Physical forces cause *HoxD* gene cluster elongation

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Hox gene collinearity is a fundamental property in the process of *Hox* gene expression. It correlates the 3' to 5' sequential gene alignment in the *Hox* gene cluster with the ontogenetic units along the anterior/posterior axis of the embryo. This property is multiscalar and cannot be treated by biomolecular mechanisms alone. In multiscale phenomena physical laws must come into play. The biophysical model (BM) provides the necessary tools for an integrated multiscalar explanation of *Hox* collinearity. According to BM, physical forces are created which pull the *Hox* genes sequentially from the compact inactive *Hox* gene cluster toward the transcription factory domain, where gene transcription is possible. The BM successfully describes the genetic engineering experiments where some genes of the vertebrate *Hox* cluster are deleted (or duplicated). Although the BM was introduced in 2001, it is only in the last 2 years that it has been adopted by the scientific community, because the evidence was missing for the existence of such forces. However, recent instrumental progress in achieving high imaging resolution (e.g. 3D DNA FISH, STORM etc.) make possible the confirmation of several BM predictions. For instance, it is found that the mouse *HoxD* cluster is elongated up to 5-6 times during *Hox* gene transcription. These unexpected physical deformations agree with the BM predictions. New experiments are proposed to test further the biophysical model. A synthesis of Biophysics and Biochemistry is proposed to explain *Hox* gene collinearity in two steps: in a first step, the BM forces translocate the *Hox* genes in the right location for transcription. In a second step, biomolecular mechanisms transcribe the translocated genes.

Speaker Biography

Spyros Papageorgiou has graduated in Physics from the Athens University, Greece. He has received his DPhil in Theoretical Physics from Oxford and Sussex Universities in 1965. He was a Research Fellow at Theory Division of CERN 1968-1970 and a Corresponding Fellow between CERN and Demokritos, Greece 1970-1973. In 1976, he started working on models in Developmental Biology. He formulated models in reaction-diffusion, pattern regulation, regeneration, gene expression etc. In 2000, he became Emeritus Research Director at 'Demokritos' and he currently study the *Hox* gene collinearity problem. He formulated the biophysical model (BM) (S Papageorgiou, BIOLOGY 2017,6, 32) based on the hypothesis of physical forces translocating the *Hox* genes toward the transcription factory domain where transcription is possible.

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