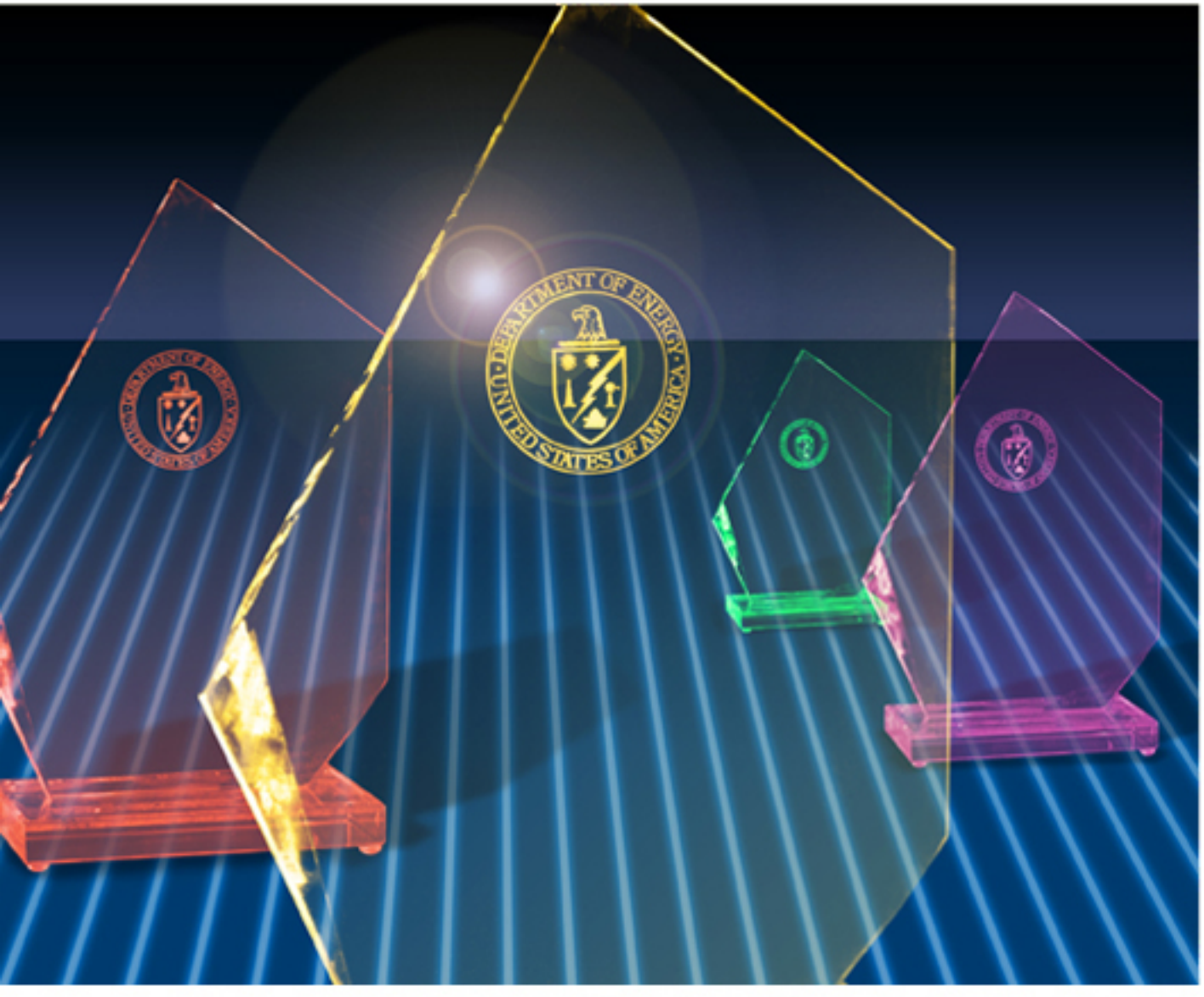
Exceptional Service Awards



Presented at the 50th Anniversary Symposium
of the Biological and Environmental Research Program
of the U.S. Department of Energy

A color brochure and other recent publications related to DOE's Biological and Environmental Research (BER) Program are available from the sources below. These publications include the proceedings of the BER 50th anniversary symposium (Serving Science and Society into the New Millennium: Doe's Biological and Environmental Research Program) and the historically comprehensive A Vital Legacy: Biological and Environmental Research in the Atomic Age.

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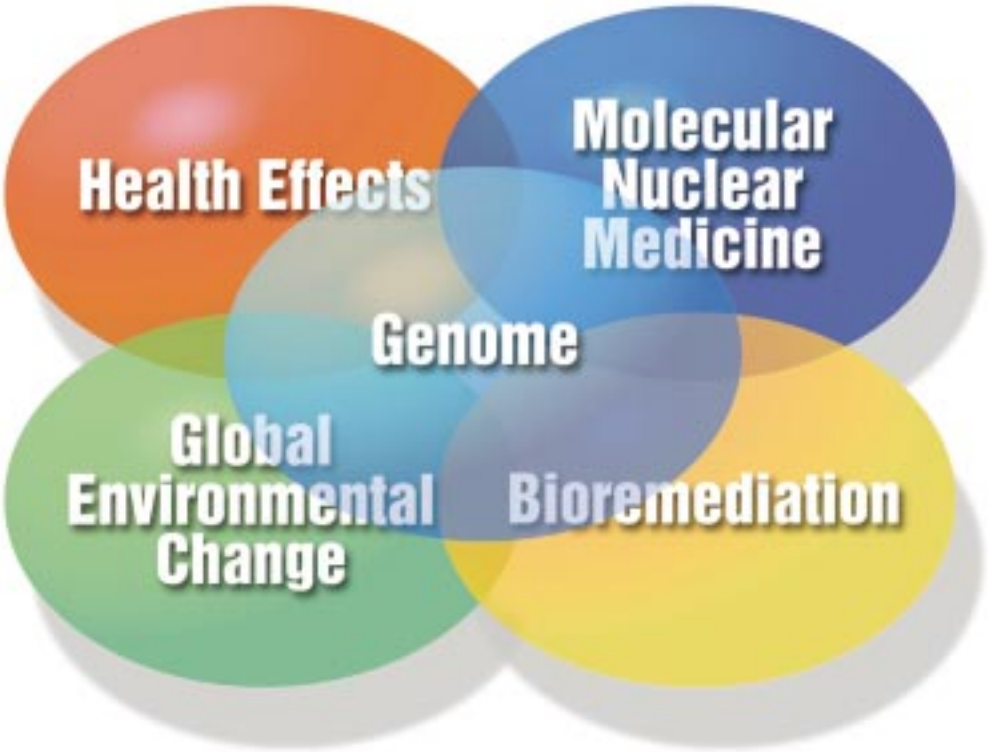
Additional information about the BER program can be found at BER Web sites:
- http://www.er.doe.gov/production/ober/ober_top.html
- http://www.er.doe.gov/production/ober/ber50.html

Cover Art: The front and back covers display an artist's rendering of the etched glass awards presented to 13 scientists for exceptional service to the Biological and Environmental Research Program of the U.S. Department of Energy. Explanations of the research photographs on the back cover (top to bottom) are printed in the picture captions on p. 11 (positron emission tomography image of the human brain), p. 31 (atmospheric model for global climate simulation), and p. 25 (the microbe Methanococcus jannaschii).

EXCEPTIONAL SERVICE AWARDS

Presented at the
BER 50th Anniversary Symposium

May 21–22, 1997



Prepared for the

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Biological and Environmental Research Program

by the

Human Genome Management Information System
Life Sciences Division
Oak Ridge National Laboratory
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Introduction

At a symposium held May 21–22, 1997, at the National Academy of Sciences, the U.S. Department of Energy (DOE) Office of Biological and Environmental Research (OBER) celebrated the legacy and promise of 50 years of achievements. On the last day of the symposium, 13 individuals were presented with Exceptional Service Awards as exemplars of the quality of effort and diversity of issues, disciplines, and institutional sectors encompassed by OBER's Biological and Environmental Research (BER) program. The awardees and their achievements are honored in this booklet.

Each award recipient is necessarily a surrogate for many others who deserve recognition for their imaginative, compelling, and productive work and for the rich promise their efforts foreshadow.

Key to the BER program's success has been its multidisciplinary, comprehensive approach to achieving a more fundamental understanding of life processes and environments and to exploiting the boundless promise of these discoveries for the public benefit. DOE and its predecessor agencies, acting on mandates set out by Congress in the Atomic Energy Act of 1946, have pursued biological and environmental research with an unwavering commitment to understanding the health and environmental consequences of energy technologies and their by-products.

Early pioneers of this research hardly could have predicted its course over the years. Studies on the effects of radioactive fallout have evolved into today's global climate change research. Explorations of human metabolism using radiotracers have led to high-resolution imaging devices and the exciting new field of molecular nuclear medicine, and questions raised by early epidemiological radiation studies gave rise to the Human Genome Project.

The future, as usual, promises unknown challenges—and unexpected opportunities. At the doorstep to the 21st century, the BER program is poised to continue its tradition of scientific advancement.

Exceptional Service Awardees

May 1997

Recipients of the Exceptional Service Awards presented by the Office of Biological and Environmental Research, U.S. Department of Energy, are pictured at the BER 50th anniversary symposium in May 1997. Seated, from left, are Edwin Westbrook, Mina Bissell, Michael Knotek, Betty Mansfield, Claire Fraser accepting for J. Craig Venter, Tuan Vo-Dinh, and Warren Washington. Standing, from left, are Michael Huston, Joe Gray, Charles DeLisi, presenter Ari Patrinos (Associate Director, DOE OBER), James Edmonds, Joanna Fowler, and W. Lawrence Gates.

Exceptional Service Award for Contributing to a Healthy Citizenry

Since the establishment of the Atomic Energy Commission (a predecessor to DOE) a half century ago, DOE's most fundamental health-research goal has been to understand the risks and exploit the benefits of energy technologies and their by-products.

As the BER program obtained definitive information in the 1940s and 1950s concerning the biological effects of relatively high levels of radiation exposure, attention turned to the potential effects of lower doses. The result was a comprehensive, long-term, multidisciplinary research program aimed at understanding the underlying mechanisms of biological damage from radiation and chemical exposures. BER studies have since revealed some of the underlying similarities of mechanisms at work in damage caused by exposure to radiation, X rays, ultraviolet light, and chemicals. These and other data obtained from the BER program have provided much of the scientific foundation for laws and standards that protect the population, including workers exposed to radiological sources.

Explorations into using radiation and radioisotopes in medical research and therapeutics led to the highly successful field of nuclear medicine, which began some 50 years ago when the U.S. Food and Drug Administration approved the first radiopharmaceutical for medical use—iodine-131, produced at Oak Ridge National Laboratory. DOE and its predecessors supported the further development and application of isotope generators, along with imaging devices to visualize the isotopes as they emit radiation in the body. These studies ultimately gave rise to many of today's tools that involve the use of radioisotopes, including imaging studies, therapeutic procedures, and diagnostic laboratory tests. Coupled with new discoveries in biology and genetics, these breakthroughs are stimulating novel ways to diagnose and treat cancer and other disorders, detect genes in action, and understand normal development and function of human organ systems.

In looking toward the next century of biological research, BER seeks to integrate human health research with information and technologies from genome, structural biology, and molecular biology research. BER's goal is to better understand the complex relationships among genes and the proteins they encode as well as the biological functions of proteins in the context of the whole organism.

To facilitate these explorations, the BER program develops and maintains DOE national user facilities housing synchrotron and neutron sources for scientists to determine the molecular structure of enzymes, antibodies, and other important biological molecules. Computational research combines computer science, structural biology, and genome research to predict the functions of biological molecules. Such understanding also is central to advancing DOE's biotechnological mission over a wide range of applications, including environmental bioremediation and energy production from biomass. These research programs will provide greatly improved molecular tools for assessing health risk and predicting and evaluating individual susceptibilities to low-level workplace and environmental exposures from energy-related activities.

BER Accomplishments

Advanced DNA-Based Tools for Medicine

- BER researchers developed fluorescent dyes to "paint" chromosomes, enabling diagnosis of some types of cancers, prediction of treatment outcomes, and quantification of DNA damage in cells.

Bioassays

- The Ames Salmonella Assay, developed with BER support, tests for potential mutagenicity and is one of the first hurdles a new compound must clear on its way to regulatory and public acceptance.
- BER-sponsored research led to the discovery and understanding of DNA repair enzymes. The enzymes were named Molecules of the Year in 1994 by *Science* magazine because of their central role in the maintenance of human health.

Radioactive Tracer Biology and Nuclear Medicine

- Research on the beneficial effects of radioisotopes in medicine gave rise to the field of nuclear medicine. An estimated 1 in 3 U.S. hospitalized patients undergoes a nuclear medical procedure, and nearly 100 million laboratory tests using radioisotopes are performed every year in the United States.
- Radioisotopes have been developed for use in detecting diseases in such organs as kidney, liver, heart, and brain.
- Radioisotopes are being used to treat thyroid diseases, pituitary tumors, and eye cancer, among other disorders.
- Development of advanced instrumentation technology, coupled with expertise in the use of radiation, led to the debut of such sophisticated imaging tools as positron emission tomography (PET), computerized tomography (CT) scans, and magnetic resonance imaging (MRI) that allow noninvasive diagnosis, monitoring, and exploration of human disorders and their treatments.
- Isotopes and other tracers of brain activity are being used to explore drug addiction, effects of smoking, Alzheimer's disease, Parkinson's disease, and schizophrenia. Research has been instrumental in linking dopamine deficiency with Parkinson's disease and in developing a treatment using the medication L-dopa.

Guidelines and Training

- BER studies provided the scientific foundation of guidelines for the safe use of diagnostic X rays and radiopharmaceuticals, safety standards used in the presence of radioisotopes in food and drinking water, and radiation-detection systems and dosimetry techniques.
- BER programs provide training and research experience for radiation biologists and health physicists, radioecologists, and nuclear medicine experts.

EXCEPTIONAL SERVICE AWARD
For Contributing to a Healthy Citizenry

Mina Bissell, Ph.D.
E.O. Lawrence Berkeley National Laboratory
Berkeley, California

Mina Bissell received a B.A. in chemistry from Radcliffe-Harvard College and an M.A. in bacteriology and biochemistry from Harvard University, where she earned a Ph.D. in microbiology and molecular genetics in 1969. She received a Milton fellowship from Harvard and was an American Cancer Society fellow at the Department of Molecular Biology, University of California, Berkeley. In 1972, she joined E.O. Lawrence Berkeley National Laboratory, where she became Director of Cell and Molecular Biology in 1988. She was named Director of the newly formed Life Sciences Division in 1992.

Dr. Bissell has published more than 100 articles and papers in peer-reviewed journals and more than 50 book chapters and reviews. She has submitted three patent applications and sits on the scientific advisory boards of several biotechnology companies. She has won numerous awards, including a Guggenheim fellowship in 1993. She was elected a fellow of the American Association for the Advancement of Science in 1995, and in 1996 she received the E.O. Lawrence Award, one of DOE's highest honors. In 1997 Dr. Bissell was President of the American Society for Cell Biology and was elected to the Institute of Medicine of the National Academy of Sciences. In 1998 she won the Mellon Award of the University of Pittsburgh and in 1999 the Eli Lilly/Clowes Award of the American Association for Cancer Research.

Mina Bissell

"In recognition of your . . . research in the area of molecular and cell biology, to understand how cell growth, differentiation, and survival are controlled in normal and cancerous breast cells."

Reversion of the Malignant Phenotype

Mina Bissell, with her team of scientists at Berkeley Lab, has taken several novel approaches to studying normal cell growth, differentiation, and carcinogenesis. Using human and mouse breast cells in a three-dimensional tissue culture model, Dr. Bissell has demonstrated that the extracellular cellular matrix (ECM), the mass of fibrous and globular proteins that surround the cell, plays a vital role in gene expression and thus bears significantly on cell growth, functional differentiation, apoptosis (programmed cell death), and cancer.

In 1981, Dr. Bissell formulated the concept of "dynamic reciprocity," in which she proposed that signals are transduced into the cell nucleus through ECM receptors (subsequently discovered by others and called integrins). These receptors would have attachments to the proteinaceous filamentous network (the cytoskeleton) that encompasses the cytoplasm, with connections to the nucleus and chromatin via the nuclear matrix. Her studies not only have confirmed the model but have revealed an unexpected role for ECM in gene expression. This research has demonstrated that ECM can trip switches deep within the nucleus and spur the genes themselves into action. Her group was the first to identify the molecular components of the ECM signal and to establish that ECM also is responsible for protecting against apoptosis. This discovery provides an important key in understanding how cell growth, survival, and differentiation are controlled in normal cells but become aberrant in tumors.

Reversion of the Malignant Phenotype. Mina Bissell's group demonstrated that the microenvironment surrounding cells plays a vital role in gene expression. After manipulation of the proteins surrounding the cell as well as the cell-surface molecules to which they bind, human breast cancer cells reverted to normal cell function in culture and tumors were reduced dramatically in immune-deficient mice. Postdoctoral fellow Dr. Valerie Weaver (left) and Dr. Bissell prepare tissue specimens for confocal fluorescence microscopy imaging of frozen sections of breast cell colonies. The inset images, captured by Dr. Carolyn Larabell of Lawrence Berkeley National Laboratory, depict this reversion: the well-organized rounded structures of normal cells (left), the haphazard arrangement of proliferating malignant cells (middle), and the return to a more normal arrangement after treatment (right). Labeled in green and red are the cytoskeletal protein actin and the cell nuclei, respectively.

In a profound insight with practical significance, Dr. Bissell and her colleagues put forward the notion that cancer is the result not only of genetic change, developmental regulation, or loss of tissue structure but is an interweaving of all these factors. Making important strides to reinforce this assertion, Dr. Bissell's group has demonstrated that, by manipulating the microenvironment and ECM receptors, overtly tumorigenic human breast cancer cells are reverted to normal cell function in culture and tumors are reduced dramatically in immune-deficient mice. These findings have vital implications for breast cancer diagnosis, prognosis, and treatment.

EXCEPTIONAL SERVICE AWARD
For Contributing to a Healthy Citizenry

Joanna Fowler, Ph.D.
Brookhaven National Laboratory
Upton, New York

Joanna Fowler is a Senior Chemist and Director of Brookhaven National Laboratory's (BNL) Positron Emission Tomography Program. After completing the B.A. in chemistry at the University of South Florida and Ph.D. in chemistry at the University of Colorado, she joined the BNL Chemistry Department in 1969. Dr. Fowler has received numerous awards, including the BNL R&D Award in 1995, Aebersold Award of the Society of Nuclear Medicine in 1997, Francis P. Garvan–John M. Olin Medal of the American Chemical Society in 1998, and the E.O. Lawrence Award in 1999.

Joanna Fowler

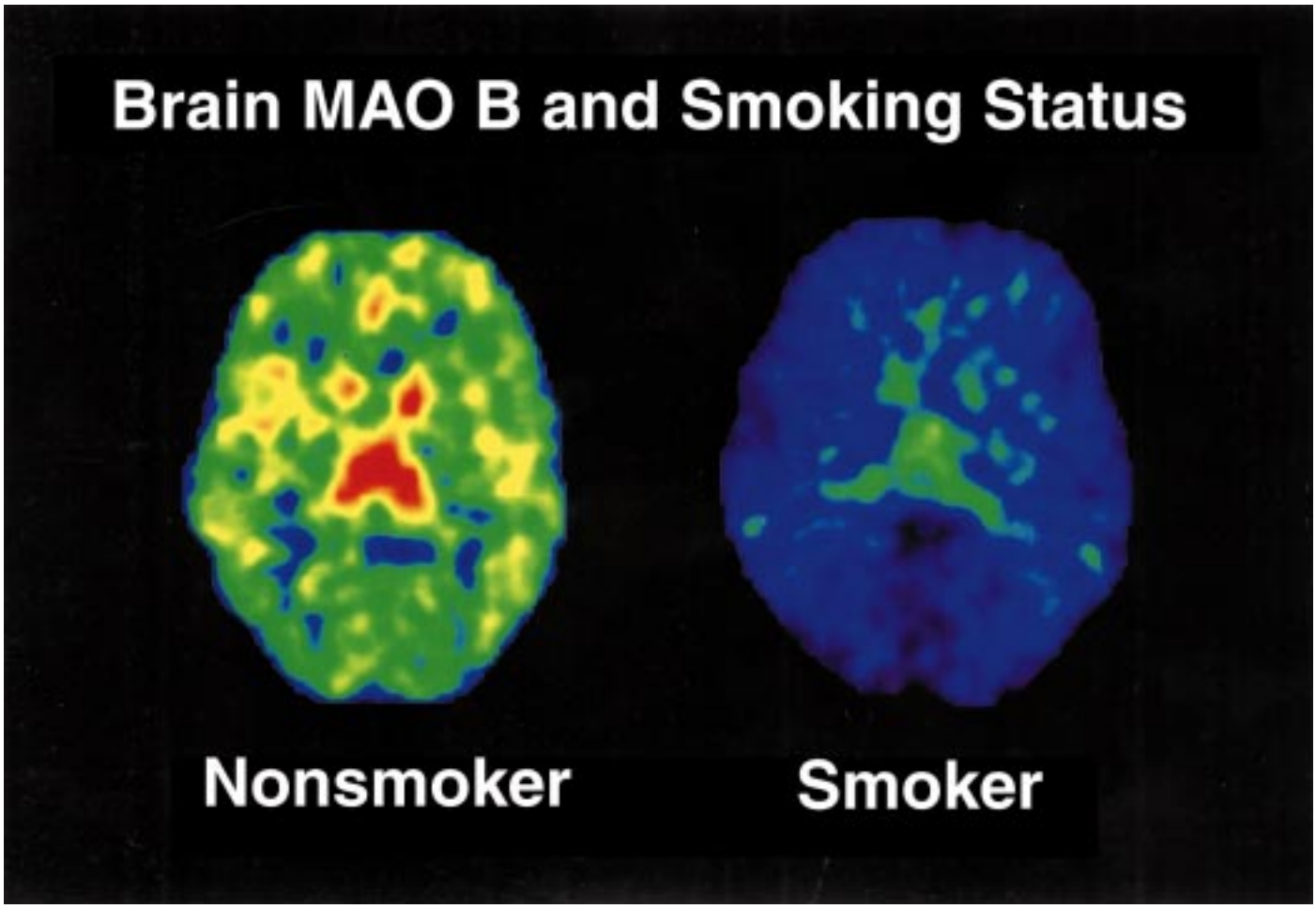
"In recognition of your . . . research for medical applications to create new concepts in medical imaging and to design, synthesize, and apply radiotracers to the study of the human brain in health and disease."

PET Technology

From her beginnings as a synthetic organic chemist, Joanna Fowler has played a seminal role in developing positron emission tomography (PET) technology, which allows researchers to monitor the brain activity of people afflicted with schizophrenia, Alzheimer's and Parkinson's diseases, brain tumors, drug addictions, and other substance abuse. The use of PET, which provides a time and space window into the function of vital organs and human biochemistry, depends on the availability of organic compounds labeled with short-lived positron-emitting radionuclides.

Dr. Fowler has made important contributions to the synthesis of labeled compounds for PET research and has opened new vistas in the study of human biochemistry and the mechanism of drug action. She made exceptional contributions to the design and synthesis of ^{18}F-fluorodeoxyglucose (FDG) in 1976, profoundly accelerating the growth of PET research. FDG, the most widely used PET tracer in the world, has played a pivotal role in understanding human brain function, in diagnosing and monitoring cancer patients, and in assessing cardiac viability.

Dr. Fowler's development of ^{11}C-cocaine provided the tools for the first documentation that cocaine movement in the human brain parallels its subjective effects. Her approach to mapping human brain

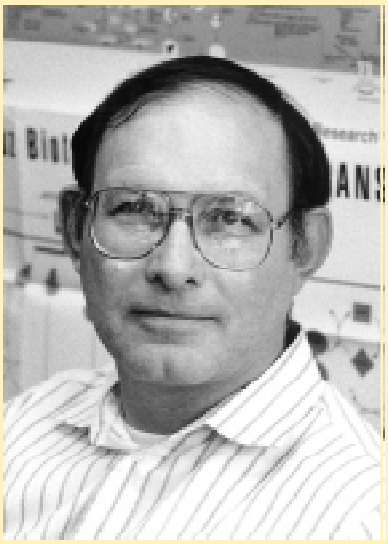


Positron Emission Tomography (PET) Technology Application to Brain Studies. Dopamine is a neurotransmitter involved in movement, motivation, and reward; monoamine oxidase B (MAO B) is a brain enzyme that breaks down neurotransmitters like dopamine. Using PET imaging and [11C]L-deprenyl-D2 (a radiotracer that maps brain MAO B), Joanna Fowler's group discovered that cigarette smokers have less brain MAO B than nonsmokers and former smokers. MAO B inhibition by smoke may account for some of smoking's epidemiological features, including the lower risk of Parkinson's disease in smokers and the high rate of smoking in individuals who are depressed or addicted to such other substances as alcohol and cocaine.

monoamine oxidase (MAO) made possible the direct measurement of the turnover rate of MAO B in the living human brain. Dr. Fowler recently used this strategy to provide the first documentation that cigarette smokers have reduced brain MAO, an observation that opens a new vista on the biological effects of cigarette smoke and offers alternative treatment strategies.

Dr. Fowler's research, coupled with pioneering research in radiotracer chemistry by Alfred Wolf and internationally recognized studies of addiction led by Nora Volkow, has pushed BNL to the forefront in the use of PET technology and led to BNL's selection as the site for a new National Institute on Drug Abuse (NIDA) Regional Neuroimaging Center. This center, funded jointly by DOE, NIDA, and the Office of National Drug Control Policy, features a new PET scanner to be used in studies to understand addiction and to develop drug-addiction treatments.

EXCEPTIONAL SERVICE AWARD
For Contributing to a Healthy Citizenry



Joe Gray, Ph.D.
University of California
San Francisco, California

Joe Gray did his undergraduate studies in physics at the Colorado School of Mines and received his Ph.D. in physics from Kansas State University in 1968. He then joined Lawrence Livermore National Laboratory as a biomedical scientist and served as leader of the Cytophysics Section from 1982 to 1991, when he accepted a position in the Department of Laboratory Medicine, University of California, San Francisco (UCSF). In 1992 Dr. Gray was appointed Senior Scientist at Lawrence Berkeley National Laboratory, and in 1993 he became Professor of Laboratory Medicine and Radiation Oncology at UCSF.

Dr. Gray has published some 170 peer-reviewed articles and 80 reviews, chapters, and other publications, and has edited 5 books. He currently holds 15 patents with 10 more pending.

Dr. Gray was President of the Cell Kinetics Society from 1983 to 1984 and was elected in 1996 to a 2-year term as President of the International Society of Analytical Cytology. He currently serves on the editorial boards of six professional journals. His honors include the 13th Research Award from the Radiation Research Society in 1985, Smith-Kline and French Distinguished Lectureship in 1986, DOE E.O. Lawrence Award in 1986, and appointment as a fellow by the American Association for the Advancement of Science in 1996 and to the Cell Proliferation Society Shiffer Lectureship in 1999.

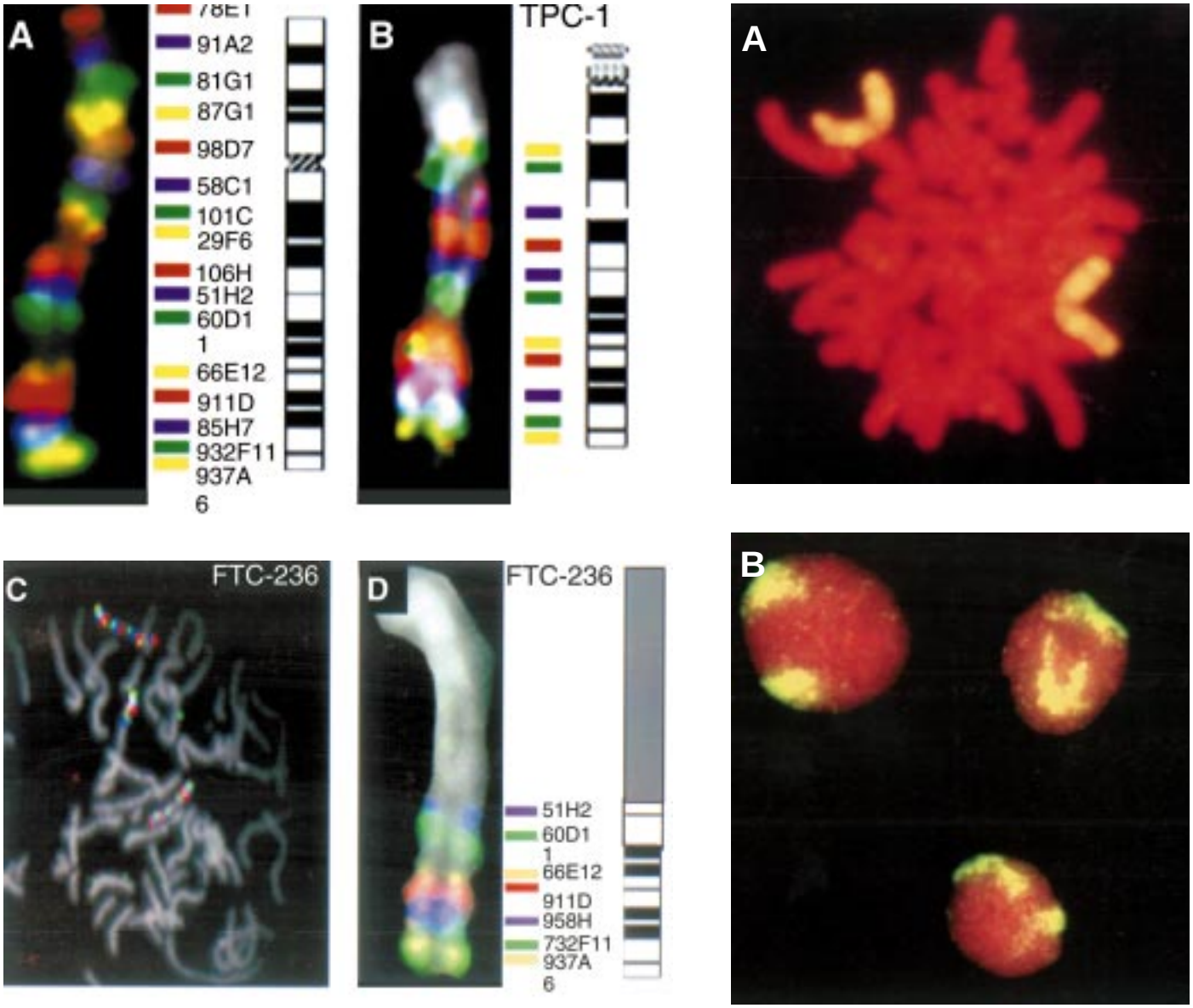
Joe Gray

"In recognition of your . . . research in the area of health effects to develop molecular cytogenetic tools such as 'chromosome paints,' so valuable for clinical and research applications."

Molecular Cytogenetics

Joe Gray's research goals are to gain a better understanding of the mechanisms by which genomic abnormalities form in solid tumors, identify and determine the function of genes associated with consistent regions of abnormality that contribute to solid tumor progression, and develop therapeutic agents to attack tumors carrying aberrations involving these genes. Molecular cytogenetic techniques such as fluorescent in situ hybridization and comparative genomic hybridization provide key information in these investigations.

Dr. Gray is well known for his work in molecular cytogenetics. One of his contributions in this area was the development of chromosome painting in collaboration with Dr. Dan Pinkel while at Lawrence Livermore National Laboratory. This technique, in which whole human chromosomes or portions are uniformly stained with fluorescent dyes for easy recognition under fluorescence microscopy, allows analysis of both interphase nuclei and metaphase chromosomes. Several dyes can be used so that different chromosomes can be recognized. Work in other laboratories has extended this capability to allow distinctive staining of all 24 human chromosomes for scoring in one preparation. Complementing and sometimes replacing expensive and time-consuming chromosome banding, painting has proved useful in identifying genetic aberrations associated with birth defects, aging, exposure to radiation, and cancer. More recently, at the University of California, San Francisco, and Lawrence Berkeley National Laboratory,



Application of Fluorescent In Situ Hybridization (FISH) in Mapping the Sites of Rearrangement After a Translocation Between Chromosomes 10 and 22 (Images: Dr. H.-U. Weier, Lawrence Berkeley National Laboratory). The four panels at left show (A) normal chromosome 10 stained with 16 different probes; (B) rearranged chromosome with parts of chromosomes 10, 21, and 22 from a thyroid cancer cell; (C) one chromosome 22 containing material from chromosome 10; and (D) closeup of chromosome 22 showing the translocated piece of chromosome 10 stained using FISH with probes from chromosome 10. Probes used in these analyses were derived from yeast artificial chromosomes.

Early Images of Whole-Chromosome Painting. The panels at right show (A) hybridization to a metaphase spread using a probe for chromosome 3 and (B) hybridization to three interphase nuclei using the same probe. Nuclei are counterstained with propidium iodide so they appear red. Hybridization signals are in yellow.

Drs. Gray and Pinkel collaborated with Drs. Anne and Olli Kallioniemi and Dr. Frederic Waldman to develop comparative genomic hybridization. In allowing regions of gene dosage imbalance to be mapped onto normal metaphase chromosomes, this technique can be applied using DNA extracted from archived tumor samples. It greatly facilitates identification of regions of recurrent abnormality.

EXCEPTIONAL SERVICE AWARD
For Contributing to a Healthy Citizenry

Tuan Vo-Dinh, Ph.D.
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Tuan Vo-Dinh, who received his Ph.D. in biophysical chemistry in 1975, is a pioneer and world leader in laser-excited luminescence spectroscopy, room-temperature phosphorimetry, synchronous luminescence spectroscopy, surface-enhanced Raman spectroscopy (SERS), field environmental instrumentation, fiberoptic biosensors, and optical data storage (ODS). A corporate fellow at Oak Ridge National Laboratory, Dr. Vo-Dinh has received numerous other honors, including five R&D 100 Awards and the Gold Medal Award from the Society for Applied Spectroscopy, French Languedoc-Roussillon Award, Martin Marietta Thomas Jefferson Award, and Inventor of the Year awards from the Inventors Club of America and the Tennessee Inventors Association.

Dr. Vo-Dinh has published some 220 articles and papers in scientific journals in the areas of analytical chemistry, molecular spectroscopy, environmental monitoring, and biomedical diagnostics. He is author and editor of 8 books and holds 19 patents, 5 of which have been licensed for commercial development (Luminoscope for pollutant screening, SERS Toxic Analyzer, SERODS optical data-storage technology, synchronous luminescence technology, and optical biopsy technology for cancer diagnosis).

Tuan Vo-Dinh

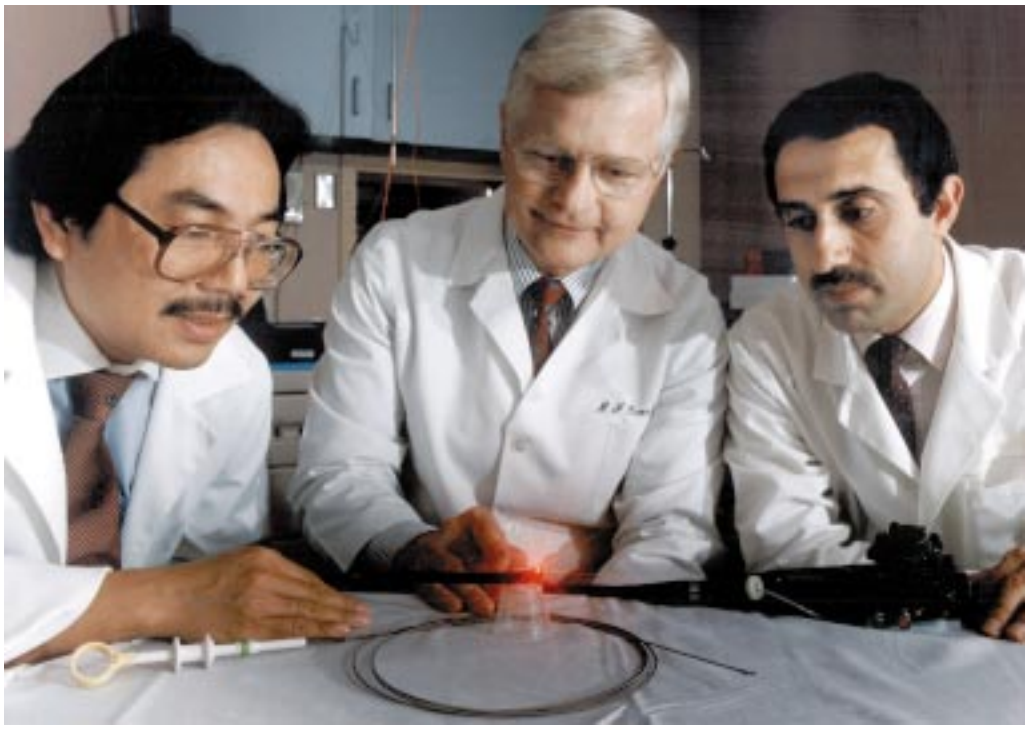
"In recognition of your . . . research . . . to discover new concepts in analytical chemistry and to invent and transfer to the private sector technologies applicable to medical and environmental monitoring."

Molecular Spectroscopy, Lasers, and Fiberoptics

Tuan Vo-Dinh has established a distinguished record of accomplishments in the field of applied spectroscopy, the science that uses the interaction of light and molecules to probe and analyze matter. His fundamental research on synchronous luminescence (SL) has set the foundations of the technique and has led to numerous applications. In the environmental and biological fields, for example, use of SL decreases the cost of environmental monitoring at petroleum plants and detects DNA damage following chemical exposure. Most spectrometer companies have incorporated SL as a standard feature in luminescence instruments.

Dr. Vo-Dinh was one of the first U.S. scientists to develop and effectively use the room-temperature phosphorescence technique for rapid and cost-effective analysis of trace organic compounds adsorbed on filter paper. He has expanded the technique for use in a passive personnel dosimeter to detect potentially toxic organic chemicals in occupational and residential environments.

Recognizing the potential of lasers in vibrational spectroscopy, Dr. Vo-Dinh demonstrated the analytical potential and general applicability of the surface-enhanced Raman scattering (SERS) effect by developing solid nanoparticle-based active substrates for use in



Minimally Invasive Optical Techniques for Rapid Cancer Diagnosis. From left, Dr. Vo-Dinh and his research colleagues, Dr. Bergein F. Overholt and Dr. Masoud Panjehpour (both of the Thompson Cancer Survival Center), have developed optical techniques for rapid diagnosis without surgery. The photograph shows the probe that directs light along optical fibers through an endoscope to the suspected tissue. Malignant tumors can be detected and differentiated by laser-induced fluorescence in less than one second.

trace organic analysis. This important technology demonstrates that practical, simple-to-prepare, and cost-effective metal-covered nanoparticle materials can provide efficient SERS substrates to detect chemical and biological compounds.

Dr. Vo-Dinh invented a technology for large-memory optical data storage (ODS) based on the SERS effect. SERODS could be useful in applications such as supercomputer memories and medical databases and imaging.

Dr. Vo-Dinh also has focused on integrating biotechnology, fiberoptics, laser techniques, and spectroscopy to develop unique antibody-based fiberoptic fluoroimmunosensors (FIS). FIS is a breakthrough in such chemical applications as assessing an individual's exposure to chemical carcinogens and response to drug therapy as well as in characterizing naturally occurring, biologically active substances. FIS also will open new horizons to the fundamental technology of a "smart catheter-sensor" for in vivo analysis of trace compounds of environmental and biomedical interest.

To address the critical need for lower costs in environmental remediation, Dr. Vo-Dinh has invented a simple method to test for polychlorinated biphenyls. The new test, which uses photoactivated fluorescence, allows for onsite sampling to avoid time-consuming laboratory analysis.

Detecting multiple sequence-specific DNA fragments from infectious human pathogens will be one of the first steps in diagnosing disease or developing a new drug. Dr. Vo-Dinh recently developed the SERGen gene probe and the biochip technology for clinical and field applications to detect DNA biotargets rapidly, simply, and without the use of radioactive labels.

Recent collaborations with scientists from the Thompson Cancer Survival Center in Knoxville, Tennessee, have resulted in development of a laser-based, nonsurgical method of detecting cancer. The technique is called "optical biopsy" because laser light is directed along optical fibers through an endoscope to excite the questionable tissue and collect the fluorescent light emitted from the tissue. This technology has proven nearly 100% accurate in diagnosing esophageal tumors in more than 500 tests on more than 100 patients. It is being developed further for diagnosing tumors in such other organs as the colon, cervix, and lungs.

EXCEPTIONAL SERVICE AWARD
For Contributing to a Healthy Citizenry

Edwin Westbrook, M.D., Ph.D.
Argonne National Laboratory
Argonne, Illinois

Born in San Juan, Puerto Rico, Edwin Westbrook received an A.B. with highest honors from the University of California, Berkeley, and both an M.D. and a Ph.D. in biophysics from the University of Chicago in 1981. From 1981 to 1983, he was a National Institutes of Health (NIH) postdoctoral fellow at the Molecular Biology Institute of the University of California, Los Angeles. In 1983, Dr. Westbrook joined the staff of Argonne National Laboratory (ANL) and in 1991 became Director of its Structural Biology Center. He was an assistant professor at the University of Chicago from 1983 to 1988 and has been an associate professor at Northwestern University since 1988.

Author of more than 60 journal articles, Dr. Westbrook has received many honors, including the Pacesetter and Exceptional Performance awards from ANL. He has been a member or chair of numerous committees for ANL, the American Physical Society, the American Crystallography Association, NIH, the National Science Foundation, and DOE.

Edwin Westbrook

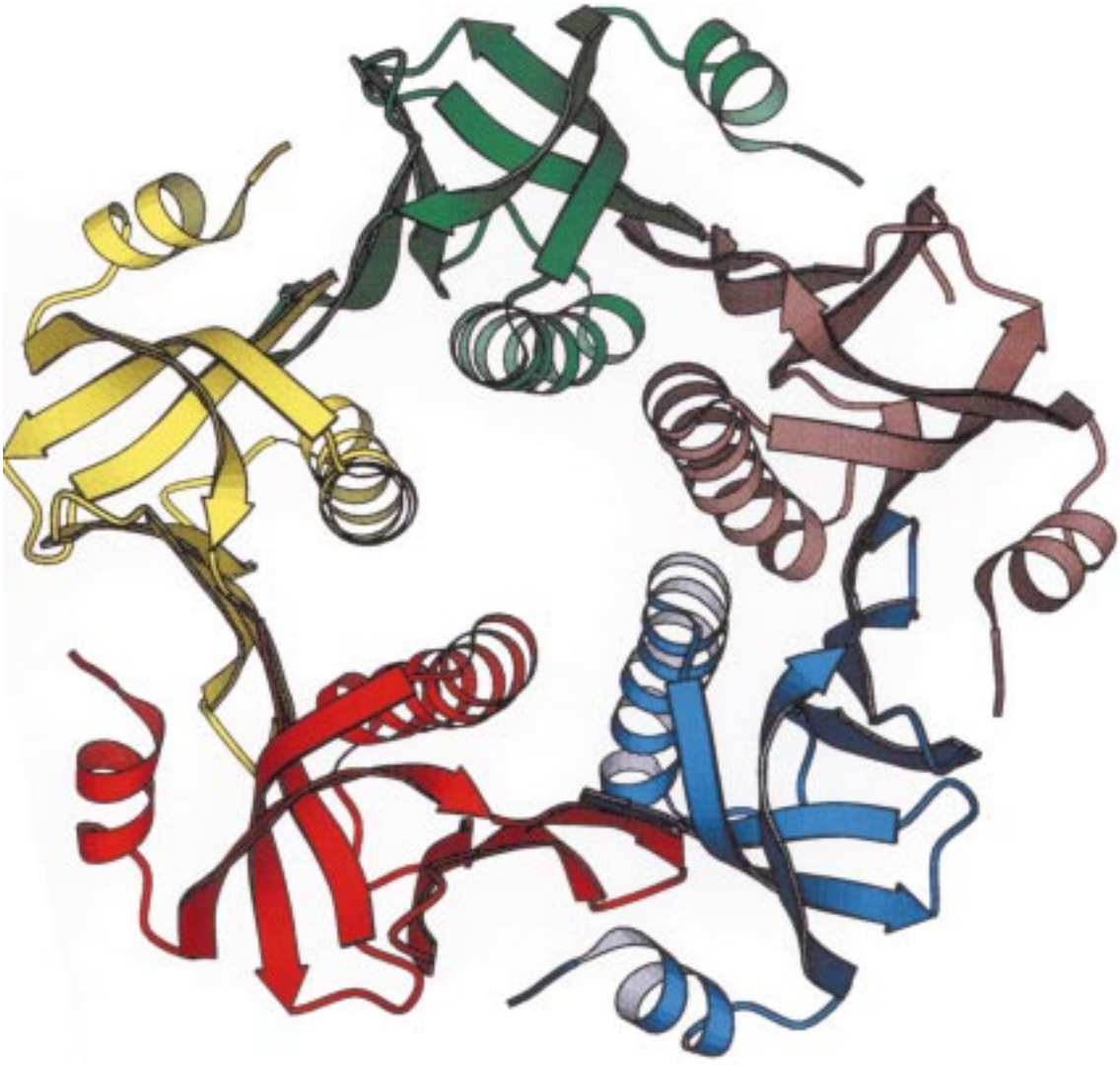
"In recognition of your . . . research . . . to develop advanced detectors for crystallography while providing leadership to establish user facilities for structural molecular biology at the Advanced Photon Source."

Protein Crystallography

The Argonne Structural Biology Center (SBC) is responsible for the design, fabrication, installation, and operation of instruments and systems for the application of synchrotron radiation to protein crystallography. SBC has built two X-ray beamlines at Argonne National Laboratory's Advanced Photon Source (APS), the nation's only third-generation high-energy synchrotron source. With its high intensity, low angular divergence, and small size, APS provides X-ray beams that are ideal for protein crystallography. The SBC beamlines can be focused onto crystals smaller than 50 microns while remaining almost parallel, and the flux densities of these beamlines are far greater than at any previous synchrotron source.

The power of the two SBC beamlines, coupled with the application of the latest electronic X-ray detectors, computer system design, and optimized software, contributes to an experimental facility that is extremely useful to protein crystallographers. The beamlines can work on structures of very large molecules and obtain accurate data quickly and efficiently.

SBC is a national user facility for structural biologists who need its unique capabilities. Access to SBC is through open peer-reviewed proposals that are



Cholera Toxin. The cholera toxin protein is made by the organism Vibrio cholerae. *When swallowed (e.g., in contaminated water), the bacterium survives transit through the human stomach and produces this toxin in the small intestine. Determining the molecular structure of cholera toxin by X-ray crystallographic methods permits rational design of vaccines against the disease.*

prioritized on the basis of scientific excellence and the need for SBC power. Users can collect extremely high quality data at the highest possible speed, while choosing any X-ray wavelength for their experiments. Applying the latest methods for structure determination, crystallographers can use the SBC facility for rapidly and accurately determining new structures of large biological molecules, refining and improving the accuracy of existing structures, and exploring the functional effects of structural modifications to known molecules. Such research is now of great importance in basic and applied research at the molecular level of biological sciences.

A large team has worked over the years to conceive, design, and build SBC. Now that the construction phase is finished, the user program is ramping up.

In addition to the Argonne beamlines, new BER-supported beamlines for structural biology are coming online at Stanford University and at the Berkeley and Brookhaven national laboratories. BER also continues to support several existing synchrotron beamlines at Stanford and Brookhaven.

Exceptional Service Award for Exploring Genomes

DOE initiated the world's first genome program in 1986 after concluding that the most useful approach for detecting inherited mutations—an important DOE health mission—is to obtain a complete DNA reference sequence. In addition, the analytical power developed in pursuit of that goal will lead to myriad applications in widely disparate fields including bioremediation, medicine, agriculture, and renewable energy.

Many are surprised to learn that the longest-running federally funded genome research effort is the 12-year-old DOE Human Genome Program. Its goal is to analyze the genetic material—the genome—that determines an individual's characteristics at the most fundamental level. In fact, the Office of Biological and Environmental Research and DOE's predecessor agencies have long sponsored genetic research in both microbial and higher biological systems, studies that include explorations into population genetics; genome structure, maintenance, replication, damage, and repair; and the consequences of genetic mutations.

The DOE program quickly proved visionary, gaining support and momentum to grow rapidly into the U.S. Human Genome Project (in partnership with the National Institutes of Health) in 1990. Today, international support is a critical component of the project as well. DOE continues to play a major scientific and leadership role through its development of biological resources; cost-effective, automated technologies for mapping and sequencing; and tools for genome-data analysis. The project currently is on track to deliver the sequence of 3 billion human base pairs by 2005.

Vital to the project's continued success is DOE's consistent and focused commitment to disseminating information about the progress, resources, and other results generated in the Human Genome Project. These communication efforts also inform researchers across the broader scientific community, who are beginning to apply the project's data and analytical power to fundamental research problems. Outreach specifically geared to nonscientists promotes public literacy in genetics and helps lay a foundation for informed discourse and responsible decision making by policymakers and the general public.

An important component of the Human Genome Project is a firm resolution to address its societal impact, including ethical, legal, and social issues that arise as a result of new tools and the increased availability of genetic data. Rapid worldwide progress in the project has heightened the urgency of this challenge.

Taking advantage of new capabilities developed by project researchers, DOE initiated the Microbial Genome Initiative in 1994 with the objective of sequencing the

genomes of bacteria having potential economic, industrial, and environmental uses. In a major scientific breakthrough in 1996, researchers sequenced the first entire genome of a microorganism—the methane-producing *Methanococcus jannaschii*—that confirmed the existence of the third major branch of life on earth, the archaea. This feat helped usher in the age of "comparative genomics," allowing extensive and detailed comparisons of entire genomes. In addition to helping researchers understand the evolution of prokaryotes, eukaryotes, and archaea, practical payoffs include the identification of genes and gene products that underlie unique microbial capabilities. These capabilities may pave the way for development of new and improved energy sources, tools for bioremediation, and a variety of industrial applications.

BER Accomplishments

Clone Resources

- DOE chromosome-specific clone libraries, which are collections containing pieces of human chromosomes maintained in bacterial and yeast cells, have been used as raw material for numerous mapping and sequencing projects around the world. The libraries have led to the isolation of a number of disease genes, including those for breast cancer, myotonic dystrophy, Huntington's disease, and colon cancer. DOE now supports a new generation of clone resources that are critical for large-scale DNA sequencing in the Human Genome Project.

Gene Finding and Mapping Resources

- A DOE cDNA initiative in 1990 led to greatly improved technologies for reading cDNA end sequences, which were shown to be a valuable resource for categorizing genes utilized in various tissues. The technologies provided the first clues to the functions of the genes from which they were derived, an approach that has attracted millions of dollars in commercial investment. cDNA molecules also are being used to identify the location of corresponding genes on chromosomes, involving laboratories worldwide in the ongoing task to map the estimated 80,000 human genes.
- The Gene Recognition and Analysis Internet Link (GRAIL) processes tens of millions of bases of DNA sequence each month for researchers around the world, making GRAIL the most widely used "gene-finding" system available.

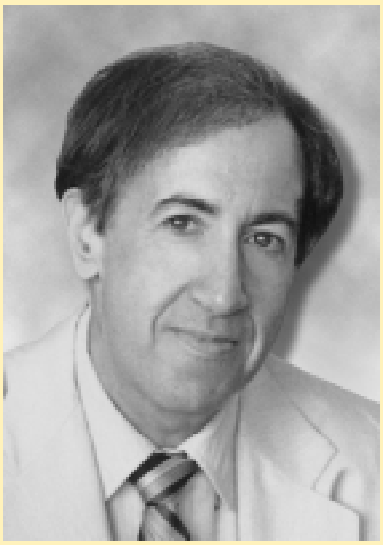
Structural Studies

- Using information about the 3-D structure of DNA polymerases (enzymes needed for DNA replication) and how they function, researchers engineered an improved polymerase, now produced commercially, that reduces the amount of expensive sequencing reagents required. More recent, highly detailed structural studies partially funded by BER are expected to lead to a further reduction in costs. The structure also will be of interest to researchers using drugs that target DNA replication, such as the antiviral AIDS drug AZT.

Microbial Genomes

- In the DOE Microbial Genome Project, nine microbes had been sequenced completely as of April 1999 and over a dozen more were in progress.

EXCEPTIONAL SERVICE AWARD
For Exploring Genomes



Charles DeLisi, Ph.D.
Boston University
Boston, Massachusetts

After receiving a B.A. in physics from City College of New York and a Ph.D. in physics from New York University, Charles DeLisi held a postdoctoral appointment for 3 years at Yale University, where he worked on nucleic acid structure. For the next decade, he worked in cellular and systems-level immunology and membrane biophysics, first at Los Alamos National Laboratory and then, from 1977 to 1985, at the National Cancer Institute, where he was a Section Chief. From 1985 to 1987, he was Associate Director of Energy Research for Health and Environmental Research (later renamed Biological and Environmental Research) at DOE. After serving for 3 years as a professor and department chair at the Mount Sinai School of Medicine, in 1990 he joined Boston University, where he is now a professor and Dean of the College of Engineering.

Author of some 200 articles and books, Dr. DeLisi has served on a number of editorial and advisory boards. He holds four patents, with two others pending.

Charles DeLisi

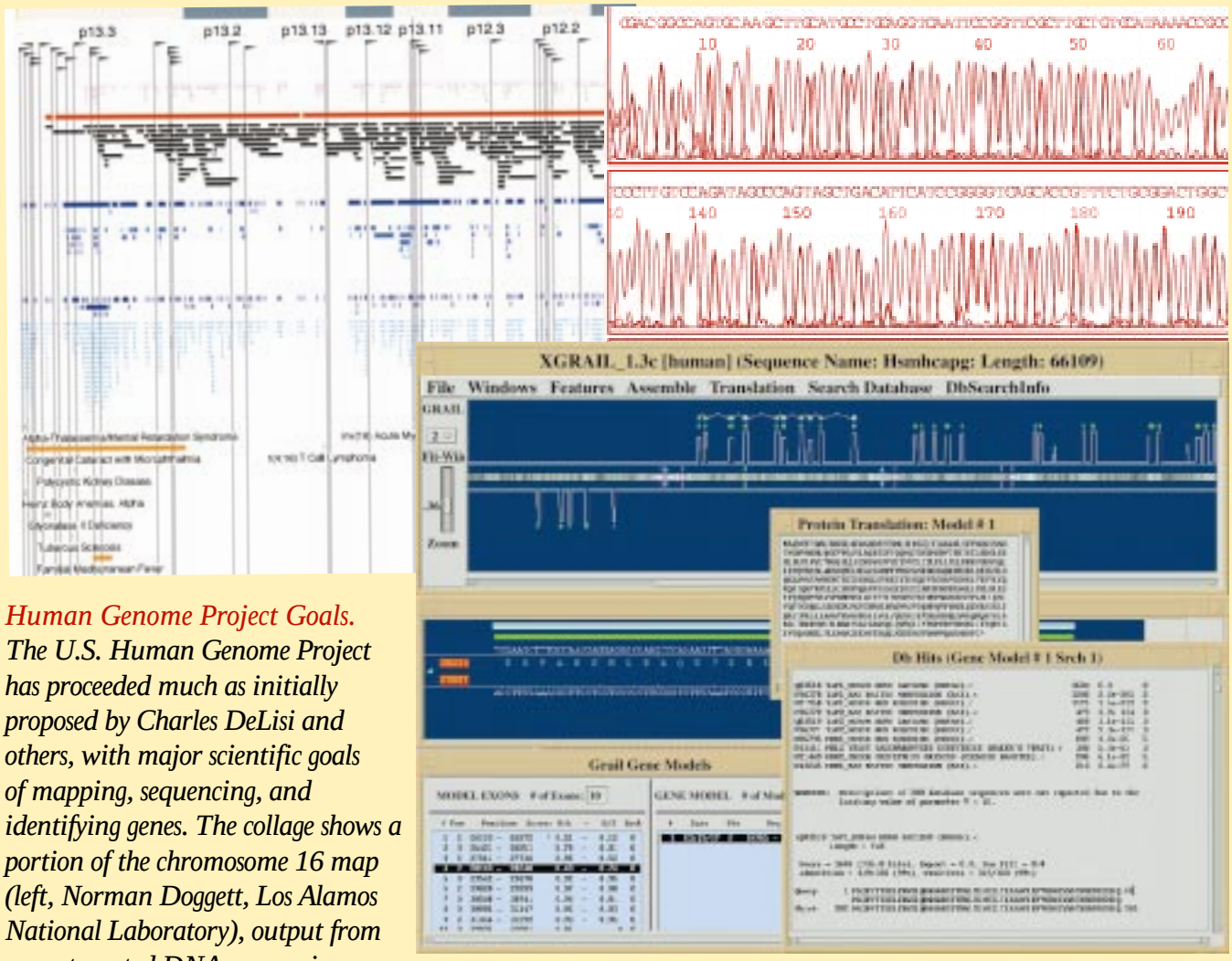
"In recognition of the seminal role you played while Associate Director for Health and Environmental Research in proposing and initiating the Department's, the nation's, and the world's first Human Genome Program in 1986."

Human Genome Program

Charles DeLisi made the statement, "The Human Genome Program did not happen at the Department of Energy by accident. It happened at DOE because it could not have happened at another agency."

By the early 1980s, he noted, the rate of DNA sequencing exceeded the rate at which the biochemical function of the encoded proteins could be determined. Sequencing rate no longer limited progress, as it had just a few years earlier. More interesting, even a conservative extrapolation indicated that the gap between data generation and conversion to knowledge would continue to widen rapidly. When Dr. DeLisi was working at the National Institutes of Health (NIH), the question of whether experimental progress was rapid enough to yield a complete human genome sequence in a current lifetime was discussed briefly on one or two occasions, but the NIH intramural atmosphere was not conducive to thinking about high-technology projects of the magnitude that would be required by such a venture.

In 1985 Dr. DeLisi was offered the pivotal opportunity of his career as head of DOE's Office of Health and Environmental Research (OHER), where large, high-technology projects were commonplace. He was, therefore, in a receptive environment when he read the Office of Technology Assessment's report on heritable mutations, which was based largely on the research of OHER investigators and which considered the possibility of full genomic sequencing.



Human Genome Project Goals. *The U.S. Human Genome Project has proceeded much as initially proposed by Charles DeLisi and others, with major scientific goals of mapping, sequencing, and identifying genes. The collage shows a portion of the chromosome 16 map (left, Norman Doggett, Los Alamos National Laboratory), output from an automated DNA sequencing machine (upper right, Linda Ashworth, Lawrence Livermore National Laboratory), and a DNA sequence-analysis program used to identify genes (lower right, Richard Mural, Oak Ridge National Laboratory).*

Dr. Mortimer Mendelsohn, who was then Associate Director for Health and Environmental Research at Lawrence Livermore National Laboratory and chair of the OHER Health and Environmental Research Advisory Committee (HERAC), had already given some thought to a massive mapping and sequencing project. He provided the essential critical evaluation of what would be required. Continuous discussions with Dr. David Smith and Dr. Benjamin Barnhart of OHER helped sort out a number of political complexities and led to the first Santa Fe workshop, chaired by Dr. Mark Bitensky, then Life Sciences Director at Los Alamos National Laboratory.

Dr. Bitensky attracted the leading molecular biologists to Santa Fe, and, within a few weeks, he was able to solicit written evaluations of the meeting from almost all of them. Those reports provided the basis for Dr. DeLisi's memos of May 1986 to Dr. Alvin Trivelpiece, then Director of the Office of Energy Research, proposing the project and outlining its scope. In retrospect, the recommendations by HERAC and workshop attendees were prescient: the project in broad outline has proceeded much as initially proposed and scheduled.

It was evident from the beginning that the genome project would substantially exacerbate the already-pressing ethical issues raised by genetic engineering. In 1987, shortly before Dr. DeLisi left DOE, he set aside 3% of its Human Genome Program funds for the ethical and legal studies that have become an important component of the project.

EXCEPTIONAL SERVICE AWARD
For Exploring Genomes

Betty Mansfield, M.S.
Oak Ridge National Laboratory
Oak Ridge, Tennessee

After receiving both the B.S. and M.S. degrees in biology with honors from James Madison University in Virginia, Betty Mansfield began work at Oak Ridge National Laboratory (ORNL) in 1977. In this position, she studied metabolic activation of carcinogens, DNA adduct formation, and gene expression following carcinogen exposure.

Collaborating with Reinhold Mann of ORNL and James Selkirk [now at the National Institute of Environmental Sciences (NIEHS)], she established and validated a two-dimensional gel electrophoresis laboratory and data-analysis system, which she used both at ORNL and during a 1-year assignment at NIEHS. These resources were useful for understanding qualitative and quantitative differences in gene expression following carcinogen treatment of normal cells and chemical treatment of malignant Friend Erythroleukemia cells as they entered a more normal state.

In 1989, Ms. Mansfield became founding editor of the *Human Genome News* newsletter and Task Leader of the Human Genome Management Information System (HGMIS), both sponsored by DOE at ORNL. HGMIS is dedicated to communication about the Human Genome Project.

Betty Mansfield

"To recognize you as founding and managing editor of *Human Genome News* and for outstanding success in communicating scientific information to the U.S. and international communities about the Department's BER Program."

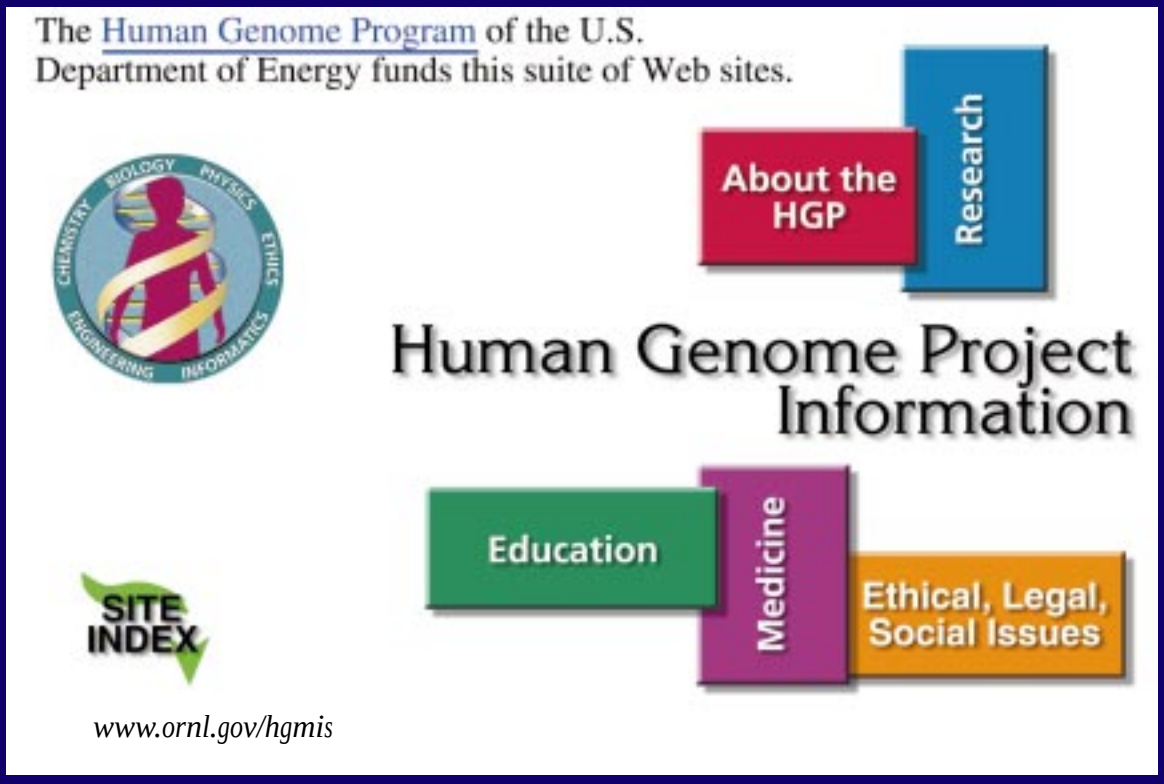
Communicating Genomic Research

The Human Genome Management Information System (HGMIS) was initiated by DOE in 1989 to advance knowledge, promote the awareness of progress and applications, reduce duplicative efforts, and foster collaborations in the Human Genome Project. Because the project and now its spinoff programs require the contributions and understanding of many different types of professionals, DOE management felt that it was important to have a dedicated publication and an organization to provide extensive sources of information regarding the generation and use of genomic data and resources.

HGMIS serves the many groups that are being heavily impacted by increased genetic knowledge. These groups include the public, allied health professionals, educators, lawyers and judges, ethicists, sociologists, and multidisciplinary scientists who are either contributing to the project or applying its data and resources in their own research or in related programs. Innovative spinoff programs are attacking fundamental biological problems in new ways, creating new classes of pharmaceuticals, and using microorganisms to help solve environmental problems.

HGMIS employs an array of vehicles to accomplish its communication goals:

- *Human Genome News* newsletter. With nearly 14,000 U.S. and foreign print subscribers, *HGN* is available to many others via the World Wide Web.



The Human Genome Project Information suite of Web sites, designed for both general and scientific audiences, offers thousands of text files and links for comprehensive coverage of genome research and its biological applications. The Web site includes all issues of Human Genome News, *which is available free via print subscription from HGMIS, as well as a number of other publications.*

HGN offers a collection of articles and information not found in any other single source, including the more discipline-specific scientific publications.

- Comprehensive text-based *Human Genome Project Information* Web site. HGMIS expends about half of its total efforts on this heavily used resource, which is visited by some 70,000 users each month. Its 2600 text files are accessed over 3 million times annually. The newly designed site includes most HGMIS and DOE Human Genome Program publications, research in progress, frequently asked questions, meeting proceedings, funding and resource announcements, calendars of genome events, and many links to related Web sites.
- DOE *Primer on Molecular Genetics*. The primer is widely used by researchers in many fields, students and teachers, genetic counselors, and biotechnology companies.
- Other resources. These include DOE Human Genome Program reports, related documents, proceedings of contractor-grantee meetings, topical handouts, informational exhibits and brochures, and program flyers.

In addition to supplying educators and meeting and workshop organizers with multiple copies of documents and other resources, HGMIS works directly with those who make inquiries by e-mail, fax, or telephone. HGMIS staff members also represent the project at selected scientific conferences and meetings and make presentations to educational, judicial, and other groups.

Ms. Mansfield noted: “Recognizing HGMIS work shows that OBER is committed to communication and openness and to informing scientists, policymakers, and the public about how OBER is spending research dollars. Not only does this commitment help set the stage for informed public discourse and input, it increases science literacy and should lead ultimately to policy decisions that better reflect societal needs.”

EXCEPTIONAL SERVICE AWARD
For Exploring Genomes

J. Craig Venter

"In recognition of your . . . research . . . for determining the first three complete microbial genome sequences, discovering and cataloging new human and microbial genes, and exemplifying the private sector's collaborative role in federal programs."

J. Craig Venter, Ph.D.
Celera Genomics Corporation
The Institute for Genomic Research
Rockville, Maryland

J. Craig Venter is President and Chief Scientific Officer of Celera Genomics Corporation and founder, Chairman, Chief Scientist, and former President of The Institute for Genomic Research (TIGR), a not-for-profit research institution. At Celera, Dr. Venter is leading the company's human genome sequencing efforts.

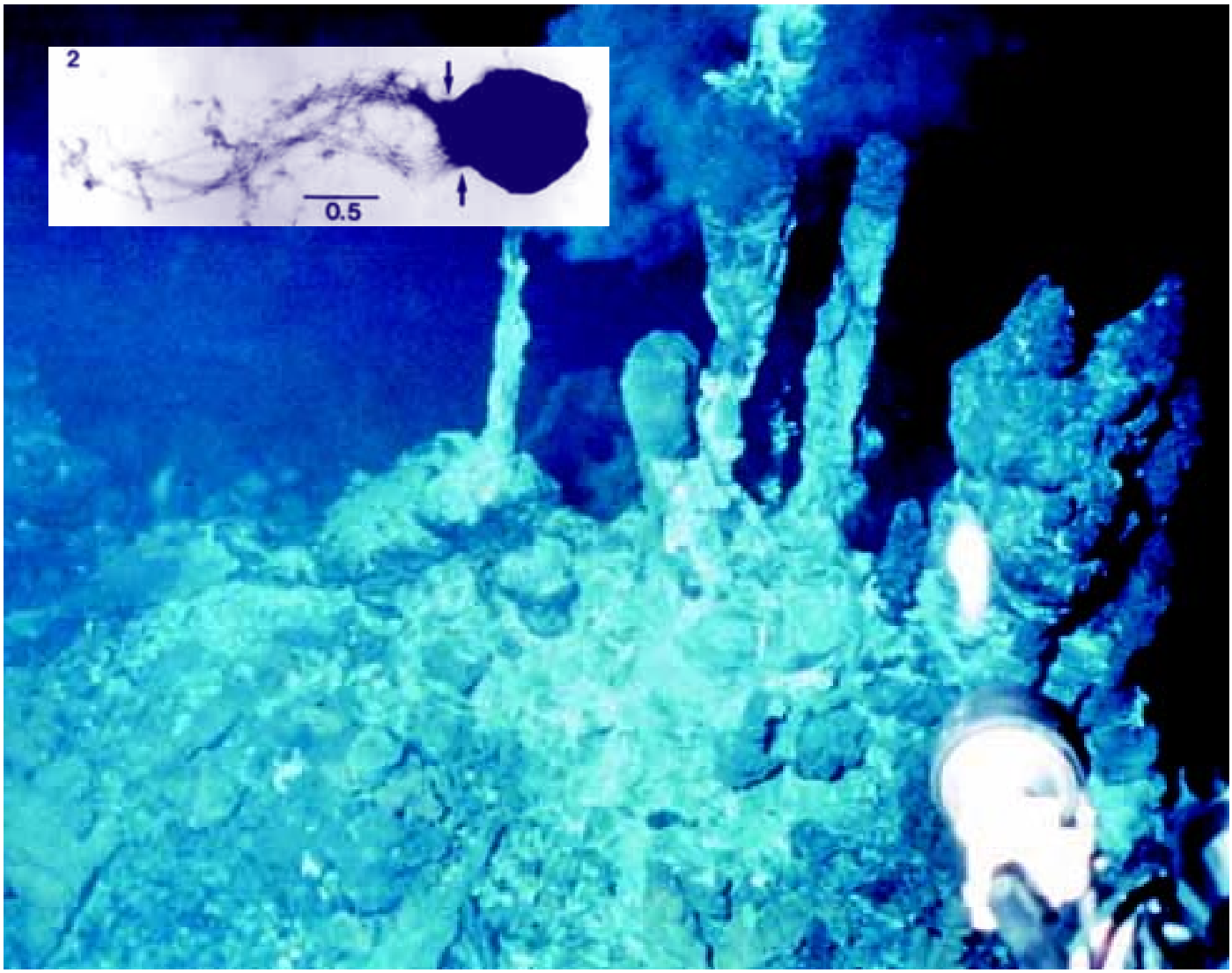
Between 1984 and the formation of TIGR in 1992, he was a Section and a Laboratory Chief in the National Institute of Neurological Disorders and Stroke at the National Institutes of Health. During his genomics and biomedical research career, Dr. Venter has revolutionized the methods by which genomes are sequenced and analyzed. In 1990, he developed expressed sequence tags (ESTs), an innovative strategy for gene discovery that has transformed the biological sciences. Over 72% of all accessions in the public database GenBank are ESTs from a wide range of species including humans, plants, and microbes. Using the EST method, Dr. Venter and the scientists at TIGR have discovered and published more than half of all human genes. New algorithms for dealing with hundreds of thousands of sequences led to the whole-genome shotgun sequencing method with which TIGR completed the first three genomes in history and a total of ten through 1998.

Author of more than 160 research articles, Dr. Venter is one of the most cited scientists in biology and medicine. He has received numerous awards and honorary degrees for his pioneering work and has been elected a fellow of several societies including the American Association for the Advancement of Science and the American Academy of Microbiology. He received his Ph.D. in physiology and pharmacology from the University of California, San Diego.

"Shotgun Sequencing"

The Institute for Genomic Research (TIGR) has interests in structural, functional, and comparative analysis of genomes and gene products in viruses, eubacteria, pathogenic bacteria, archaea, and both plant and animal eukaryotes. The whole-genome sequencing strategy used by TIGR is called a "shotgun" method, in which the genome is sheared randomly into small pieces that are then cloned, sequenced, and reassembled to form a whole genomic sequence. With this approach, there is no need to develop a genetic or physical map of the genome before sequencing it; the sequence itself serves as the ultimate map.

In large shotgun-sequencing projects, DNA fragments are assembled into a consensus sequence. Key to the shotgun method's success is the availability of a truly random genomic DNA clone library and a powerful, accurate algorithm for reassembling the fragments into a complete genome. The basic approach for genome assembly is to compare all individual sequences to find overlaps and use this information to build a consensus sequence. Using software they developed for large-scale genome sequencing projects, TIGR investigators have assembled the



Methanococcus jannaschii *and Hydrothermal Vent. The microbe* M. jannaschii*, whose complete DNA sequence confirmed a third major branch of life on earth, was isolated in 1983 in the area of the above "smoker," a hydrothermal vent on the floor of the Pacific Ocean (photograph: Woods Hole Oceanographic Institution). Inset (scale = 0.5 μm): Electron micrograph of* M. jannaschii*, stained with uranyl acetate to show the two bundles of polar flagella, indicated by arrows (micrograph: Dr. W. Jack Jones).*

complete genomes of *Haemophilus influenzae, Mycoplasma genitalium*, *Methanococcus jannaschii*, *Archaeoglobus fulgidus*, *Helicobacter pylori*, *Borrelia burgdorferi, Treponema pallidum*, *Thermotoga maritima*, and *Deinococcus radiodurans.* TIGR is sequencing other microbes, including *Shewanella putrefaciens*.

The next step in whole-genome analysis is to identify all the predicted genes and search the translated protein sequences against protein sequences available in public databases. Because of the tremendous conservation in protein sequence among organisms throughout evolution, putative genes can be identified by sequence similarities.

Exceptional Service Award for Protecting the Environment

DOE's Biological and Environmental Research (BER) program originally focused on understanding the fate, transport, and transformation of airborne radioisotopes released during nuclear weapons testing and production. Other studies examined the ecological impacts and processes that cycle radioactivity through plants and animals to humans. Now, evolving research is directed toward understanding the basic chemical, physical, and biological processes of the earth's atmosphere, land, and oceans and toward developing new methods for remediating the nation's nuclear weapons testing and production sites.

Global Climate Change

Research is conducted to understand and predict global climate change and the potential ecological consequences that may result from energy-related aerosols and greenhouse gases. BER climate-change research and modeling studies include exploration of factors affecting the earth's radiant-energy balance and seek to quantify sources and sinks of energy-related greenhouse gases, especially carbon dioxide. This ongoing research is a vigorous priority for BER and its interagency partners in the U.S. Global Change Research Program.

Environmental Remediation

BER's Environmental Remediation portfolio is developing more effective and efficient processes for cleaning up soils, sediments, and groundwater contaminated by nuclear weapons production and testing. Among the means available for reclaiming the environment are the tools of molecular biology. The first forays into bioremediation—the use of biological processes to address the problems of waste management—began in the late 1960s with attempts to harness microbes to clean up wastes from coal conversion reactions and nuclear materials processing.

The successful BER subsurface science program that explored the deep subsurface environment for microorganisms, coupled with new strategies and technologies arising from the Human Genome Project, allowed BER to initiate the Microbial Genome Project (MGP) in the mid-1990s. MGP investigators are studying microbes that are or could be important for solving bioremediation challenges and serving other economic and industrial interests. Analysis of the genomes of these microbes is providing insights into how they survive, especially under extreme conditions, and will afford opportunities to

exploit biochemical mechanisms and pathways not expressed in higher organisms.

With the establishment of the Natural and Accelerated Bioremediation Research (NABIR) program in 1995, BER has sought to build on the foundation laid by subsurface science research, bringing together geologists, chemists, biochemists, molecular and cellular biologists, microbiologists, and ecologists. NABIR-funded researchers conduct laboratory studies, field studies at contaminated sites, and theoretical research to enhance the scientific basis for using bioremediation to restore and protect the environment.

A key part of BER's commitment to environmental restoration resides in the new William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) at Pacific Northwest National Laboratory in Washington state. EMSL, whose operational startup in 1997 corresponded with the 50th anniversary of the BER program, is the only national collaborative user facility dedicated to DOE's environmental mission (see p. 34). Research at EMSL will open new vistas on the chemistry of our environment, furnishing insights into how chemical waste streams and contaminated environments can be cleaned up and providing clues to the long-term fate of chemicals released into the ground, air, and surface waters.

BER Accomplishments

Airborne Pollutant Dispersion

- BER research helped to establish the world's earliest and most authoritative monitoring network to detect airborne radioisotopes. The use of atmospheric tracers has led to the improved ability to predict pollutant dispersion.

Radioecology

BER work with radioactive tracers, together with the program's introduction of computer simulations, led to the creation of the new fields of radioecology and systems ecology.

- Specific methodologies have been developed to estimate the bioaccumulation of radionuclides in terrestrial and aquatic organisms, and the first analog models were introduced to simulate the distribution, cycling, and fate of radionuclides in ecosystems.
- The first ecology research program devoted entirely to developing a theoretical basis for understanding and predicting the behavior of complex ecology systems was initiated.
- Radionuclides were used to quantify the historical effects of human activities on aquatic environmental quality.

Global Climate Change

- Improvements in cloud and radiative parameterizations and in computational techniques are leading to improvements that will be necessary for general circulation models to represent a climate system at regional and local scales.
- BER scientists quantified the ocean carbon cycle and determined the fate of carbon dioxide produced by fossil fuel combustion.
- Global carbon cycle models predicted the future doubling of atmospheric carbon dioxide from the combustion of fossil fuels.
- Global change research produced a historical climate database revealing a global trend of rising night-time temperatures over the past 50 years, a finding consistent with the greenhouse gas warming theory.

Bioremediation

- After receiving EPA approval, BER scientists initiated the first U.S. field trial of a genetically engineered microorganism used to monitor biodegradation of polycyclic aromatic hydrocarbons, a first step toward developing a process for degrading these chemicals in contaminated soils.

EXCEPTIONAL SERVICE AWARD
For Protecting the Environment

James Edmonds

"In recognition of your . . . research . . . to understand the environmental and economic consequences of carbon dioxide emissions and for developing innovative models to assess the energy impact on climate."

James Edmonds, Ph.D.
Pacific Northwest National Laboratory
Washington, D.C.

James A. Edmonds is a Chief Scientist and Technical Leader of Economic Programs at the Washington, D.C., office of Pacific Northwest National Laboratory (PNNL). He has been associated with PNNL since 1986, during which time he has fostered programs in global climate change and sustainable development. Codeveloper of the well-known Edmonds-Reilly-Barns model of global energy and economy, Dr. Edmonds has written several books and numerous papers on global change. He serves on a variety of advisory committees, testifies before the U.S. Congress on related issues, and provides briefings to DOE and other Executive Branch organizations on issues related to climate change. He also acts as a reviewer and editor for numerous journals.

Dr. Edmonds' current focus is on policy research and on developing the Global Change Assessment Model system. His Global Climate Change Group received the PNNL Director's Award for Research Excellence in 1995.

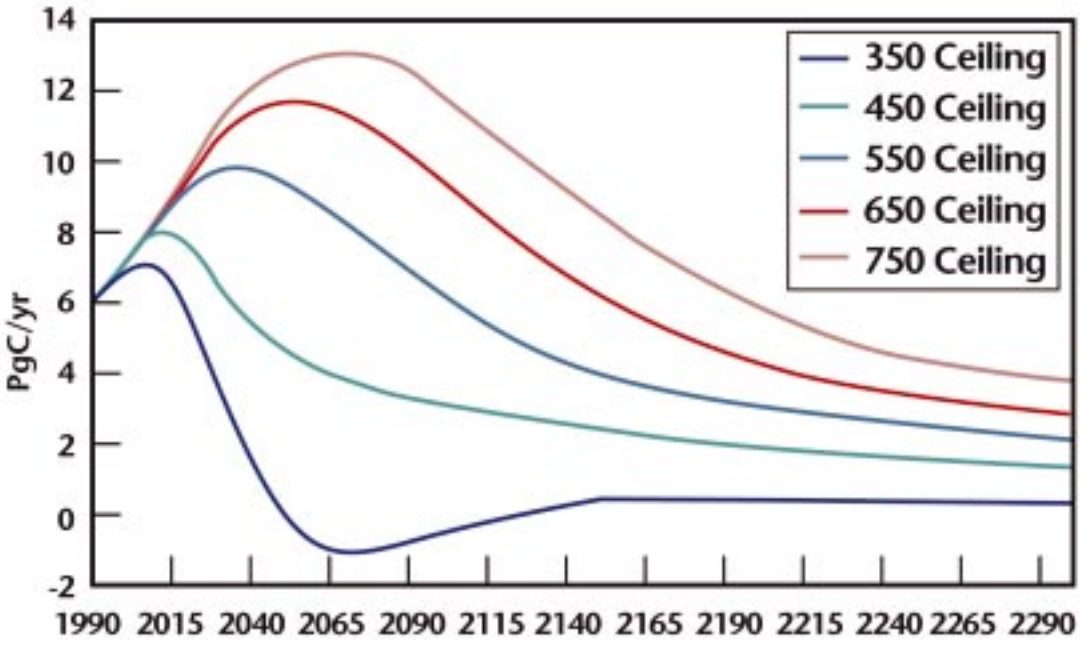
Before joining PNNL, Dr. Edmonds headed the Washington, D.C., office of the Institute for Energy Analysis, Oak Ridge Associated Universities (1978–86). He previously served as an assistant professor of economics and Chairman of the Department of Economics and Business Administration at Centre College of Kentucky (1974–78). Dr. Edmonds received an M.A. and a Ph.D. from Duke University.

Energy Use and Climate Change

James Edmonds has spent the last two decades working on the problem of climate change. During that time, he has watched the research move from a backwater niche of marginal academic interest, populated by a small, tight-knit community of dedicated researchers, to the center of international negotiations. At the end of 1997, these negotiations culminated in COP3 in Kyoto, with literally trillions of dollars riding on the wisdom of decisions.

When he began his work on the relationship between energy and climate in 1978, only the stewards of the Biological and Environmental Research (BER) program took the issue seriously. In supporting scientific research to illuminate the nature and structure of the issue, Dr. Edmonds points out, BER was a leader in an otherwise disinterested world. He says that after 1988, everyone was an instant expert, and it was amazing how many people suddenly realized that they had been working on climate research all their lives but just had not known it.

Dr. Edmonds' own work, which is focused on integrating knowledge about climate changes, led him to a broader appreciation of the roles of BER and the



Profiles of Global Anthropogenic Carbon Emissions for Alternative Atmospheric Concentration Ceilings. These profiles modify previously suggested paths of carbon emissions, which were constructed prior to the development of Dr. Edmonds' Global Change Assessment Model and were less economical.

Steady-State Concentration →	450 ppmv	550 ppmv	650 ppmv	750 ppmv
Deflection Date BAU (Tech+)[a]	2007	2013	2018	2023
Maximum Emission Date	2011	2033	2049	2062
Maximum Emission[b]	8.0	9.7	11.4	12.5

[a] The deflection date is the year in which emissions in the emissions stabilization trajectory first fell below BAU emissions by more than 0.1 PgC/yr.

[b] PgC/yr fossil fuel carbon emissions on the date of maximum total anthropogenic carbon emissions.

Office of Energy Research in laying down scientific foundations for understanding and solving the problem of climate change. Meeting the goal of the framework convention on climate change requires that the free venting of carbon from fossil fuels ultimately be replaced with noncarbon-emitting energy technologies. This change will require not only better versions of existing technologies but a whole new generation of energy technologies that currently do not exist and never will exist unless the frontiers of relevant science are pushed forward.

Developing these scientific foundations for future environmentally friendly energy systems is not a task for fair-weather researchers or for agencies without resolve, Dr. Edmonds says. The work is, in fact, a daunting challenge, but it is precisely this kind of challenge upon which BER thrives. He expects that at the time of BER 100, the program's contributions will include helping to solve the climate problem.

EXCEPTIONAL SERVICE AWARD
For Protecting the Environment

W. Lawrence Gates

"In recognition of your . . . research conducted in . . . global climate change through the development of methodology to intercompare climate models to systematically ascertain and correct model biases and errors."

W. Lawrence Gates, Sc.D.
Lawrence Livermore National Laboratory
Livermore, California

W. Lawrence Gates joined the Biological and Environmental Research family in 1989 when he accepted a position at Lawrence Livermore National Laboratory to direct the newly authorized Program for Climate Model Diagnosis and Intercomparison. Before that, he was professor and Chairman of the Department of Atmospheric Sciences and Director of the Climatic Research Institute at Oregon State University. After receiving a doctorate in meteorology from the Massachusetts Institute of Technology, Dr. Gates was a research meteorologist at the Air Force Cambridge Research Center, Boston, and at the Rand Corporation in Santa Monica. He also was on the faculty of the Department of Atmospheric Sciences at the University of California at Los Angeles.

Among the professional committees on which Dr. Gates currently serves, perhaps the most important is his chairmanship of the Joint Scientific Committee for the United Nations World Climate Research Programme. He also is the founding executive editor of the international journal *Climate Dynamics*, published by Springer.

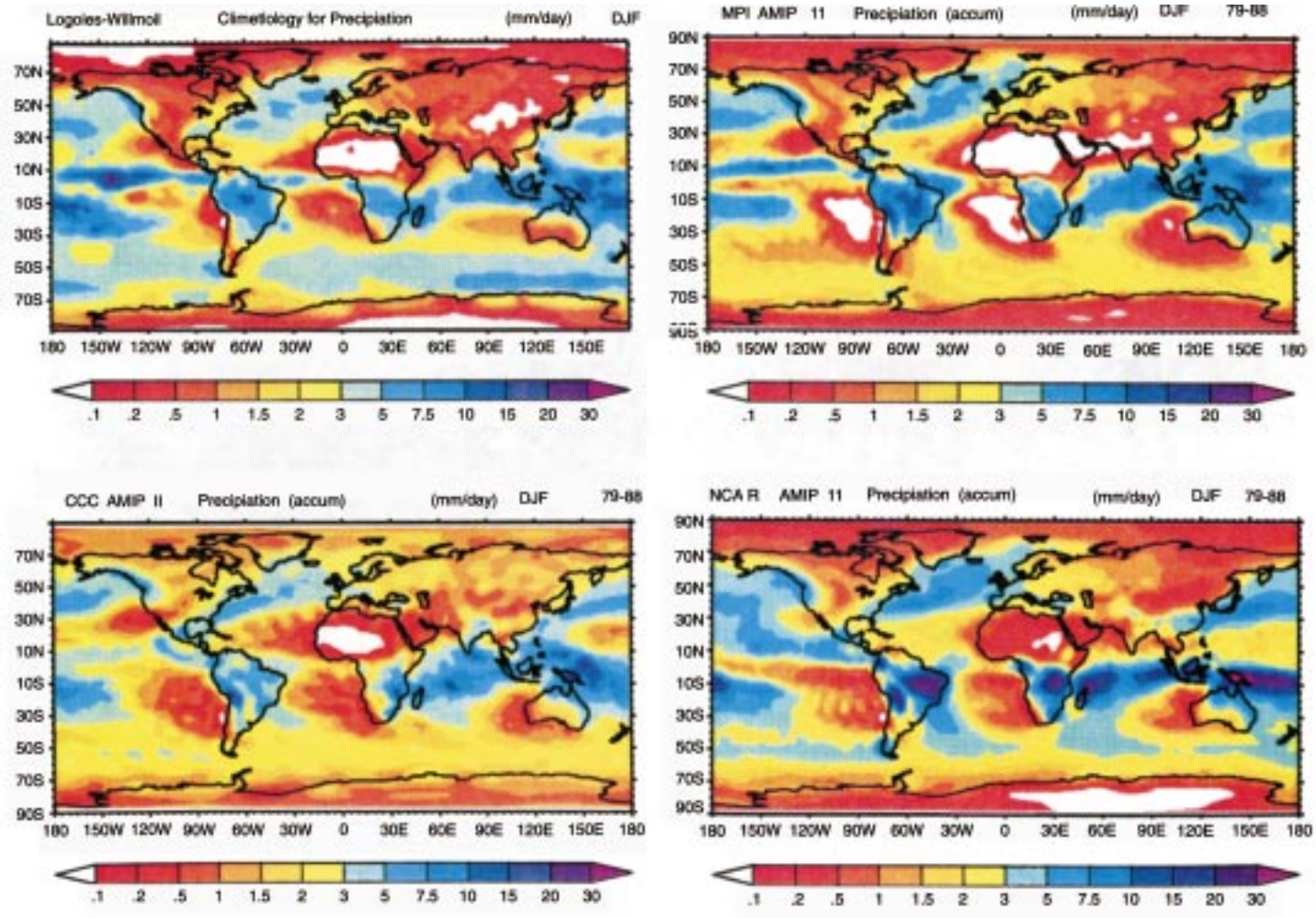
Dr. Gates' research interests range over the atmospheric and oceanic sciences, including dynamical, modeling, and diagnostic studies. In recent years, his primary interest has been climate research, with a focus on analysis, validation, and intercomparison of atmospheric and atmosphere-ocean model performance.

Global Climate Projection

With the establishment of the Program for Climate Model Diagnosis and Intercomparison (PCMDI) at Lawrence Livermore National Laboratory in 1989, the Biological and Environmental Research Program recognized the critical need for increased climate-model accountability. Unlike weather, whose course can be predicted over a few days, projection of climate and its changes requires an accounting of long-term global interactions among atmosphere, oceans, ice, and land surface in response to often-subtle changes in the driving forces.

Climate projection can be accomplished only with mathematical and physical models whose solutions require the most powerful computers. Critical to the model's effectiveness is its ability to portray geographical and seasonal distribution of such principal climate parameters as cloudiness, precipitation, temperature, and circulation and to simulate such important phenomena as El Niño and monsoons.

In many cases, a model's errors in simulating climate changes are considerably greater than the anticipated future climate changes. In cooperating with



Atmospheric Models for Global Climate Simulation. The observed global precipitation distribution is shown in the upper left, and simulations by three representative models are given in the other panels (Max-Planck-Institute for Meteorology, Hamburg, Germany, upper right; Canadian Climate Centre, Victoria, Canada, lower left; National Center for Atmospheric Research, Boulder, Colorado, lower right). Although all models were supplied the same information on sea-surface temperature, solar radiation, and atmospheric composition, there are apparent and different errors in each model's ability to reproduce the observed precipitation in many regions of the world. The systematic diagnosis of such errors can lead to identification of their causes and thence to improvement of the models.

the national and international climate-modeling community, PCMDI has pioneered the systematic diagnosis of model errors and is implementing the international Atmospheric Model Intercomparison Project on behalf of the World Climate Research Programme. PCMDI also has developed widely used standards and software for data storage, display, and transmission as part of an international climate-modeling infrastructure. This work has led to the identification of heretofore-unsuspected model errors and to a new understanding of the predictability of atmospheric behavior and related climate anomalies.

EXCEPTIONAL SERVICE AWARD
For Protecting the Environment

Michael Huston

Michael Huston, Ph.D.
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Michael A. Huston attended Deep Springs College in California and received a B.A. in biology from Grinnell College in 1973 and a Ph.D. in biological science from the University of Michigan in 1982. He completed a dissertation on the effects of light and nutrients on tropical rain forest succession in Costa Rica. He joined Oak Ridge National Laboratory (ORNL) in 1983 as a Wigner fellow, with research interests in ecology, forest succession, population dynamics, nutrient cycling, disturbance effects, and species diversity.

From 1987 to 1993, Dr. Huston was Project Leader of the Walker Branch Watershed Project at the ORNL National Environmental Research Park. Now a Senior Scientist in the Environmental Sciences Division, he is the author of numerous papers and a 1994 book on biological diversity. Dr. Huston served as panel member and writing coordinator of the White House Task Force for Environmental Research and Monitoring in 1995 and as a consultant for the United Nations Commission for Sustainable Development from 1994 to 1995.

"In recognition of your . . . research . . . in developing innovative concepts of the general patterns of biodiversity and how environmental changes and human influences affect biodiversity."

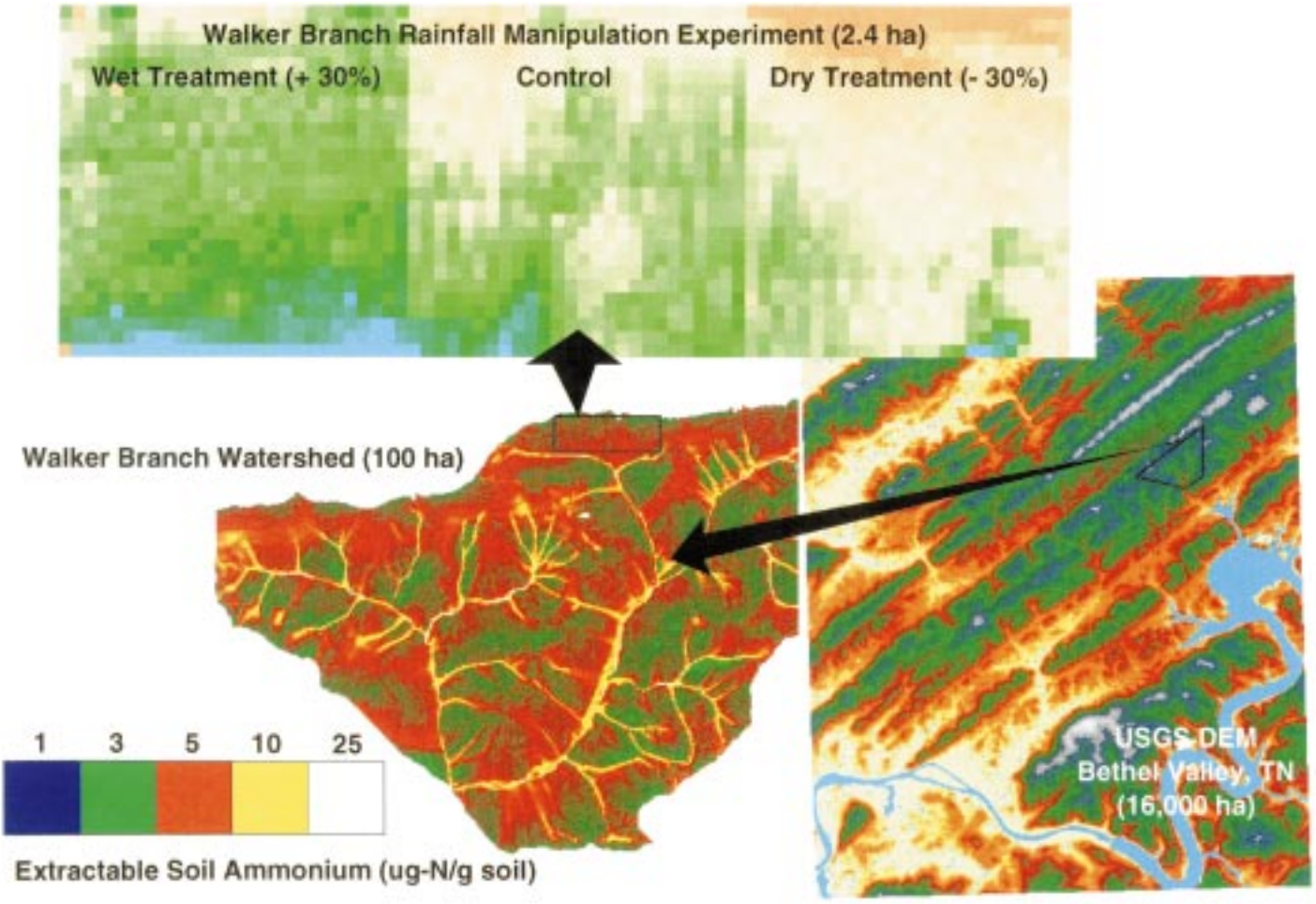
Ecological Science

Michael Huston states that ecology is a field that sits at the interface of many sciences. Genetics, molecular biology, and cellular biology define organisms, and ecology is the study of organisms and their interactions with the environment. Scientists attempt to understand ecology through global climate modeling and a variety of studies, many of which are sponsored by DOE.

At this interface, he says, are many complex interactions directly involving humans. Humans share genetic traits with a large proportion of other organisms on earth, just as they also share the physical space of the planet itself. So ecology is a field that intimately involves people, organisms, and the environment.

"We have heard a lot about multidisciplinary fields. Ecology is perhaps the epitome of a multidisciplinary field, having to depend upon genetics and molecular biology on the one hand and on global climate and earth system studies on the other and making use of computational biology, physiology, and animal behavior. For investigators to be effective, their work must occur in a multidisciplinary context."

Dr. Huston compliments DOE's foresight in creating and perpetuating an environment in which scientists can interact with people outside their field—hydrologists, geochemists, stable isotope geochemists, physiologists, and climate modelers. Without this kind of support, he says, they could not do the kind of work they do.



Landscape Hydrology Modeling. Computer models of landscape topography can be used to predict the consequences of interacting hydrological, ecological, and biogeochemical processes. The digital elevation model of Bethel Valley, Tennessee, shows a portion of the Oak Ridge National Environmental Research Park, bounded by the meandering Clinch River. DOE's Walker Branch Watershed research site is located on one of the long parallel ridges within this region. The colored pattern of the inset map was produced using a computer model of landscape hydrology in combination with field measurement of soil ammonium, the major form of nitrogen available to plants in most soils. The highest levels of soil ammonium are found in valley bottom areas, where favorable soil moisture conditions support tree species with leaves that decompose rapidly and release ammonium into the soil. The inset rectangular portion of Walker Branch Watershed shows a large-scale (80 by 240 meters) experiment, initiated in 1993, on the response of deciduous forests to climate change. The natural patterns of soil moisture are altered by capturing a portion of the rain falling on the "dry plot" and transferring it to the "wet plot."

DOE had the foresight to create such unique resources as the physics facilities at Oak Ridge National Laboratory and also has established, protected, and endowed the National Environmental Research Parks on DOE's own reservation lands. Within the Environmental Research Park at Oak Ridge, the Walker Branch Watershed is now entering its 30th year of continuous DOE-supported long-term intensive research on the ecosystem. This basic research addresses a suite of problems related to the impacts of energy and energy technologies on the environment. Dr. Huston points out that such field facilities and computers, along with the expertise of outstanding people, have made possible many significant accomplishments.

EXCEPTIONAL SERVICE AWARD
For Protecting the Environment

Michael Knotek

Michael Knotek, Ph.D.
Argonne National Laboratory
Argonne, Illinois

"In recognition of your . . . leadership in bringing to fruition the William R. Wiley Environmental Molecular Sciences Laboratory, a national collaborative user facility for providing innovative approaches to meet the needs of the Department's environmental missions."

After earning a B.S. in physics from Iowa State University and M.S. and Ph.D. degrees in physics from the University of California, Riverside, Michael Knotek participated in the Quantum Theory Project at the University of Florida and worked on transport in organic systems at Oklahoma State University. Since the late 1970s, Dr. Knotek has been studying synchrotron radiation and the properties and phenomena of matter.

Before 1985, he was affiliated with Sandia National Laboratories and later was Chairman of the National Synchrotron Light Source, a DOE user facility on Long Island. From 1989 through 1994, Dr. Knotek served as Director of the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) at Pacific Northwest National Laboratory, where he led the establishment of EMSL and its scientific programs.

Dr. Knotek was honored by DOE's Office of Basic Energy Sciences in 1984 for his work on stimulated desorption and in 1985 for research on stress-corrosion cracking in solids. In 1987, he was elected a fellow of the American Physical Society. He received the DOE Distinguished Associate Award in 1993 for synchrotron radiation research and in 1996 for his role in restructuring the Fusion Energy Sciences Program. Author of about 100 papers, Dr. Knotek is a member of several DOE committees, as well as numerous national and international boards and advisory groups that aim to advance science and bring its benefits to society.

Leadership in Science

In October 1997, the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), a major national scientific user facility, opened its doors at Pacific Northwest National Laboratory. The facility's mission is to develop a molecular-level understanding of the physical, chemical, and biological processes that underlie environmental remediation, waste processing and storage, human health effects, and atmospheric chemistry. Fundamental environmental molecular science conducted at the facility will provide the knowledge base needed to address DOE's challenging environmental issues.

To address the complexities and breadth of the nation's environmental problems, a new level of experimental and theoretical capability is required in the physical and life sciences. Within the Wiley EMSL, the complement of research equipment and general laboratory infrastructure designed to meet that challenge is grouped into several different facilities: High Field Magnetic Resonance Facility, High Field Mass Spectrometry Facility, Molecular Sciences Computing Facility, and several Research Environments dedicated to surface structure and chemistry. EMSL contains several one-of-

William R. Wiley Environmental Molecular Sciences Laboratory (EMSL). Located at Pacific Northwest National Laboratory, Richland, Washington, EMSL will provide state-of-the-science experimental and computational capabilities in environmental molecular sciences to users from universities, national laboratories, and the private sector.

According to Dr. Knotek, the existing 750-MHz nuclear magnetic resonance spectrometer and the ultrahigh-field instrumentation currently in development will provide unparalleled sensitivity and resolution. These technologies will facilitate investigations into biomolecular structure and the dynamics of biologically and environmentally relevant molecules.

a-kind and first-of-a-kind instruments that will support scientific advances in a variety of disciplines.

The High Field Magnetic Resonance Facility will contain instruments to support studies of the molecular structure of enzymes, proteins, and DNA as they relate to bioremediation and cellular response effects. The Molecular Sciences Computing Facility has one of the nation's fastest massively parallel computers, which expands the capability to perform ab initio calculations of molecular structure for increasingly larger single molecules and complex systems.

The Research Environments include collections of specialized instrumentation that support fundamental research in nanostructural materials, interfacial structures and compositions, reactions at interfaces, and gas-phase monitoring and detection. These and many other unique scientific capabilities at EMSL are being used to provide the scientific solutions to DOE's environmental challenges.

Dr. Knotek stated, "Building a building is just a start. Buildings are only places for people to work and for ideas to occur. In that sense, the job has just started."

EXCEPTIONAL SERVICE AWARD
For Protecting the Environment

Warren Washington, Ph.D.
National Center for Atmospheric Research
Boulder, Colorado

Born in Portland, Oregon, Warren Washington earned a B.S. in physics and an M.S. in meteorology from Oregon State University. After completing his Ph.D. in meteorology at Pennsylvania State University, he joined the National Center for Atmospheric Research in 1963 as a research scientist. Dr. Washington's areas of expertise are atmospheric science and climate research, and he specializes in computer modeling of the earth's climate.

He has published more than 100 papers in professional journals and a book on climate modeling that is considered a standard reference. He has served as a climate-system modeling consultant and advisor to a number of governmental officials and committees and has been a member of numerous panels and boards. He was appointed by President Clinton to the National Science Board in 1994.

Dr. Washington is a fellow and Past President of the American Meteorological Society and a fellow of the American Association for the Advancement of Science. Among his many honors are the Le Verrier Medal of the Societé Meterologique de France, received in 1996. In February 1997, he was inducted into the National Academy of Sciences Portrait Collection of African-Americans in Science, Engineering, and Medicine.

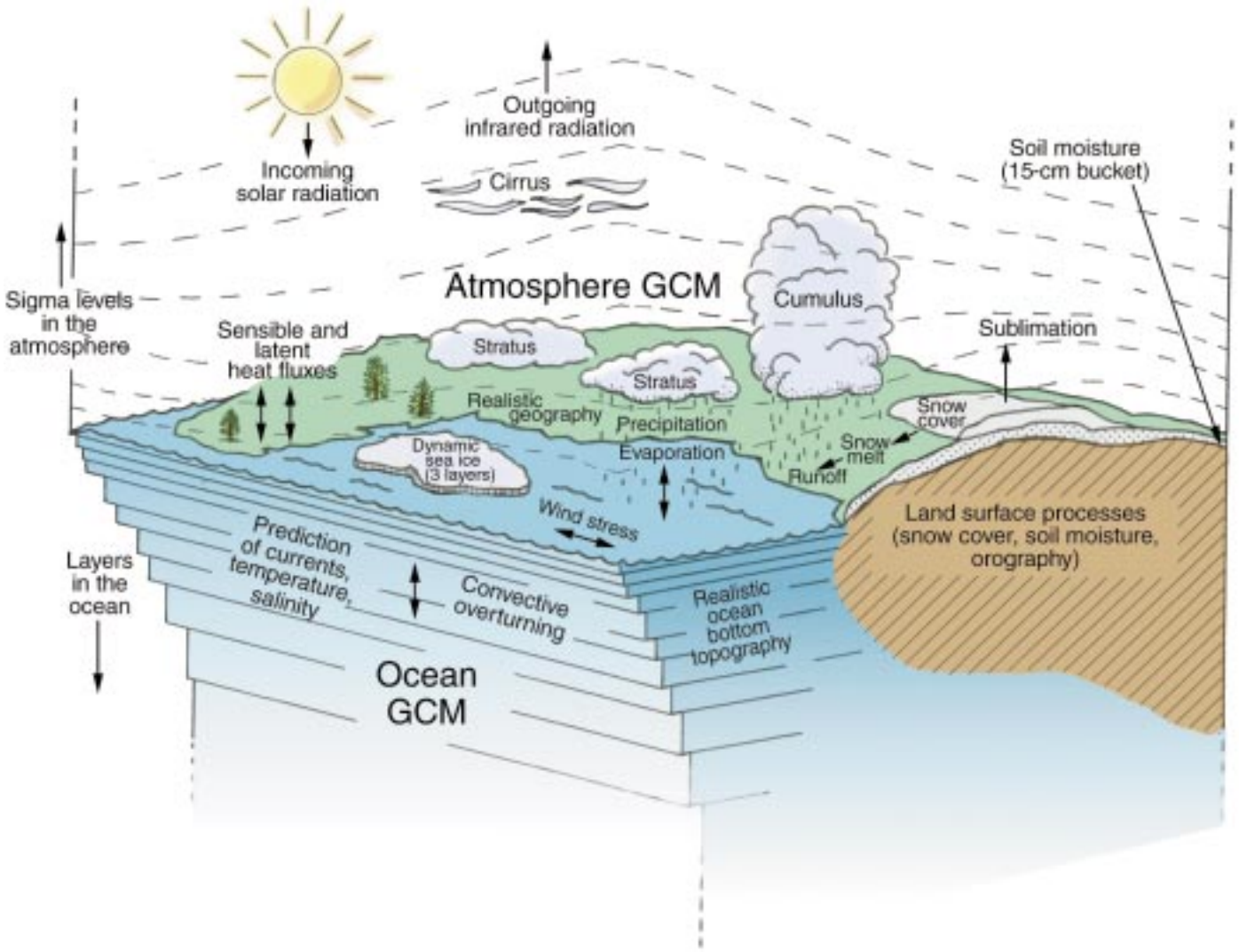
Warren Washington

"In recognition of your . . . research conducted in . . . the development and application of advanced coupled atmospheric and oceanic general circulation models to study the impacts of anthropogenic activities on future climate."

Climate Modeling

The DOE Biological and Environmental Research Program has been a leader in sponsoring research on possible climate change. DOE's strength in the early use of computers with an emphasis on physics contributed to the development and use of climate models.

Dr. Washington has been supported by DOE for almost 20 years in building complex three-dimensional models to study the climatic impacts of anthropogenic changes, for example, climate warming caused by the burning of fossil fuels. Over the years, the scientific community has made the model components more realistic so that, with further research and improved understanding of such processes as cloud formation and ocean circulations, current models are remarkable simulators of a climate system. Much improvement, however, is needed, and remaining shortcomings are being addressed by DOE and other governmental agencies. As the models become more certain in producing the present and past climates, they will become more reliable indicators of future climate change.



Coupled Climate Model. This schematic shows various aspects of a coupled climate model that accounts for interactions among the atmosphere, ocean, land, and sea ice. Modern climate models predict such atmospheric variables as temperature, wind, precipitation, and cloud type; such oceanic variables as current, temperature, and salinity; and such sea ice variables as thickness, motion, and concentration. Surface temperature, snow, and soil moisture are computed over land regions. (GCM: general circulation model)

Dr. Washington anticipates that future climate modeling will be done at not one but a number of institutions. It will be done in a distributive way, indicating that the information age is making possible cooperative research at many different sites.

"We must not pursue the quest for scientific knowledge as the only objective in our scientific research," Dr. Washington noted, "but we must also help society deal with some important issues such as climate change."

Appendix

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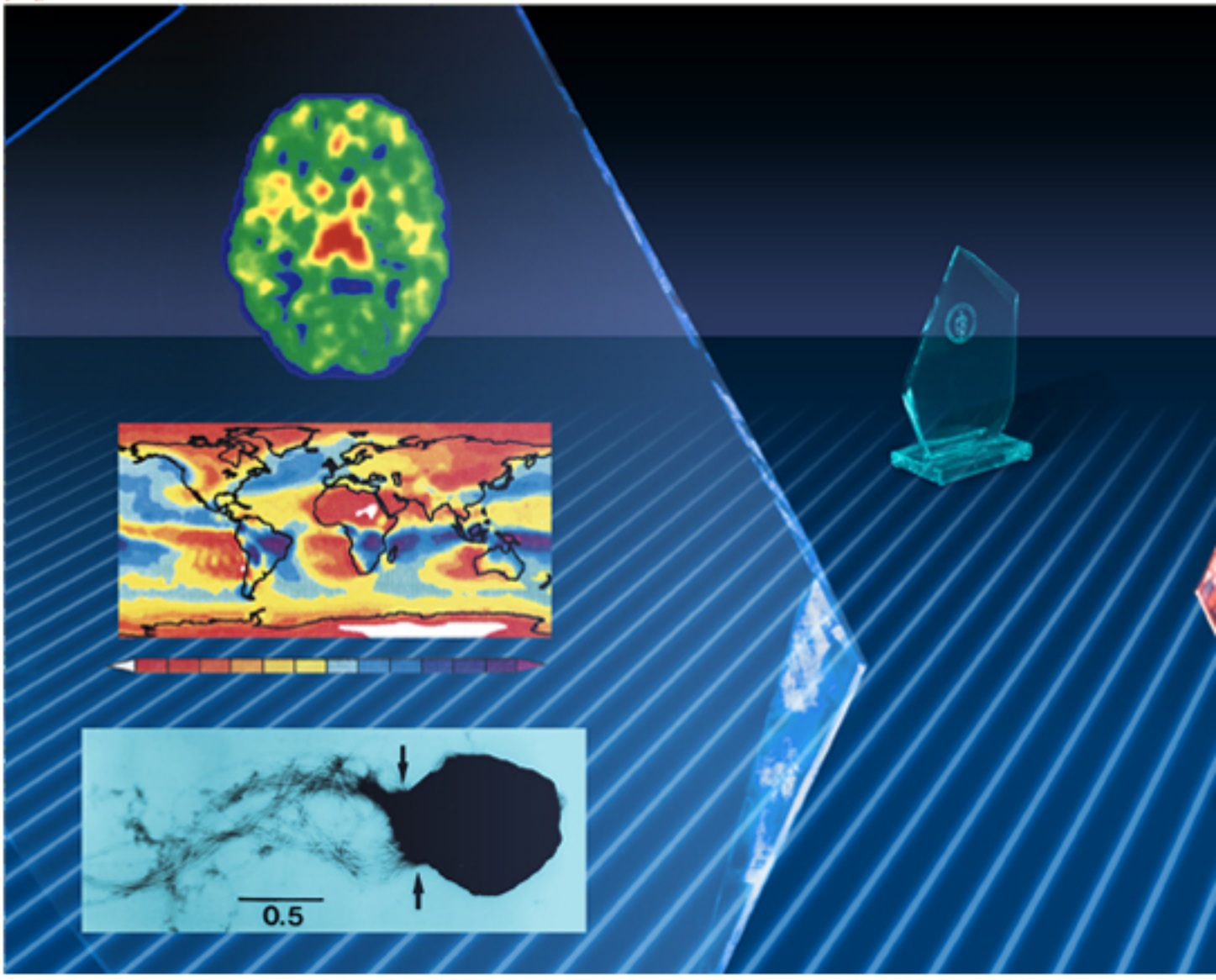
Web sites listed above contain information related to the awardees' work.



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