Demonstrated, predictable, information-rich: why biologists should not be afraid of stochasticity in gene expression

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Abstract

Double Session: The Nature of Cellular Complexity (Kupiec, Gandrillon, Paldi, Ojalvo, Nicholson, Matlin)
Stochastic gene expression (SGE) is a phenomenon receiving an ever-growing attention because it exerts a strong influence on many important normal or pathological processes. SGE means that in a population of clonal cells (all harboring the same genome) placed in the same environment, SGE causes a visible and measurable heterogeneity in the patterns of gene expression. This has now been clearly demonstrated in a large number of experimental settings.

The controversy therefore now shifts in two directions:

- Since noise is frequently (and wrongly) equated to unpredictability, biologists wonder how "order emerges from chaos".
- Two opposing view on the biological role of noise (including SGE) are in the balance: for some, noise has to be suppressed as much as possible for it is a nuisance to the cell or, for others, noise can be beneficial since it can be used by organisms, for example during the commitment of cells to different differentiation pathways.

We would like to propose that what can actually be seen at the cellular level is the microscopic molecular noise that is "filtered out" (or regulated) by macroscopic structures that have been selected by evolution, precisely because of their ability to "encapsulate" or regulate the amount of SGE, and to make it beneficial for living organisms. This makes SGE both predictable, and a very rich source of information regarding the biophysical processes at stake. This last part will be illustrated from a recent study where one deduced microscopic parameters from macroscopic measurements, with the use of a dedicated gene expression model.

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