A Mathematical Model of Liver Regeneration

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Abstract

Many human and animal tissues regenerate. after an injury that is not very severe, the skin, muscle and bone tissue cells together with the immune system and stem cells will repair the damage. Not all organs regenerate. The heart, the brain and other parts of the nervous system do not. The liver is in a special category since it can regenerate after a loss of about 2/3 its mass [1, 2]. There is large body of literature on experimental work on liver regeneration [5, 6]. Many of the experiments are done with animal models such as mice and rats, but not all the processes are the same as for humans. So there is a need for mathematical models that can help understand the processes involved, try different scenarios and help decide what are the better options for a fast and complete recovery. Existing diseases can hamper the recovery. The hepatocytes or liver cells reproduce to repair the injury but they also move. In [8] the authors give some references to recent modeling efforts. The mathematical models go from the very simple such as that of [11] based on logistic growth to [12] that consider that cells grow to occupy the damaged region based on the same percentages as those in the healthy regions. In [4, 7] are models considering different cells and chemical factors. A more complete model is in [3]. In this presentation we develop a model of liver regeneration after resection based on ordinary differential equations. It is based on [7, 3, 10]. We introduce delays due to the time it takes the different cells to replica and obtain a model based on delay differential equations [9]. The system of equations is solved numerically and comparisons are made with experimental data. Since the parameters have a large variation, a global sensitivity analysis is performed citesaltelli.

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