

## The 2021 National Eye Institute Strategic Plan: Driving Innovation in Eye and Vision Research

The National Eye Institute (NEI) has been a world leader in directing and funding eye and vision research since 1968, when Congress and President Lyndon Johnson established it as an independent entity within the National Institutes of Health (NIH) to manage national efforts in vision science.<sup>1</sup> The current annual NEI budget is \$835 million. Now in 2021, the NEI is releasing a new Strategic Plan, which outlines our directions and priorities over the next 5 years and is the first NEI Strategic Plan since 2012.<sup>2</sup>

Why do we need a new NEI Strategic Plan? As unprecedented advances in science and computing have occurred during the past several decades, we are rapidly moving into an era where knowledge discovery is no longer limited by technology, but only by creativity. Modalities such as genetics, molecular diagnostics, information technology, and data science are providing the vision research community with unique opportunities to improve understanding of disease mechanisms, leading to novel diagnostic and therapeutic tools. The ongoing coronavirus disease 2019 (COVID-19) pandemic has demonstrated the value of investment in research, as highly effective vaccines were developed at an extraordinary pace due to decades of scientific investigation.<sup>3</sup> At the same time, the pandemic has exposed many underlying health disparities and highlighted the importance of making scientific advances accessible to the entire population. Because of this evolving landscape in research, healthcare, technology, and public health, we found it vital to revise the NEI mission statement as part of developing the Strategic Plan (Table). This is the first revision of NEI's mission since our founding in 1968, and begins: "The mission of the National Eye Institute is to eliminate vision loss and improve quality of life through vision research." To address these opportunities and challenges, we have framed our new Strategic Plan around this mission.

One component of our mission is to drive innovative research to understand the eye and visual system, prevent and treat vision diseases, and expand opportunities for people who are blind or require vision rehabilitation. How has NEI-supported research advanced the practice of eye care? I can immediately draw on two examples from my own experience. In July 1997, at the beginning of my ophthalmology residency, I examined a baby whose parents were concerned because he was not tracking objects normally. I eventually diagnosed Leber congenital amaurosis (LCA), and needed to tell the parents the devastating news that the natural progression of the disease meant that the child would experience continued vision loss, and that there were no available medical or surgical interventions to prevent or forestall that outcome. But now, in 2021, when I hold a baby with *RPE65*-associated LCA, I can tell the family that there is a treatment available because of decades of research in genetics, disease pathophysiology, and gene therapy.<sup>4-7</sup> Similarly, in July 2001, when I began my career in pediatric ophthalmology, I cared for a premature infant who was left with lifelong vision loss from severe retinopathy of

TABLE. National Eye Institute Mission Statement (2021)

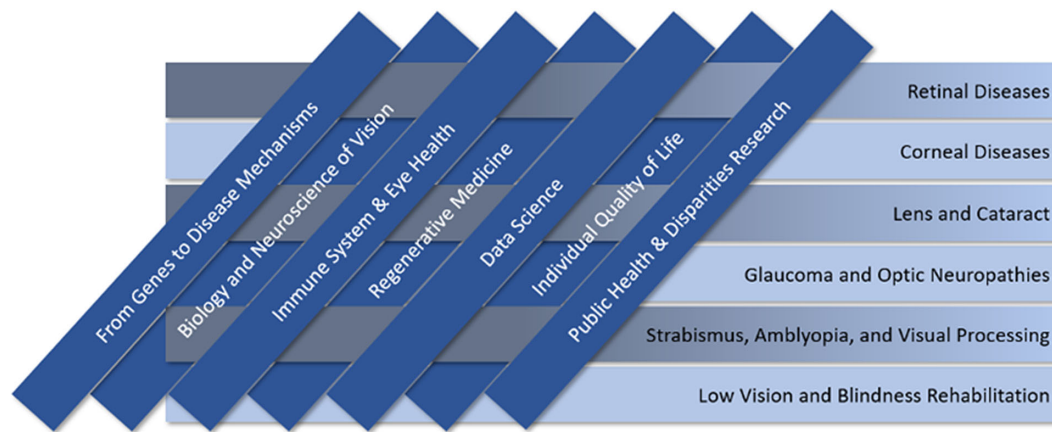
**The mission of the National Eye Institute is to eliminate vision loss and improve quality of life through vision research.** To achieve this mission, NEI provides leadership to:

- Drive innovative research to understand the eye and visual system, prevent and treat vision diseases, and expand opportunities for people who are blind or require vision rehabilitation.
- Foster collaboration in vision research and clinical care to develop new ideas and share knowledge across other fields.
- Recruit, inspire, and train a talented and diverse new generation of individuals to expand and strengthen the vision workforce.
- Educate health care providers, scientists, policymakers, and the public about advances in vision research and their impact on health and quality of life.

This was developed in collaboration with internal and external stakeholders.

prematurity (ROP). As a clinician, it was extremely difficult knowing that there were limits to what I could do to help infants with a blinding disease. Now, with the benefit of 20 years of research in ROP, we can treat severe disease more effectively using laser and pharmacological therapies; we can use telehealth to provide expertise to hospitals without an ophthalmologist on hand; we can realize the promise of more accurate diagnosis using artificial intelligence; and we have more effective vision rehabilitation technologies than ever before.<sup>8-14</sup>

Why is this important for the NEI Strategic Plan? These examples speak to the impact of sustained public investment in research and innovation, in which the government commits to long-term exploration that eventually leads to interventions that prevent or eliminate vision loss. From an academic perspective, research in the eye and visual system is important because it can have enormous, broader impact. At the National Eye Institute, we are proud to have supported the work of eight Nobel Prize winners, beginning with the foundational brain development studies of Hubel and Wiesel. Many other seminal innovations have occurred first in the visual system because it is an accessible setting for conducting research which can then be generalized to other domains. For example, the vision field has been at the leading edge of the revolution in artificial intelligence for medicine because of the ease of capturing ocular data, such as retinal images, and quantitative clinical outcome measures, such as visual acuity and imaging metrics.<sup>15-17</sup> As a result, the first US Food and Drug Administration (FDA)-approved autonomous artificial intelligence system was created for detecting diabetic retinopathy.<sup>18</sup> Innovative work in regenerative medicine has occurred in the visual system for similar reasons, including the feasibility of targeted surgical intervention. The first FDA-approved gene therapy for an inherited disease targeted a retinal degeneration,<sup>7</sup> and was the culmination of decades of research that began with identification of mutations in the *RPE65* gene.<sup>4-6</sup>



**FIGURE.** Seven cross-cutting areas of emphasis (vertical bars) in National Eye Institute Strategic Plan. These do not replace the existing core program structure (horizontal bars) but, rather, highlight evolving areas that will require interdisciplinary approaches.

Having creative thinkers in research and clinical practice is essential to our future. Thus, another component of our mission is to recruit the most talented and diverse workforce into the vision field to help drive innovation. Young investigators have many potential career paths, and can be motivated by work that has broad scientific significance. As a beginning medical student, I was interested in computational neuroscience and considered becoming a neurosurgeon. Then I spent several years working in a neurosurgery research laboratory that studied the rabbit retina,<sup>19</sup> discovered how much innovative work in neural information processing was being done in the visual system,<sup>20</sup> and decided to become an ophthalmologist. Many other young people will enter this field if we can communicate the opportunities available. With regard to a broader message to the larger community, we need to inspire the public and policymakers to understand the value of vision research and vision health, in order to support and amplify research that results from the NEI Strategic Plan. One of the first steps in communicating this message to the larger community is for our community to embrace it fully.

How does this Strategic Plan aim to promote collaboration across fields? NEI's core research program areas are currently organized by anatomy and disease: retina; cornea; lens and cataract; glaucoma and optic neuropathy; strabismus, amblyopia, and visual processing; and vision rehabilitation (Fig.).<sup>21</sup> These NEI core areas coincide with clinical divisions of most ophthalmology and optometry departments. In developing the new Strategic Plan, we hope to enhance these core research programs by layering on methodological expertise with the goals of addressing challenges across the entire visual system and facilitating translation of promising findings into clinical care and population health. To accomplish this, we have organized the plan around seven cross-cutting areas of emphasis: genetics, neuroscience, immunology, regenerative medicine, data science, quality of life, and public health and health disparities. These seven areas are tracks of study that resemble the structure of most university basic science programs. By identifying these areas of emphasis, we aim to highlight important perspectives and expertise that complement the existing core portfolio at NEI. Rather than replacing the existing core programs, they will underscore areas where interdisciplinary approaches can link mechanistic science with clinical applications (see Fig.).

The NEI Strategic Plan aims to leverage the enormous potential to drive generalizable innovation beginning with basic science. We have opportunities to build infrastructure for mechanistic genetic research by curating databases to link disparate genetic, -omics, imaging, clinical, epigenetic, and social determinants of health data, by establishing standard data representation models for the community, and by leading the biomedical field into a culture of data sharing.<sup>22,23</sup> Synergies may occur by integrating findings from systems neurobiology and behavior into models of perception, or from combining insights from non-human primates and other animal models. Improved models for chronic immune-mediated disease will permit study of positive and negative regulatory responses, and new model systems for studying the impact of immunosenescence on disease may produce ocular as well as broader discoveries. Innovations in ocular imaging and cell-based therapy will stimulate foundational studies involving transplant survival, tissue integration, immunosuppression strategies, and visual function outcomes that will also support other fields, such as gene therapy, cellular reprogramming, and gene editing.<sup>24</sup> Advances in artificial intelligence and machine learning are creating the potential for finding complex, latent relationships in large-scale datasets. The vision field offers enormous opportunities for methodological innovation in development of algorithms that integrate multiple data types – from biological to imaging to clinical to social and population-based.

Our NEI Strategic Plan aspires to support curiosity-driven science, while encouraging collaboration to facilitate translation of findings. A series of parallel editorials discusses other aspects of the NEI Strategic Plan.<sup>25–28</sup> We hope every researcher, clinician, and stakeholder group member will review this Strategic Plan,<sup>2</sup> recognize and advocate for the generalizable significance of vision research, and consider how they can contribute to the innovations that will eventually help eliminate vision loss and improve quality of life.

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