Statistical Inference for Stochastic Models of Follicle Stem Cell Dynamics

Nicole Karnoub (Mentor: Dr. Simon Tavaré, 2026 IICD SRP)

Division and differentiation rates are biological parameters that can be used to describe model stem cell populations. The two must be kept in balance to maintain tissue homeostasis. *Drosophila* germariums containing follicle stem cells (FSCs) serve as ideal systems for studying this balance, displaying distinct spatial organization and heterogeneity (diversity) in division rates and differentiation outcomes as observed experimentally. However, given that FSC behavior is stochastic, experimental data yields only a partial summary of the system and direct inference of key biological parameters is thus challenging.

It is with this project that we aim to develop and later analyze simplified stochastic models describing FSC division, movement between spatial tissue layers, and differentiation into follicle cells. Using a likelihood-based method, the Expectation-Maximization (EM) algorithm, we will estimate model parameters from experimental data. Beginning with Cedric Smith's gene-counting method, an early example of EM use, we will extend this technique to the FSC system. Our objectives are to update model structure and inference procedures to better estimate biological parameters (i.e., division and differentiation rates), improving and demonstrating the utility of quantitative and computational approaches to the study of stem cell dynamics.