

# Division of Interdisciplinary Medicine and Biotechnology



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## ● Overview

The Division of Interdisciplinary Medicine and Biotechnology (IMBIO) is a newly formed division, perhaps the first of its type to be housed within a clinical department. IMBIO is organized under the leadership of Dr. Sukhatme as division director and Dr. A. Goldberger as the associate director. The Division has both research and educational missions at BIDMC, at Harvard Medical School and its affiliated hospitals and with Harvard University, especially the Allston initiative. It anticipates many interfaces with other institutions both locally (such as MIT) and nationally.

IMBIO believes that we are at a unique juncture in medical history. The deciphering of the human genome affords an unprecedented platform for basic science discoveries in biology. This “genomics revolution” coupled to the information technology revolution and certain technological advances (such as robotic methods for high-throughput screening, developments in mass spectrometry, novel imaging modalities, etc) will make medicine an information-rich discipline in which health and disease will be assessed increasingly by multi-parameter data that will be easy to gather, transmit and mine. Such information – if properly extracted and analyzed – will inexorably shift healthcare from a “one size fits all” paradigm to “individualized care”. Additionally, there will be more emphasis on preventative and predictive care and less on “symptomatic” care. In turn, biomarkers will streamline the drug development process and a subset of them will be linked to the pathophysiology of a disease process, thus providing novel therapeutic targets. Finally, the ability to view disease as a “systems problem” will lead to new insights with diagnostic and therapeutic implica-

tions. Thus “hardware” to elicit and detect “signals” from biological systems including humans (“translational technologies”), both *in vivo* and *ex vivo*, and analysis using sophisticated computational methods of the data obtained will lead to novel insights into disease pathophysiology – a central goal in IMBIO.

Moreover, IMBIO’s mission is to initiate and facilitate linkage from BIDMC to university departments in engineering, computational sciences, physics, and chemistry. Insights from public health, law, and business will also be welcome. IMBIO will also facilitate interactions within the Department of Medicine by helping identify clinical or scientific problems that may benefit from such interactions or from methodologies that cross divisional lines. As detailed below, IMBIO will build a cross-departmental think-tank of fellows and faculty to accomplish this goal.

## ● Educational Programs

The Division has a journal club every two weeks where speakers from the community discuss their research projects – the common thread is that they have an interdisciplinary approach to them. A new journal club directed at fellows and residents will be starting in the fall that will highlight research methodologies and problems that might benefit from such approaches. It is hoped that a think-tank of fellows will thus be established, who are well-versed in thinking “out-of-the-box”. A course for MIT graduate students (Translational Medicine Seminars) has been initiated by Dr. Sukhatme under the auspices of the Harvard-MIT Health Sciences and Technology (HST) Program. Plans are also underway for a one week “crash course” in medicine for those in other disciplines.

## ● Research Activities

### Research Funding • AY'07

Federal Direct.....	261,458
Federal Indirect.....	180,536
Other Direct.....	236,358
Other Indirect.....	11,604

Dr. Sukhatme's primary research interests are in vascular biology and in cancer, with projects that extend from laboratory research to clinical trials. They are detailed in the Nephrology Division's section, since Dr. Sukhatme is currently chief of that Division as well. Relevant to IMBIO, he is taking an integrated view of the cancer problem and investigating some "out-of-the-box" ideas for therapy. Drs. Hanai, Chan and Seth work closely with him.

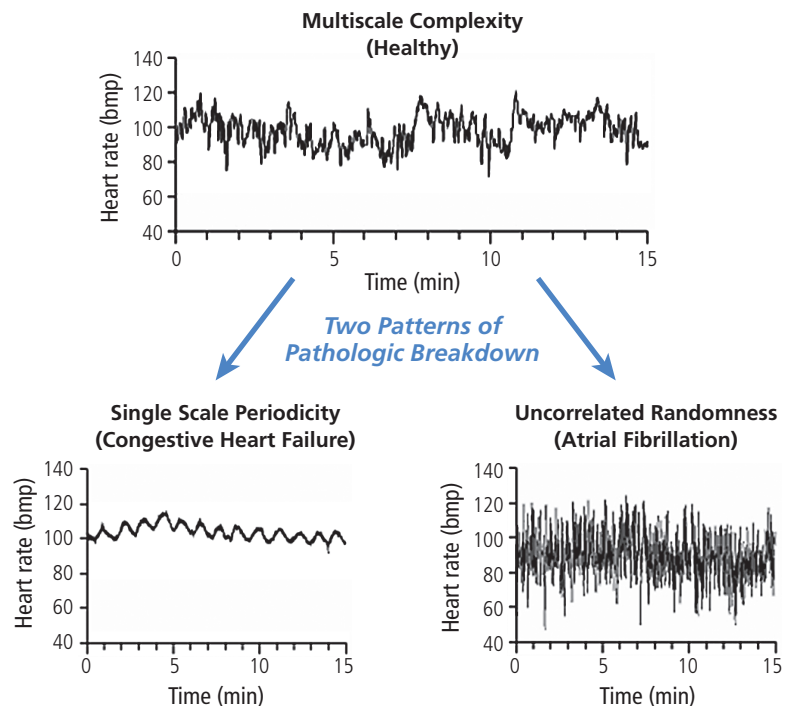
Drs. Goldberger, Peng and Costa focus on understanding nonlinear dynamics and fundamental mechanisms of complex systems. They have developed quantitative algorithms to probe some of the generic features of these systems and applied them to such diverse areas as heart rhythms in health and disease, forecasting drug toxicity, complexity analysis of coding and noncoding human DNA sequences, and gait stability.

Dr. Libermann (as director) and Drs. Gu, Zerbini, and Bhasin run the BIDMC Genomics Center and Cancer Proteomics Core. Their research primarily focuses on renal, prostate and ovarian cancer, utilizing state-of-the-art genomics, proteomics and bioinformatics approaches. Additionally, they have collaborated with a wide range of scientists both locally and nationally in many other areas.

Dr. G. Weber is a medical bioinformatician with a background in biomedical engineering, computer science, and medicine. His research interests focus on ways in which biomedical informatics can improve medical education, research and patient care. Dr. Weber has established a Biomedical Research Informatics Core (BRIC), to provide informatics services to BIDMC researchers.

## ● Award and Honors

Dr. Madalena D. Costa was invited faculty at Santa Fe Institute/NIH Workshop on The Foundations of Theoretical Medicine, Santa Fe, NM, July 2006 and the recipient of an individual research award ("Multiscale Analysis of Complex Biologic Systems") from the James S. McDonnell Foundation. Dr. Ary L. Goldberger, Program Director of the NIH Research Resource for Complex Physiologic Signals ("PhysioNet"), was an invited member of the NHLBI Strategic Planning Committee on Bioinformatics and Computational Biology, Bethesda, MD, July 11-12, 2006. Dr. Chung-Kang Peng was Adjunct Professor, Department of Mechanical Engineering, Yuan-Ze University, Taiwan. He was also an invited speaker at the DARPA Workshop on State-Dependent Delays in Regulatory Networks, Rutgers, NJ and other meetings. Dr. Griffin Weber was elected to the Aesculapian Club of Harvard Medical School (awarded by Harvard Faculty) and recipient of the Mass Medical Society Medical Technology Award.



- Healthy dynamics (top panel) are marked by complex, multiscale fluctuations with long-range (fractal) correlations. With aging and disease, this complexity breaks down, leading to either highly monotonous patterns (single scale, repeating cycles; lower left panel) or complete loss of correlations with random variations, as in atrial fibrillation, a common cardiac arrhythmia.

● *Selected Publications*

Bhasin, M, Reinherz, EL, Reche PA. Recognition and classification of histones using support vector machine. *J Comput Biol* 2006; 13:102-12.

Chan JL, Mietus JE, Raciti PM, Goldberger AL, Mantzoros CS. Short-term fasting-induced autonomic activation and changes in catecholamine levels are not mediated by changes in leptin levels in healthy humans. *Clin Endocrinol* 2007; 66:49-57.

Costa M, Priplata AA, Lipsitz LA, Wu Z, Huang NE, Goldberger AL, Peng C-K. Noise and poise: Enhancement of postural complexity in the elderly with a stochastic resonance-based therapy. *Europhys Lett* 2007; 77:68008.



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● Drs. Ary Goldberger, Associate Division Chief (left), and Vikas Sukhatme, Chief (right), enjoy a laugh at an IMBIO seminar.

● *Faculty*

Barden Chan, PhD	Chung-Kang Peng, PhD
Madalena D. Costa, PhD	Pankaj Seth, PhD
Ary L. Goldberger, MD	Vikas P. Sukhatme, MD, PhD
Xuesong Gu, PhD	Griffin Weber, MD, PhD
Junichi Hanai, MD, PhD	Luiz Zerbini, PhD
Manoj A. Kumar, PhD	
Towia Libermann, PhD	

Goldberger AL. Giles F. Filley Lecture: Complex systems. *Proc Am Thorac Soc* 2006; 3:467-71.

Jones J, Libermann TA. Genomics of renal cell cancer: The biology behind and the therapy ahead. *Clin Cancer Res* 2007; 13:685s-692s.

Lerma C, Lee CF, Glass L, Goldberger AL. The rule of bigeminy revisited: Analysis in sudden cardiac death syndrome. *J Electrocardiol* 2007; 40:78-88.

Libermann TA, Zerbini LF. Targeting transcription factors for cancer gene therapy. *Curr Gene Therapy* 2006; 6:17-33.

Peng C-K, Yang AC-C, Goldberger AL. Statistical physics approach to categorize heart rate dynamics. *Chaos* 2007; 17:015115.

Wu Z, Huang NE, Long SR, Peng C-K. On the trend, detrending and the variability of non-linear and non-stationary time series. *Proc Natl Acad Sci USA* 2007; 104:14889-14894.