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Mathematical Biology

Introduction to the special collection in honor of Avner Friedman

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It is an honor and a privilege to present to the readers of the Journal of Mathematical Biology this special collection in honor of Professor Avner Friedman on the occasion of his 90th birthday.

At birthdays like this most researchers have long retired in all the meanings of the word. For Avner, none are true. This birthday finds him scientifically more active than ever. Asked recently what period of his research Avner considered the best and most exciting he responded: "now". Quite amazing!

Ten years ago Avner's 80th birthday was honored with a special issue of Discrete and Continuous Dynamical Systems, Series B. At that time, he had about 450 publications and 24 books. As a joke, one of us challenged him to reach 500 publications, but he took the challenge very seriously and since then published 90 more papers and 3 books. This would be a very impressive accomplishment for any researcher at the top of their career, but in the past ten years Avner further broadened his interests to new topics in Mathematical Biology, including the modeling of wound healing, models of the heart, or models for plaque formation related to Alzheimer's disease. This expansion of interests was nicely described by one of his recent collaborators, Adrian Lam from Ohio State University who said: "He showed me what happens when a powerful mathematician develops an intense curiosity in how the human body works".

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Avner shared with us an anecdote which goes back in time, when he was only 23 and living in Israel. With his freshly awarded Ph.D., he applied for a faculty position at the British Consulate in Tel Aviv. He got invited for the interview and, all excited, boarded the bus in Jerusalem. However, when the British official looked closer at his resume, he turned him down because the lower age limit for applicants was 25. How disappointing! Now, almost 70 years later, Avner is trying to show that in science no age limits of any kind should be applied, and his exceptional productivity is certain proof of that.

His list of collaborators and advisees is long and new names are added to it all the time. It is hard to believe, but in the last 10 years, since we celebrated his 80th birthday, Avner added 54 new collaborators! These were mostly young researchers whose careers are shaped by these experiences. Out of his 26 advisees, most have landed good faculty positions at universities and institutes all over the world and their comments emphasize his role in their scientific development: "Avner was always passionate about new research topics and he told me several times that 'one needs to think outside the box'. What he meant was that one should not stay in a safe environment in terms of mathematical techniques and research topics" (Yangjin Kim, Konkuk University, Seoul); "His rigorous and positive attitude toward scientific research has been deeply influencing me and my research career" (Xiulan Lai, Renmin University of China). His trainees educate future generations of researchers in mathematical biology passing the experience gained. "This (way) of working on problems instead of learning knowledge itself has influenced me a lot even today when I advise my graduate students" (Paul Tian, New Mexico State University). Aside from its substance, Avner's work schedule and style were subject to comments. His co-workers were impressed by his long working hours ("every day from 8 a.m. to 6 p.m. in his office") and amazed how "full of energy" their mentor was. And all of this impressed collaborators who were more than half a century younger than him! Personal comments like being "humble in collaboration" and a "true gentleman" testify to his character, but probably the most comprehensive statement came from a colleague, renowned mathematical biologist Mark Chaplain from St. Andrews, Scotland: "His willingness to learn new things, adopt new approaches, work with others, share his knowledge, his energy and enthusiasm for applied mathematics in general and now in mathematical biology in particular are inspirational and an example to all of us who follow in his (large) footsteps. But over and above his mathematical abilities, and first and foremost, he is a wonderful person."

Perhaps Avner's major contribution to mathematical biology was his founding of the Mathematical Biology Institute (MBI) at Ohio State in 2002. His vision for the MBI had at least two components. One aim was to foster the collaborations between mathematicians and biologists, and he once said that the area of biology is like an ocean of opportunity for the applications of mathematical tools. In fact, when Avner talked about biology, he meant the life sciences in general, as he himself worked closely with medical doctors on wound healing and tumor growth, etc. Though he did not say it explicitly, he has "cure the cancer" in his mind. Another aim of the MBI was to train the next generation of mathematical biologists, as Avner put it. Each year the MBI welcomed postdocs with different backgrounds, and Avner would talk with them one by one, which some privately called the 'Avner interview'. Avner worked with many

MBI postdocs, some of whom have become leading experts in mathematical biology, and some of them are included as contributors to this special issue.

In order to honor Avner on his 90th birthday, several of his former students, postdocs, collaborators and colleagues kindly agreed to contribute their work to this issue, and most of their topics reflect Avner's recent research interests. Cancer modeling is still at the center of his work and the articles submitted address various aspects of this immensely large and extremely important research topic. Among others they include aspects of tumor progression, the forming of a necrotic core, metastasis, heterogeneity, cancer migration and chemotaxis, as well as the effect of the growing tumor on the surrounding tissue. The variety of approaches and techniques applied come from the theory of partial differential equations to which Avner devoted most of his professional career. Some papers presented here address more theoretical aspects of various classes of dynamical systems with emphasis on spatial models and show their potential in application to real life problems. Avner once said "I like mathematics, but I am in love with applications" and certainly the past twenty years of his career, when mathematical biology got his attention, are proof of this. Besides cancer, other interesting topics presented here include the modeling of plaque formation or the timely problem of covid modeling, both from the point of view of the disease and the epidemiological aspects of it. But medical applications are only one of the facets of mathematical biology, and dynamical systems, especially spatial models, play an important role in this field. This is reflected in this issue, and some of the topics such as pattern formation in vegetation and formation of cell shapes are addressed here as well.

Closing on a more personal note, we remark that Avner likes to interact with young people whenever possible during his professional travels, and is always popular amongst them, as illustrated by the photograph taken in a class he gave at Lodz University of Technology in Poland. He also would like to be viewed as a complete person, not only as a teacher and researcher, and since kayaking is one of his favorite sports, we included a picture of him taken this fall in his new kayak.

We, the guest editors, hope that you will enjoy reading this interesting collection of articles devoted to an extraordinary researcher and human being. If any of these topics inspire you to pursue your own research, this will be the best birthday present for Avner, because this is what he enjoyed the most in his career: to inspire others.

To Avner – Happy Birthday, and our hopes for many more years of fruitful work and inspiration.

The Guest Editors
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