Differentiated cells do not revert to an embryonic state in normal development. However, the method called nuclear reprogramming enables these differentiated cells to be reversed to an embryonic state. One essential event in the reprogramming process is reactivation of embryonic genes such as Oct4 (also known as Pou5f1). This reprogramming of transcriptional programs can be achieved by transplantation of mammalian somatic nuclei to the giant Xenopus laevis oocyte nucleus, referred to as the germinal vesicle (GV). Factors and mechanisms responsible for this transcriptional reprogramming have not been elucidated. Recently, we have found that a polymerized form of actin is abundantly present in nuclei transplanted into the Xenopus oocyte nucleus and plays an important role in transcriptional reactivation of Oct4. This study emphasizes a significant contribution of nuclear actin in transcriptional activation. Here, we discuss possible roles of nuclear actin in Xenopus oocytes and in other cell types in the context of transcriptional activation.

As cell differentiation progresses, expression of embryonic genes is silenced. This silenced gene state in a somatic cell can be reprogrammed to be transcriptionally active by several different experimental strategies, including nuclear transfer to an egg/oocyte, cell fusion with embryonic cells, and induced pluripotency by defined factors. Nuclear transfer-mediated reprogramming is believed to be the most efficient route to reprogram somatic cells. However, oocyte factors and mechanisms involved in this efficient reprogramming have remained elusive. In order to gain mechanistic insight into the reprogramming by oocytes, we have developed the Xenopus oocyte nuclear transfer system in which hundreds of mammalian nuclei are injected into the germinal vesicle (GV) and reactivation of embryonic genes is detected from the transplanted nuclei without the help of cell division and new protein synthesis. The reprogrammed transcripts can be detected in a very sensitive manner and monitored at a single nucleus level. This simple and quantitative method gave us a unique opportunity to explore oocyte factors and mechanisms involved in the reactivation of silenced embryonic genes, and hence in transcriptional reprogramming.

In our recent study we have demonstrated that polymerized actin is present in the GV and transplanted nuclei and plays an important role in transcriptional reactivation of Oct4. This study emphasizes a significant contribution of nuclear actin in transcriptional activation. Here, we discuss possible roles of nuclear actin in Xenopus oocytes and in other cell types in the context of transcriptional activation.
nuclear actin in gene reactivation has been shown using Xenopus oocytes.\textsuperscript{13} In cultured cells, the importance of nuclear actin in transcriptional activation upon cell differentiation,\textsuperscript{23,24} retinoic acid treatment\textsuperscript{25} and inflammatory response\textsuperscript{26} has also been reported by several different groups. Notably, two recent reports clearly show a requirement for nuclear actin\textsuperscript{26} and an actin nucleator,\textsuperscript{24} which regulates actin polymerization, in the context of transcriptional activation and chromatin remodeling. Huang et al. found that coronin 2A, a component of the NCoR complex, mediates interaction with oligomeric nuclear actin and the NCoR complex.\textsuperscript{26} This binding of nuclear actin to NCoR triggers the clearance of NCoR from gene promoters. Since the NCoR complex represses gene expression, the clearance of NCoR induces gene activation. Thus, nuclear actin is involved in transcriptional activation by de-repressing silenced genes. Taylor et al. showed that the Wiskott-Aldrich syndrome protein (WASp), an actin nucleator, translocates to nuclei during T-cell differentiation and nuclear WASp associates with histone H3K4 trimethyltransferase RBBP5 and H3K9/H3K36 tri-methy lase JMJD2A.\textsuperscript{24} Association of WASp and these enzymes is important for achieving their enzymatic activities on appropriate target genes. Interestingly, polymerized nuclear actin is also recruited to the same target genes as WASp upon gene activation.

Nuclear actin in transcriptional activation is an emerging and fascinating topic for research. We still have many questions to answer in this research field. Xenopus oocytes may be a very suitable material to study functions of nuclear actin since they possess abundant naturally stored nuclear actin, which can be visualized easily as shown in our recent study.\textsuperscript{13} In the reprogramming field, it might be worth examining whether nuclear actin plays a role in other reprogramming systems, such as iPSC cells and cell fusion.

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