Conference
When experimentalists meet theoreticians
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Ziskind building, Room 1
Weizmann Institute of Science,
76100 Rehovot

Opening remarks:

I would like **to welcome the speakers and the participants**. I'm happy that we succeeded to gather a panel of specialists from different fields. Organizing the meeting is almost a full time job and I would like to thank those who helped me to make this event possible: **E. Korkotian** who designs the wonderful poster, Diana and Terry who help us with administration work and realize our web page.
I have to thank our financial supports which permitted us to organize such meeting: half comes from my HFSP grant and the second half from the Belfer family, which supports our department of mathematics.

Cell biology and modern biophysics have revealed the complexity of cellular processes. Today, various fields of science are involved in the biological adventure of understanding the cell function:
-**Experimental Physics** have helped though instrumentation: with amplifiers, microscopes, imaging techniques, patch clamp recording, to record single channel so on.
-**Computer Science** offers very powerful tools for data analysis, which is heavily used in gene identification.
-**Theoretical physics and applied mathematics** offer the possibility to construct models from biophysical considerations. Mathematical analysis leads to analytical formula but also to the coherent and rational design of computer simulations.

While for the first two cases, **Experimental Physics** and **Computer Science**, interactions with biologists is nowadays routine, for **Theoretical physics and applied mathematics** the connection with biologists is much more recent and one of the goal of such meeting is to consolidate such connection.

Why experimentalists should talk to theoreticians?

During the past 5 years, we and many other groups around the world have tried to apply methods from applied mathematics, statistical physics to model cellular processes at a biophysical level.
By collaborating with biologists, we were lead to interdisciplinary approaches, and we were able touch various fields of science. We obtain few results and I would like to mention some of them.

-Hodgkin attracted the attention of the physiology community to the phototransduction question: how light is transformed into a cell signal. What is the molecular mechanism involved?
We have built models of **the phototransduction** and formulated equations for the mean and the variance of the number of phosphodierase molecules activated during the activation of a single rhodopsin or coneopsin. These models lead us to design experiments which where done in the lab of J. Korenbrot at UCSF: we analyzed diffusion in rods and cones, the noise in photoreceptors and today it lead us to the conclusion that the spontaneous rate of PDE in dark cannot be the same as the rate of PDE activation during light activation.

-To analysis the dynamics of **receptor trafficking** on the surface of neurons, a research which started at UCSF with discussions with R. Nicoll and continued with interactions with biologists such as A. Triller and D. Choquet from France, we developed, Zeev Schuss, myself and our students, **the theory of the small hole**, which consists in estimating the mean time a random molecule stays inside a bounded domain when it can only escape through a small hole.
It turns out that this mean time is exactly the mean time for two molecules to meet and thus it is exactly the reciprocal of the forward binding rate. This concept was for us at the basis of modeling hierarchies of chemical reactions in small domains, which may involve few amounts of molecules.

-Another field that was of interested for us is neuronal physiology. Thus, in parallel with experiments, which were carried out in the lab of M. Segal at the Weizmann Institute Of Science, we developed new computations to quantify the geometry of **dendritic spines**, which are microstructures, the locus of excitatory connections in neuronal cells. Although we are far from revealing the role of dendritic spines, our collaboration lead us to some new ideas about how these structures are regulating calcium.

More and more quantitative questions require the construction of sophisticated mathematical models, based on **biophysical principles.** We can imagine the complexity of understanding electrical properties of dendrites based at a molecular level or the difficulties to estimate how a cell takes a decision from molecular interactions: it can be the decision to fire an action potential or not, to enter or not in a new stage of the cell cycle or to trigger apoptosis. **The possibility to coarse grained these processes is a fundamental step toward analysis and this is what can theory provide.**

I would like that this **meeting opens opportunities** for us to know each other, to reveal the problems we are interested in and the methods we are using. Those of us who are theoreticians are interested in modeling biological processes at a biophysical level and thus interacting with biologists is a fundamental step of our research. But concept from theory can also be extremely fruitful to reveal the biology. At least three examples can cross our mind:

1-the **helicoidal structure of the DNA** molecule came out from analysis of X-rays crystallographic picture by Waston-Crick.

2-The second example is coming from A. Turing where in his 1952 paper, introduced the idea and developed **the reaction-diffusion equation to model a molecule, which he calls a morphogen,** which goes from cell to cell in order to specify their position. He shows that this process can generate morphogenetic gradient, which ultimately leads to cell differentiation and specialization.

3-The last example is the **Hodgkin-Huxley model,** also published in 1952, which show that opening and closing of channels can generate a wave of depolarization crossing the axon.

There are much more examples and the best, we hope, are to come from future collaborations. Many others and I believe that cellular biology, biochemistry biophysics, are sufficiently advance in terms of the phenomenology so that we can now start to understand basic principles.

To finish, I would like to recall that the strength of the Weizmann Institute, as it is seen overseas, is really in the Life sciences, but I believe that it is also in the **opportunity to create new collaborations among different departments, which can only be done at the individual level.** I hope that this meeting will create new interactions and fruitful discussions. I hope that it will help us to

bridge the gap between communities: mathematics is not simply a tool to fit data, but rather based on some physical rules, it really leads to identify principles and reveals the complexity of cellular biology.

I hope that you will all enjoy the meeting, which is divided into four parts: three about science and the last one about musics: the concert is only Chopin and the pianist is Zeev Schuss.

The first session is about

Signalling in neuronal and photoreceptor microdomains.

The second session is about

Theory of diffusion in microdomains

The last session is about
Trafficking inside the cytoplasm and the nucleus