On a cancer discrete-continuous model that explains Peto's paradox.

M.E. Gaudiano

National Scientific and Technical Research Council of Argentina

Blood of mammals is composed of a variety of cells suspended in a fluid medium known as plasma. Hematopoiesis is the process for the generation of all cellular blood elements. A continuous supply of cells is necessary to compensate for the loss of cells due to apoptotic senescence or migration out of the circulating compartment. Blood cell formation has at its root hematopoietic stem cells that have the dual property of self renewal and the ability to differentiate into all types of blood cells. Despite of being essentially a stochastic phenomenon followed by a huge number of discrete entities, blood formation has naturally an associated continuous dynamics, because the cellular populations can on average easily be described by (e.g.) differential equations. This deterministic dynamics by no means contemplates some important stochastic aspects related to abnormal hematopoiesis, that are especially significant for studying certain blood cancer deceases. For instance, by mere stochastic competition against the normal cells, leukemic cells sometimes do not reach the population thereshold needed to kill the organism. Of course, a pure discrete model able to follow the stochastic paths of billons of cells is computationally impossible. In order to avoid this difficulty, we seek a trade-off between the computationally feasible and the biologically realistic, deriving an equation able to size conveniently both the discrete and continuous parts of a model for hematopoiesis in terrestrial mammals, in the context of Chronic Myeloid Leukemia. Assuming the cancer is originated from a single stem cell inside of the bone marrow, we also deduce a theoretical formula for the probability of non-diagnosis as a function of the mammal average adult mass. In addition, this work cellular dynamics analysis may shed light on understanding Petos paradox, which is shown here as an emergent property of the discrete-continuous nature of the system.

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