Large population and size scale limit of a stochastic particle model describing an age and space-structured population

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Résumé

The development of ovarian follicles is a unique instance of a morphogenesis process occurring during both prepuberal and adult life and resulting from a molecular dialogue between somatic cells and germ cells. In mammals, the initiation of follicular development from the pool of resting follicles is characterized by an increase in the oocyte size concomitant with the surrounding somatic cells proliferating to build an avascular tissue called granulosa. Here, we present a stochastic individual-based model describing the first stages of the basal part of follicular development, where the cell population is structured with respect to age (progression within the cell cycle) and space (radial distance from the oocyte). The model accounts for the direct physical contacts at the oocyte-granulosa interface and the tightly-tuned molecular dialogue between the oocyte and granulosa cells. The model can help both to describe the 3D morphogenesis of the follicle up to antrum formation and to explain pathological situations of imbalance between oocyte growth and follicular cell proliferation. Detailed quantitative simulations results are provided in the ovine species, in which well characterized genetic mutations lead to a variety of phenotypic follicle morphogenesis.

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