AJP-Cell Physiology begins a Theme series on Evolution and Cell Physiology

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Since evolution is the basis of organismal development (“ontogeny recapitulates phylogeny”), an understanding of evolutionary biology is fundamental to ideas regarding cellular and subcellular organization and function. Although key concepts and findings in cell biology and evolutionary biology might thus be considered complementary to one another, the two disciplines are rarely looked at in this way. Evolution is sometimes viewed as the mysteries that underlie natural selection, but an alternative notion is that it is the history of an organism, including short-term events (e.g., development) and long-term ones (i.e., phylogeny). The application of a “cellular approach” reduces the process of evolution to perhaps its smallest functional unit, i.e., if there is no cell membrane, “data” regarding evolution are not biologic. In developmental biology, morphogenesis generates structure and function such that at the cellular level, ontogeny and phylogeny can be viewed as one and the same, and in particular, as cell-cell communication (signaling). Such an idea can focus attention to the cellular mechanisms of homeostasis that act to form, sustain, facilitate, or modify changes needed in both structure and function for homeostatic adaptation. Examples of such mechanisms include the ability of microvascular shear stress to remodel cellular niches through modification of cell-cell interactions intergenerationally; the widespread morphogenetic actions of growth factors (and their cognate receptors) to alter cell structure, size, and function; and the use of the second messenger cyclic AMP as a mechanism by which organisms respond to depletion of energy sources. The multigenerational impact of cellular epigenetic mechanisms—and their regulation by cell signaling networks—is another important example. By focusing on the complementary effects of external and internal selection on homeostasis as the fundamental “level of selection,” one hopes to identify general mechanisms for stability and change, and gain insight into how evolution “works” beyond just mutation and selection, while in parallel, obtaining new insights into cell and organismal physiology. One may also gain insight regarding the evolution of traits that increase vulnerability to pathophysiology and disease, such as proposed “mismatches” between form/function and the environment in which organisms live (e.g., the “Hygiene Hypothesis” that seeks to explain the increased incidence of atopic disease and asthma in developed countries).

With these ideas as background, we have organized a Theme series of review articles by several experts that seek to enlighten readers about key examples of “Evolution and Cell Physiology,” with a particular focus on cell-cell communication. This series of reviews was inspired by presentations at the American Physiological Society-sponsored EB 2013 Symposium, entitled “Evolution viewed through the lens of cell signaling.” The authors are John Torday (University of California, Los Angeles), Neil Blackstone (Northern Illinois University), William Weis (Stanford University), and Andre Le Bivic (IDBML, Marseille, France), whose topics will be, respectively: cell signaling as a central theme of evolutionary biology, cell signaling from mitochondria to Metazoa, epithelial polarization in Dictyostelium and the origin of metazoan multicellularity, and the evolution of junctional complexes.

We hope that readers will be stimulated by these reviews and that the articles will help them think about their own work in an “evolutionary context.” We welcome comments and thoughts regarding this Theme series.

DISCLOSURES

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