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Authors: Maria Almonacid, Marie-Emilie Terret,
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Control of nucleus positioning in mouse oocytes

Authors: Maria Almonacid[#], Marie-Emilie Terret and Marie-Hélène Verlhac

Affiliations:

CIRB, Collège de France, and CNRS-UMR7241 and INSERM-U1050, Equipe Labellisée FRM, Paris F-75005, France.

[#] correspondence should be addressed to MA (maria-elsa.almonacid@college-de-france.fr)

Abstract

The position of the nucleus in a cell can instruct morphogenesis in some cases, conveying spatial and temporal information and abnormal nuclear positioning can lead to disease. In oocytes from worm, sea urchin, frog and some fish, nucleus position regulates embryo development, it marks the animal pole and in *Drosophila* it defines the future dorso-ventral axis of the embryo and of the adult body plan. However, in mammals, the oocyte nucleus is centrally located and does not instruct any future embryo axis. Yet an off-centre nucleus correlates with poor outcome for mouse and human oocyte development. This is surprising since oocytes further undergo two extremely asymmetric divisions in terms of the size of the daughter cells (enabling polar body extrusion), requiring an off-centring of their chromosomes. In this review we address not only the bio-physical mechanism controlling nucleus positioning via an actin-mediated pressure gradient, but we also speculate on potential biological relevance of nuclear positioning in mammalian oocytes and early embryos.

Key words: mouse oocyte, nucleus, actin, advection, active diffusion, early embryo development

Introduction

Regulation of nuclear position is essential for the achievement of a variety of cellular and developmental functions. In the female gamete of most species, nuclear positioning close to the oocyte cortex prepares for the very asymmetric divisions allowing the maintenance of