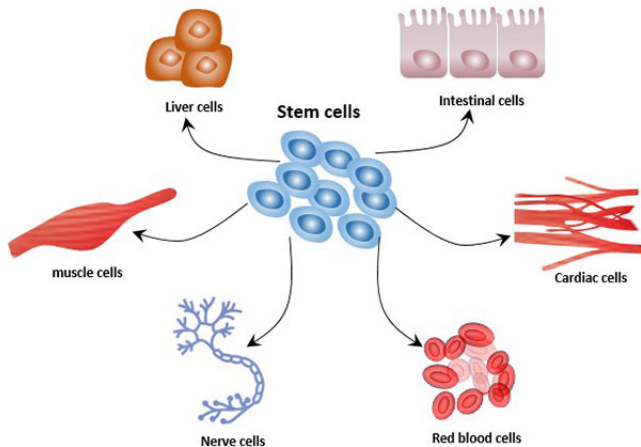# Gene Regulatory Networks for Cellular Differentiation - a Random Boolean Network Approach

Riccardo Scheda
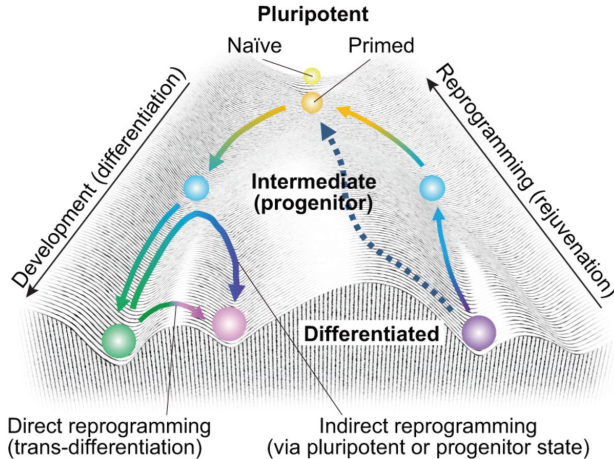
Applied Physics
University of Bologna

May 2020

Cellular Differentiation

Fitness Landscape

Pluripotent

Naïve   Primed

Development (differentiation)

Reprogramming (rejuvenation)

Intermediate (progenitor)

Differentiated

Direct reprogramming (trans-differentiation)

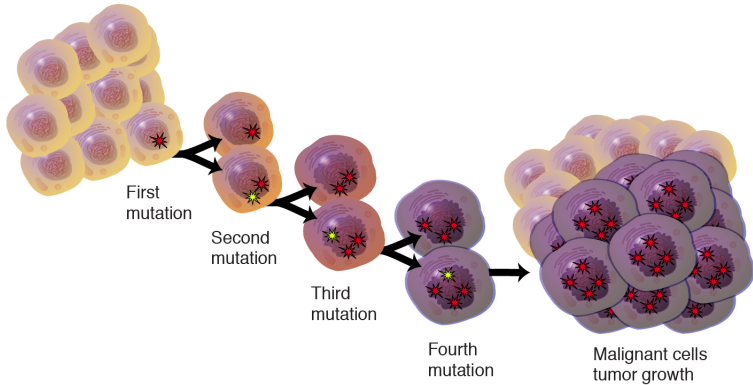Indirect reprogramming (via pluripotent or progenitor state)

Gene Regulatory Networks

Cellular differentiation and other mechanisms in cell dynamics are governed by the gene regulatory networks (GRN)
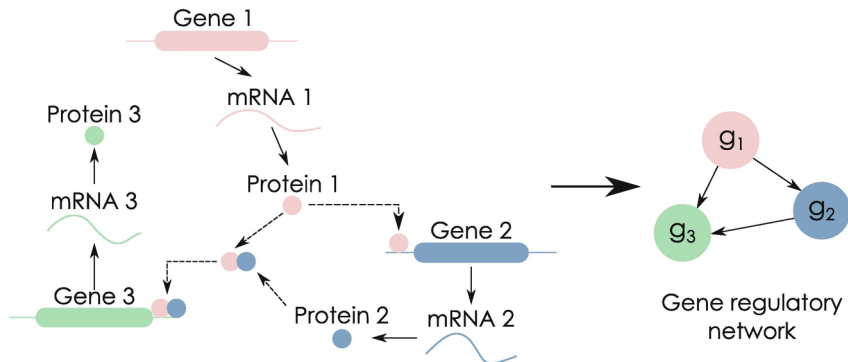
Mutation

Studies confirmed that during the process of GRN we can have mutations in the networks which cause the birth of cancer cells

Stuart Kauffman proposed to model GRN using Random Boolean Networks (RBN) which are networks in which each gene is a node in a directed graph and can be "on" or "off", so we have that each node σ_i can have values 0 or 1.
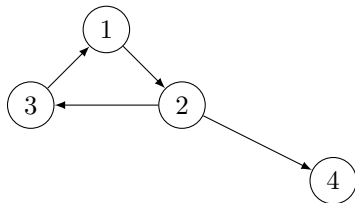
RBN Dynamics

The evolution of the state of each node $\sigma_i(t)$ is given by a Boolean function $\Lambda_i(\sigma_{i_1}, ..., \sigma_{i_k})$ of K parameters, which are the incoming links from the other nodes in the network:

$$\sigma_i(t+1) = \Lambda_i(\sigma_{i_1}(t), ...\sigma_{i_k}(t))$$