Frontier of life science

‘Frontier’ does not simply mean ‘innovation’, but reflects ‘unexpectedness’ or ‘surprise’. In this issue, we select four interesting biological studies that present not only new discoveries but also surprising observations. These findings might provide us new angles to understand the complex biological systems.

It is well known that plasmids containing genetic information can move from one prokaryotic cell to another, which is the most important way to exchange genetic information among the prokaryotic cell-communities. Recently, researchers have revealed that the similar way may also be used in multi-cellular organisms. In the first research article of this issue, Dr Zeng and colleagues reported that extracellular vesicles carrying genomic DNA fragments could be transferred from donor cells to recipient cells. Importantly, the authors showed for the first time that the genomic DNA fragments transferred via extracellular vesicles not only increased the genomic DNA-coding mRNA and protein levels, but also influenced the physiological function in recipient cells. This work indicates that a new way of ‘horizontal genetic information transfer’ exists in eukaryotic cell-communities.

Recent advances in the research area of stem cells have showed that Nanog, Sox2, and Oct4 play critical roles in pluripotency and genomic re-programming of stem cells (Cheng et al., 2011). Surprisingly, the work from Dr Zhu’s laboratory presented in this issue showed that these transcription factors could directly regulate the migration of mammalian epithelial cells. The authors showed that the ectopic expression of Nanog induced the disorganization of actin cytoskeleton and resulted in the inhibitory effect on cell migration. Furthermore, the authors found that the Nanog also down-regulated the mRNA expression of Tβ4 and Rnd3 that are involved in promoting cell migration. Interestingly, the over-expression of Nanog suppressed both gastrulation and cell migration in zebrafish embryos, implying a dual role of this kind of transcription factors in the coordination of cell differentiation and migration.

Directional localization of proteins on the cell surface is critical for proper functions of the cell, but how to direct the protein distribution remains elusive. In the present issue, Dr Lenkei and colleagues reported a systematical analysis on the mechanism of G-protein-coupled receptor (GPCR) distribution on the neuronal surface. The authors showed that the polarized distribution on the neuronal surface is GPCR conformation-dependent, which resulted in specific endocytosis of GPCRs in the somatodendritic domain and then transcytotic delivery of these GPCRs to distal axonal portions. Based on their results, the authors proposed that chronic modifications of basal GPCR activation may lead to previously un-anticipated changes in brain function through the perturbation of polarized GPCR distribution on the neuronal surface.

Not only proteins but also small molecules in cells are required for controlled distribution in order to carry out cellular functions. By using a novel fluorescent probe, Dr Pizzo and Pozzan’s laboratory revealed the complex distribution of Ca\(^{2+}\) in the Golgi apparatus (GA). The authors showed that luminal Ca\(^{2+}\) concentration appeared higher than that of the trans-Golgi, but lower than that of the ER, suggesting the existence of a cis- to trans-GA Ca\(^{2+}\) concentration gradient. This work implies that each sub-compartment of GA maintains its Ca\(^{2+}\) identity with specific Ca\(^{2+}\) homeostatic properties.

Reference