Journal club

LOV IS ALL WE NEED

For us cell biologists, seeing is believing, and thus we thrive to visualize molecular events in time and space. Many of our assay systems and functional readouts are based on endpoint analysis, mostly even of bulk material; however, cellular processes such as protein modifications or gene expression occur in a much faster time frame than we had ever imagined with protein dynamics playing a crucial part. It is therefore essential that we gain more insights into the real-time dynamics of cellular components with respect to their spatial organization and to develop tools to interrogate the interplay between protein function and localization in individual living cells.

A fast growing field is optogenetics; that is, the use of light to steer cellular processes using genetically encoded photoreceptors. In an inspiring paper, Wu *et al.* showed how a fusion between the small GTPase RAC1 and the blue-light-responsive LOV (light, oxygen or voltage) domain from the common oat *Avena sativa* could control lammelipodial dynamics in single motile living cells. The work demonstrated the power of this light-switchable module to rapidly activate endogenous downstream signalling by uncaging RAC1, which resulted in efficient and directed cell locomotion guided by light only. Although there are several other photoreceptors that bear advantages, such as longer excitation wavelengths, the beauty of the LOV domain lies in its simplicity for optogenetic applications, which does not require a sophisticated microscopy set up; it is a single, small protein with a fast turn-on and -off speed, which makes it tightly controllable and reversible.

> “a tool to not only ‘see’ but also control cell activity and organization”

This paper has influenced my view on how to approach and think about spatiotemporal control of cellular processes, and it inspired us and another group to develop an optogenetic tool for releasing autoinhibition of endogenous formins to enable spatial actin dynamics in 2013. Several studies have been published that further developed this optogenetic strategy to investigate cell functions, including cell polarization, nuclear import or protein–organelle interactions. Thus, we now have a tool to not only ‘see’ but also control cell activity and organization.

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