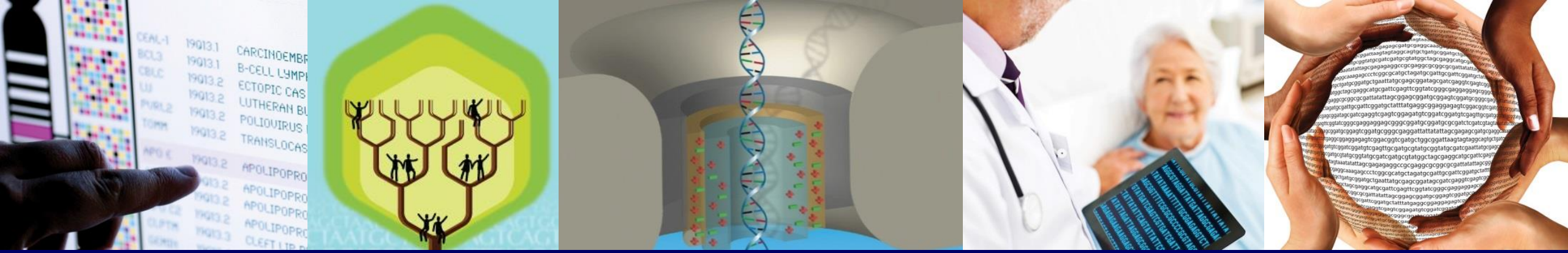

Virtual Workshop:
Ethical, Legal, and Social Implications of Gene-Environment Interaction Research

Eric Green, M.D., Ph.D.
Director, NHGRI

National Human Genome Research Institute

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Like NIEHS (and many other institutes), NHGRI aims to explore gene-environment interactions

2020 NHGRI Strategic Vision

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Perspective

Strategic vision for improving human health at The Forefront of Genomics

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Starting with the launch of the Human Genome Project three decades ago, and continuing after its completion in 2003, genomics has progressively come to have a central and catalytic role in basic and translational research. In addition, studies increasingly demonstrate how genomic information can be effectively used in clinical care. In the future, the anticipated advances in technology development, biological insights, and clinical applications (among others) will lead to more widespread integration of genomics into almost all areas of biomedical research, the adoption of genomics into mainstream medical and public-health practices, and an increasing relevance of genomics for everyday life. On behalf of the research community, the National Human Genome Research Institute recently completed a multi-year process of strategic engagement to identify future research priorities and opportunities in human genomics, with an emphasis on health applications. Here we describe the highest-priority elements envisioned for the cutting-edge of human genomics going forward—that is, at 'The Forefront of Genomics'.

Beginning in October 1990, a pioneering group of international researchers began an audacious journey to generate the first map and sequence of the human genome, marking the start of a 13-year odyssey called the Human Genome Project[1–3]. The successful and early completion of the Project in 2003, which included parallel studies of a set of model organism genomes, catalysed enormous progress in genomics research. Leading the signature advances has been a greater than one million-fold reduction in the cost of DNA sequencing[4]. This decrease has allowed the generation of innumerable genome sequences, including hundreds of thousands of human genome sequences (both in research and clinical settings), and the continuous development of assays to identify and characterize functional genomic elements[5,6]. These new tools, together with increasingly sophisticated statistical and computational methods, have enabled researchers to create rich catalogues of human genomic variants[7,8], to gain an ever-deepening understanding of the functional complexities of the human genome[9], and to determine the genomic bases of thousands of human diseases[9,10]. In turn, the past decade has brought the initial realization of genomic medicine[11], as research successes have been converted into powerful tools for use in healthcare, including somatic genome analysis for cancer (enabling development of targeted therapeutic agents)[12], non-invasive prenatal genetic screening[13], and genomics-based tests for a growing set of paediatric conditions and rare disorders[14], among others.

In essence, with growing insights about the structure and function of the human genome and ever-improving laboratory and computational technologies, genomics has become increasingly woven into the fabric of biomedical research, medical practice, and society. The scope, scale, and pace of genomic advances so far were nearly unimaginable when the Human Genome Project began; even today, such advances are yielding scientific and clinical opportunities beyond our initial expectations, with many more anticipated in the next decade.

Embracing its leadership role in genomics, the National Human Genome Research Institute (NHGRI) has developed strategic visions for the field at key inflection points, in particular at the end of the Human Genome Project in 2003[15] and then again at the beginning of the last decade in 2011[16]. These visions outlined the most compelling opportunities for human genomics research, in each case informed by a multi-year engagement process. NHGRI endeavoured to start the new decade with an updated strategic vision for human genomics research. Through a planning process that involved more than 50 events (such as dedicated workshops, conference sessions, and webinars) over the past two years (see http://genome.gov/genomics2020), the institute collected input from a large number of stakeholders, with the resulting input catalogued and synthesized using the framework depicted in Fig. 1.

Unlike the past, this round of strategic planning was greatly influenced by the now widely disseminated nature of genomics across biomedicine. A representative glimpse into this historic phenomenon is illustrated in Fig. 2. During the Human Genome Project, NHGRI was the primary funder of human genomics research at the US National Institutes of Health (NIH), but the past two decades have brought a greater than tenfold increase in the relative fraction of funding coming from other parts of the NIH.

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genome.gov/2020sv

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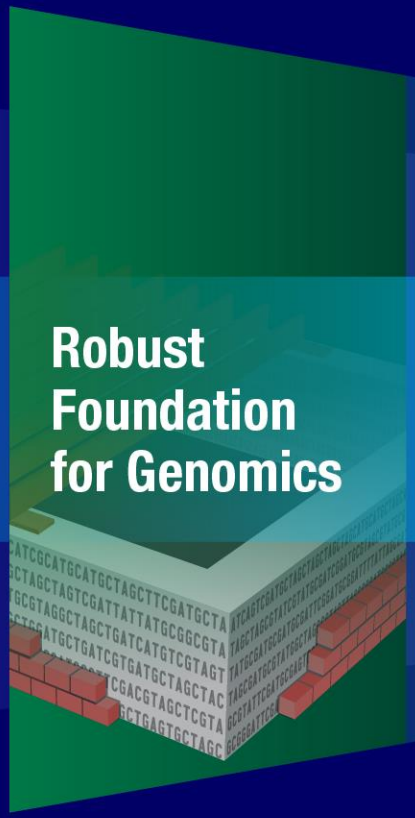
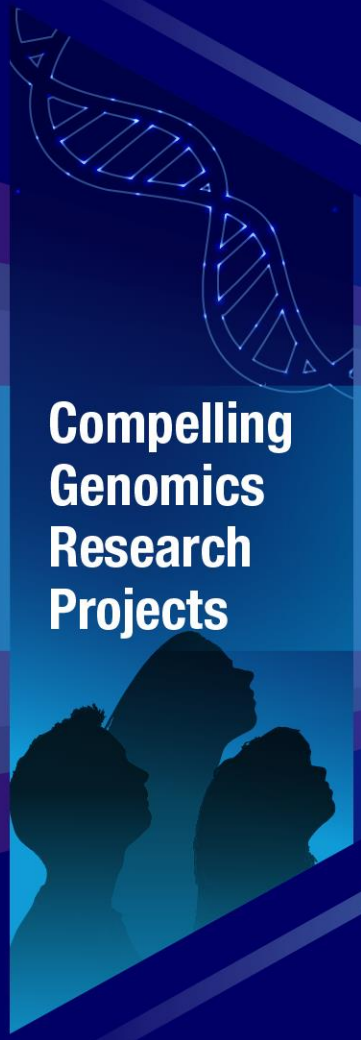
Guiding Principles and Values

Robust Foundation for Genomics



Breaking Down Barriers

Compelling Genomics Research Projects



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GxE – an NHGRI Guiding Principle/Value

*"Provide a conceptual research framing that **consistently** examines the role of both genomic and non-genomic contributors to health and disease — **routinely** considering the importance of social and environmental factors that influence human health (and the interactions among those components and genomics)"*

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Specific GxE Goals

- **Functional Genomics**
- **Multi-omic Approaches to Disease and Risk**
- **Data Science Methods**
- **Health Disparities**

- *Nature* volume 586, pages 683–692 (2020) *https://doi.org/10.1038/s41586-020-2817-4*
- *https://grants.nih.gov/grants/guide/notice-files/NOT-HG-22-007.html*
- *https://www.genome.gov/event-calendar/multi-omics-in-health-and-disease*
- *https://www.genome.gov/Funded-Programs-Projects/Electronic-Medical-Records-and-Genomics-Network-eMERGE*
- *https://www.genome.gov/Funded-Programs-Projects/PRIMED-Consortium*

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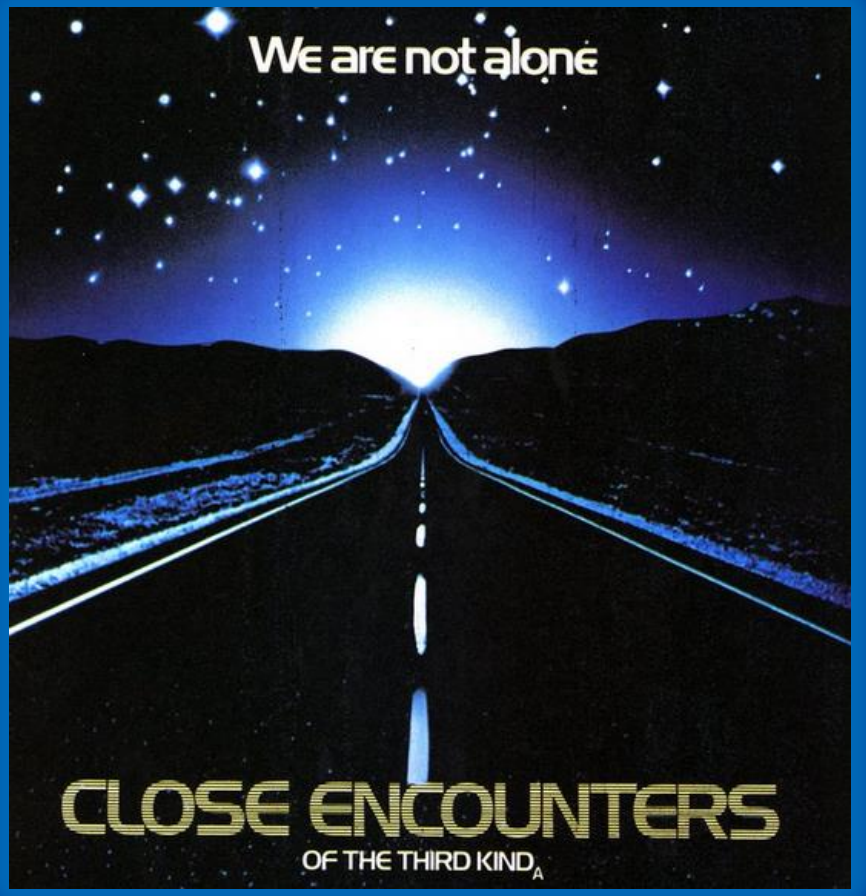
Partnership is Needed



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Stewardship in GxE Research

Tools, methods, and knowledge that NHGRI and genomics can bring to the table:

- **Genomic and functional databases**
- **DNA sequencing methods**
- **Large-scale data handling and analysis methods**
- **Phenotype databases (e.g., PhenX toolkit)**

Need to further build NHGRI's assets for GxE research

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NHGRI's Assets Include ELSI

NHGRI Ethical, Legal, and Social Implications Research Program

- **Origins at start of Human Genome Project**
- **Multidisciplinary**
- **Broad range of implications of genomics**
- **Informs genomics research**

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ELSI Scholarship Guides Genomics

- Research data governance
- Return and communication of research results
- Conflation of race and biology in genomics
- Working in concert with communities
- Social implications of research findings

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GxE ELSI to Date

Thank you for taking part!

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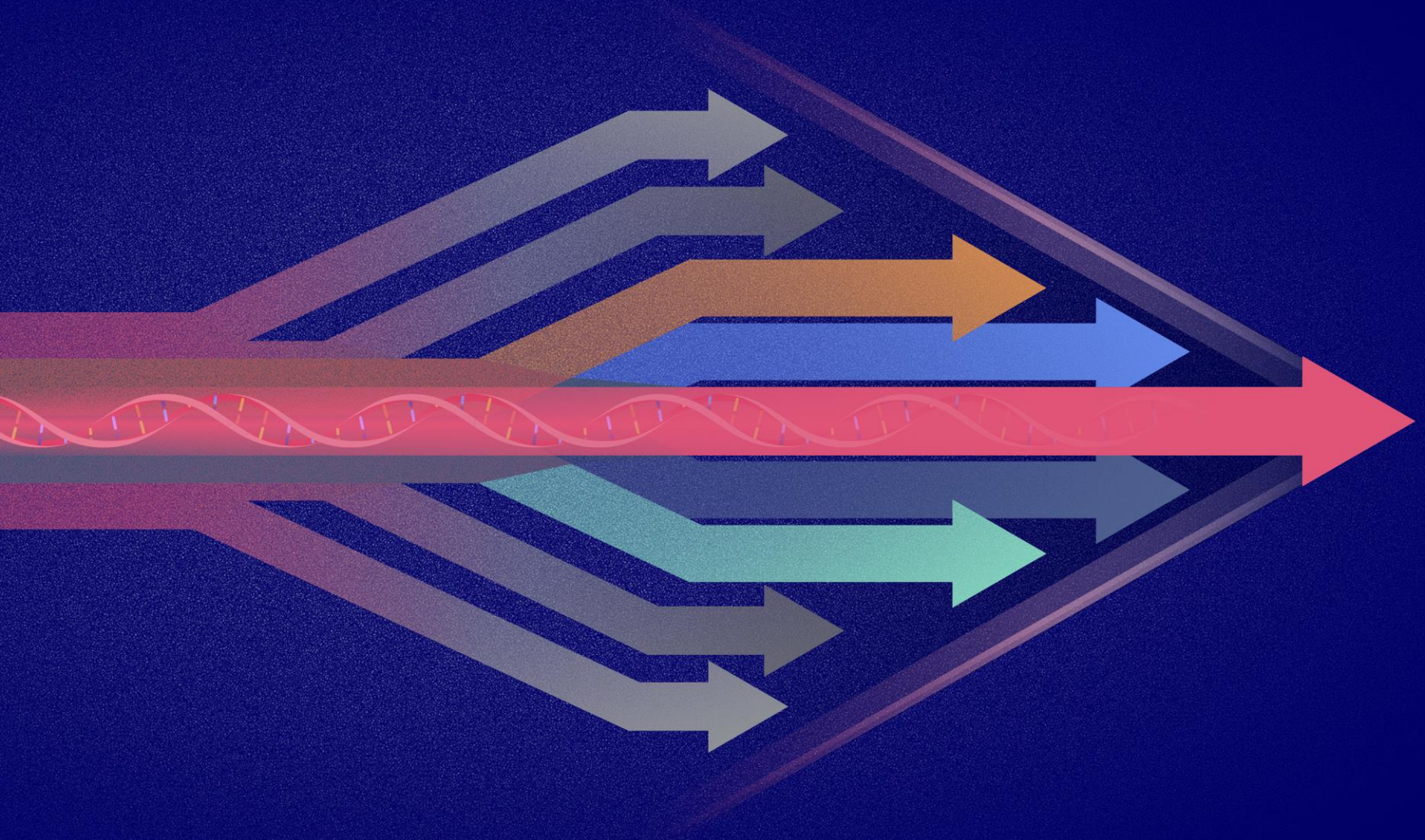

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