

Concept Clearance

Branch: GEHB

Council Period: 202201

Concept Title: Oceans & Human Health

Introduction

The ocean is a complex mixture of metals, legacy and emerging chemical contaminants, pesticides, and, most visibly, plastic pollution. There are harmful algal blooms and other natural toxins, which plague both marine and freshwater, disrupting the food chain, water quality, and human health directly. Climate change deepens these concerns through extreme weather events along the coast such as hurricanes and flooding, and through general disturbances to water temperature, salinity, and pH, perturbing delicate ecosystems. With a third of the total human population living within 60 miles of an oceanic coast, and more than 80% of ocean pollution arising from land-based sources, environmental stewardship of our waterways is a team problem requiring team-based solutions.

For nearly two decades, spanning three generations of RFAs, the NIEHS has partnered with the National Science Foundation (NSF) on a focused effort to address crucial topics related to oceans and human health. This concept presents a vision for a renewal of the Oceans & Human Health (OHH) Program.

The OHH program embodies the values and priorities set by NIEHS through its Strategic Plan. Through interdisciplinary sciences that bridge basic molecular biology and toxicology to oceanography and computational geosciences, researchers are driven by questions related to population susceptibility, co-exposures, and interactions between the environmental and human microbiome. In promoting translation, grantees seek to learn from and understand past patterns of exposures to inform future risk and improve on ways to share that data with other researchers, and with the audiences who need it most. OHH researchers are committed to enhancing environmental health sciences through stewardship by forging new collaborations with local colleges and community advocacy groups, providing unique opportunities for students and postdoctoral trainees, and by undergoing continual introspection and evaluation of their own research and engagement efforts. Given the scope of work and assemblage of strategies to improve coastal and Great Lakes exposure-related health, OHH is well-poised to continue to further the NIEHS mission now and into the future.

Research Goals and Scope

The fundamental thesis of the OHH Program during this renewal will remain unchanged: to promote interdisciplinary collaborations among biomedical researchers, and physical and oceanographic scientists to gain knowledge of the impact of marine and Great Lakes exposures on human health. By establishing and maintaining community partnerships, the program strategizes ways to adapt, prevent, and counteract these exposures to improve the lives of the populations in that area. Practically, the scope of this program will remain broad, to foster a variety of types of research studies specific to the exposures endemic to the geographic area of each research team, and the resources available to them.

The OHH portfolio is distributed across multiple topics, including chemical pollutants, harmful algal bloom toxins, other marine toxins, and climate change. Research projects encompass but are not limited to the following: harmful algal bloom (HAB) modeling and forecasting, toxin and pathogen characterization, use of sentinel species and biofilters for exposure assessment, discerning the effects of climate change on bloom dynamics and potential for toxicity, and the impact of hurricanes on seafood safety. These studies employ a wide range of *in silico*, *in situ*, *in vitro*, and *in vivo* approaches, and use several types of model organisms, including rats and mice, sea urchins, bottlenose dolphins, and zebrafish.

Oceans-related exposures, and their impacts on human health especially affect coastal communities, particularly those that are dependent on the oceans for their food and livelihood. The effects of pollution and climate change fall heavily on populations that do not have the resources to combat or buffer impacts of ocean-related events or exposures and are highly susceptible to the increasingly frequent harmful algal blooms. Centers work with local partners, which significantly increases success for development of strategies to adapt, prevent, and protect from exposures. Some approaches to data dissemination and translation include establishment of monitoring programs for coastlines or beaches which inform fishing or swimming advisories, recruitment of citizen scientists to help in sample collection, development of educational materials for local schools and health care practitioners who need to be prepared to identify the signs of acute HAB toxicity, and collaboration with local regulatory bodies on safe swimming or drinking water conditions.

Most of the above listed topics are still a critical concern in the realm of human health effects from ocean or Great Lakes exposures. Additional gap areas that can be addressed in the renewal of the OHH program and through other funding opportunities in the upcoming years are described herein. One example is promoting the study of co-exposures, or combined susceptibilities. There are many combinations that may be of interest, including: anthropogenic exposures combined with HAB toxins, freshwater and marine HAB toxins, seafood contamination combined with respiratory exposure to blooms, or community or individual effects of hurricanes and subsequent blooms. Another example of an information gap is human exposure levels to natural toxins. This could start to be answered through characterization of human exposure routes, target organs, and ADME properties for marine toxins by sampling or modeling. Other exposures that could use additional attention in the coming years of OHH are microplastics (MPs), and freshwater HABs such as cyanobacteria and the resultant toxins. There is evidence for human exposure to microplastics, and concern for direct and indirect MP toxicity, as MPs can act as a vector for transport and shelter of microorganisms that harbor marine toxins. Cyanobacteria produce hundreds of understudied cyanopeptides, for which there is not much known about the toxicity.

Mechanism and Justification

The objectives of the Oceans & Human Health program would be best met through a combination of a multi-component center-like mechanism, and with RFAs for independent research projects on specific topics.

The Centers for Oceans & Human Health jointly supported by NIEHS and NSF provide an extremely rare opportunity for biomedical researchers and oceanographers, physical scientists, chemists, and community partners to investigate different elements of environmental exposures and inform each

other's work. NSF and NIEHS are both committed to continuing this partnership, which has fostered genuine interdisciplinary collaboration to provide impactful and lasting results. Ocean-related concerns are evolving, and teams of researchers will be well-equipped to incorporate novel technologies and pursue new avenues of investigation. The renewed Centers program will require at least three distinct research projects: one or more focusing on toxicology or human health impacts, one on further characterization of marine or Great Lakes-related exposures, and one considering direct impact of climate change. The renewal would require inclusion of a community engagement core, and an administrative core. Thorough and intentional data sharing will also be a crucial element of the program. In this way, the Centers will be well-poised to continue to accelerate the translation of the rich body of data and knowledge into the hands of affected communities, health practitioners, and policy makers.

In addition to our continued partnership with NSF, there are topics able to be more directly addressed through independent research solicitations supported by NIEHS. Such topics may include characterizing the nature and toxicity of harmful algal blooms in freshwater sources beyond the Great Lakes, investigating new and emerging contaminants of concern, assessing exposure levels or exposure routes of marine-based pollutants in coastal populations, development of biomarkers for exposure or toxicity from ocean-related exposures, etc.

During this 2021-2030 UN Decade for Ocean Science, there may be additional opportunities for NIEHS to take action and join other agencies in pursuing innovative science for an equitable and sustainable ocean.