Harnessing the Power of Zebrafish to Advance Environmental Health Sciences

The enormous challenge facing NIEHS is to identify how environmentally relevant exposures are causally related to adverse health outcomes. Even more challenging is unraveling specific toxicity mechanisms. Traditional rodent models are simply too slow and expensive to evaluate the universe of potential exposures. With ARRA funding from NIEHS, we have invented robotics to automate the production, exposure and assessment of 3 million zebrafish embryos per year. Embryonic development is an ideal stage to identify chemical hazards because this complex and dynamic period requires the full repertoire of molecular signaling, thereby increasing the probability of identifying adverse gene chemical interactions. This “whole-animal” toxicity platform provides essential phenotypic anchoring to identify hazardous exposures, while facilitating the discovery of the targets and pathways that are responsible for toxicity. We now have an unprecedented capability to identify phenotypic responses following complex exposures, including complex mixtures collected with passive sampling technology from superfund sites and from the recent Gulf oil spill. Additional facilities are being developed to grow-out embryonic exposed zebrafish to evaluate long-term effects on behavior and adult diseases. Through the combined application of robust genomic, transgenic, and computational tools, we have demonstrated the power of this approach to gain mechanistic insights into gene-chemical interactions relevant to human health.