selected molecules and ions are positioned so as to convert random thermal motion into directed flow, thus enabling otherwise thermodynamically unfavorable reactions. They vary from a few to a few hundred nanometers in size and can be both mobile and transitory. They are usually situated between apposing membranes but, unlike membrane-delimited organelles, nanospaces are contiguous with the cytosol. Some examples of critical cellular processes occurring in nanospaces are excitation–contraction coupling in muscles, the stabilization and control of multiprotein complexes such as membrane-bound cellulose synthases, focal adhesion turnover during cell migration, calcium homeostasis, and intracellular signaling.

Cytoplasmic nanospaces are the key to understanding information transfer within cells. Indeed, it is within nanospaces that macromolecules such as cholesterol can be exchanged, ion concentrations adjusted by orders of magnitude relative to that in the bulk cytosol, key reactants are concentrated, and intracellular signaling molecules are synthesized, degraded, and their effectors are found. This spatial restriction enables signaling networks to operate in parallel but use the same basic molecules, thus enabling specific outcomes with little to no cross-talk. How nanospaces form, how they are maintained, and how cellular processes operate within them and the consequences of their malfunction has only begun to be understood. However, such understanding is critically important because all cells rely on nanospaces for optimal function and nanospace breakdown is accompanied by disease.

To exploit the full potential of new technological advances, we require a multidimensional approach promoting interaction between biologists, biophysicists, mathematicians, and computational biologists. Conveying the knowledge to both experts and non-experts requires focusing student attention on 3D visualization and its scientific importance. To assess the needs and barriers to moving forward, in October 2010, we held a workshop in Vancouver, British Columbia, Canada. We examined the architecture, composition, and function of cytoplasmic nanospaces, the techniques used to study them, and the development of scientifically accurate modeling and visualization tools for understanding nanospace biology and visual–spatial literacy in graduates and undergraduates. The manuscripts published in this special issue of *Protoplasma* are the proceedings of our workshop.

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