Mathematical models on cancer progression

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Abstract. The Cancer Stem Cell (CSC) involvement into tumor progression, tumor recurrence, and therapy resistance is one of the most studied subject of current cancer research [10,4,8,6]. Nevertheless, due to the complex dynamics characterizing the CSC tumor, a comprehensive theory has not been established yet. To this end, some advises can be obtained combining mathematical modeling and experimental data [5,9,2,7]. Indeed, mathematical modeling is a powerful instrument which may drive the comprehension of a biological system, providing a clear description of its essential dynamics.

The aim of this talk is hence to show how the CSC tumor growth could be described/studied through the application of mathematical models. In details two different modeling approaches are presented: the former one consists in a multilevel/multiscale model [1], which details both molecular and cellular aspects. By means of this framework we were able to reproduce the tumor growth trend observed in mice, highlighting the strong connection existing between cellular events and cell population dynamics. We were also able to reproduce molecular vaccinations, correctly miming the in vivo vaccinations in animals. However, this detailed approach can engender difficulties in the parameter estimation process when only few kinetic information is available.

The second contribution [3] was designed really to address this complexity issue. We defined a new compartmental mathematical framework only focusing on the cell subpopulation dynamics. Indeed, the aim of this work was to describe CSC tumor progression trying to identify its essential mechanisms at population level. Through a quantitative and qualitative analysis of our model was hence possible to define rules controlling the breast cancer progression.

Lastly, we point out that the CSC theory is applicable to several other human cancers. Therefore, being our two model based on the key dynamics of the CSC theory, they can be further adapted for the study of many other tumor cases too.

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