Biology and Medicine Through Mathematics Conference 2024

May 17th, 11:00 AM - 11:30 AM

A model of oocyte population dynamics for fish oogenesis

Louis Fostier
INRAE (Institut national de recherche pour l'agriculture, l'alimentation et l'environnement), louis.fostier@inrae.fr

Frédérique Clément
INRIA (Institut national de recherche en sciences et technologies du numérique), frederique.clement@inria.fr

Romain Yvinec
INRAE, romain.yvinec@inrae.fr

See next page for additional authors

Presenter Information

Louis Fostier, Frédérique Clément, Romain Yvinec, and Violette Thermes

A model of oocyte population dynamics for fish oogenesis

Louis Fostier[1,2], Frédérique Clément[1], Violette Thermes[3], Romain Yvinec[1,2]

We introduce and analyze a quasilinear size-structured oocyte population model, with non local nonlinearities on recruitment, growth and mortality rates to take into account interactions between cells. We pay special attention to the form of the recruitment term, and its influence on the asymptotic behavior of the cell population. This model is well-suited for representing oocyte population dynamics within the fish ovary. The nonlocal nonlinearities enable us to capture the diverse feedback mechanisms acting on the growth of oocytes of varying sizes and on the recruitment of new oocytes.
We firstly investigate the existence and uniqueness of global bounded solutions by transforming the partial differential equation into an equivalent system of integral equations, which can be solved using the Contraction Mapping Principle.
In a second step, we investigate the asymptotic behavior of the model. Under an additional assumption regarding the form of the growth rate, we can, through the use of a classical time-scaling transformation, reduce the study to that of a semilinear equation with linear growth speed and nonlinear inflow boundary condition. Using arguments from the theory of abstract semilinear Cauchy problems, we investigate the local stability of stationary solutions and the existence of Hopf bifurcations by examining the roots of a characteristic equation involving the eigenvalues of the linearized problem around equilibrium states.
When the mortality rate is zero, the study of existence and stability of stationary solutions is simplified. Explicit calculations and numerical simulations can be carried out in certain relevant cases, providing concrete illustrations of these theoretical results.

1 EPC MUSCA, Université Paris-Saclay, Inria, Centre Inria de Saclay, 91120 Palaiseau, France
2 BIOS, PRC, INRAE, CNRS, Université de Tours, 37380 Nouzilly, France
3 INRAE, UR1037, LPGP, Rennes, France