Stiffness mediated heterogeneity

Rahul Kulkarni

January 14, 2015

Abstract

1 Introduction

2 Implemetation

2.1 Program Flow

2.2 Cell/ECM properties and their range

Table 1: Biological Cell

Prpoerty Name	Value
age	0
type	{1,2,3}
stiffness	(0,1)
divisionRate	(0,1)
size	(0,1)
contractility	(0,1)
invasiveness	(0,1)
degradationPotential	(0,1)
sensingRadius	1

Table 2: Biological Cell type

Prpoerty Name - type	Value
Cancer Stem Cell	1
Transient Amplifying Cells	2
Terminally Differentiated Cell	3

Table 3: ECM Site

Prpoerty Name	Value
type	0
fiberDensity	(1,10)
crossLinking	(0,1)

2.3 Function details

2.3.1 Update Division Rate

$$divisionRate = \frac{Number\ of\ ECM\ Sites\ in\ Neighbourhood}{Number\ of\ ECM\ Sites\ in\ Neighbourhood\ +\ 1} \tag{1}$$

2.3.2 Update Stiffness

$$stiffness = \frac{\sum_{\forall\ i\ and\ ECM\ Site\ \in\ Neighbourhood} crossLinking_i}{Number\ of\ ECM\ Sites\ in\ Neighbourhood} \tag{2}$$

2.3.3 Update Degradation Potential

$$degradationPotential = \frac{\sum_{\forall\ i\ and\ ECM\ Site\ \in\ Neighbourhood} fiberDensity_i}{\sum_{\forall\ i\ and\ ES\ \in\ Neighbourhood} fiberDensity_i\ +\ 2} \tag{3}$$

2.3.4 Update Fiber Density

$$fiberDensity_i = fiberDensity_i - fiberDensity_i * averageDegradationRate \qquad (4)$$

where

$$Average\ Degradation\ Rate = \frac{\sum_{\forall\ i\ and\ BC\ \in\ Neighbourhood} degradationPotential_i}{Number\ of\ BC\ in\ Neighbourhood} \qquad (5)$$

where BC is Biological Cell

2.3.5 Update State Of Cancer Stem Cell

Data: present cell and neighbourhood cell details , α
Result: state of one random free neighbourhood cell
if *cell type = Cancer Stem Cell* **then**
    check if there are free neighbourhood cell;
    if *if there are free neighbourhood cell* **then**
        select one in random;
        set age $\leftarrow$ 0;
        r $\leftarrow$ random(0,1);
        if $r < \alpha$**then**
            set the free cell type as Transient Amplifying Cell;
        else
            set the free cell type as Cancer Stem Cell;
        end
    end
end

Algorithm 1: Update State Of Cancer Stem Cell

2.3.6 Update State Of Transient Amplifying Cell

Data: present cell and neighbourhood cell details , β
Result: state of one random free neighbourhood cell
if *cell type = Transient Amplifying Cell* **then**
    if *if age of cell* $> \beta$**then**
        set the cell type as Terminally Differentiated Cell;
    else
        check if there are free neighbourhood cell;
        if *if there are free neighbourhood cell* **then**
            select one in random;
            set the free cell type as Transient Amplifying Cell;
            set age $\leftarrow$ 0;
        end
    end
end

Algorithm 2: Update State Of Transient Amplifying Cell

2.3.7 Update State Of Terminally Differentiated Cell

Data: present cell , γ
Result: state of present cell
if *cell type = Terminally Differentiated Cell* **then**
    if *if age of cell* $> \gamma$**then**
        set the cell type as ECM Site;
    end
end

Algorithm 3: Update State Of Terminally Differentiated Cell

3 Results