Computational model of cancer stem cell dynamics

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INTRODUCTION

- Computational model
- Studies the behavior of a complex system by computer simulation
- Common computational models are weather forecasting models, earth simulator models, flight simulator models, molecular protein folding models

INTRODUCTION

- Stem cells
- Undifferentiated biological cells that can differentiate into specialized cells
- Cancer stem cells (CSCs)
- Cancer cells found within tumors with ability to give rise to all cell types found in a cancer sample

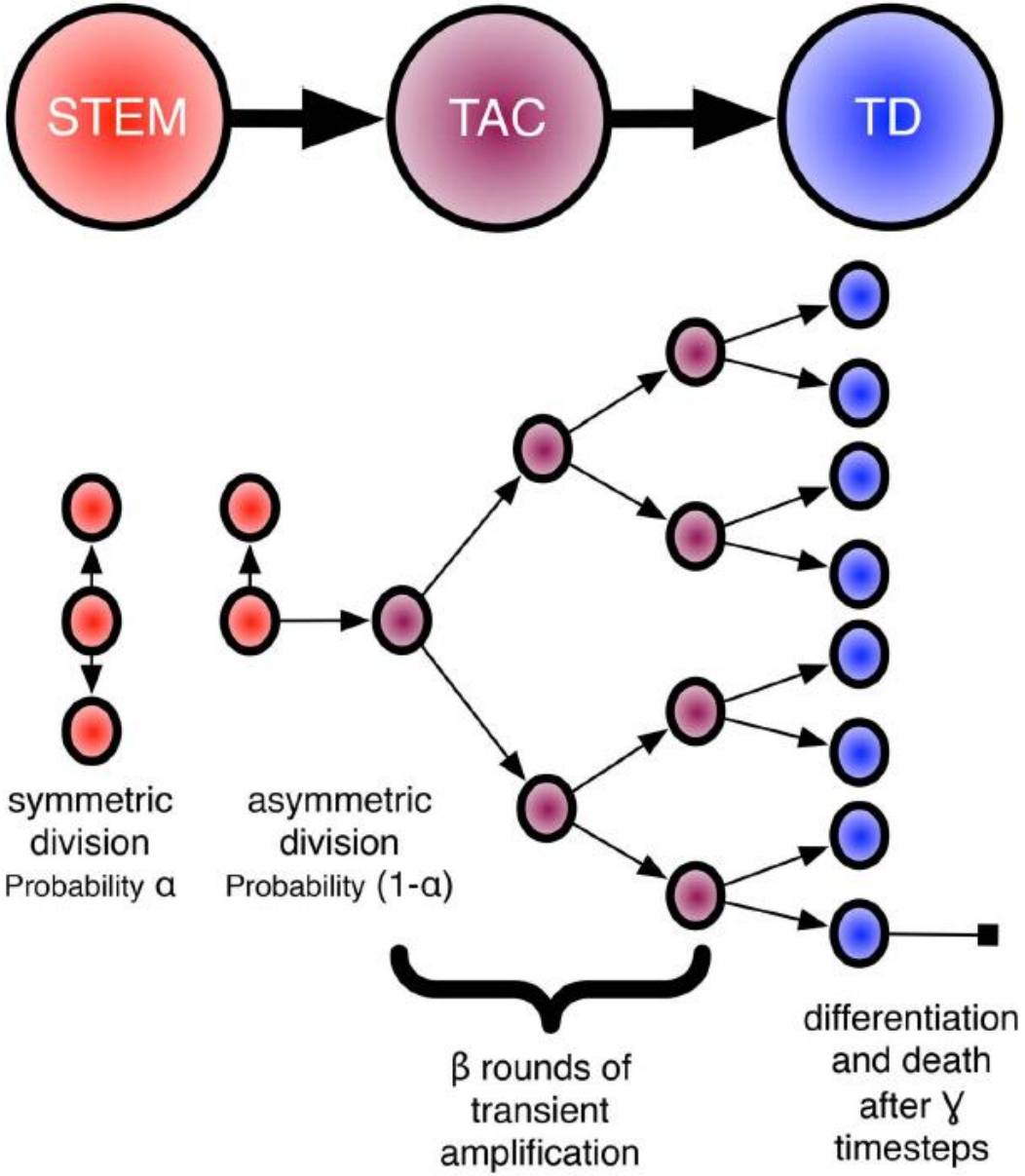
INTRODUCTION

- For theoretical model of a generalised stem-cell driven tissue with a simple microenvironment - computational model which is a hybrid, discrete/continuous computational cellular automaton model
- Cellular automaton consists of a regular grid of cells, each in one of a finite number of states

INTRODUCTION

- Subpopulation of tumour cells, called TICs
- Transient Amplifying Cells (TACs)
- Terminally Differentiated Cells (TDs)
- Hierarchical Model (HM)

INTRODUCTION



PROBLEM STATEMENT

- To develop a computational model based on the available experimental data to gain further insights about the origin of CSCs and their role in promoting cancer.
- By applying discrete models, automata theory, and cellular automaton programming to create more accurate models of population growth and a better understanding of population dynamics.

PROBLEM STATEMENT

- A two dimensional computational model of the HM of a TIC-driven tissue. And to generalise the intrinsic alterations which a TIC could undergo much in the same way that the hallmarks of cancer have generalised non TIC-specific alterations.
- Computational predictions will be experimentally tested by PhD students in the lab.

MOTIVATION

- Following chemotherapy, CSCs left behind would be able to replenish a tumor and cause a relapse of the cancer
- Tumor modeling and understanding relapse due to CSCs are currently ill understood because most organisms with relapse cancers *in vitro* die before they can be further studied
- Development of specific therapies targeted at CSCs holds hope for improvement of survival and quality of life of cancer patients

OBJECTIVES AND SCOPES

- Successful completion of the problem will contribute to our understanding of how CSCs contribute to cancer invasiveness
- Considering the parameters in the model as non-specific, they could apply to any tissue TIC and do not assume specific genetic mutations.

OBJECTIVES AND SCOPES

Parameters being addressed:

1. Symmetric/asymmetric division rate of stem cells (α)
2. Number of allowed divisions of TACs (β)
3. Lifespan of TDs (γ)

DESCRIPTION OF THE WORK

Cell types to simulate:

1. CSC
2. TAC
3. TDC

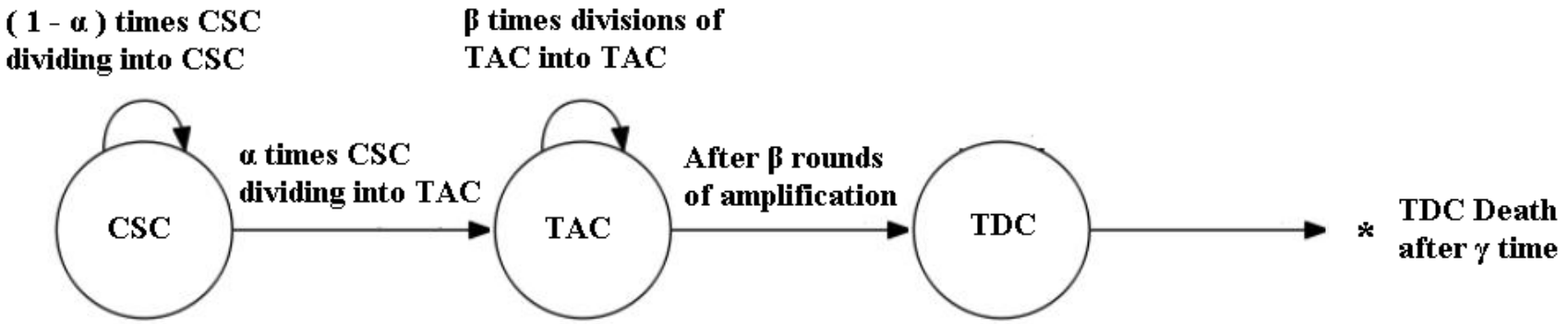
Extra Cellular Matrix Site (ES , where E stands for ECM Extra Cellular Matrix)

DESCRIPTION OF THE WORK

The rules to update the state of cells are based on parameters:

1. α : P(CSC dividing into TAC)
2. 1 - α : P(CSC dividing into CSC)
3. β : Number of divisions of TAC (after which they transform into TDC)
4. γ : Life time of TDC

DESCRIPTION OF THE WORK



DESCRIPTION OF THE WORK

Tools and programming to be used:

1. Using C++ in Dev C ++ IDE
2. Doxygen to generate documentation out of program
3. Octave to generate images and graphs
4. GitHub for version control

CONCULSION

- Learning outcomes on successful completion will be to understanding to develop computational models for getting insights into biological problems.
- A cellular automata simulation of generalised stem-cell driven tissue with a simple microenvironment.

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THANK YOU