The Future of Interdisciplinary Research and Training: How to Conquer the Silo Guardians

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We have entered a new era in biomedical research in which large interdisciplinary teams are being established to answer important scientific questions. Scientists of multidisciplinary backgrounds within universities are combining forces and interinstitutional consortia that include alliances between academia and industry are springing up around the country to generate breakthrough advances. A number of driving forces are at work to establish these collaborative research approaches. By contrast, there also are barriers to be surmounted by institutions with silo mentalities for effective partnerships to be established. In order for this new era of research to reach maximal effectiveness, new approaches to education of the young and retraining of established administrators and scientists must take place. These issues were explored thoroughly at the 2006 annual meeting of the Association of Anatomy, Cell Biology and Neurobiology Chairpersons (AACBNC) that was held in Aruba from January 18 to 21. The theme of this historic meeting was the Future of Interdisciplinary Research and Training: Breaking Down the Barriers. In this introductory article, we discuss the formation of a trendsetting Institute of Biomedical Sciences and Technology, the concept of the AACBNC meeting, and the influence of the Institute on the content of the meeting. The proceedings of this meeting, including Nobel Laureate Papers and Nobel Round-Table Discussions on the future of interdisciplinary research and training, are contained in this special issue of *Experimental Biology and Medicine*, a journal dedicated to the publication of multidisciplinary and interdisciplinary research in the biomedical sciences. Exp Biol Med 231:1189–1191, 2006

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Interdisciplinary Research and Training

In the post–human-genome world in which we live, the landscape of biomedical research has changed. Many important questions can only be answered by research teams consisting of scientists of multidisciplinary background who combine expertise in the biological, physical, engineering, and computer sciences.

Based on this new paradigm, in January of 2003, an Institute of Biomedical Sciences and Technology (IBMST) was created to stimulate the formation of teams of scientists with different backgrounds and expertise. The IBMST was created at the University of Texas at Dallas and began with only 11 multidisciplinary faculty. IBMST was the product of Dr. Steven R. Goodman's vision and he became its first director. Today, IBMST is a national interdisciplinary/interinstitutional consortium consisting of over 100 faculty coming from universities and medical schools covering the states of Texas, Louisiana, Oklahoma, Pennsylvania, New Jersey, Illinois, Vermont, California, Ohio, and South Carolina. Why has IBMST grown so rapidly? Because it is based on a simple principle on which virtually all researchers can agree. The principle is that in the electronic post–human-genome world in which we live, there is no reason for boundaries between disciplines, institutions, states, or nations when it comes to biomedical research that benefits mankind. Dr. Goodman gave a short presentation on IBMST at the 2006 annual meeting of the Association of Anatomy, Cell Biology and Neurobiology Chairpersons (AACBNC); but as you will understand from this introductory paper, the theme, several participants, and the content of this meeting were largely influenced by this trendsetting institute. Individuals who want to learn more about IBMST can go to the Web site (http://www.ibmst.com), and faculty who want to join can contact Steve Goodman.

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The Concept for the AACBNC Meeting

The 2006 annual meeting of the AACBNC was held in Aruba from January 18 to 21. Dr. Goodman was responsible for the theme and content of the meeting as the president of the chairs' organization. Dr. Charles A. Blake contracted with the meeting hotel to organize the meeting as the secretary-treasurer of the chairs' association. Because the interdisciplinary theme of the Aruba meeting matched a stated goal of the Society of Experimental Biology and Medicine (SEBM), and the future direction of its journal *Experimental Biology and Medicine* (EBM), Dr. Blake (President of the SEBM) and Dr. Goodman (whose term as editor-in-chief of EBM begins with this issue) decided that the July 2006 issue should contain the content of the Aruba meeting. In this manner, we can share this wonderful meeting with a much broader audience.

The theme of this historic meeting was the Future of Interdisciplinary Research and Training: Breaking Down the Barriers. The dream associated with creating the meeting was that we would attract three Nobel Laureates to participate. The goal was to have one in the area of chemistry, one in physics, and one in the biological sciences. These Nobel Laureates would give a talk on their research, but also would be involved in Round-Table Discussions related to the theme of the meeting. We were very pleased when the following Nobel Laureates agreed to participate: Dr. Aaron J. Ciechanover (Technion-Israel Institute of Technology, Haifa, Israel), Dr. Russell A. Hulse (University of Texas at Dallas, Richardson, Texas), and Alan G. MacDiarmid (University of Texas at Dallas, Richardson, Texas). Russell and Alan were both members of the IBMST Advisory Board and therefore were strong supporters of the interdisciplinary underpinnings of our meeting's theme. Aaron's participation in the meeting also demonstrated his enthusiasm for the modern emphasis on team interdisciplinary research and training in the biomedical sciences. Aaron joined the IBMST Advisory Board after this AACBNC meeting was concluded.

Russell Hulse won the Nobel Prize in Physics in 1993 for the discovery of binary pulsars. This was the first proof of Einstein's theory of relativity. Russell gave a brilliant presentation of his Nobel Lecture so that we bio-types could clearly understand his work on astrophysics. Amazingly, Russell's Nobel Prize was based on his graduate studies at the University of Massachusetts in Amherst. We highly recommend that faculty who read this article send your students to read Russell's Nobel Lecture. You will be amazed at the increased activity in your laboratory on evenings and weekends from this simple assignment. For the last 10 years, Russell has been actively involved in promoting science education for kindergarten through twelfth grade (K–12). We believe that you will find the insights in his Nobel paper in this issue into how science education must change to meet our new interdisciplinary world to be extremely thought provoking. Aaron Ciechanover won the Nobel Prize in Chemistry in 2004 based on his groundbreaking work on the ubiquitin-proteasome system for ATP-dependent protein turnover. His presentation at the AACBNC meeting dealt with the entire history of this field up to the current importance of his work in cancer treatment. Aaron's work has created an entire new field in cell biology and is one of the most fundamental discoveries in the history of this discipline. We thank the Nobel Foundation for giving us permission to reprint Aaron's Nobel Lecture in this issue. Alan MacDiarmid won the Nobel Prize in Chemistry in 2000 for his discovery of conducting polymers. Unfortunately Alan broke his hip, and he had hip-replacement surgery two weeks before our meeting. While he could not make the meeting physically, he was with us in spirit. He has included his manuscript, "Agrienergy (Agriculture/Energy: What Does the Future Hold?" for this special issue. We thank all three Nobel Laureates for their contributions to the 2006 AACBNC meeting and this special issue of EBM.

The Content of the AACBNC Meeting

In addition to giving talks on their Nobel Prize–winning studies, we involved Aaron and Russell in two Nobel Round-Table Discussions that are published in this issue. The first Round-Table Discussion dealt with the subject of "The Future of Interdisciplinary Research and Training." The moderator was Steve Goodman and additional panel members were Dr. Da Hsuan Feng (Vice President for Research and Economic Development at the University of Texas at Dallas) and Stephen Fluckiger (Senior Partner at Jones Day Law Firm and head of their Life Science and Biotechnology Practice in Dallas, Texas). Da Hsuan has been the administrator at the University of Texas at Dallas who is most supportive of the interdisciplinary and inter-institutional efforts of IBMST. Therefore, he was the perfect individual to ask about how university administrators can nurture these activities. Stephen Fluckiger is the chairman of the IBMST advisory board and has done more than anyone we know to nurture the relationship between academics and industry. Accordingly, he addressed the question of how this relationship is changing in the modern interdisciplinary world. The primary respondents to how K–12 education (Russell Hulse) and graduate and medical education (Aaron Ciechanover) must adapt to the new interdisciplinary paradigm were our two Nobel Laureates. We believe that you will find their comments and interaction with the audience to be fascinating. We also have contributed papers by Stephen Fluckiger and Da Hsuan Feng on these subjects within this issue of EBM.

The second Round-Table Discussion was on the subject of "Conflicts of Interest, Scientific Misconduct, Fair Sharing, and Intellectual Property in an Interdisciplinary/Inter-Institutional Consortium." This discussion was supported by a grant written by Steven R. Goodman to the American Association of Medical Colleges (AAMC) and the Office of Research Integrity (ORI). Part of the grant

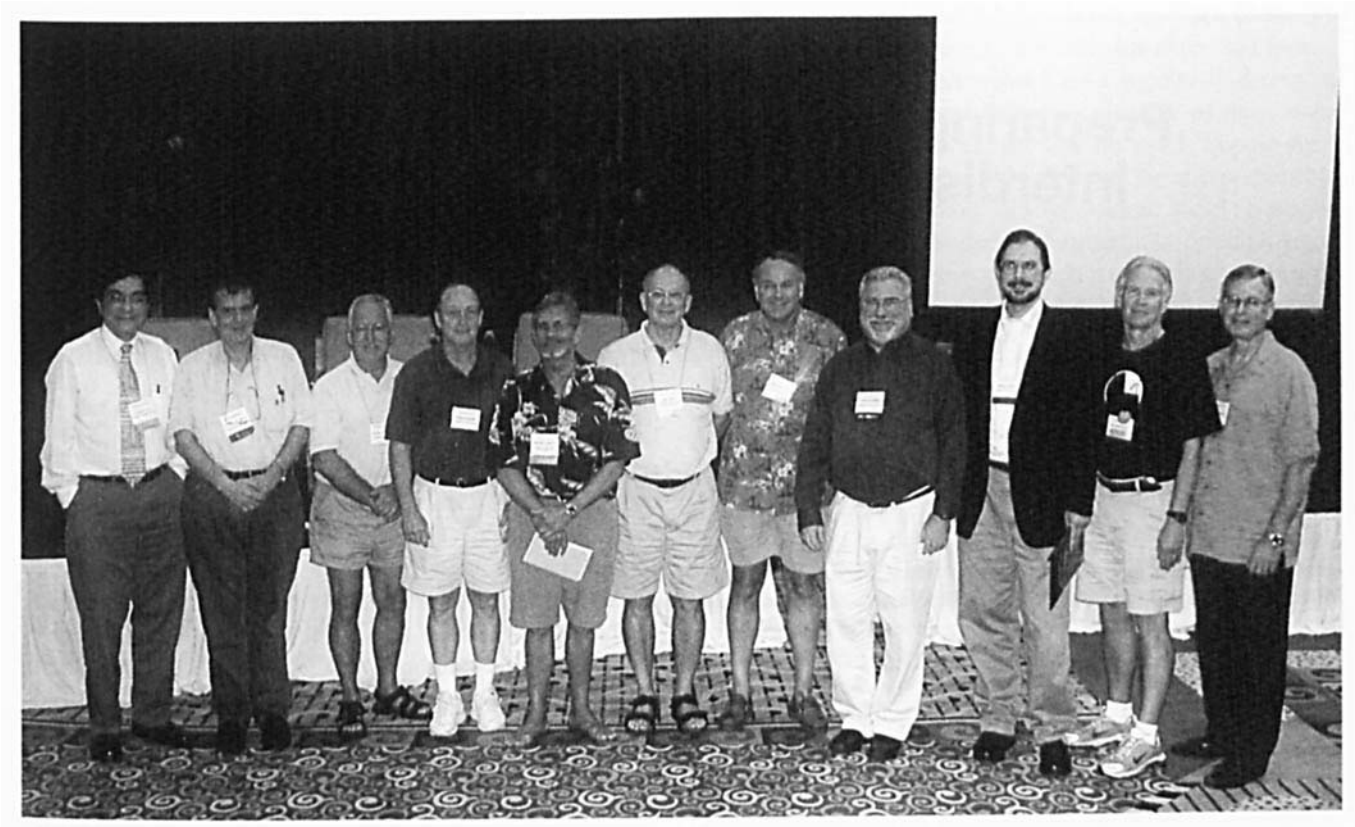

Figure 1. Shown at the 2006 Annual Meeting of the Association of Anatomy, Cell Biology and Neurobiology Chairpersons are (from left to right) Da Hsuan Feng, Aaron J. Ciechanover, Peter J. Stambrook, Charles A. Blake, Michael T. Shipley, James R. West, John Clancy, Jr., Steven R. Goodman, Russell A. Hulse, William B. Rhoten, and Stephen L. Fluckiger.

application was our intention to publish the content of this Round-Table Discussion in order that it would reach a broader audience than those in attendance at the Aruba meeting. We are fulfilling that agreement by publishing the content of this discussion in this special issue. The Round-Table Discussion was moderated by Susan Ehringhaus, who is the chief general counsel for the AAMC. Susan is an expert on the subject of conflict of interest, and she teed up this discussion for the panelists. Another panelist was Chris Pascal, who directs the ORI at the U.S. Department of Health and Human Services. Chris is a leading expert on proper conduct of research issues, and he teed up the discussion of the scientific misconduct questions for the panel. This discussion was so lively that its focus turned out to be entirely on conflicts of interest and scientific misconduct. We hope you will share this text with a broad spectrum of faculty, postdoctoral fellows, and students. We feel that it will be extremely helpful in courses that your medical school or university offers on the subject of research integrity.

We had a very exciting minisymposium at this meeting on "The Cell Cycle and Cancer." We are very pleased that one of the speakers in this session, Dr. Eric S. Knudsen, has written a minireview on this subject for inclusion in this special issue. We also thank Dr. Peter J. Stambrook for organizing this session.

Postscript

One of us (S.R.G.) was an attendee at the famous Woodstock Concert in 1969. I had the feeling on leaving that concert, and battling incredible traffic, that I had just experienced a once-in-a-lifetime event. Amazingly, I have experienced that same sense only once since then and it was while leaving this 2006 AACBNC meeting in Aruba. We were having the right discussion, at the right time, with the perfect participants. You will see the content of our meeting in this special issue, but what you will not be able to read about are the new lifelong friendships that were created in Aruba. You cannot know the new research and administrative collaborations that were initiated. You will only later learn that seminal international collaborations were formulated between the Technion-Israel Institute of Technology in Haifa, Israel, the University of Texas at Dallas, and IBMST. This was a meeting that was amazingly educational at the time, but the ripples will last forever. We are glad that we can share some of the excitement with you through this special issue. We could not have a better special issue to inaugurate the new interdisciplinary theme of *Experimental Biology and Medicine*.

We thank the Association of Anatomy, Cell Biology and Neurobiology Chairpersons, American Association of Medical Colleges, and the Office of Research Integrity at the U.S. Department of Health and Human Services for the financial support that made this special issue a reality.