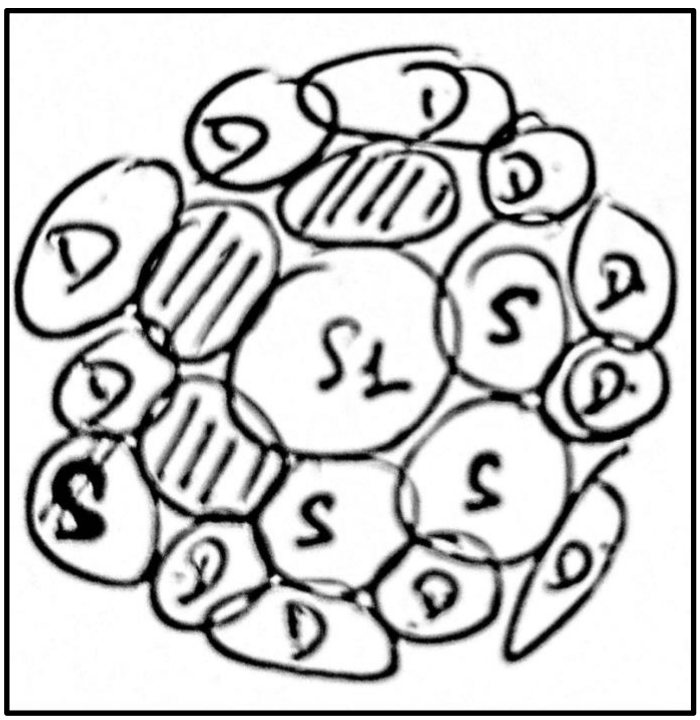
In the current state of the tumor, cancer stem cells S1 and S2 are surrounded by two layers of neighboring cells each. In the 1st degree neighboring cell layer around S1, there are 3 vacant cells and 3 cancer stem cells, and in the 2nd-degree neighboring cell layer, there are 1 cancer stem cell and 11 differentiated cells. In the 1st neighboring cell layer around S2, there are 3 differentiated cells and 3 vacant cells and in the 2nd neighboring cell layer, there are 4 vacant cells and 8 differentiated cells.

For S1 cell, compute cell density and probability of cell differentiation. For S2 cell, compute cell density and probability of entering the cell cycle. Use the baseline values of the parameters from Lecture 2.

Start with drawing a picture of these cells (S_1, S_2) similar to slide 2 of the Module 2 Lecture. Then use equations in slides 6 (den) and 7 (p_d) with baseline parameters from slide 10 to compute cell S_1 density and probability of cell differentiation. Finally, use equations in slides 6 and 8 (p_c) with baseline parameters from slide 10 to compute cell S_2 density and probability of entering the cell cycle. Make sure to show all your work.



S1 surrounded by 1st and 2nd-degree CSC (S),

Differentiated (D) and Vacant Cell Neighbors

1. Compute den(S1)

$$den(S1) = N1 + N2 / (2 * k)$$

Where

- N1 = 1^{st} degree CSC neighbors = 3
- N2 = 2^{nd} degree CSC neighbors = 1
- k = Damping coefficient for the second-degree neighbors = 2

$$den(S1) = 3 + 1 / (2 * 2) = 3.25$$

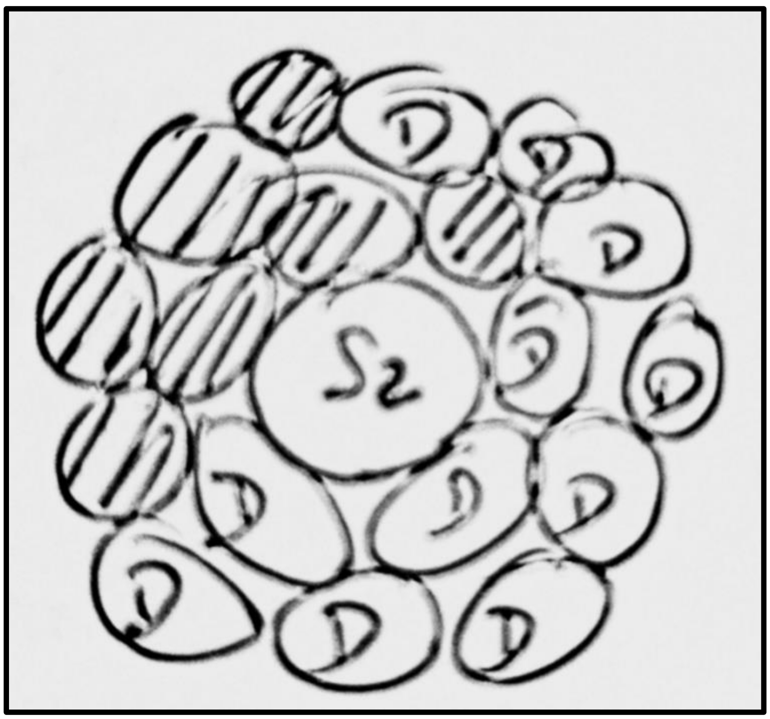
2. Compute $p_d(S1)$

$$p_d(S1) = p_{max} – a^m . (p_{max} – p_{min}) / (a^m + dens(S1)^m)$$

Substitute

- $p_{min} = 0$
- $p_{max} = 0.1$
- m = 5
- a = Number of CSC neighbors giving the half-maximal differentiated rate = 3
- dens(S1) = 3.25

$3^5 = 243$
$p_d(S1) = 0.1 - 3^5 * (0.1 – 0) / (3^5 + 3.25^5) = 0.1 – 243 * 0.1 / (243 + (3.25^5)) \sim 0.0599$



S1 surrounded by 1^{st} and 2^{nd}-degree Differentiated (D)

and Vacant Cell Neighbors

3. Compute den(S2)

$$den(S2) = N1 + N2 / (2 * k)$$

where

- N1 = 1st degree vacant cell neighbors = 3
- N2 = 2nd degree vacant cell neighbors = 4
- k = Damping coefficient for the second-degree neighbors = 2

$$den(S2) = 3 + 4 / (2 * 2) = 4$$

4. Compute $p_c(S2)$

$$p_c(S2) = 1 – (1 – p_0)^n = n * p_0 + 0(p_0)$$

Substitute

- p_0 = basic probability of entering cell cycle = 0.006
- n = number of vacant automata cells in the neighborhood of S2 = dens(S2) = 4

$$p_c(S2) = 1 – (1 – 0.006)^4 \sim 0.0238$$