

# *Thirty-Sixth Annual Briefing NEW HORIZONS IN SCIENCE*

*November 1 through 5, 1998  
Hyatt Regency Hotel  
Cambridge, Massachusetts*

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# *Sunday, November 1*

## *6:30 p.m. to 9:30 p.m.*

### WELCOME RECEPTION

The Castle, Boston University. Shuttle service begins at 6:15.

# *Monday, November 2*

## *8:30 a.m. to 11:30 a.m.*

### THE POST-GENOMIC ERA

DNA sequence data from the Human Genome Project continues to accumulate at a furious clip, providing the raw material for the biology of the next century. What's ahead?

#### *NATURE'S LEGO SET*

Temple F. Smith, Ph.D., Professor of Biomedical Engineering, Director, BioMolecular Engineering Research Center, Boston University, Boston, MA

The next critical hurdle: establishing the function of proteins encoded by newly acquired sequences. The traditional way has been to search through the genomes of simpler organisms in hopes of finding genes of known function bearing similar sequences. But that strategy has led to any number of errors, something genome "curators" are now striving to fix. One proposed solution: key in on the sequences of substructures called protein domains, nature's Lego set.

#### *CHEMICAL GENETICS*

Timothy J. Mitchison, Ph.D., Professor of Cell Biology, Co-Director, Institute of Chemistry and Cell Biology, Harvard Medical School, Boston, MA

For many DNA sequences, "comparative genomics" won't work. Reason: the sequences are novel; hence, no match-ups. What then? The most successful approach has been to mutate the gene and look for changes in the experimental model as a clue to protein function. But now researchers believe they can get answers far more quickly by using small, synthetic molecules that bind directly and precisely to target proteins in any cell type – a procedure that also promises to become a new and important tool for drug discovery.

#### *PHARMACOGENOMICS/BIOLOGICAL WARFARE DEFENSES*

Charles R. Cantor, Ph.D., Professor of Biomedical Engineering, Director, Center for Advanced Biotechnology, Boston University; Chief Scientific Officer, Sequenom, Inc., San Diego, CA.

The Human Genome Project, when completed, will provide the genetic blueprint for the species as a whole. It will not, however, tell us much about genetic variation, the differences that make each of us more or less susceptible to diseases or more or less responsive to drugs. That has prompted efforts to develop new technologies for delineating differences in genotype, approaches that will not only usher in a new era in medicine but also lead perhaps to more effective defenses against biological weaponry.



*Monday, November 2*  
*12:00 Noon*

LUNCHEON

Empress Room, 11th Floor, Hyatt Regency.

*2:30 p.m. to 5:30 p.m.*

GRAVITATIONAL PHYSICS: THE COMING WAVE

Clifford Will, Ph.D., Professor and Chair, Department of Physics, Washington University, St. Louis, MO

Of the four fundamental forces of nature, gravity has been studied the longest but continues to present some of the deepest challenges to physics – these having to do with gravity wave detection; colliding black holes; the age and geometry of the universe; relativity; and the unification of gravitation and quantum theory. A National Academy of Science-backed committee is readying a report aimed at better defining scientific objectives for the next decade and offering proposals for achieving those targets. A co-chair of the committee offers his personal take on it all.

MATTER AT ABSOLUTE ZERO

Wolfgang Ketterle, Ph.D., John D. MacArthur Professor, Research Laboratory of Electronics and Department of Physics, Massachusetts Institute of Technology, Cambridge, MA

In 1924, Einstein predicted it. In 1995, scientists finally confirmed it. Cooling a gas to close to absolute zero yields a Bose-Einstein condensate, a novel kind of quantum matter in which the atoms all “march in lockstep” to form one giant matter wave possessed of many exotic properties. Researchers are now working toward using these condensates as a test bed for deeper exploration of the quantum world; as the linchpin for a new generation of ultra-precise atomic clocks; to make exacting measurements of fundamental physical constants.

*6:30 p.m.*

Hospitality Suite open.

# *Tuesday, November 3*

## *8:30 a.m. to 11:30 a.m.*

### FASHIONING NOVEL PHOTOBIOMOLECULES

Kenneth J. Rothschild, Ph.D., Professor of Physics, Boston University, Boston, MA

Researchers involved in the decades-long effort to fathom the structure/function nexus of bacteriorhodopsin – along with its evolutionary kin, rhodopsin, the agent of vision – stand on the threshold of some major payoffs. Building on their hard-won knowledge of nature's rules for molecular assembly and recognition, they have learned to make light-responsive versions of normally non-photonic biomolecules. As a result, a host of new applications beckon, from optoelectronic biocircuits to photonic sensors for use in cancer screening.

### THE IMPERILED OCEANS

C. Drew Harvell, Ph.D., Associate Professor and Curator, Section of Ecology and Systematics, Division of Biological Sciences, Cornell University, Ithaca, NY

James T. Carlton, Ph.D., Professor of Marine Sciences, Williams College, and Director, Maritime Studies Program, Mystic Seaport-Williams College, Mystic, CT

There's a growing sense that the Earth's oceans are under siege. New pathogens seem to be having significant and increasing impact on the ecology of the sea, including commercially important fisheries. Scientists worry, too, that global warming may exacerbate matters further. Adding to those anxieties: the threat the oceans pose as potential reservoirs and incubators of human disease; the havoc wreaked by exotic invaders, alien plants and animals transported to freshwater and marine ports. What's to be done?

## *12:00 Noon*

### LUNCHEON

Empress Room, 11th Floor, Hyatt Regency.



# *Tuesday, November 3*

## *2:30 p.m. to 5:30 p.m.*

### UNDER THE VOLCANO: A NEW LOOK

Stanley N. Williams, Ph.D., Professor of Volcanology, Department of Geology, Arizona State University, Tempe, AZ

More than 1,500 active volcanoes threaten the lives of a half-billion people. And, given population pressures, that number will continue to rise as the areas bordering many of these potentially explosive sites succumb to development. Several new technologies offer great promise in improving scientists' ability to forecast catastrophic eruptions. But there's still the question of how to adapt this new-found know-how (and the uncertainties that go with it) to the needs and resources of the developing world, where most of the danger lies.

### CHAOS/MUSIC/IMAGE

Diana S. Dabby, Ph.D., Laboratory for Information and Decisions Systems, Massachusetts Institute of Technology, Cambridge, MA

"Whither music in our time?" mused Charles Ives. In the 1980s, a concert pianist wondered much the same. Perusal of a journal devoted to tomorrow's music left her puzzled. The contributors were primarily engineers and scientists, not professional musicians. What, she wondered, if a pro were to acquire their tools? She set about doing just that, mastering the principles of chaos and inventing a variation technique that has opened the way to a fresh hearing of music both old and new, as well as a novel look at image.

## *7:00 p.m.*

### CASW RECEPTION AND ANNUAL BANQUET

Ballroom, George Sherman Union, Boston University. Shuttle service begins at 6:45.

Presentation of the National Association of Science Writers' Science-in-Society Journalism Awards.

Featured Speaker: Dudley R. Herschbach, Ph.D., Baird Professor of Science, Harvard University, Cambridge, MA, on "Sacred and Profane Love."



# *Wednesday, November 4*

## *8:30 a.m. to 11:30 a.m.*

### **NEW SYNERGISMS**

Unusual interdisciplinary alliances are opening new avenues for solving a slew of daunting biological riddles.

### *THE PHYSICS OF ALZHEIMER'S DISEASE*

H. Eugene Stanley, Ph.D., University Professor, Director, Center for Polymer Studies, Professor of Physics, and Professor of Physiology, School of Medicine, Boston University, Boston, MA

What role, if any, do senile plaques have in the development of Alzheimer's disease? By calling into play the tools of statistical mechanics and advanced 3-D laser imaging, and given the availability of a transgenic mouse model for the disease, a coalition of physicists and physicians believes it now has the wherewithal to track the evolution of these plaques and their consequent neuronal impact. By way of these studies, they hope to get at the basic underpinnings of this devastating malady and, ultimately, to develop and test new strategies for halting and even reversing the disease process.

### *THE MATHEMATICS OF THE CENTRAL NERVOUS SYSTEM ...*

Nancy Kopell, Ph.D., Professor of Mathematics, Co-Director, Center for BioDynamics, Boston University, Boston, MA

The central nervous system got rhythms aplenty. Said rhythms accompany all aspects of mental activity, from sensory processing to motor control. States of mind – e.g. attention, exploration and quiet awareness – also have their own signature rhythms. As does sleep. How does the nervous system create and modulate these rhythms? More to the point: how does it make use of these patterns to perform important tasks? Mathematical analysis of neurological activity may provide answers that may one day lead to new weapons against Parkinson's tremor, epilepsy and other rhythm disorders.

### *... AND THE CELL CYCLE*

James J. Collins, Ph.D., Professor of Biomedical Engineering, Co-Director, Center for BioDynamics, Boston University, Boston, MA

The goal: to have the power not only to fine tune – to speed up or slow down – the elaborate biochemical choreography involved in cell division but also to control daughter-cell size. With the help of a newly developed mathematical model of the cell cycle – based on input from a range of disciplines, including cell biology, engineering, non-linear dynamics and computer science – researchers have in fact succeeded in achieving that goal. The promise: new cancer treatments; development of novel drug-delivery systems.



# *Wednesday, November 4*

## *12:00 noon*

Shuttle service to Boston University. See tip sheet for local dining establishments.  
Sessions reconvene at 2:00 p.m. in the Symposium Room, Ninth Floor, The Photonics Center, 8 St. Mary's Street.

## *2:00 p.m. to 3:15 p.m.*

### WELCOME TO THE PHOTONICS CENTER

Donald Fraser, Ph.D., Director

### FELLING BACTERIA

Shyamsunder Erramilli, Ph.D., Associate Professor of Physics, Boston University, Boston, MA

Wounded soldier rushed to field hospital. Most immediate dilemma: treating potentially fatal bacterial sepsis. But treat how? Unable to wait for culture identifying offending species, doctors must guess ... and hope they're right. Now, imagine this scenario: Soldier arrives. Wound scanned with laser, which instantly I.D.'s invader via signature spectrum. Medics tune to wavelength that singles out and kills the microbe and blast away. Early studies suggest the free electron laser may make this medical dream come to pass.

### 'ENTANGLEMENT' MICROSCOPY

Malvin C. Teich, Ph.D., Professor of Electrical and Computer Engineering, Biomedical Engineering, and Physics, Boston University, Boston, MA

Bahaa E. A. Saleh, Professor and Chair, Department of Electrical and Computer Engineering, Boston University, Boston, MA

By harnessing quantum-sourced light, researchers have found a way to look far more deeply into living tissue than heretofore possible using far less intense levels of radiation than would have been required had classical light sources been put to the task. That cuts down on photodamage. Called entangled-photon microscopy, this new technique will cast some new, much-needed light on a broad constellation of fundamental biological processes.

## *3:30 p.m. to 4:45 p.m.*

### LABORATORY PRESENTATIONS AND DEMONSTRATIONS

## *6:00 p.m.*

### 'TASTE OF NEW ENGLAND' GALA

Hosted by Boston University at The Photonics Center.



# Thursday, November 5

## 8:30 a.m. to 11:30 a.m.

### THE ECO OF THE CITY

Steward T. A. Pickett, Ph.D., Senior Scientist, Institute of Ecosystem Studies, Millbrook, NY

When you hear mention of the science of ecology, you probably think wilderness, regions sparsely inhabited by humans. Fact is, that has long been the way of it. But there's a major change afoot as ecologists, armed with new ideas for studying ecosystems, train their sights on the "last frontier" – the human-dominated metropolis. With funding from the National Science Foundation, two cities have been selected for long-term observation. The results, it is hoped, will lead to a much-enhanced quality of life for urban dwellers.

### BRONZE-AGE SEAFARING

Shelley Wachsmann, Ph.D., Meadows Assistant Professor of Biblical Archaeology, Institute of Nautical Archaeology, Texas A&M University, College Station, TX

Having assembled all available threads of evidence, a marine archaeologist provides the first comprehensive overview of seafaring during a pivotal period of human development (c. 3000 - 1200 B.C.). In the newly published *Seagoing Ships and Seamanship in the Bronze Age Levant*, he offers a provocative look at how diverse cultures were affected by nautical deeds. Much remains to be learned about this lost world, but only if scientists beat the plunderers to as-yet undiscovered wrecks lying deep beneath the wine-dark waters of the Mediterranean.

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