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Mini-Symposium:
Recent Progress in Mammalian Oocyte Maturation:
Insight into Its Molecular Mechanisms

Preface

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In mammalian developing follicles, primary oocytes enter meiosis but are arrested at the diplotene stage of prophase I. The oocytes stay in this dormant state for months and years until they are about to be ovulated. In response to the preovulatory luteinizing hormone (LH) increase, the large nucleus of the oocyte (called the germinal vesicle, GV) in preovulatory follicles undergoes GV breakdown (GVBD), chromosome condensation, and extrusion of the first polar body in preparation for fertilization and early embryonic development.

Recent progress in molecular techniques have allowed us to further our understanding of the molecular mechanisms underlying mammalian oocyte maturation through intensive molecular research. Based on this knowledge, the clinical application of *in vitro* maturation (IVM) of human oocytes has been undertaken, but outcomes remain poor because of the reduced developmental competence of oocytes after IVM. Of more concern is the role that IVM of oocytes may play in causing or accentuating long-term development and health problems of fetuses and neonates after *in vitro* production of embryos and embryo transfer. This is a largely unexplored area, yet the application of such techniques, especially the safety of clinical IVM, is significant and requires monitoring before acceptance as a routine procedure.

This mini-review introduces the recent progress in our understanding of the molecular mechanisms of oocyte maturation and is presented by four outstanding Japanese researchers in this field.

Although the preovulatory surge of LH is the primary event responsible for the induction of maturation of the oocyte, LH does not act directly on the oocyte due to the absence of functional LH receptors in germ cells and cumulus cells. However, cumulus cells are known to mediate LH signaling from granulosa cells expressing LH receptor to induce oocyte maturation. The important roles of cumulus cells are described by Dr. Shimada.

The actions of LH/hCG on the oocyte are mediated either by paracrine factors secreted by LH-responsive somatic cells (theca and mature granulosa cells). Among the paracrine factors, epidermal growth factor (EGF)-like growth factors promote meiotic resumption and cumulus expansion by depositing cell matrix through activating cyclooxygenase (COX)-2-derived prostaglandin (PG) E2. Focusing on gene deficient animal models, Dr. Takahashi summarizes the roles of PGs in oocyte maturation.

In response to the LH surge, the somatic factors activate downstream signaling in oocytes to promote maturation. Dr. Hoshino reviews three major signal pathways (PKA, PI3K, and MAPK) that contribute to oocyte maturation. Furthermore, the pivotal roles of Maturation/M-phase promoting factor (MPF) in oocyte maturation are discussed by Dr. Naito.

It is my great hope that this mini-review summarizing the recent steps forward in our knowledge about oocyte maturation will lead to insights which will help us to overcome the poor clinical outcome of IVM.