Acta Scientific Neurology (ISSN: 2582-1121)

Volume 3 Issue 11 November 2020

Review Article

Possible Applications of Noisy Synthetic Systems in Covid-19

Sisir Roy[1]* and Sarangam Majumdar[2]

[1]Conciousness Studies Programme, National Institute of Advanced Studies, IISc Campus, Bangalore, Karnataka, India

[2]Dipartimento di Ingegneria Scienze Informatiche e Matematica, Università degli Studi di L'Aquila, Via Vetoio-Loc. Coppito, L'Aquila, Italy

***Corresponding Author:** Sisir Roy, Consciousness Studies Programme, National Institute of Advanced Studies, IISc Campus, Bangalore, Karnataka, India.

Received: September 29, 2020

Published: October 22, 2020

Abstract

Noise is usually thought as an unwanted signal in the study of science and technology. The introduction of stochastic resonance in nonlinear dynamical systems change our view of the role of noise (in living systems) from the destructive nature to constructive one. We highlight some recent time observations on the role of noise in synthetic systems. Finally, we address the possible application of synthetic systems in a Covid-19 situation along with the role of noise in the systems.

Keywords: Covid-19; Synthetic Biology; Noise

Introduction

Noise is an unavoidable part of non-living and living systems. It is well known that noise plays a catastrophic role in science and engineering. In the context of communication systems, the concept of noise was introduced by the Shannon and Weaver. In any physical system, the fundamental fact is that when the signal voltage arrives the demodulator, it will be accompanied by a voltage waveform which varies with time in an unpredictable manner. This unpredictable voltage wave form constitutes a random process and usually known as noise. Here, the signal plays destructive role since it corrupts the signal [1]. On the other hand, the introduction of stochastic resonance in non-linear dynamical systems changed our concept regarding the role of noise in living systems [2]. So, a significant issue has been raised that what is the role noise in synthetic systems. We already noticed some fluctuations in the study of complex synthetic systems. Synthetic biology is a cross-disciplinary subject where we are taking about there engineering, rewiring and design principle of the living systems for better understanding the underlying mechanism of biological systems [3-5]. We discuss the role of noise in synthetic systems and its possible applications in the current covid-19 situation.

Role of noise in synthetic systems

In an early stage of the synthetic systems research, Elowitz and Leibler [6] proposed repressilator (a gene oscillatory network) which exhibits fluctuations in its oscillations. Questions pop up automatically regarding the noise sources as well as its interaction with the system. These questions were studied by several modelling schemes such as synthetic models, stochastic models and computer simulations. It is already indicated that the studies in nonlinear dynamical systems switched the paradigm from the catastrophic to constructive nature of noise. It has a fundamental impact in living systems. We are trying to understand that how the meaning of noise is changed in synthetic biology.

Repressilator is an empirical component in the study of synthetic systems. Synthetic systems can be useful to discover underlying mechanism of a biological systems and give us a chance to make noise visible (by image technology) [7]. We are rolling into deep

to get more insight of synthetic systems. We can categorise synthetic biology into two different form: basic science and other is application oriented. First category is related to physics and second category is related to engineering. Most of the scientists are working in the second one. According to their respective background scientists are trying to approach the problem. The physicists and engineers have different point of view to tackle the problem and exploring the problem. Both the communities share some common grounds such as robustness, feedback loops and noise [2,5].

The significant argument in this context is "Why should we care about noise given the fact that biological organisms function despite the noise in and around it?" But noise is an inherent feature of all biological systems. We have to consider noise and deal with it to revel the unknows. So, it is an inevitable for all systems. We point out some examples in synthetic systems where noise plays an important role [2,5].

We begin with the stochastic gene expression, where internal and external noise control the phenotype heterogeneity in genetically identical populations. Noise is associated with the randomness, which is considered as an intrinsic property of gene expression [8]. Noise is studied from two approaches by Knuutila., *et al* [9]. Chen and Li [10] studied the robustness of gene regulatory network with the help of the concept of entropy. In a recent past, scientists raised question about how synthetic biology offer us a new significant and fundamental insights [11].

Synthetic biology gives us new insight to understand gene expression and explore the noise in the systems as well. Ciechonska., *et al*. [11] envisaged an exciting change for synthetic biology as "creating in order to understand" towards "creating in order to cure".

Possible applications

Synthetic biology is a multidisciplinary subject which deal with the living systems using different branches of science such as engineering, physics, chemistry. But the most nagging question is how to handle high-levels of complexity and design synthetic systems. To overcome this complexity several scientists and engineers came forward and discovered design principle, re-engineering and rewiring of the living systems. Why it is so important? The approach of synthetic biology is far advanced than previous basic science approaches to understand the underlying mechanism and locate unknown pathways in the biological complex phenomena [4]. Researchers developed gene circuits from scratch and also created artificial cells which are drawing attention to synthetic biology to speed up development of a vaccine to fight against current pandemic COVID-19. The National Institute of Health, USA and Bill and Melinda Gates foundation have invested in synthetic biology to engineer vaccine for COVID-19. A vaccine developed through synthetic biology would be highly scalable and would work globally Scientists are able to take genome assemblies for SARS-COV-2 and use those sequences to build genomic constructs for vaccine candidates.

Conclusion

It is evident from the above analysis that the noise (both internal as well as external noise) plays important role in understanding gene expression. Moreover, effect of these types of noise cannot be neglected in genomic sequencing process. Now to build genomic constructs (using these sequences) for a vaccine candidate developed through synthetic biology, one must consider the role of these types of noise. For example, the destructive roe of external noise can be minimized using optimizing procedure as done in engineering discipline. But it may not be possible to control the effect of internal noise using such optimizing procedure. It may open up a fascinating area of research to observe the effect of internal noise (in the sense of destructive or constructive manner) at the level of making a robust genomic construct. It is interesting to note that one finds the noise from the analysis of genomic sequences data. However, it is a big challenge to differentiate the internal noise from the external noise from the analysis of the data.

This will help us not only to engineer sustainable COVID-19 vaccine using synthetic biology approach but also shed new light to understand the functional aspects of noise in living organisms.

Bibliography

1. Majumdar S and Roy S. "Noise in Science and Technology vs. Biological System". *Microbial Communication* (2020): 163-170.

2. Majumdar S and Roy S. "Role of Noise in Synthetic Biology". *Microbial Communication* (2020): 159-162.

3. Majumdar S and Roy S. "Synthetic Biology and Microbial Communication". *Microbial Communication* (2020): 137-157.

4. Simpson ML. "Rewiring the cell: synthetic biology moves towards higher functional complexity". *Trends in Biotechnology* 22.11 (2004): 555-557.

5. Majumdar S and Roy S. "Microbial Communication: Mathematical Modeling, Synthetic Biology and the Role of Noise". *Springer Nature* (2020).

6. Elowitz MB and Leibler S. "A synthetic oscillatory network of transcriptional translation". *Nature* 403 (2000): 335-338.

7. Andrea Loettgers. "Synthetic Biology and the Emergence of a Dual Meaning of Noise". *Biological Theory* 4 (2010): 340-356.

8. Nishimura K., *et al.* "Stochasticity in gene expression in a cell-sized compartment". *ACS Synthetic Biology* 4.5 (2015): 566-576.

9. Knuuttila T and Loettgers A. "Varieties of noise: Analogical reasoning in synthetic biology". *Studies in History and Philosophy of Science Part A* 48 (2014): 76-88.

10. Chen BS and Li CW. "On the interplay between entropy and robustness of gene regulatory networks". *Entropy* 12.5 (2010): 1071-1101.

11. Ciechonska M., *et al.* "From noise to synthetic nucleoli: can synthetic biology achieve new insights?" *Integrative Biology* 8.4 (2016): 383-393.