

**Statement to the United States Commission on Ocean Policy
[Preliminary]**

**by Dr. Allen Dearry
National Institute of Environmental Health Sciences, NIH**

**Presented at the Southwest Regional Meeting
Cabrillo Marine Aquarium
San Pedro, CA**

April 18, 2002

OCEANS AND HUMAN HEALTH

Admiral Watkins and Distinguished Members of the Commission,
I am pleased to appear before this panel to discuss linkages between
environmental quality of our nation's and the world's waters and human health.

INTRODUCTION

The mission of NIEHS is to develop the science base to prevent the contribution of the environment to human illness or disease. This is achieved through basic research, population-based studies, behavioral and community-based research, clinical investigations, and technology transfer to ensure that our results are communicated to affected individuals and communities, physicians, public health practitioners, and regulatory agencies.

Although most of the visible environmental problems of the 1950s and 1960s have been ameliorated, massive quantities of toxic agents are still polluting our environment. This includes chemicals that are known to be animal and human carcinogens and neuro-, immuno-, or developmental toxicants. Whether current levels of exposure to these agents are contributing to the high incidence of cancer, Parkinson's and Alzheimer's disease, asthma, autism, learning disabilities, diabetes, or other complex disorders is a matter of considerable concern.

It is now well established that such complex diseases are caused by multifactorial interactions of genes and environment. That is, no single factor is responsible for the development of complex diseases; genetic predisposition, exposure to environmental agents, behavior, gender, diet and nutrition, and age or stage of development may be contributors. Genes are only a small part of our make-up; the environment has a spectacular impact on one's health status. That is, genes exert their influence with certain environmental constraints. Genes may "load the dice" in favor or against the development of a specific disease, but do not dictate when, or if, a specific illness will develop. Therefore, preventing the development of common diseases will require an understanding of the contribution of both genes and the environment to their etiology.

IMPORTANCE OF OCEANS AND HUMAN HEALTH

NIEHS views 'oceans and human health' (OHH) as both an opportunity and a challenge. The more we learn about ocean processes and ocean life, the more we realize how critical the ocean will be for the future well-being of mankind. The majority of the world's population lives in close proximity to oceans. While less than 2% of the Earth is habitable coastal zone, approximately 60% of the global population currently lives within that minuscule area - a proportion that is expected to expand to 75% by the year 2020. Such increases in coastal populations have contributed to a growing reliance on the oceans for national security, economic development, public health and safety, and quality of life, in the U.S. and around the world.

The different ways in which the ocean influences human health range from threats to public health associated with climatic events such as El Nino to the benefits to medical science from marine bioprospecting for new drugs to treat infectious and chronic diseases. Oceans have become conduits for a number of environmental threats to human health. At the same time, there are positive impacts such as the use of marine organisms to develop new medical treatments and a better understanding of biological processes.

To guard against adverse health threats and to take advantage of the medicinal benefits that oceans might provide, the impacts of the oceans on human health need to be more fully explored and new research efforts need to be directed to this area. The primary goal of our strategy for OHH is to bring together members of the ocean sciences and medical communities to develop a multidisciplinary research program that has the capacity to address areas where improved understanding of marine processes and systems has the potential to reduce public health risks, improve our ability to provide and react to early warnings of health threats, and enhance our existing biomedical capabilities.

MILESTONES

A number of activities, both national and international, over the last few years, have served to focus increased attention on issues related to OHH.

At the 1998 World's Fair in Lisbon, for example, the NIEHS cosponsored the US Pavilion on the theme of OHH, with a number of interactive displays and exhibits demonstrating how ocean processes affect human health. NIEHS Centers participated in providing materials for this Pavilion, which was seen by 12 million people from around the world.

WORKSHOPS

NIEHS has sponsored and participated in a number of conferences and related interactions over the past 4 years, which have helped to provide input and guidance in development of an OHH research agenda.

Most recently, NIEHS, in partnership with NSF, held a roundtable meeting to update and further define a research strategy. You have the report from that roundtable in your notebook for today's meeting.

As a result of recommendations from these conferences, we've identified 3 broad areas that we feel are most likely to lead to scientific advances in the near term based upon existing expertise and technology.

HARMFUL ALGAL BLOOMS

Harmful algal blooms represent the most notorious marine hazard to both man and animal.

HABs know no geographic bounds and appear to be increasing worldwide. Nutrient enrichment, ballast water transport, and changing coastal conditions may contribute to global increases in HABs, but quantitative information is incomplete. The toxic materials produced by HABs interfere with human and animal metabolism, nerve conduction, and CNS processing. The highly toxic materials produced by HABs are present in our seafood, in water, and some types can be entrapped in seaspray and become airborne.

In the US alone, there are more than 60,000 reports of human intoxication each year. Health effects range from acute neurotoxic disorders to chronic and persistent diseases such as amnesic shellfish poisoning and chronic liver disease.

Areas requiring further research include:

- Describing the families and classes of organisms that produce HABs, as well as the biochemical pathways by which distinct organisms produce toxins.
- Designer materials, produced via organic, metabolic, or genetic manipulation, hold potential for producing many new tools for research and diagnostic uses.
- Biomarkers of exposure are crucial since toxins produce their effects at concentrations that approach limits of detection. Epidemiologic studies are needed to better define potential human health risks.

VECTOR- AND WATER-BORNE DISEASES

Waterborne disease has altered the course of human history, and it is still a leading cause of death among children from all nations. All major forms of microorganisms cause waterborne diseases in humans, including viruses, bacteria, fungi, protozoans, algae, and helminths. Many of these disease agents

can be conveyed by seawater or the plants and animals that live in seawater, and the coastal oceans and viruses are most frequently implicated in outbreaks of waterborne disease. Historically, the major diseases of record were cholera, typhoid fever, dysentery, polio, infectious hepatitis, and schistosomiasis.

These diseases are still important, but global climate change and anthropogenic influences are altering the impact of waterborne diseases. Because the oceans act as an immense reservoir for water, heat, and carbon; and because changes in atmospheric conditions modify the thermal-driven circulation of the world's oceans, both man-made and climatic forces have potential to alter the spread and virulence of waterborne pathogens. Investigative teams including microbiologists, meteorologists, remote sensing experts, epidemiologists, and ecologists are required to examine the interplay among oceans, climate, and vector-borne disease.

- The agents causing waterborne disease often escape detection with traditional methodologies, indicating a need to develop new and more sensitive detection and quantification approaches.
- New tools in genomics and proteomics should lead to a better understanding of the pathogenicity and survival of marine-borne pathogens.
- Population-based studies are required to evaluate the risks of various pathogens.

MARINE PHARMACEUTICALS

Terrestrial plants, animals, and microbes are a source for more than half of the medicinal drugs on the market today. Despite continued and more sophisticated searches for new bioactive agents, there has been a decreasing return in molecular diversity and hence in new drug compounds. At the same time, many of the bacteria that cause life-threatening diseases have become resistant to existing antibiotics, making the need for new drug discovery more urgent. Because the diversity of life is greater in the ocean than on land, marine organisms offer a promising source of novel compounds with therapeutic

potential. Although marine biodiversity is immense, technical difficulties and lack of knowledge of the marine environment have prevented scientists from more fully exploring the use of marine life and its derivatives to prevent and treat human disease.

- Marine microorganisms pose a particular challenge because of the difficulty in classifying and culturing them. At the same time, they represent a novel resource for discovery of pharmaceuticals.
- New applications of molecular genetics can be employed to isolate biosynthetic genes from these organisms and to express these pathways in hosts for production of marine pharmaceuticals.
- New techniques for culturing such organisms are needed to fully understand their therapeutic potential. Aquaculture, cell culture, microbial fermentation, and recombinant DNA techniques may provide alternative sources of material for research and drug development.

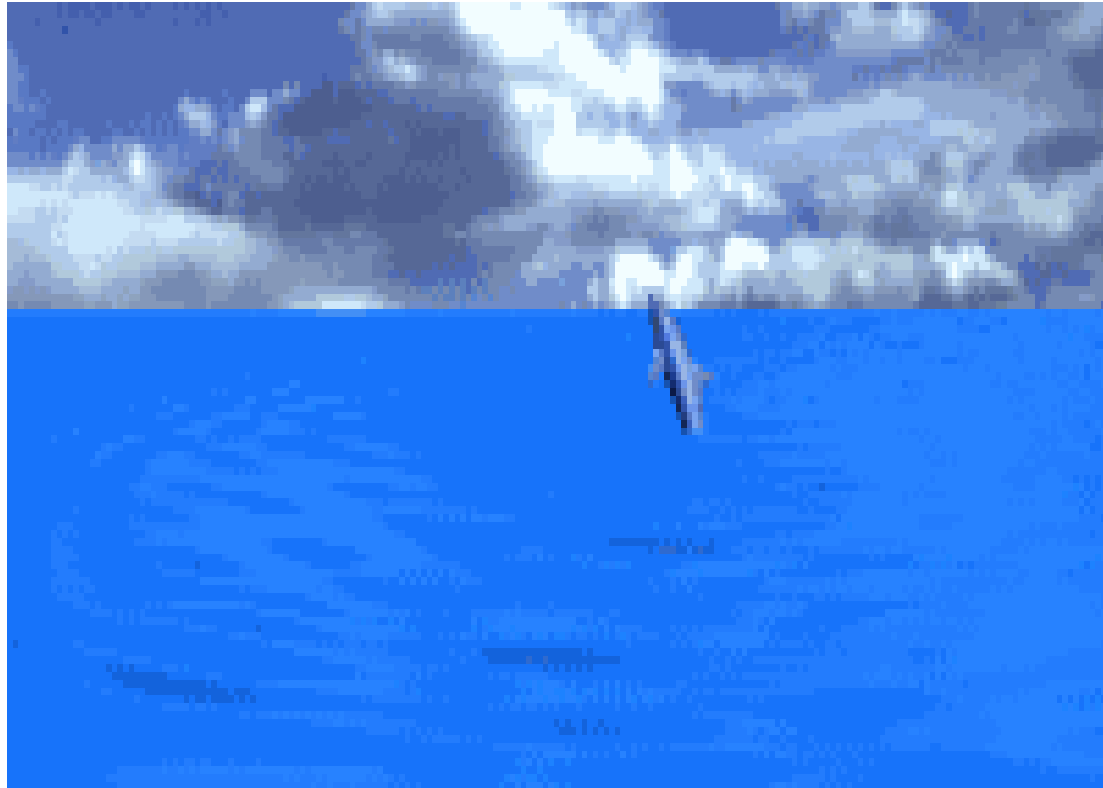
PROGRAM GOAL

Fully realizing the links between the oceans and human health requires nurturing cooperative studies in fields as diverse as physical oceanography, public health, epidemiology, marine biology, and medicine. There is clearly a need for scientific exchange among these fields in order to ensure an integrated research approach to issues where human health and ocean systems intersect.

Overall, then, the goal of a proposed NIEHS program to address OHH is to partner with our colleagues at NSF to develop a multidisciplinary research and prevention effort that can identify marine contaminants and hazards, prevent their harmful health effects, and develop products from the ocean that can enhance human well-being. Developing Centers of Excellence in Oceans and Human Health will provide for a national and international network of investigators and will foster an interconnected research approach dedicated to understanding the complexities of linking oceans and human health.



Oceans and Human Health



Allen Dearry, Ph.D.

National Institute of Environmental Health Sciences

April, 2002



Mission Statement

Human health and human disease result from three interactive elements: environmental factors, individual susceptibility and age. The mission of the National Institute of Environmental Health Sciences (NIEHS) is to reduce the burden of human illness and dysfunction from environmental causes by understanding each of these elements and how they interrelate.



Importance of Oceans and Human Health

- 60% of world population: coastal regions
- Conduits for a number of environmental threats to human health
 - Natural disasters, infectious diseases, toxic algal blooms
- Harbor diverse organisms that show great promise for
 - Providing new drugs & models for research



National/International Milestones

- The United Nations declared 1998 as the International Year of the Ocean.
- 1998 World's Fair in Lisbon - NIEHS cosponsored the US Pavilion having a theme of Oceans and Human Health.
- Presidential Commission on Ocean Policy established, 2000
- VA, HUD Appropriations Report for FY 2001 recognized need for research linking human health and oceans.



Program Goal

To develop an inter-agency, multidisciplinary research and prevention program focused on detecting potential marine-based contaminants, preventing associated illness, and developing products from the ocean that will enhance human well-being.



Program Description

- “Centers in Oceans and Human Health”
- Multidisciplinary centers with a central research theme.
 - 3 identified research areas
 - Eco-systems approach (e.g., polar regions, urban harbors, estuaries)
- Centers comprised of:
 - multiple research projects,
 - research service cores and
 - a translational research component.
- Hypothesis-driven research projects comprised of biological and physical sciences.



National Institute of Environmental Health Sciences

The National Institute of Environmental Health Sciences (NIEHS) is unique within the NIH because its primary focus is to *prevent* disease rather than to find ways to treat illnesses already afflicting people. The institute does this by approaching health as an integrated response of all organ systems of the body to the environment. Areas of special interest to NIEHS are cancer, birth defects, asthma, diabetes, infertility, neurodegenerative and developmental disorders and autoimmune disease. Thus, rather than focusing on one or two specific organs; the NIEHS takes a holistic approach to human health.

The most effective way to prevent disease and disability is to understand the cause of an illness and change the conditions that permit it to occur. A key strategy for preventing many diseases or minimizing disease progression is to minimize or eliminate adverse effects of chemicals in the environment and food supply. This preventive strategy underlies the concept of "environmental health". The premier research facility for this discipline in the U.S. is the NIEHS of the National Institutes of Health (NIH).

The NIEHS pursues its goals by studying the impact of a wide variety of chemical and biological agents found in the air, ground, food and water on human health. Among the types of agents NIEHS studies are:

- industrial chemicals
- food and nutrients
- agricultural compounds
- infectious agents
- pharmaceuticals and medicinal herbs
- socioeconomic and lifestyle factors
- by-products of combustion and industrial processes
- physical agents such as heat and radiation

These studies are performed in laboratories and in the field by NIEHS or by research laboratories that receive support from the Institute. The information gained from these studies form the backbone of many of the important regulations established by the Environmental Protection Agency, the Food and Drug Administration and other government oversight and regulatory agencies. This information also is the scientific basis for many laws passed by the U.S. Congress to protect the health of U.S. citizens.

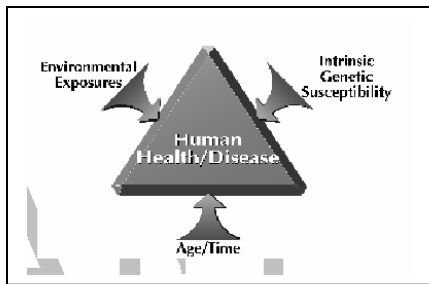
We, as a nation, believe that reducing exposures to adverse environmental agents is the best way to protect our health and the health of our children. A continually growing base of knowledge suggesting that environmental chemicals may be important triggers of many human medical problems supports this belief. Examples of such diseases include:

- Cancer
- Autoimmune diseases
- Parkinson’s Disease
- Neurodegenerative disorders
- Birth defects
- Asthma
- Heart disease

- Diabetes
- Learning and behavioral disorders
- Kidney disease
- Infertility
- Uterine fibroids
- Osteoporosis
- Low birthweight

UNDERSTANDING THE HUMAN BODY IN HEALTH AND DISEASE

The substantial long-term commitment the U.S. has made to funding the basic sciences has led to significant improvement in our understanding of the nature of disease at the cellular and molecular level. It has provided researchers with extraordinary tools for unraveling the secrets of the genetic basis of disease and genetic susceptibility to disease-



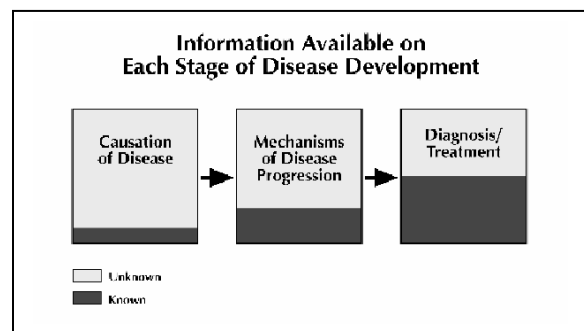
causing agents. NIEHS is using and extending this information to make further advances in the area of environmental health, especially in the understanding of the molecular events that begin the disease process. Thus, a large part of the NIEHS research is devoted to understanding the fundamental biological processes that maintain life and how environmental agents can adversely affect

these processes and set the stage for disease and disability.

In essence, an important objective of NIEHS is to understand the first stage of what can be visualized as a three-stage disease process (Figure 1):

Figure 1

- Stage 1:* Initial “trigger,” or initiating event (can be environmental in origin)
- Stage 2:* Progression of cellular and molecular events that are set in motion by the trigger
- Stage 3:* Clinical signs that lead to diagnosis and treatment of the disease



The key to disease prevention is successful intervention at Stage 1, before the disease process gets underway. However, as shown in Figure 1, much of biomedical research has concentrated on Stage 3, diagnosis and treatment. While more is now being learned about Stage 2 – the molecular and cellular events leading to disease – relatively little is known about Stage 1. Yet this first stage is the most important one for successful disease prevention and intervention.

Further complicating our understanding of the environmental causes of disease is the fact that individuals can differ in their susceptibility to environmental agents. For example, some people can detoxify potentially dangerous compounds rapidly because their bodies

have enzymes that break down these chemicals quickly. However, other people may detoxify the same agents much more slowly. Consequently, they remain exposed to these potential dangers for a longer time. Likewise, the ability of the body to repair environmental damage to genetic material varies from person to person. In addition, the level of toxicity of a particular environmental agent can vary depending on the time of life during which exposure occurred. In sum, the following elements make up a person's "risk profile" for any potential hazard:

- Exposure to environmental agents
- Specific time at which exposures occur
- Underlying, individual susceptibility to environmental agents

This complex interaction of risk factors and individual susceptibility regulates the risk of disease development in an individual, while obscuring the contribution of any specific factor. However, newly developed technologies and knowledge developed during the past several decades help researchers tease apart these different elements as they relate to specific diseases. By defining the components of enhanced susceptibilities, the NIEHS enables risk managers to make informed environmental health decisions.

In addition to contributing to the creation of new environmental health knowledge, the NIEHS also serves the public by empowering individuals and communities to manage, and reduce, their environmental problems. These programs include:

- Grants to support university-community partnerships that address local environmental health issues.
- Outreach activities required by NIEHS of academic research institutes it supports.
- Communication tools such as the *Report on Carcinogens*, the NIEHS journal *Environmental Health Perspectives*, and the public peer review of studies conducted under the National Toxicology Program.