Free Executive Summary

Genes, Behavior, and the Social Environment: Moving Beyond the Nature/Nurture Debate

Committee on Assessing Interactions Among Social, Behavioral, and Genetic Factors in Health, Lyla M. Hernandez and Dan G. Blazer, Editors


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Over the past century, we have made great strides in reducing rates of disease and enhancing people’s general health. Public health measures such as sanitation, improved hygiene, and vaccines; reduced hazards in the workplace; new drugs and clinical procedures; and, more recently, a growing understanding of the human genome have each played a role in extending the duration and raising the quality of human life. But research conducted over the past few decades shows us that this progress, much of which was based on investigating one causative factor at a time—often, through a single discipline or by a narrow range of practitioners—can only go so far. Genes, Behavior, and the Social Environment examines a number of well-described gene-environment interactions, reviews the state of the science in researching such interactions, and recommends priorities not only for research itself but also for its workforce, resource, and infrastructural needs.

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Summary

During the twentieth century, great strides were made in reducing disease and improving the health of individuals and populations. Public health measures such as sanitation, improved hygiene, and vaccines led to major reductions in mortality and morbidity (Turnock, 2001). Increased attention to the hazards of the workplace resulted in reduced injuries and better health for workers (IOM, 2003a). Advances in biomedical research helped expand knowledge of disease and spurred the development of new clinical and pharmaceutical interventions. More recently, the sequencing of the human genome has provided information that holds the promise for further improving human health.

Over the years a large body of evidence has emerged indicating that social and behavioral factors such as socioeconomic status, smoking, diet, and alcohol use are important determinants of health (Berkman and Kawachi, 2000; IOM, 2000; Marmot and Wilkinson, 2006). Recent studies also suggest that examining interactions among genetic and social-environmental factors could greatly enhance understanding of health and illness. For example, Caspi and colleagues (2003) found “evidence of a gene-by-environment interaction, in which an individual’s response to environmental insults is moderated by his or her genetic makeup.” In a study showing how the social environment can influence biological response, Manuck et al. (2005) found that the socioeconomic status of communities is associated with variations in central nervous system serotonergic responsivity, which may have implications for the prevalence of psychological disorders and behaviors such as depression, impulsive aggression, and suicide.
As part of a strategy to determine how best to integrate research priorities to include an increased focus on the impact on health of interactions among social, behavioral, and genetic factors, the National Institutes of Health (NIH), Office of Behavioral and Social Sciences Research, in conjunction with the National Human Genome Research Institute and the National Institute of General Medical Sciences, requested that the Institute of Medicine undertake a study to examine the state of the science on gene-environment interactions that affect human health, with a focus on the social environment. The goal of the study was to identify approaches and strategies to strengthen the integration of social, behavioral, and genetic research and to consider the relevant training and infrastructure needs. More specifically, NIH requested the following:

1. Review the state of the science on the interactions between the social environment and genetics that affect human health.
2. Develop case studies that will demonstrate how the interactions of the social environment and genetics affect health outcomes; illustrate the methodological issues involved in measuring the interactions; elucidate the research gaps; point to key areas necessary for integrating social, behavioral, and genetic research; and suggest mechanisms for overcoming barriers.
3. Identify gaps in the knowledge and barriers that exist to integrating social, behavioral, and genetic research in this area.
4. Recommend specific short- and long-term priorities for social and behavioral research on gene-social environment interactions; identify mechanisms that can be used to encourage interdisciplinary research in this area.
5. Assess workforce, resource, and infrastructure needs and make actionable recommendations on overcoming barriers and developing mechanisms to accelerate progress.

Chapter 2 of this report explores the impact of the social and cultural environment on health, examining what we know about the influences of these factors on health, and identifying the limitations of current research. Genetic factors and their impact on health are examined in Chapter 3, which focuses on what is known or theorized about the direct link between genes and health and what still must be explored to understand the environmental interactions and relative roles among genes that contribute to health and illness. The impact of behavioral factors on health is explored in Chap-

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1For purposes of the study, sponsors clarified that the term *social environment* refers to the relations among people as individuals and in societies and not environmental conditions such as global warming and toxic waste, even if they result from human activities.
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While research on the impact of interactions has the potential to further the understanding of disease risk and aid in the development of effective interventions to improve the health of individuals and populations, there is a dearth of research that encompasses all three domains. Much remains to be learned about how these factors interact to impact health, including the most basic concept of defining interaction and how it can be characterized. Because greater etiological understanding is needed to identify future clinical research and develop effective interventions aimed at improving health outcomes, the committee focused its efforts on etiological research.

RECOMMENDATIONS

The recommendations discussed below are designed to explicate and facilitate research on the impact on health of interactions among social, behavioral, and genetic factors. Each recommendation is followed by a chapter number in which additional discussion related to the recommendation can be found.

Transdisciplinary Research

Contributions from research conducted over the past few decades, including the sequencing of the human genome, are pushing scientists to move beyond examining single agents of health and disease to a broader systems view, which is based on the understanding that health outcomes are the result of multiple determinants and their interactions (Lalonde, 1974; Evans and Stoddard, 1990; Kaplan et al., 2000; IOM, 2003a; IOM, 2003b). Understanding the associations between health and interactions among social, behavioral, and genetic factors requires research that embraces the systems view and includes an examination of the interactive pathways through which these factors operate to affect health.2 Such research requires the participation of scientific investigators from a variety of different fields and a shift in focus from efforts that are dominated by single disciplines to research that involves collaborative participation of scientists with various expertise at all stages of the research process. While interdisciplinary research focuses on answering questions of mutual concern to those from various disciplines and multidisciplinary research involves research questions of both mutual and separate interest to participating investiga-

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2Interactive physiological pathways pass information from the social world to genes and play a central role in understanding gene-environment interactions.
tors, transdisciplinary research “implies the conception of research questions that transcend the individual departments or specialized knowledge bases because they are intended to solve research questions that are, by definition, beyond the purview of the individual disciplines” (IOM, 2003b). Therefore, the committee makes the following recommendation:

Recommendation 1: Conduct Transdisciplinary, Collaborative Research. The NIH should develop Requests for Applications (RFAs) to study the impact on health of interactions among social, behavioral, and genetic factors and their interactive pathways (i.e., physiological). Such transdisciplinary research should involve the genuine collaboration of social, behavioral, and genetic scientists. Genuine collaboration is essential for the identification, incorporation, analysis, and interpretation of the multiple variables used. (Chapter 6)

Key social variables which have been linked consistently and robustly to health outcomes include educational attainment, income and wealth, occupational status, social networks/social support, and work conditions. Well-established behavioral and psychological variables that affect health outcomes include tobacco/alcohol/drug use, eating behavior, physical activity, temperament, perceived stress and coping, perceived social support, emotional state, and motivation. Essential genetic factors affecting health include the DNA sequence variation, structural chromosomal changes, gene expression, epigenetic modifications, and downstream targets of gene expression.

In the search for a better understanding of genetic and environmental interactions as determinants of health, certain fundamental aspects of human identity (i.e., sex/gender and race/ethnicity) pose both a challenge and an opportunity for clarification. However because sex/gender and race/ethnicity are more complicated than they appear, they need to be considered and analyzed from a variety of perspectives, including social, cultural, psychological, historical, political, genetic, and geographic/ancestral.

Relevant physiological measurements and pathways should also be considered. Understanding the pathways through which interactions operate will aid in identifying links between major levels of organization of living systems: social groups of individuals, individuals composed of physiological systems, physiological systems composed of cells, and cells composed of molecules, especially DNA. Ultimately the results of such research may help to identify where to intervene along the causal chains and pathways between the social world and genes that cause disease in order to improve health outcomes.

Many determinants of health are not static, that is, they influence health in a variety of ways throughout the life course. For example, poverty may differentially and independently affect the health of an individual at different stages of life (e.g., in utero, during infancy and childhood, during
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pregnancy, or during old age). Personality traits and psychological status are also known to change over the lifespan and have potential to affect health. In addition to these well-established factors, a growing body of research has documented associations between cultural factors and health (Berkman and Kawachi, 2000). The influence of social, behavioral, and genetic factors on health involves dimensions of both time (critical stages in the life course and the effects of cumulative exposure) and the context or culture within which variables operate to influence health outcomes. Therefore, the committee makes the following recommendation:

Recommendation 2: Measure Key Variables Over the Life Course and Within the Context of Culture. The NIH should develop RFAs for studies of interactions that incorporate measurement, over the life course and within the context of culture, of key variables in the important domains of social, behavioral, and genetic factors. (Chapter 6)

Modeling Strategies

For the most part research has taken a linear approach when examining the link between a particular set of variables (e.g., social-environmental or genetic variables) and health. Yet, there remains the need to connect and integrate knowledge across multiple determinants of health in order to understand the mechanisms of integration (for example, how social factors are translated into physiological effects on cellular responses, including changes in gene expression). Future studies should recognize that a linear approach does not reflect the integrated nature of how health outcomes are generated. Therefore, the committee recommends the following:

Recommendation 3: Develop and Implement New Modeling Strategies to Build More Comprehensive, Predictive Models of Etiologically Heterogeneous Disease. The NIH should emphasize research aimed at developing and implementing such models (e.g., pattern recognition, multivariate statistics, and systems-oriented approaches) for incorporating social, behavioral, and genetic factors and their interactive pathways (i.e., physiological) in testable models within populations, clinical settings, or animal studies. (Chapter 6)

With approximately 30,000 genes in the human genome, most genes are likely to serve different functions at different times in different environments (McClintock et al., 2005). The ability to measure and evaluate differential gene expression has the potential to provide important insights into the study of health and disease. Alterations in DNA sequence and gene
expression can be modified at different points throughout the life course, dictating variation in protein levels and functionality, as well as subsequent levels of metabolic products that are associated with those proteins. These factors can be measured through the use of genomic, transcriptomic, proteomic, and metabonomic technologies. However, further development of these technologies is needed to allow researchers to accurately study the molecular systems that interact with social and behavioral variables to influence health outcomes (see Chapter 6 for a more detailed discussion of these technologies). Thus, the committee recommends the following:

**Recommendation 4: Investigate Biological Signatures.** Researchers should use genomic, transcriptomic, proteomic, metabonomic, and other high-dimensional molecular approaches to discover new constellations of genetic factors, biomarkers, and mediating systems through which interactions with social environment and behavior influence health. (Chapter 6)

The context or culture within which individuals exist also is known to exert influence on health outcomes. Relevant social and cultural environments include not only an individual’s immediate personal environment (e.g., his/her family), but also the broader social contexts such as the community in which a person resides. Health psychologists are increasingly calling attention to the critical role of sociocultural context, a necessary factor to consider if efforts to modify risk behaviors are to be effective. Different subgroups may have different genetic backgrounds, as well as varying cultural or socioeconomic characteristics that influence patterns of behavior, thereby creating a correlation between genotype and environmental exposure. Furthermore, it may be found that polymorphisms occurring in genotypes that act as destructive or protective factors for disease and health may be created, modified, or triggered by cultural and contextual factors. It is important to determine if research findings are applicable beyond a small population, and to capitalize on unique gene-environment interactions that could contribute to a broader understanding of factors, mechanisms, and processes. Therefore, the committee recommends the following:

**Recommendation 5: Conduct Research in Diverse Groups and Settings.** The NIH should encourage research on the impact of interactions among social, behavioral, and genetic factors and their interactive pathways (i.e., physiological) on health that emphasizes diversity in groups and settings. Furthermore, NIH should support efforts to ensure that the findings of such research are validated by replication in independent studies, translated to patient-oriented research, conducted and applied in the context of
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Use of Animal Models

Animal research studies are an important complement to clinical and community-based research because they can serve as models for gene-environment interactions and pathways of human disease. Animal models can be used to conduct studies in which different aspects of social, behavioral, and genetic variables can be controlled, standardized, or manipulated to a significantly larger extent than can be accomplished in human studies. These models also allow for the invasive examination of organ-, tissue-, and region-specific mechanisms at the physiological, cellular, and molecular levels. Animals with short reproductive cycles and life spans provide an invaluable tool for conducting developmental and life-span studies, as well as breeding experiments and genetic manipulation that facilitate the elucidation of inherited traits and genetic effects. In some cases, animal models provide opportunities to establish causality through studies examining the temporal sequence of events, or studies involving removal followed by the add-back of hypothesized mediators at the genetic, protein, physiological, behavioral, or social environment level. Therefore, the committee makes the following recommendation:

Recommendation 6: Use Animal Models to Study Gene-Social Environment Interaction. The NIH should develop RFAs that use carefully selected animal models for research on the impact on health of interactions among social, behavioral, and genetic factors and their interactive pathways (i.e., physiological). (Chapter 7)

Research Design and Analysis

A clear formulation of the concept of “interaction” and an understanding of research designs that can be used to test for interactions are central to making progress in assessing the impact on health of interactions. Statistical tests for interaction are entirely dependent on the measurement scale (e.g., additive or multiplicative) used to evaluate the effects of different factors on health. Use of different measurement scales can lead to substantively different conclusions about whether or not interaction is present, and therefore, to different recommendations for intervention. Thus, determining the measurement scale is critical to the design of future studies and to the interpretation of their results. The choice of measurement scale should not be based on statistical convenience. Instead, it should be based on a theoretical model for disease causation that is more closely tied to biology.
Epidemiologists have built a conceptual framework for interaction based on the counterfactual model and the sufficient-component cause model (see Chapter 8 for discussion of these models). Beginning with this conceptual framework, defined at the level of an individual, it is possible to predict patterns of risk in the population when interaction is or is not present. Such an analysis leads to the conclusion that an additive scale for testing interaction more closely reflects the underlying biology than a multiplicative scale. That is, when two factors participate in the same sufficient cause (interaction defined conceptually), disease risks in individuals with both risk factors will be greater than expected from the additive effects of each risk factor alone.

Currently, most of the statistical software commonly used for epidemiologic analysis includes tests for interaction on a multiplicative scale but not on an additive scale. Thus testing for interactions on an additive scale requires the development of new, accessible statistical software. Also, tests for interaction require extremely large sample sizes; hence multisite collaborations may be required in order to assemble databases of sufficient size that are needed to assure adequate statistical power. Additionally, given the complexity in defining interaction and testing for it, new, efficient study designs should be developed for testing interaction. Therefore, the committee recommends the following:

Recommendation 7: Advance the Science of the Study of Interactions. Researchers should base testing for interaction on a conceptual framework rather than simply the testing of a statistical model, and they must specify the scale (e.g., additive or multiplicative) used to evaluate whether or not interactions are present. If a multiplicative scale is used, consistency with an additive relation between the effects of different factors also should be evaluated. The NIH should develop RFAs for research on developing study designs that are efficient at testing interactions, including variations in interactions over time and development. (Chapter 8)

Infrastructure

Research conducted to elaborate the impact of interactions among social, behavioral, and genetic factors on human health places several demands on the research infrastructure. This infrastructure includes the human infrastructure (e.g., education and training), data, and incentives and rewards.

The foundation of the research enterprise is the education of its researchers. Given that advances in genomics have been recent—and the challenge of incorporating genetic research with behavior and social factors
is even more recent—it is likely that there are many current researchers who have gaps in their scientific training. Furthermore, training is needed for pre- and postdoctoral students. While universities (and high schools), NIH, and other funders of research training share responsibility for educating researchers, NIH, as the major funder of biomedical and behavioral research, is poised to make major contributions to training a cadre of researchers to conduct transdisciplinary research. Several existing mechanisms could be used as is or modified to facilitate the education of investigators in transdisciplinary research. Therefore, the committee recommends the following:

**Recommendation 8: Expand and Enhance Training for Transdisciplinary Researchers.** *The NIH should use existing and modified training tools both to reach the next generation of researchers and to enhance the training of current researchers. Approaches include individual fellowships (F31, F32) and senior fellowships (F33), transdisciplinary institutional grants (T32, T90), and short courses.* (Chapter 9)

The study of interactions presents a significant need for datasets that provide information across multiple disciplines, thus allowing the evaluation of gene-environment interactions. Datasets to study such interactions are typically large, difficult to collect, and costly. Therefore, it is important to support the development and use of datasets that can be shared among a wide audience of researchers.

Datasets that already include biological and genetic measures could be augmented to include social and behavioral variables. However, these additions must not only be feasible, but more importantly, they must be scientifically compelling. Alternatively, new datasets with the necessary variables could be developed. For example, health conditions or diseases could be identified for which there is a suspected or known genetic contribution, behavioral factors are likely to be involved, and hypotheses have been formed regarding the role of social factors.

Because there is a significant need for datasets that provide information for the three domains discussed (social, behavioral, and genetic factors), the committee recommends the following:

**Recommendation 9: Enhance Existing and Develop New Datasets.** *The NIH should support datasets that can be used by investigators to address complex levels of social, behavioral, and genetic variables and their interactive pathways (i.e., physiological). This should include the enhancement of existing datasets that already provide many, but not all, of the needed measures (e.g., the National Longitudinal Survey of Youth, ADDHealth) and the encouragement of their use. Furthermore, NIH should develop new*
datasets that address specific topics that have high potential for showing genetic contribution, social variability, and behavioral contributions—topics such as obesity, diabetes, and smoking. (Chapter 9)

The report *Facilitating Interdisciplinary Research* (NAS/NAE/IOM, 2004) outlined several key conditions for effective interdisciplinary research, including “sustained and intense communication, talented leadership, appropriate reward and incentive mechanisms (including career and financial rewards), adequate time, seed funding for initial exploration, and willingness to support risky research.” The committee believes that these same conditions apply to transdisciplinary research. Although aspects of university functioning, such as rewards and incentives, are not within the purview of NIH, they may ultimately affect the ability of NIH to find researchers who can conduct the kind of transdisciplinary research that is envisioned here.

One major challenge is acknowledging multiple investigators on team projects. The recent NIH announcement of plans to recognize multiple Principal Investigators represents a significant advancement in providing external recognition for members of research teams. As NIH explores such new approaches, the next step would be for universities to use that information in ways that would ensure that the impact of the incentives and rewards are felt at the campus level, such as the credit toward promotion and tenure that accrues to those who participate in such projects.

Scientific peer review of research applications also is a key step involved in the support of any area of research. It is not uncommon to hear investigators lament that transdisciplinary projects have difficulty in undergoing the peer review process. An important goal, therefore, is to ensure that transdisciplinary work is fairly reviewed and truly valued throughout the review process. It is not enough to simply place people from different disciplines on a review group. Specific steps need to be taken to ensure that reviewers will be able to appreciate the transdisciplinary nature or goals of a proposal. These steps include selecting reviewers who have engaged in transdisciplinary work and training reviewers about its importance and the differences between transdisciplinary research and other types of research.

Approaches to advance the field of transdisciplinary research need to be systematically applied toward the goal of fostering a type of research that has inherent scientific challenges and that faces specific institutional hurdles. Therefore, the committee makes the following recommendation:

**Recommendation 10: Create Incentives to Foster Transdisciplinary Research.** *The NIH and universities should explore ways to create incentives for the kinds of team science needed to support transdisciplinary research. Areas to address include (1) hiring, promotion, and tenure policies that acknowledge the contributions of*
collaborators on transdisciplinary teams; (2) peer review that includes reviewers who have experience with inter- or transdisciplinary research and are educated about the complexity and challenges involved in such research; (3) mechanisms for peer review of research grants that ensure the appropriate evaluation of transdisciplinary research projects; and (4) credit for collaborators in teams, such as NIH acknowledgement of co-investigators and university sharing of incentive funds. (Chapter 9)

Ethical, Legal, and Social Implications

Several important ethical and legal issues need to be addressed when considering information produced by research assessing the impact on health of interactions among social, behavioral, and genetic factors. Although these issues apply to all types of research, they are especially sensitive when considering the transdisciplinary research discussed in this report. First is the issue of conveying complex scientific findings accurately to the public, policymakers, and other researchers. Claims about scientific findings are at times simplified and even exaggerated, sometimes because of the complexity of the concepts or because of economic and social pressures to emphasize the significance of findings in easily understandable terms. These difficulties are compounded by the fact that the media, understandably, prefers straightforward, easy-to-deliver messages. However, failure to convey the limitations and complexity of scientific findings has a significant impact, because beliefs about causation of health and disease affect the allocation of responsibility and resources, which has ethical and social implications.

Another issue of concern is the development of policy based on scientific findings. The array of factors that must be considered in deciding how to use the knowledge gained from research on gene-environment interactions in developing social policy is very broad and extends far beyond the science itself and into a variety of social and ethical considerations. To address difficulties in how individuals and groups understand complex scientific findings, as well as the potential impact such findings could have on policy development, the committee makes the following recommendations:

Recommendation 11: Communicate with Policymakers and the Public. Researchers should (1) be mindful of public and policymakers’ concerns, (2) develop mechanisms to involve and inform these constituencies, (3) avoid overstating their scientific findings, and (4) give careful consideration to the appropriate level of community involvement and the level of community oversight needed for such studies. (Chapter 10)
In addition to research assessing the impact on health of interactions among social, behavioral, and genetic factors and their interactive pathways (i.e., physiological), improving health also requires individuals to act upon research findings. Therefore, the committee recommends the following:

**Recommendation 12: Expand the Research Focus.** The NIH should develop RFAs for research that elucidate how best to encourage people to engage in health-promoting behaviors that are informed by a greater understanding of these interactions, how best to effectively communicate research results to the public and other stakeholders, and how best to inform research participants about the nature of the investigation (gene-environment interactions) and the uses of data following the study. (Chapter 10)

According to the Criteria for IRB Approval of Research (45 CFR § 46.111(a)(7) (2006)), Institutional Review Boards (IRBs) are responsible for ensuring, where appropriate, the protection of research participants’ privacy and the data regarding them. Studying the impact of interactions among social, behavioral, and genetic factors on health requires the collection of information about relevant DNA variants as well as clinical or other phenotypic information. This often includes sensitive personal behavior information and social factors. The risk to research participants could be substantial if such information is accessed by people and institutions outside the study. Given the sensitivity of such research and its implications, it is of primary importance to address the issues of data sharing and informed consent. Therefore, the committee makes the following recommendations:

**Recommendation 13: Establish Data-Sharing Policies That Ensure Privacy.** IRBs and investigators should establish policies regarding the collection, sharing, and use of data that include information about (1) whether and to what extent data will be shared; (2) the level of security to be provided by all members of the research team as well as the research and administrative process; (3) the use of state-of-the-art security for collected data, including, but not limited to, NIH’s Certificates of Confidentiality; (4) the use of formal criteria for identifying the circumstances under which individual research results will be revealed; and (5) how, before sharing data with others, recipients must agree to use data only in ways that are consistent with those agreed to by the research participants. Furthermore, if a mechanism to identify individual research participants is retained in the database, IRBs and investigators should consider whether to contact participants prior to initiating research on new hypotheses or other new research. (Chapter 10)
Recommendation 14: Improve the Informed Consent Process. Researchers should ensure that informed consent includes the following: (1) descriptions of the individual and social risks and benefits of the research; (2) the identification of which individual results participants will and will not receive; (3) the definition of the procedural protections that will be provided, including access policies and scientific and lay oversight; and (4) specific security, privacy, and confidentiality protections for protect the data and samples of research participants. (Chapter 10)

CONCLUDING REMARKS

This report is intended to encourage and facilitate the growth of transdisciplinary research on the impact on health of interactions among social, behavioral, and genetic factors. Such research could further understanding of disease risk and aid in the development of effective interventions to improve the health of individuals and populations. Yet, achieving such understanding is not a short-term effort. Immediate priorities for action include training investigators in transdisciplinary research, expanding and developing datasets that include social, behavioral, and genetic variables (measured over the life course), developing new research strategies, and attending to the important ethical, legal, and social implications of such research. Such steps will facilitate the conduct of hypothesis-generating research to identify high-priority areas for study, which will then lead to targeted studies of interactions focused on specific health outcomes.

Health outcomes are multidetermined and result from complex interactions of many factors over time. Yet, the study of health outcomes has been driven primarily by disciplines that focus upon their own unique areas of expertise. If the study of health outcomes is to advance, investigators must break out of these disciplinary “silos” and attack the determinants of health in concert.

REFERENCES


“Knowing is not enough; we must apply. Willing is not enough; we must do.”

—Goethe
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This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Jane E. Sisk, Centers for Disease Control and Prevention and Elena O. Nightingale, Institute of Medicine. Appointed by the National Research Council and Institute of Medicine, they were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.
Preface

Developing this report about facilitating integrated research on how the social environment and genetic function affect health outcomes has been tremendously rewarding, in large part because the effort was a collaboration among scientists from the social, behavioral, and biological sciences. Committee research and discussion illuminated associations among social factors and health, behaviors and health, and genetics and health. Committee collaboration resulted in a vision, described in this report, of how future research, transdisciplinary in nature, can contribute to the science of gene-social environment interactions and to explaining individual and population health and health disparities.

Yet, transdisciplinary research faces many challenges, not the least of which are those encountered when attempting to conduct collaborative research across disciplines. In a sense, the challenge of collaboration was illustrated in the work of this committee, whose scientists came from the fields of sociology, demography, psychology, psychiatry, research design, law, ethics, medicine, public health, epidemiology, biology, molecular virology, and genetics. Despite the fact that each committee member already had demonstrated a willingness to work with those from other disciplines on problems that crossed social, behavioral, and genetic lines, committee understanding and collaboration were not achieved effortlessly. Research conducted by different disciplines rests on different knowledge bases, often with different areas of focus—for example, the geneticist emphasizes individuals, while sociologists examine groups and societies. To form a group that could work collaboratively, it was necessary to devote meeting time to
developing a common understanding of each others’ definitions, terms, knowledge about what various disciplines have contributed to our understanding of disease risk, and an appreciation and value for the research designs and methods used by practitioners of the different disciplines. It was only after this had been accomplished that rapid progress could be made in developing an integrated approach to the task at hand—that of determining how researchers can begin to assess the impact on health of interactions among social, behavioral, and genetic factors.

In transdisciplinary research, investigators will be faced, on a broader scale, with the challenges that confronted this committee. Foremost among these challenges is the need to appreciate and value the contributions of other disciplines. Other challenges and approaches to addressing them are described in the body of the report, but the committee believes that the challenge of fostering true collaboration merited the emphasis that is provided in this preface. Successful transdisciplinary research that is conducted on gene-social environment interaction could provide a way for us to redefine how we think about health and disease. Such a redefinition, however, is not a short trip going forward with a specific goal in mind; rather, it is a journey that will require time and patience. This report and its recommendations are intended to launch us on that journey.

Dan G. Blazer, Chair
Committee on Assessing Interactions Among Social, Behavioral, and Genetic Factors in Health
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