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Nonequivalence of Maternal Centrosomes/Centrioles in Starfish Oocytes: Selective Casting-Off of Reproductive Centrioles into Polar Bodies

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Abstract

It is believed that in most animals only the paternal centrosome provides the division poles for mitosis in zygotes. This paternal inheritance of the centrosomes depends on the selective loss of the maternal centrosome. In order to understand the mechanism of centrosome inheritance, the behavior of all maternal centrosomes/centrioles was investigated throughout the meiotic and mitotic cycles by using starfish eggs that had polar body (PB) formation suppressed. In starfish oocytes, the centrioles do not duplicate during meiosis II. Hence, each centrosome of the meiosis II spindle has only one centriole, whereas in meiosis I, each has a pair of centrioles. When two pairs of meiosis I centrioles were retained in the cytoplasm of oocytes by complete suppression of PB extrusion, they separated into four single centrioles in meiosis II. However, after completion of the meiotic process, only two of the four single centrioles were found in addition to the pronucleus. When the two single centrioles of a meiosis II spindle were retained in the oocyte cytoplasm by suppressing the extrusion of the second PB, only one centriole was found with the pronucleus after the completion of the meiotic process. When these PB-suppressed eggs were artificially activated to drive the mitotic cycles, all the surviving single centrioles duplicated repeatedly to form pairs of centrioles, which could organize mitotic spindles. These results indicate that the maternal centrioles are not equivalent in their intrinsic stability and reproductive capacity. The centrosomes with the reproductive centrioles are selectively cast off into the PBs, resulting in the mature egg inheriting a nonreproductive centriole, which would degrade shortly after the completion of meiosis.

Keywords

centrosome; centriole; centrosome reproduction; centriole duplication; starfish; oocyte; meiosis; spindle

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