My Career in Mathematical Biology

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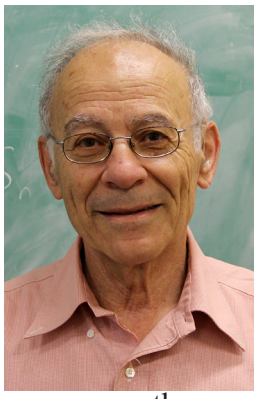

I began my academic career as a theorem proving mathematician. For the next 30 years I have worked in the field of partial differential equations with some diversions into stochastic differential equations and control theory, but had little contact with engineers and physical scientists. Then, in 1985, I was invited from Northwestern University to Purdue University to build a center for applied mathematics. This was when I first moved from my "comfort zone" of pure mathematics to new zones where one first raises a scientific question and only then tries to develop whatever mathematical models and mathematical ideas that will address that question. I began to talk to engineers, and discovered for the first time the excitement of doing interdisciplinary research.

Two years later I assumed the directorship of the Institute for Mathematics and its Applications (IMA) at the University of Minnesota. Here again I had the opportunity to learn about many scientific disciplines which mathematics can advance as well as benefit from. In particular, we ran several programs in mathematical biology: cardiac rhythm and the role of calcium, medical imaging, genomics/proteomics, and statistics in the health sciences. I became convinced that great opportunities are awaiting for mathematicians interfacing with biologists.

So when the NSF, in 2000, solicited proposals for new mathematical institutes, I saw my calling in the creation of a mathematical institute that will build bridges to biology. In 2001 I moved to The Ohio State University, where we developed a proposal for a Mathematical Biosciences Institute. When the proposal was funded and I became the director of the MBI, I immersed myself in learning biology. I began to read books and book chapters (several times), talk to biologists, and sit down with postdocs to work on building mathematical models that can predict experimental results. This has been an exciting life changing experience.

Although it does take time and effort for a mathematically educated researcher to delve into biology to the extent that he/she can then work with biologists on joint projects, the rewards are tremendous. You can easily identify interesting questions that are highly motivated, and some of them may even lead to new mathematics, even pure mathematics. Choosing "good" problems is an acquired skill. I have been working on projects that deal with cancer and cancer therapy, wound healing, and immune response to infection. Moving into mathematical biology has been a most rewarding and enriching journey in my later life, and I am still going.

Selected Publications

1. (with J.J.L. Velazquez) A free boundary problem associated with crystallization of polymers in a temperature field, Indiana Univ. Math. J., Vol. 50 (2001), 1609-1649.
2. (with F. Reitich) Quasi-static motion of a capillary drop, II: the three-dimensional case, J. Diff. Eqs., Vol. 186 (2002), 509-557.
3. (with M.A. Fontelos) Symmetry-breaking bifurcations of free boundary problems in three dimensions, Asymptotic Analysis, Vol. 35 (2003), 187-206.
4. (with X. Chen) A free boundary problem for an elliptic-hyperbolic system: An application to tumor growth, SIAM J. Math. Analysis, Vol. 35 (2003), 974-986.
5. (with B. Hu) Bifurcation from stability to instability for a free boundary problem arising in a tumor model, Archive Rat. Mech. & Anal, 180 (2006), 293-330.
6. A free boundary problem for a coupled system of elliptic, hyperbolic, and Stokes equations modeling tumor growth, Interface and Free Boundaries, Vol. 8 (2006), 247-261.
7. (with B. Hu) Uniform convergence for approximate traveling waves in linear reaction-hyperbolic system, Indiana Univ. Math. J., Vol. 56 (2007), 2133-2158.
8. (with J. Day and L. Schlesinger) Modeling the immune rheostat of macrophages in the lung in response to infection, PNAS, Vol. 106 (2009), 11246-11251.
9. (with C. Xue and C. Sen) A Mathematical model of ischemic cutaneous wounds, PNAS, Vol 106 (2009) 16782-16787.
10. (with H. Jain, S. Clinton, A. Bhinder) Modeling mutation acquisition in prostate cancer undergoing androgen ablation therapy, PNAS, Vol. 108 (2011), 19701-19706.