LIEBER INSTITUTE *for*
BRAIN DEVELOPMENT
MALTZ RESEARCH LABORATORIES

ON THE ROAD TO PREVENTION:

A DECADE OF DISCOVERY

Ten-Year Anniversary Report

RECOLLECTIONS FOR THE FUTURE

Dear Friends,

Ten years ago, *Nature* magazine did a full-page news piece on the opening of the Lieber Institute for Brain Development (LIBD). The word was out that something dramatic was about to happen in scientific research about the brain and behavior. What happened was the launch of the first and still the only medical research institution devoted specifically to understanding how genes and the environment build human brains from early in life that travel along a developmental trajectory leading to schizophrenia and related disorders. The institutional model and culture, inspired by the vision of two philanthropic families with a personal stake in the outcome, were and still are unique among academic research institutions.

The Lieber Institute for Brain Development was established as a 501c3 medical research organization with a distinct vision: to create a unique institutional environment where scientists from diverse disciplines could work together as a committed intramural faculty with explicit milestones and shared goals, unencumbered by many of the financial pressures of typical academic life to achieve progress that had eluded more traditional academic and private industry research models. Key to rounding out the vision was the establishment of a hybrid research enterprise with facets of both academia and biotech. The mission was similarly clear-cut: exploit recent advances and discoveries in genetics and developmental biology to understand the developmental origins of schizophrenia and related neuropsychiatric disorders, and to use the results of this effort to improve the lives of affected individuals.

“The concept of the LIBD was the brainchild of Connie and Steve Lieber, principal supporters of research in brain and behavior for over 30 years.”

We began a series of conversations in late 2005, followed by a series of meetings with leading scientists and university executives. In Steve Lieber’s words, “We were looking for a new direction in our philanthropy.” As we finalized a plan to go forward in 2010, Connie put her seal on the project: “This is our dream, to get to the bottom of what causes these illnesses and it is going to take a focused, concerted effort…and this is what this institute is all about.” Steve and Connie asked Milton and Tamar Maltz to join as founders and establish the Maltz Research Laboratories (MRL) because they shared the vision and commitment. As I look back on these past 10 years of research operations, I recall telling Connie and Steve that we wouldn’t cure schizophrenia in ten years, but we would change the field. And I'm proud to say, we’ve done that and much more.

Today, the LIBD/MRL is a bricks-and-mortar institution with a diverse and talented scientific faculty and support staff of more than 125 people in 50,000 square feet of state-of-the-art research space on a major academic medical campus

affiliated with a major academic institution—the Johns Hopkins University School of Medicine. To date, investigators at LIBD/MRL have published over 300 scientific manuscripts, with 30 appearing in top tier journals such as Nature and Science. LIBD scientists have collaborated with investigators across the USA and in six other countries, and been awarded NIH and foundation grants and industry contracts totaling well over $100M. The term “leverage” is an understatement in describing returns made possible by the original philanthropic investments.

The LIBD/MRL has created unparalleled resources in human brain tissue and living human cell lines that represent invaluable investments in mission critical biological material and in leveraged assets for ongoing and future partnerships. LIBD/MRL scientists have generated the most extensive data about how genes are represented in the human brain, across the lifespan and in illness, including in schizophrenia, bipolar disorder, depression, PTSD, and suicide. These discoveries represent critical branch points for the development of novel therapeutic interventions, but the Lieber Institute’s accomplishments don't stop there:

- In less than 10 years, the drug development program has already licensed three drugs for clinical development: one for autism, one a non-opiate pain treatment, and another for cognitive impairment in a broad spectrum of brain disorders, with others in the pipeline.

- LIBD/MRL scientists have discovered a dramatic area of biology and medicine related to brain development and genetic risk for schizophrenia involving the health of the human placenta. This is a new frontier in the study of child development and developmental behavioral disorders with prevention potential.

- LIBD/MRL scientists launched a landmark partnership with a leader of the African American faith-based community in Baltimore and with Morgan State University to bring personalized medicine related to brain disorders to the African American community. The African Ancestry Neuroscience Initiative, which is based on donations for research of over 500 brains from African American families, has been recognized by Governor Hogan of Maryland for a special budget allocation and has received additional support from Brown Financial Management of Baltimore and the Abell Foundation.

I could go on and on, as this is only a brief, selective mention of some of what has happened since the Nature piece sounded the trumpet. This report will delve further into the excitement—not just the scientific breakthroughs, but the fantastic people who have made it happen.

The first decade of LIBD/MRL has been, in many respects, a pilot project to instantiate the vision of the founders that a new approach to researching developmental disorders would advance the field beyond what was thought possible and find new therapies. The Lieber-Maltz pilot project has evolved into a first-in-class scientific enterprise.

My suggestion to Connie and Steve 10 years ago that we would not cure schizophrenia no longer applies to the horizon we now face. With your continued support, we will revolutionize how we prevent and treat human brain disorders.

Sincerely,
Daniel R. Weinberger, M.D.
Director and CEO, Lieber Institute for Brain Development
Maltz Research Laboratories

WORDS OF REMEMBRANCE

by **Daniel R. Weinberger, M.D.**

Director and CEO,
Lieber Institute for Brain Development
Maltz Research Laboratories

The past 10 years have been a period of remarkable achievement for the Lieber Institute for Brain Development and for the Maltz Research Laboratories, but it also has been a time of deep sadness with the untimely loss of three Lieber family founders: Connie, Sam and Steve. Connie in 2016, Sam in 2019, and we lost Steve to COVID-19 in March 2020.

The Lieber family epitomized selflessness, commitment, humility, and unparalleled generosity. Connie and Steve were the principal philanthropists supporting research about mental illness for over 30 years. They pioneered a new course in neuroscience research and made their philanthropy a driving force in scientific progress. Their dedication to discover the causes and, ultimately, the cure for conditions like schizophrenia ignited the transformative power of their philanthropy.

The Liebers knew that research was the royal road to opening a new chapter in understanding mental illness. They knew that research was the best way to reduce stigma, and that knowledge and scientific information were the anecdotes to fear and myth. They committed themselves and their resources to improving the lives of others. And they also knew that mental illness research needed a booster shot.

That booster materialized at a meeting in the American Airlines lounge at LaGuardia Airport 15 years ago. There, we hatched the concept of establishing a new research institute, unique in having a focused mission and an intramural faculty devoted to achieving that mission. While the rest is history, the current state of the institute would not have been possible without their steady and informed advice and counsel.

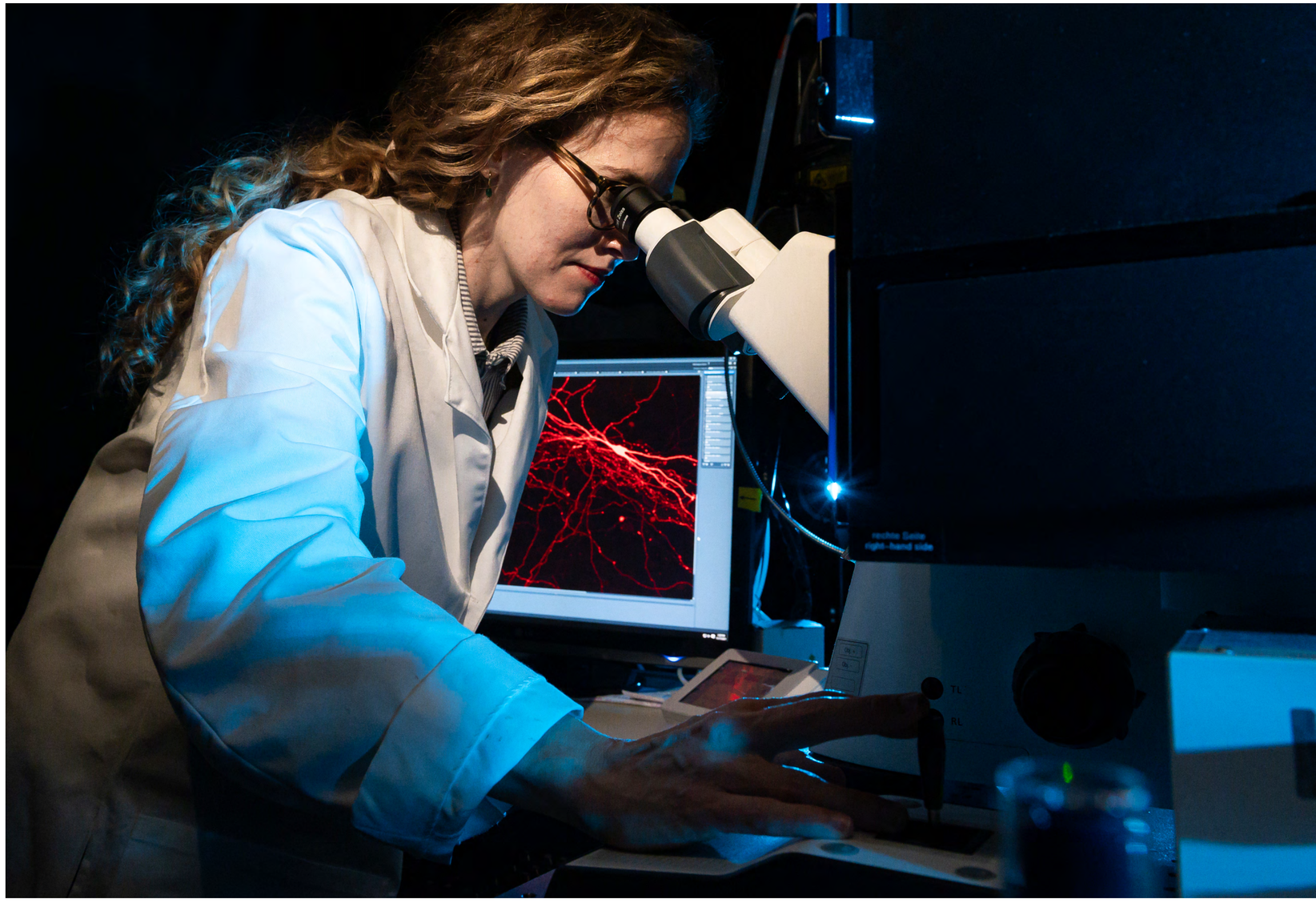
Not a week went by that I was not engaged with the Liebers in a substantive discussion of science, public policy with regard to psychiatric illness, new directions in research, and overall Institute progress. Connie and Steve's passion was to "get to the bottom of what causes schizophrenia" and related developmental brain disorders. They walked the walk every day in pursuit of this goal.

Connie, Steve and Sam are the DNA of this Institute. They will always be in our hearts and in our minds. In honor of their passion, aspirations, and dedication to this research effort, the faculty and staff of the Lieber institute for Brain Development rededicate our efforts to achieve the mission they empowered us to pursue.

A DECADE OF DISCOVERY

For 10 years, the Lieber Institute has focused intensively on finding the root causes of developmental brain disorders such as schizophrenia, bipolar disorder, depression, and suicide. Our work, however, is far from over. The science of genomics and brain development has cleared the way for entirely new approaches to predicting, preventing, and treating mental illness.

One in five people will experience a major mental health issue in any given year–it's a pervasive problem and the leading cause of disability worldwide.



The discoveries of Lieber Institute scientists in our first ten years have chipped away at the critical questions of what causes mental illness and how we can prevent and treat it. In our next decade and beyond, the Lieber Institute will build upon those discoveries to dig even deeper into the workings of the human brain. Our science will provide relief for patients and their families who struggle with developmental brain disorders.

LIBD

OUR MISSION

We relentlessly push the scientific frontier to discover ways to treat, cure, and ultimately, prevent neuropsychiatric disorders.

What We Do

The Lieber Institute for Brain Development is the only research institution in the world focused specifically on understanding how genes and the environment influence human brain development in ways that lead to schizophrenia and other related developmental brain disorders.

Who We Are

We are a group of multidisciplinary and optimistic researchers, working at the cutting edge of science, utilizing state-of-the-art tools to unlock the mystery of the brain and transform the way we approach the development of new treatments, and ultimately cures.

Why Us?

With more than 3,700 human brains donated and over 1,600 human cell lines, we have assembled the largest, most carefully curated and characterized biological resource for the study of neuropsychiatric disorders in the world. These critical resources are providing insights into the biological causes of these disorders, the first step in prevention.

Institute Accomplishments

3700+
Brains Collected

4
New drugs out-licensed for further development

126
Team Members

$235M
Invested to date

>$100M
In grants & contracts to date

2
New federal laws enacted

70+
Collaborations

300+
Total publications

BUILDING ONE OF THE MOST EXTENSIVE BRAIN REPOSITORIES IN THE WORLD

With 3,700+ human brains collected, the Lieber Institute has assembled the largest, most carefully curated and characterized collection of human postmortem brains in the world for the study of neuropsychiatric disorders.

COLLECTION PROCESS

Our team collects brain tissue donations from four medical examiner sites and one organ donation program around the country. Working with the examiner's staff, we identify potential cases for donation and contact the next of kin to obtain informed consent.

After an intensive informed consent process, we obtain a detailed clinical history via interviews with the family. We then collect extensive medical records that are thoroughly reviewed by a team of clinical experts. The selection of brains for a given scientific project involves a series of procedures to maximize the likelihood of discovering the role of illness-associated genes in the brain.

“At the Lieber Institute, we have the largest and most carefully curated brain collection in the world dedicated to finding the causes of neuropsychiatric diseases.

The need for effective therapeutics for neuropsychiatric disease has never been greater. Studying the human brain offers hope for therapeutics in the domains of neurology, neurosurgery, and psychiatry.

Having a standardized collection protocol directly supervised out of our central laboratory allows us to collect a large number of useful donations every year, minimizing the variability that comes from collections without a central standardized protocol.

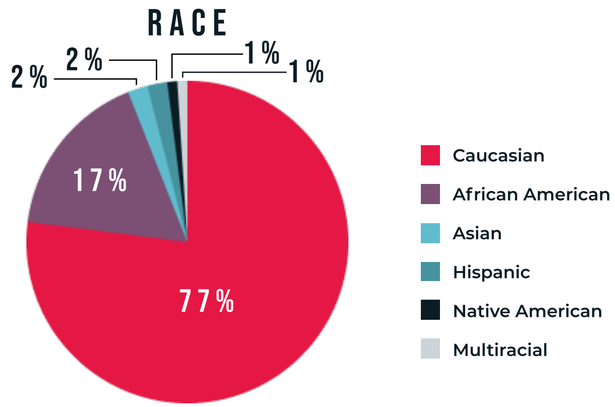
We plan to continue to grow our brain collection, drawing in donations that reflect the growing diversity of genetic ancestry in the nation. We hope to encompass increasing numbers of subjects with sub-Saharan African, East Asian, South Asian, and Native American ancestries to better understand neuropsychiatric illnesses.

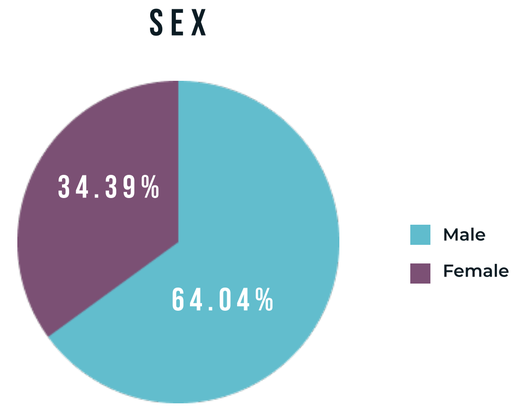
We want to advance personalized medicine for everyone, no matter where your family originally came from around the world.”

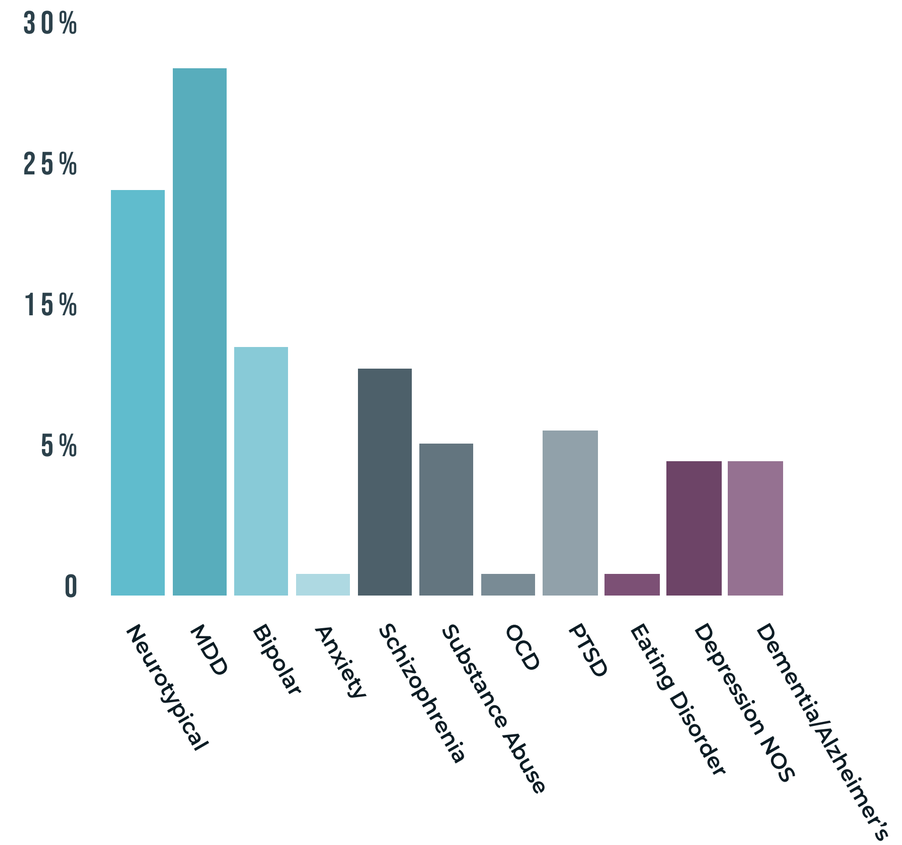
Dr. Thomas Hyde, MD, PhD, Chief Medical Officer

The brain repository is a catalytic resource that drives discovery of the mechanisms of diseases.

Our brain repository covers lifespan, sex, and race. It allows us to conduct innovative research along all stages of life and including many brain disorders.







Drug Discovery: Translating Science into Hope

The Lieber Institute drug discovery team drives the mission of the institute to translate basic scientific discoveries into meaningful treatments. The team works closely with basic science researchers to take their findings and develop plans to identify new therapies. The group consists of chemists and pharmacologists who collaborate to make and evaluate new chemical compounds to find drug candidates. The Lieber Institute's drug discovery program has produced a robust pipeline of potential therapeutics. We have successfully developed and out-licensed four compounds for clinical development and continue to optimize the way we identify drug targets. The Institute is looking for partners and support to advance the development of our growing list of promising treatments.

In 2021, Boehringer Ingelheim and the Lieber Institute formed a joint research and licensing collaboration focused on the development of novel centrally acting COMT (catechol-O-methyltransferase) inhibitors for the potential treatment of cognitive deficits in a spectrum of neuropsychiatric disorders, including schizophrenia. COMT is a dopamine metabolizing enzyme. Dopamine signaling is critical to the cognitive and behavioral impairments seen in neuropsychiatric disorders. Lieber Institute research suggested centrally acting COMT inhibitors have potential for treating these conditions, but until now, such compounds have been unavailable for clinical testing.

CURRENT PIPELINE OVERVIEW

TARGET IDENTIFICATION	TARGET VALIDATION	LEAD ID	LEAD OPTIMIZATION	IND-ENABLING TOXICOLOGY

ONGOING PROJECTS

RNA Pol 1 (Oncology)

Dopamine D5 PAM (CIAS, FTD, TBI)

IP6K1 (Bipolar, diabetes)

KCNH2 (Cognition)

PARTNERED PROJECTS

$NA_V1.8$ (PTHS, Pain)	**Outlicensed to Biotech**
GABA-A (Autism, visceral pain)	**Outlicensed to Biotech**
COMT (Cognition)	**Outlicensed to Boehringer Ingelheim**

“The drug discovery team is uniquely placed to rapidly respond to the latest developments in psychiatry research. While neuroscience research is experiencing a slight resurgence within the pharmaceutical industry, most of this effort is focused on neurodegeneration and pain research. There is a huge need for groups like ours to discover and validate novel treatment strategies for psychiatric disorders.”

James Barrow, PhD, Director of Drug Discovery

“Our lab focuses on identifying and validating novel therapeutic strategies to address cognitive deficits in neuropsychiatric disorders. Quality of life and functional outcomes for patients are directly correlated with the severity of cognitive impairment and, unfortunately, currently available treatments do not offer significant improvement. For these reasons, I think this area of research has the potential to have a substantial impact on patients’ lives.”

Gregory Carr, PhD, Lead Investigator, Drug Discovery

Dedicating A Lost Life to Helping Others

Stafford Nibley's parents cherish their memories of his beautiful singing voice, his acting and athletic skills, his outgoing and, by contrast, sometimes shy nature. He was sensitive and intelligent, precocious and cheerful, they recall.

After graduation from high school, when Stafford's friends were going off to college, he planned to attend Catholic University to study music in the fall of 2014. He had starred in numerous musicals in school, at community colleges near his home in Washington, DC, and at the Theater Lab in Washington, and dreamed of a career in musical theater.

Instead of preparing for college, though, Stafford and his family took a different path. They continued their long, painful journey searching for relief from the mental illnesses that tortured him. His diagnoses included depression and borderline personality disorder, as well as addictions to the drugs and alcohol he used to self-medicate.

The Nibleys tried everything. Stafford enrolled in 43 rehabilitation and mental health programs in the last 10 years of his life. He was hospitalized 20 times for self-harm incidents. His family did everything they could to save him.

Still, in May 2021, the Nibleys lost their Stafford. He died at the age of 25, suffering from an overdose and, as the family noted in their long and loving obituary for their youngest son, "the effects of a lifetime of mental illness." The death was characterized a suicide, though it is impossible to know Stafford's intentions.

In the haze of their grief, Stafford's family got a call from Dr. Thomas Hyde, Chief Medical Officer of the Lieber Institute. He described a research program dedicated to finding the genetic mechanisms that make people like Stafford vulnerable to mental illness, addiction, and death at such a young age. In their research, Lieber scientists use cells collected from the brains of deceased people who had been diagnosed with certain mental illnesses in life. Dr. Hyde asked if the family would be willing to donate Stafford's brain to the Lieber Institute.

"There wasn't a second that we hesitated," Stafford's father, Stuart, recalls. "Of course, we wanted to do that! Maybe his struggle and his life were not futile. Maybe he can begin to help advance the understanding of the brain. It gives us a sense of purpose."

Lieber Institute scientists are seeking the "why" to explain how patients like Stafford, who have accessed and exhausted all available resources and treatments, can still have tragic outcomes. If scientists understand the genetic mechanisms that make people prone to mental illness, as well as the environmental triggers that turn on those genes, they could create effective treatments that target those mechanisms.

"We've realized the current state of medical and psychiatric treatment is just not at a point where it could help Stafford," says Stuart. "That's the point of the Lieber Institute's research."

In the wake of Stafford's death, his family and vast network of friends and loved ones have donated in record numbers to the Lieber Institute in his name. His parents vow to do whatever they can to help advance the science that might save others like him.

"God gave Stafford to me for 25 years," his mother says, as her eyes fill with tears. "He was such a gift. I never gave up on him."

An Amazing Spirit

Priscilla Agnew-Hines will never forget her son's beautiful eyes. It was those eyes she thought of when hospital staff approached her to donate his organs when he passed in March of 2020. His beautiful eyes could live on, giving sight to someone else.

She also agreed to donate his brain to the Lieber Institute for Brain Development. Her donation became part of the largest collection of donated brains of African ancestry in the world. Lieber scientists are gathering genomic data from the collection to correct a major disparity in brain science—81 percent of the large-scale genomic datasets that scientists have used to study the human genome come from people of European descent, though this group makes up less than 16 percent of the world population.

Larry Agnew was 41 years old when he died with a deadly mix of substances in his blood. He was a kind man, devoted to his church. He had a loving family. Larry played elite football in high school, was a member of his church band, and taught drums. He began playing drums at the age of three—his grandfather led a family singing group and little Larry traveled and performed with them. "My son was a light," Priscilla says. He never met a stranger.

As a child, on a hot summer day, he would bring home neighborhood children his mother had never met to share his precious cache of popsicles, she recalls.

As an adult, Larry struggled with substance use. He had experienced childhood trauma and was a victim of gun violence as an adult when he was shot in the leg at the age of 39. His life began to take a different track in his junior year of high school, his mother remembers. He had to repeat 11th grade and lost an exciting opportunity to play football in Hawaii, his mother recalls.

"Life shifted for him," Priscilla says. She knew he was drinking and using drugs. Over the years, she reached out to him, tried to ask what was wrong, and how she could help.

"When you see a person spiraling down, you try to connect with them, try to find a reason why," she says. "No matter what you do as a parent to try and support that individual, there has to be something that triggers them to want to change."

Larry wasn't able to beat his demons. His mother cherishes her memories of him: his beautiful eyes, how grateful she felt that he was able to walk her down the aisle at her wedding before he passed. She also wonders what is different about Larry and other people who struggle with substance use.

"There are so many of our young people here who are addicted to drugs," says Priscilla, who has studied to become a substance use recovery coach since Larry's passing. "What can I do to discover what causes them to lean on drugs? What's the triggering point that causes addiction? Is it mental illness or an underlying issue of genetics?"

Her friends and family were surprised when she announced, at his funeral, that she had donated his organs, including his brain, which would help advance neuroscience.

"If you look at the statistics, with African Americans, we don't have enough participation in studies to possibly fully understand" what drives certain people to addiction or to suffer from post-traumatic stress disorder, Priscilla says. "So how can you evaluate what is the common denominator? I hope we can help them locate some of those genes. I want to do whatever I can to discover what causes people to lean on drugs."

IN RECOGNITION OF OUR DONOR FAMILIES

The Board of Directors, staff, and faculty of the Lieber Institute for Brain Development want to extend our deepest gratitude for your selfless gift to the Lieber Institute.

We know that psychiatric illnesses can have devastating effects on patients, their families, and friends. The costs of mental illness, both emotional and economic, ripple through communities. Diagnosis and treatment of these disorders are simply not good enough. In fact, psychiatric conditions rank among the most disabling diseases worldwide, according to the World Health Organization.

At the Lieber Institute we are working to change that. We are the only institution in the world focused exclusively on understanding the neurodevelopmental origins of psychiatric disorders and translating these discoveries into improved treatments that change the lives of affected individuals—and our community as a whole.

By donating your loved one's brain to scientific research, you have given a gift that will ultimately help many people who struggle daily with serious mental disorders. Many of our brain donor families have also organized fundraisers in the name of their lost loved ones. These monetary donations made to the Lieber Institute also help us do this important work, which we cannot do without private support.

In your time of grief and loss, you thought of others. You ensured that your loved ones would have an impact on the world long after their passing. Your gift may give hope to other families struggling with psychiatric illness. Please accept our most sincere thanks for your generosity.

OUR RESEARCH

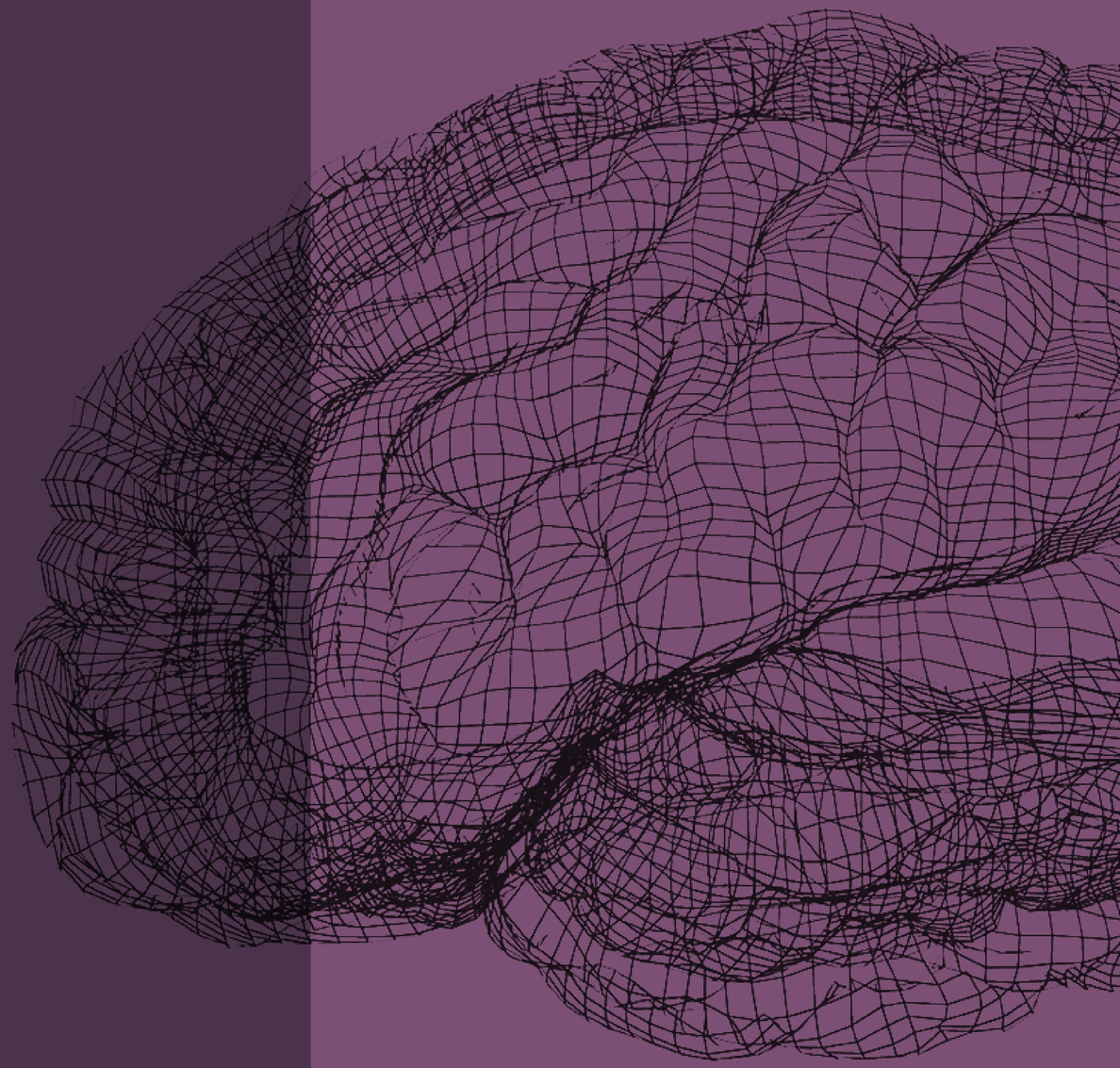
The human brain is an incredibly complex organ; so complex that scientists don't even agree on how many neurons it contains.

Studies say somewhere between 86 and 100 billion. There's so much more that's unknown about the brain, such as what exactly causes brain disorders like schizophrenia, autism, and depression. Traditional therapies for these conditions target the symptoms, not the root causes. In most cases, medications for brain disorders were discovered incidentally, and drug therapies have remained the same for decades.

The Lieber Institute asks what lies at the root of mental illness.

Something in the human genome predicts our risk of developing brain disorders, and something in the environment turns that risk into reality for people who fall ill.

Lieber researchers apply cutting-edge science to these questions, striving to uncover new treatments and diagnostic tools that can help us treat these conditions and—the holy grail of neuroscience—prevent them.



Research

SCHIZOPHRENIA

HEALTH DISPARITIES

MATERNAL & CHILD HEALTH

AUTISM

MOOD DISORDERS

ADDICTION

SUICIDE

AGING DISORDERS

PTSD

Approximately 3.5 million people are living with schizophrenia in the U.S.

Lifespan is reduced by 10–20 years

Around 80–90% of people with schizophrenia are unemployed

Less than 50% receive appropriate care

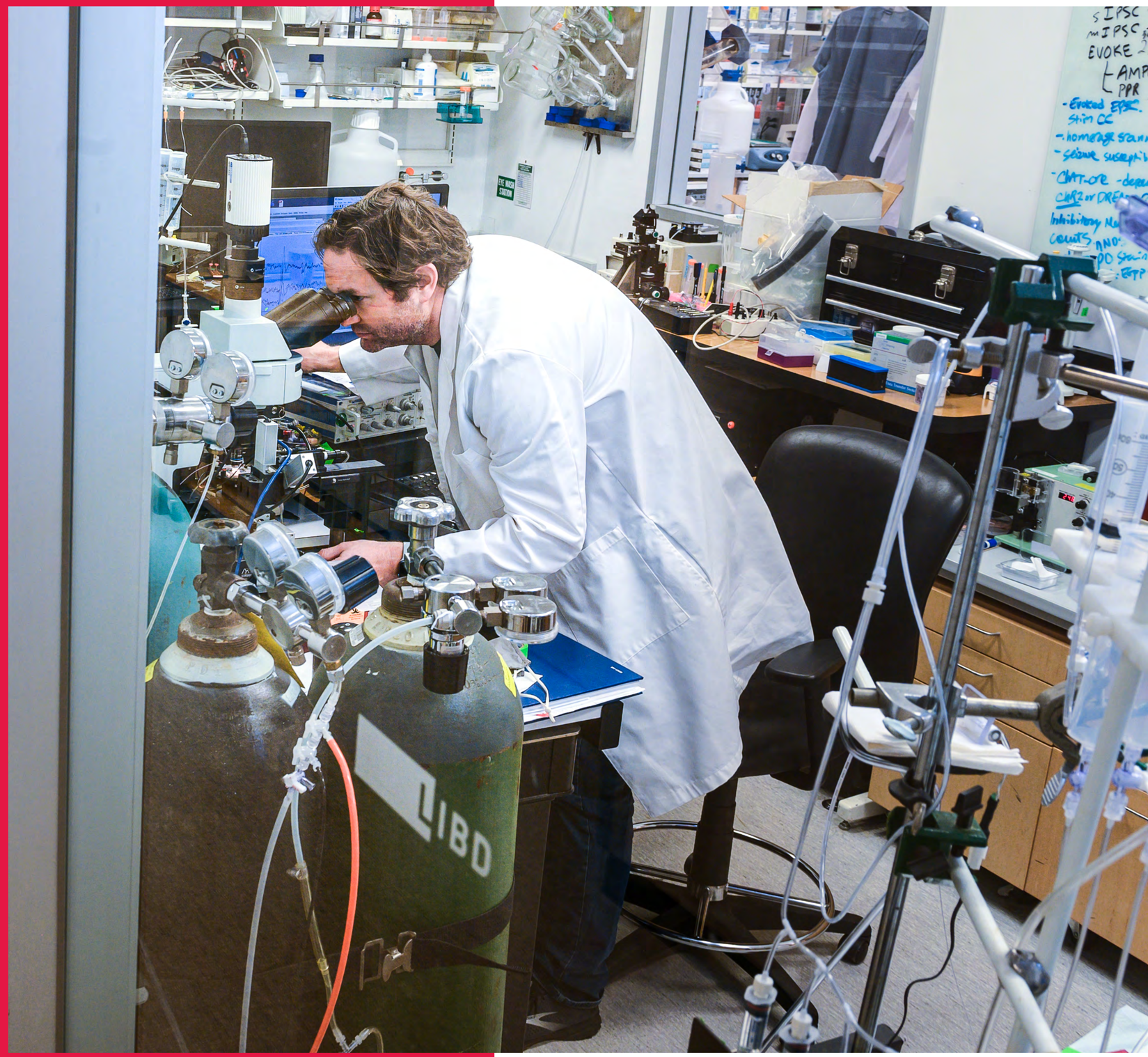
Prevention: The Holy Grail

Watching a loved one go through their first psychotic episode can be a life-altering, terrifying experience. Schizophrenia robs young people of their chance at a life of independence, leading to decades of challenges for the patient, their family, and friends.

Schizophrenia is a chronic brain disorder triggered by genetic, epigenetic, developmental, and environmental factors that interfere with brain development and function. Characterized by diverse psychopathology, schizophrenia's core features are delusions and hallucinations, impaired motivation, social withdrawal, and cognitive impairment (poor performance over a wide range of cognitive functions).

Discovering more about this disease, its genetic origins, and environmental triggers could help doctors diagnose and treat the condition. But preventing the devastating illness in the first place is the ultimate goal of schizophrenia research.

Schizophrenia's cause remains a mystery, but the Lieber Institute is researching hundreds of slight genetic differences that increase the risk for developing this brain disease and the role that early development, including placental health, plays in the later development of schizophrenia.



KEY PUBLICATIONS

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, 2022

Electrophysiological measures from human iPSC-derived neurons are associated with schizophrenia clinical status and predict individual cognitive performance

Authors: Page, S.C., Sripathy, S.R., Farinelli, F., Maher, B.J., et al.

Description: For the first time, researchers used neurons derived from human stem cells to predict the cardinal features of psychiatric illness, particularly psychosis and cognitive deficits in patients with schizophrenia.

NATURE NEUROSCIENCE, 2020

Profiling gene expression in the human dentate gyrus granule cell layer reveals insights into schizophrenia and its genetic risk.

Authors: Jaffe, A., Hoeppner, D., Saito, T. et al.

Description: Studying the gene expression in different cells of a brain region helps explain the genetic risk for schizophrenia and how the disease manifests.

NEURON, 2019

Regional Heterogeneity in Gene Expression, Regulation, and Coherence in the Frontal Cortex and Hippocampus across Development and Schizophrenia

Authors: Collado-Torres, L., Burke, E., Peterson, A., et al.

Description: New research expands on prior studies, finding that different brain regions implicated in schizophrenia have different types of biology and may require specific medical interventions.

NATURE REVIEWS NEUROSCIENCE, 2017

Genetic insights into the neurodevelopmental origins of schizophrenia.

Authors: Birnbaum, R., Weinberger, D.

Description: Studies of schizophrenia explain how the environment in early development interacts with genetic risk to lead to mental illness in adult years.

"In my lab, we model schizophrenia with stem cells derived from schizophrenia patients. We differentiate these stem cells, which contain the patient's entire genetic background, into neurons and compare them to neurons from neurotypical individuals. Noting the differences between the two groups helps us examine the biological mechanisms underlying schizophrenia."

Brady Maher, PhD, Lead Investigator

"Lieber scientists were the first group to show that many schizophrenia risk genes seem to be turned on even before birth in the developing prenatal infant. We found the genes for schizophrenia in the placenta, the organ that supports the infant and is principally derived from the fetal genome. These genes are associated with complicated pregnancies and explain the link between pregnancy complications and schizophrenia. Our research approaches placental health as a primary prevention against schizophrenia. Prevention is the holy grail of our work."

Daniel Weinberger, MD, Director and CEO

HEALTH DISPARITIES

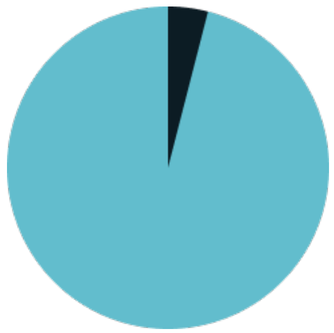
Mattlyn Young, 23, is the first Morgan State University student to work as an intern in the Lieber Institute's labs through the AANRI.

She is studying for her master's degree at Morgan State University, and during her time at the Lieber Institute, she helped analyze DNA from people with African ancestry.

Seeking a Cure for Disparities in Science and Medicine

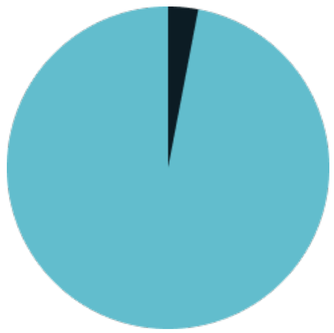
Systemic racism in the U.S. has shaped the country's health care and biomedical research systems. We see evidence in the disparities in health outcomes across racial and ethnic groups, an academic research enterprise that doesn't capitalize on the country's diverse pool of talent to develop new scientists, and a long and warranted history of mistrust between historically marginalized racial and ethnic groups and the broader biomedical ecosystem.

People of African descent are 20% more likely to experience serious mental health problems and twice as likely to develop Alzheimer's disease



Fewer than 5% of brain research participants are Black

81% of large-scale genomic datasets are of European descent, though this group makes up less than 16% of the world population



Fewer than 4% of brain researchers are Black

AFRICAN ANCESTRY NEUROSCIENCE RESEARCH INITIATIVE (AANRI)

AANRI is a collaboration formed by African American community leaders in Baltimore in partnership with the Lieber Institute and Morgan State University, a public historically black university. The AANRI is a bold effort to establish a framework that advances substantive and sustainable progress towards equity across the biomedical research landscape. The unique approach taken by the AANRI is to promote coordinated change across many domains of biomedical research, with communities of African ancestry leading the trajectory of the research agenda.

Each partner in the AANRI plays a critical and equal role focused on the following pillars:

1

Community Engagement

2

Training and development of a diverse research workforce with a focus on individuals of African ancestry

3

Public engagement in scientific research through communications and advocacy

4

Cutting-edge, high-priority scientific research relevant to the biological underpinnings of health disparities, as well as their interactions with social determinants of health

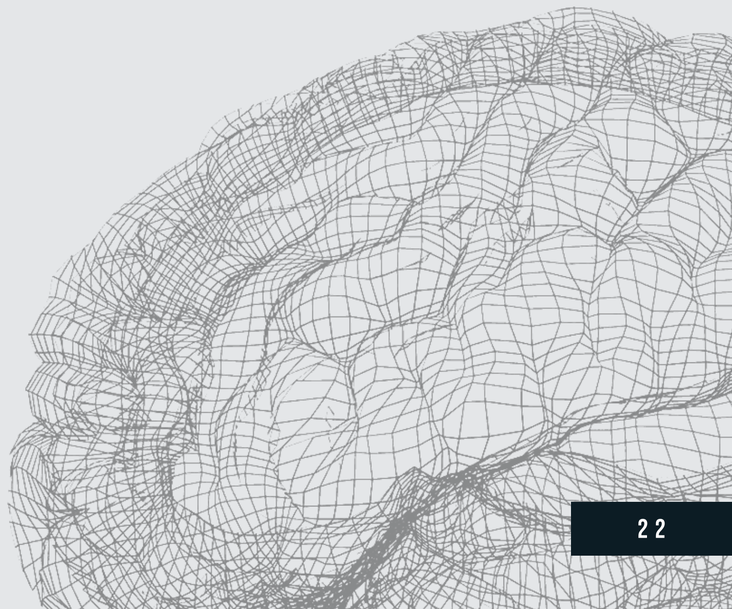
Key Publication

NEURON, 2020

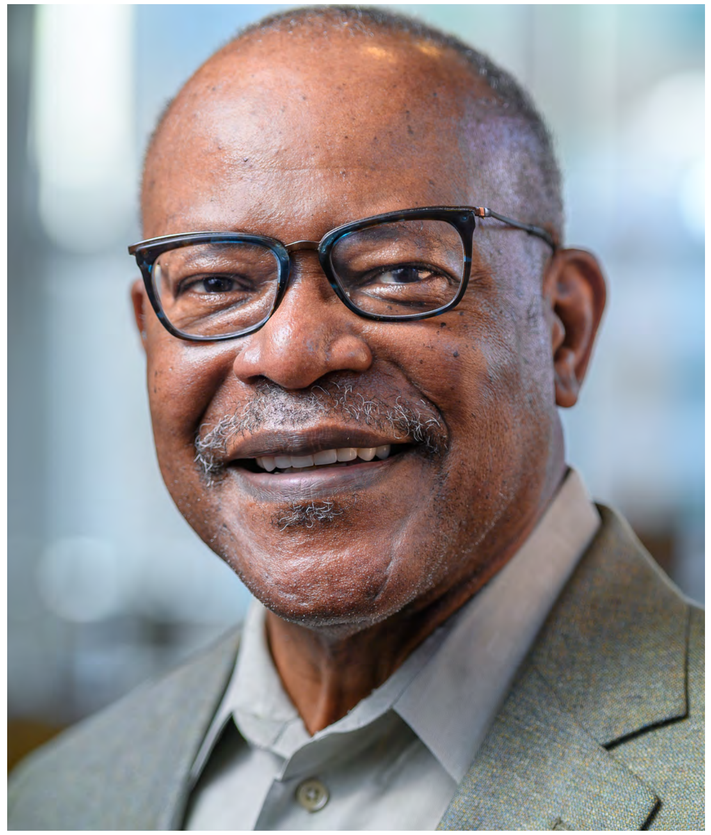
Missing in Action: African Ancestry Brain Research

Authors: Weinberger, D., Dzirasa, K., Crumpton-Young, L.

Description: The Lieber Institute is partnering with other groups to elevate the role that genetics of people of African ancestry play in psychiatric research and the search for mental illness cures.



Diversity in Science: A Second Calling



Rev. Dr. Alvin Hathaway, Sr.

Chief Executive Officer of the African Ancestry Neuroscience Research Initiative (AANRI) and former Pastor of Union Baptist Church in Baltimore

Last year, as I retired after 17 years as the Pastor of Union Baptist Church in Baltimore, I knew I needed to commit myself to a new mission to strengthen my community. I am honored to have found a new purpose as CEO of the African Ancestry Neuroscience Research Initiative (AANRI) in partnership with the Lieber Institute for Brain Development (LIBD) and Morgan State University.

The mission of the AANRI is to tackle the issue of disparities in scientific research to build a more inclusive and healthy future for everyone. From the very beginning of my talks with Lieber Institute leadership, I understood deeply the importance of its work.

When I found there was a shortage of African Americans participating in biomedical research, I saw it as a clear issue of social justice. This wasn't a question of a particular institution's bias or discrimination. Here was a disparity embedded into the whole field of biomedical research, a bias that must be addressed. Here was Lieber and its leadership joining the community in this social justice struggle—that's very different from what I have experienced in my career as a pastor and activist for decades in Baltimore.

I also have a very personal connection to this issue as I had a brother who was developmentally disabled, and I saw how that affected his life and our family's lives. Beyond my own family, I see the impact of health disparities everyday on the streets of Baltimore.

When I learned that here, in my backyard in East Baltimore, the Lieber Institute had collected more than 500 brains of African Americans donated by next of kin to be a part of neuroscience research, my colleagues and I knew we had to act to push this work forward.

AANRI focuses specifically on neuroscience because of the serious racial disparities in the field. Did you know that many mental illnesses are more common in people of African ancestry than those of European ancestry? Research shows African Americans are 20% more likely to experience serious mental health problems than the general population. We are twice as likely to develop Alzheimer's disease. And yet, today, on average, only about 5% of participants in research studies of brain disorders are people from underrepresented racial or ethnic groups.

The second issue the AANRI confronts is bringing diversity to the people designing and conducting medical research. Only about 4% of neuroscience PhDs go to Black scientists, according to the Society for Neuroscience, and just 3% of neuroscience postdocs and 1% of neuroscience faculty members in the U.S. are Black.

Through the Lieber Institute, I've learned that genomic science is the key to unraveling the causes and

treatments for developmental brain disorders such as schizophrenia, bipolar disorder, and depression. A staggering 81% of the large-scale genomic datasets scientists use for this research are of European descent, though this group makes up less than 16% of the world's population.

How will we learn more about the neuroscience of all people—those of European ancestry, as well as those from other parts of the world—if underrepresented racial and ethnic groups aren't part of the conversation?

Through the AANRI, we are establishing a framework to advance progress toward equity across the biomedical research landscape. We're focusing on community engagement and education about biomedical research, training and developing a diverse research workforce, and conducting cutting-edge scientific research into the biological underpinnings of health disparities, as well as how those disparities interact with social determinants of health.

The work has already begun. AANRI scientists are sequencing the genomes of the samples of African descent in the Lieber Institute's extensive collection of donated postmortem brains. The Lieber Institute is training students of African descent in neuroscience and laboratory work in hopes that they'll enter the field and diversify its workforce. Working with our partner, Morgan State University, we are planning a collaborative training and community outreach infrastructure to support our work.

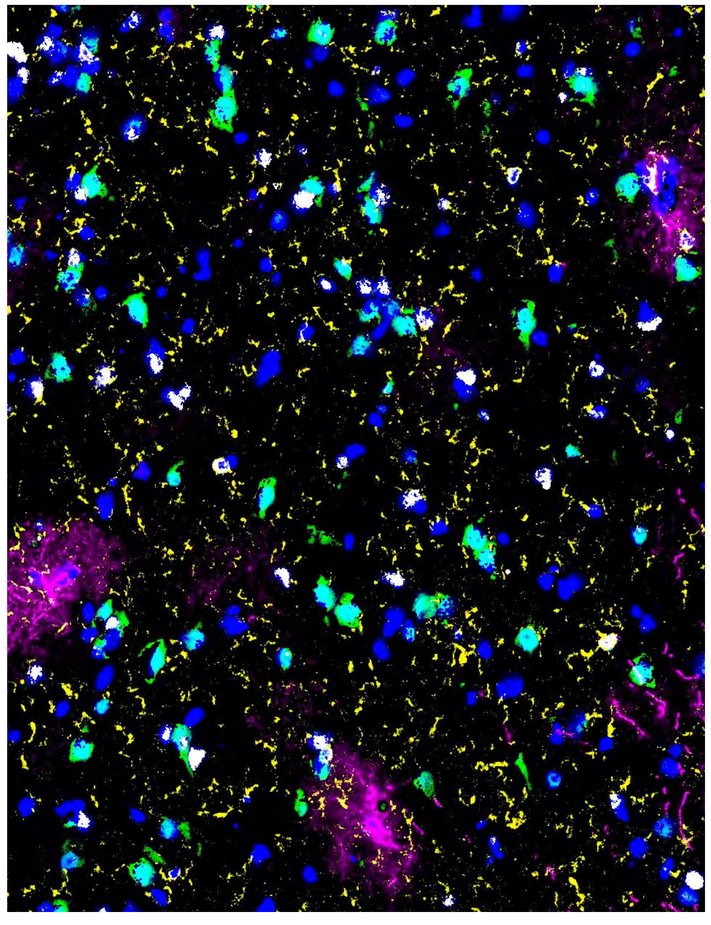
The Black community vividly remembers tragedies like the Tuskegee syphilis experiments or the famously immortal cells of Henrietta Lacks. These incidents feed a perception in the community that biomedical research is inherently discriminatory—that social justice wrongs like these are the norm in medicine.

At AANRI, we hope to counterbalance that idea by flooding the field with information about what makes research ethical and non-discriminatory. We want to foster crucial conversations like how to reimburse people and communities for their contributions to science—a vital element of the Henrietta Lacks case. We want community members to understand what makes research ethical and socially just. We want to educate both researchers and the community on how science can best serve all of us.

After decades as a pastor, I'm honored to undertake this quest for equity, diversity, and social justice in medicine. As I do so, I always think of my brother and our family. Had it come sooner, how could this revolution in medicine have changed our lives?

Rev. Dr. Alvin Hathaway, Sr.

Chief Executive Officer of the African Ancestry Neuroscience Research Initiative (AANRI) and former Pastor of Union Baptist Church in Baltimore



MATERNAL & CHILD HEALTH

The standard treatment for pregnancy complications has remained the same for hundreds of years: bed rest

Developmental behavioral disorders occur two to four times more often in males than females

The placenta is the only organ removed from the human body that is not routinely sent to a laboratory for examination

The Importance of Early Childhood Development

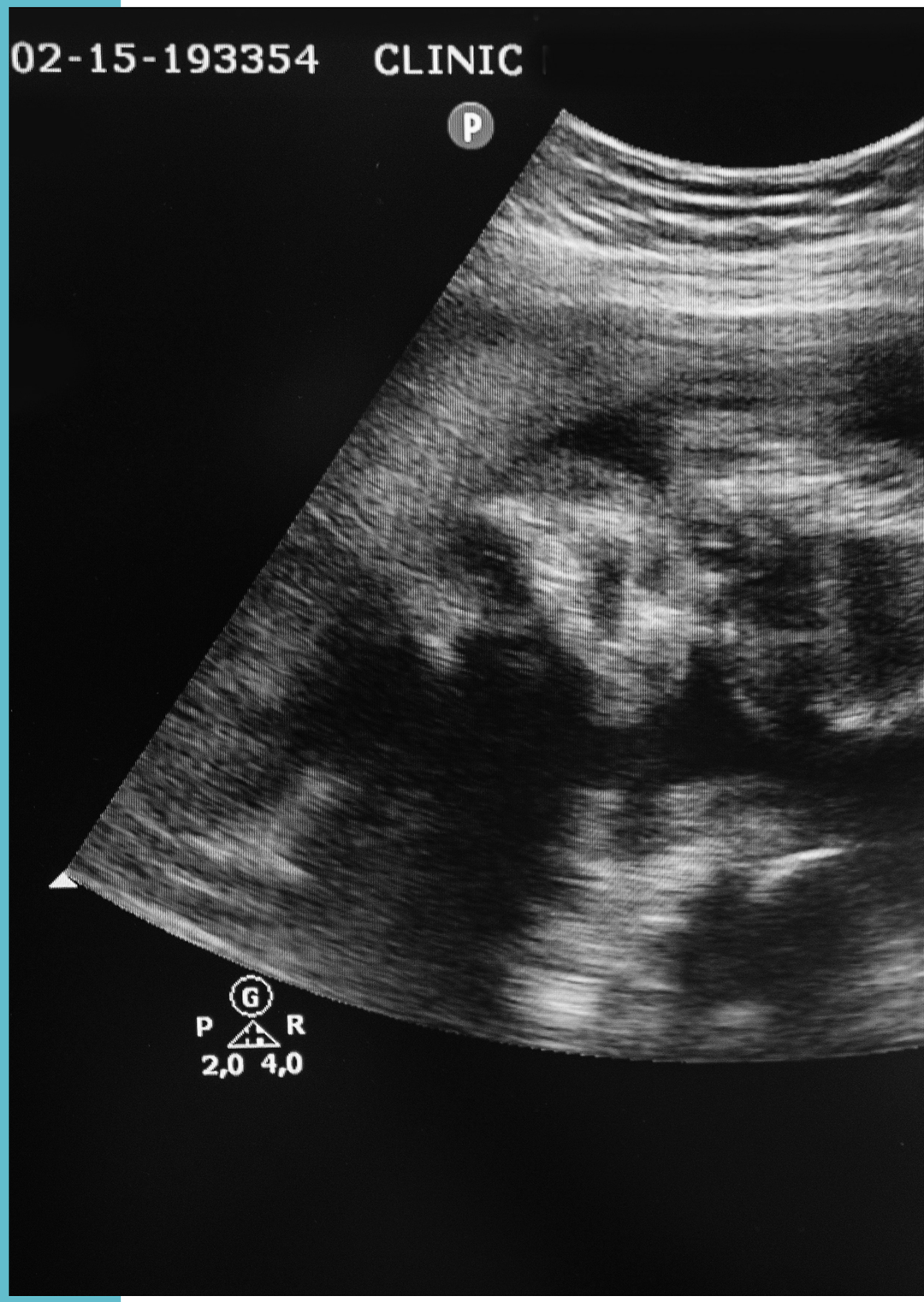
Early childhood is a crucial time that sets up children for a lifetime of adaptation to the complexities of human life. During the first five years of life, stress is a risk factor for depression, anxiety disorders, drug abuse, and many other medical conditions. But what if this crucial period of development begins even before birth, in the womb?

The ingredients of early childhood development are the genes that a child inherits and, in a process called epigenetics, the way the environment affects those genes, turning them off or on. The process begins immediately, as soon as the egg is fertilized. The developing brain is affected deeply by its environment as it grows in its mother's body.

What if genetic testing of the placenta—an organ that carries the child's genes, not the mother's—could give us advanced insight into a child's biological predisposition to a specific illness? Suppose doctors knew what external stimuli turned on genes for conditions like schizophrenia and autism. In that case, they could determine which pregnancies are at risk and which environmental triggers pregnant people should avoid. Prenatal personalized medicine could be the future of healthy brain development.

Lieber Institute researchers have found that the placenta is an incredible window into the earliest stage of developmental brain disorders. For example, their research has found that the placenta's health can influence a child's risk of schizophrenia and other neurodevelopmental disorders. In examining placentas from complicated pregnancies, researchers found schizophrenia genes were turned on more often in the placentas from male children than females, explaining in part perhaps why men are more likely to develop the condition.

Lieber's scientists use their unique insight to understand better the factors that bias genomic development toward or against successful adaption to the world. Their ongoing research is looking for more mechanisms of early brain development that scientists could use to evaluate or eliminate a child's risk of neurodevelopmental disorders.



KEY PUBLICATIONS

NATURE MEDICINE, 2018

Convergence of placenta biology and genetic risk for schizophrenia.

Authors: Ursini, G., Punzi, G., Chen, Q. et al.

Description: Researchers' findings clarify the placenta's role in the later manifestation of schizophrenia.

GENOME BIOLOGY, 2019

Divergent neuronal DNA methylation patterns across human cortical development reveal critical periods and a unique role of CpH methylation.

Authors: Price, A.J., Collado-Torres, L., Ivanov, N.A. et al.

Description: Researchers studied DNA methylation—a chemical process that changes when genes turn on and off—and identified critical time periods in brain development.

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, 2021

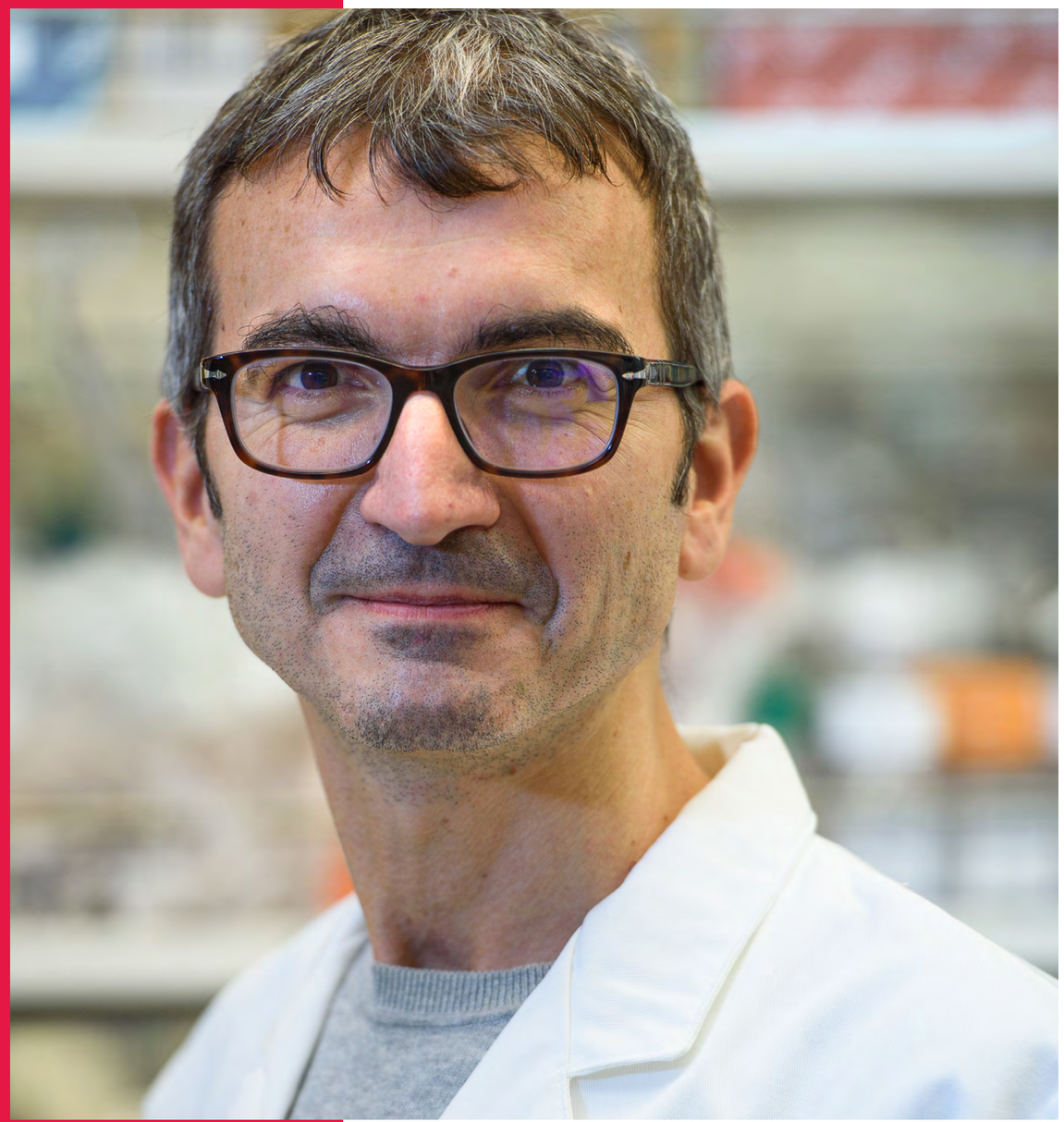
Placental genomic risk scores and early neurodevelopmental outcomes.

Authors: Ursini, G., Punzi, G., Langworthy, B., et al.

Description: Researchers show that early postnatal brain development is compromised by genes related to risk for schizophrenia that are expressed in the placenta during a complicated pregnancy.

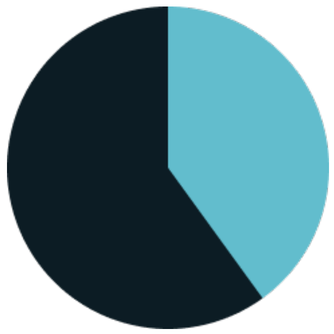
“About 46% of babies born in the U.S. experience at least one adverse event—a complication during pregnancy, labor or delivery, or early in their neonatal life. Fortunately, most babies survive and thrive, even after complications. However, they may be at a higher risk of developing a neuropsychiatric disorder later in life. The study of the link between maternal and child health and early paths of risk for schizophrenia is highly relevant for both prevention and treatment."

Gianluca Ursini, MD, PhD, Investigator

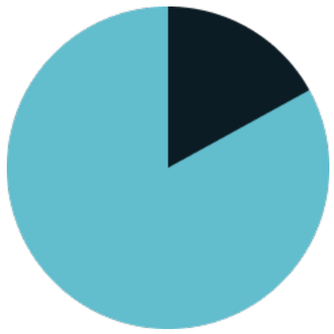


MOOD DISORDERS

About 2.8% of U.S. adults have bipolar disorder



40% of Americans experience depression at some point in their lifetime



Nearly 83% of bipolar disorder cases are classified as severe

Genes, The Environment And Mood

Mood disorders such as depression, anxiety, and bipolar disorder are relatively common—affecting one in five people—and can be debilitating. Depression involves feelings of sadness, low energy, and often sleep disruptions. Bipolar disorder involves depression with periods of mania, a condition that consists of an overabundance of energy and a conviction that one is on the verge of doing great things. Mania can involve spending sprees, expensive travel, and very grandiose ideas.

These disorders are unique because their effects can be temporary and changeable—people with depression or anxiety aren't usually permanently depressed or anxious, and people with bipolar disorder swing between the two extremes. This instability makes finding genes for these disorders challenging, though we know the essential role genetics plays. Genes cause a predisposition for the conditions, genes determine one's likelihood of recovery, and something in the environment triggers how these genes are expressed in the brain.

Lieber is examining the intersection of genes and the environment in the development of mood disorders. Identifying the underlying genes and the environmental triggers that turn them on during development could allow doctors to evaluate risk and even prevent or cure these conditions. **Lieber researchers, for example, have identified the first conclusive link between air pollution and depression.** The more air pollution a person is exposed to, the more depression they are at risk of experiencing. The research could inform policy to reduce pollution and help people at high risk of mood disorders to seek lower pollution places to live.

"Understanding what and how environmental risks act on genes in affecting brain function at the core of psychiatric disability could help us define new and improved treatment strategies, ranging from public health policies to personalized medicine."

Hao Yang Tan, MD,
Lead Investigator

Key Publications

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, 2021

Air pollution interacts with genetic risk to influence cortical networks implicated in depression

Authors: Li, Z., Yan, H., Zhang, X., et al.

Description: Air pollution can heighten the risk of major depression in people at genetic risk for this disease.

NATURE NEUROSCIENCE, 2022

Amygdala and anterior cingulate transcriptomes from individuals with bipolar disorder reveal downregulated neuroimmune and synaptic pathways

Authors: Zandi, P.P., Jaffe, A.E., Goes, F.S. et al.

Description: For the first time, researchers pinpoint significant differences in gene expression in two specific regions of the brain of hundreds of patients with bipolar disorder.

Alzheimer's disease is the most common cause of dementia in older people

Alzheimer's is the sixth leading cause of death in the U.S.

About 6 million Americans, most of them older than age 64, have dementia caused by Alzheimer's

Alzheimer's patients live an average of 8-10 years after diagnosis

The Challenges of Growing Older

People are living longer, and that means more time to enjoy the pleasures of one's life—spending time with family, practicing beloved hobbies, studying topics of interest. But at the same time, longer lives mean more time for the health problems that come with aging.

Babies born in the U.S. in the year 1900 were expected to live an average of just 47 years. By 1998, newborns were expected to live to an average age of 79. Scientists have predicted that the average life expectancy should continue to rise about 2.5 years per decade.

Alzheimer's disease is the most common cause of dementia in older people and is the sixth leading cause of death in the U.S. About 6 million Americans, most of them older than age 64, have dementia caused by Alzheimer's. The disease is characterized by an inability to think, remember and reason. It typically interferes with a person's ability to live their daily life and engage in everyday activities.

Alzheimer's disease involves complex brain changes, including damage to the hippocampus, a part of the brain critical to memory. As the disease spreads throughout the brain, crucial neurons die, and one part of the brain after the other begins to shrink. Eventually, patients may need caregivers to see to their every need.

It's unclear exactly what causes Alzheimer's disease and other kinds of dementia, but we know there are genetic risk factors that make people more prone to developing the conditions.

Alzheimer’s has about 60% heritability. The Lieber Institute's unique collection of postmortem brains gives our scientists access to brain tissue of all ages. By examining brain tissue at all stages of life, scientists are looking for signs and symptoms characteristic of Alzheimer's disease at many ages, trying to identify the biological mechanisms of the disease in hopes of preventing and treating it.

Lieber Institute scientists use a cutting-edge technique called single-cell genomics to study the various types of cells in the human brain. They’ve found that about 10-20% of human neurons have complex genomic rearrangements that set them apart from a person's other neurons. These so-called CNV neurons are uniquely susceptible to aging-related death. Lieber scientists are interested in how CNV neurons are active in schizophrenia and Alzheimer's disease.

The Institute pioneered an advanced technique that allows scientists to examine the genomics of a single cell at a time, using the technology to parse out varying genes between cells of the same person. They hope the technology will help develop screening to establish who is at risk of Alzheimer's disease and drug targets to allow doctors to treat Alzheimer's and other forms of dementia.

“The unfortunate consequence of today’s longer lifespan is an increased prevalence of age-related neurodegenerative disease and dementia. A clear understanding of the initiating events in age-related brain disease could provide new drug targets to extend the human health span. My lab studies CNV neurons, how they alter the genetic landscape of schizophrenia, and how some may contribute to resilience to Alzheimer’s disease. We also develop induced pluripotent stem cell-based models of neurodegenerative disease to allow scientists to study these conditions better.”

Michael McConnell, PhD, Investigator

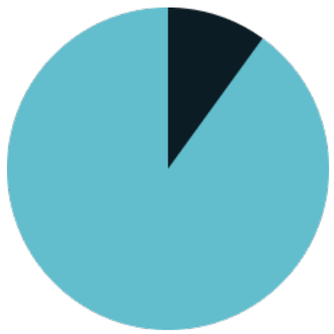
SUICIDE

Can We Prevent Suicide?

Suicide is the 10th leading cause of death in the U.S. It is unique among psychiatric disorders in that a short, intense moment of active suicidal crisis may end a person's life forever—the most severe of consequences. However, there is no treatment that specifically targets suicide. Instead, therapies focus on the co-existing psychiatric disorders, including depression or schizophrenia, that have made a person feel suicidal.

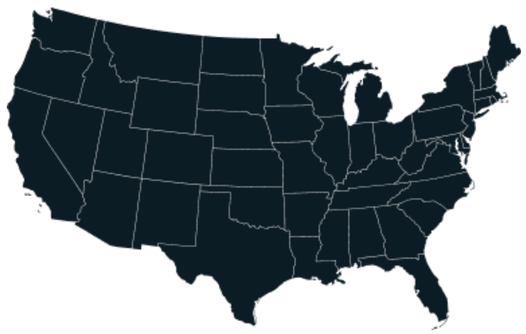
There is certainly a genetic component to suicide, meaning that it can run in families. Twin studies, however, have shown there is more to it. Scientists believe epigenetics—the interaction of genes and the environment—is at play. Perhaps early trauma or illness can turn on specific genes, increasing a person's risk of suicide. Until we unravel the biological mechanisms underlying suicide, it's hard to fully understand, treat, or prevent it.

Suicide is the 10th leading cause of death overall in the U.S.



90% of people who die by suicide have a psychiatric illness at the time of death

In 2019, there were nearly 2.5 times as many suicides as homicides in the U.S.



Lieber scientists ask what happens in the brain that makes some people take their own lives. The Lieber Institute is uniquely positioned for this research since many of our postmortem brain collection samples come from people who died by suicide. Those samples are precious in research on suicide because the biology of suicide—the underlying mechanisms that made the suicide possible—is fixed in the brain at the time of death.

Lieber researchers are looking at these biological snapshots of what occurred in the brain at the moment of suicide completion to determine what's different about these brains. Lieber Institute researchers are even considering different types of suicide to find biological differences and similarities. The Institute's researchers are working on a potential new treatment to reduce suicidal thoughts and prevent attempts.

Key Publication

AMERICAN JOURNAL OF PSYCHIATRY, 2022

Genetics and Brain Transcriptomics of Completed Suicide

Authors: Punzi, G., Ursini, G., Chen, Q., et al.

Description: Researchers examining the genomics and transcriptomics of suicide found that patients who died by violent suicide are distinct from those who died by less violent suicidal means.

"I study suicide as a separate entity with its own specific complexity and phenomenology. Severe anxiety, agitation, and impulsivity may be better indicators of suicidal behavior than a psychiatric diagnosis. There are no pharmacologic treatments to address suicide specifically. It's imperative that we find ways to protect affected patients from the risk of harming themselves."

Giovanna Punzi, MD, PhD, Research Scientist

AUTISM

One in 44 children has been diagnosed with autism spectrum disorder (ASD)

ASD is more than four times more common among boys

Autism: A Window Into the World of Developmental Disorders

Raising a child with autism can be a frightening proposition for parents. It can mean a lifetime of managing complicated therapies and medical visits, mounting medical bills and concerns that parents may be providing assistance well into adulthood. People with autism can be college graduates with high IQs who have difficulty socializing, but they may also be nonverbal and require constant care.

Autism spectrum disorder begins early in development and encompasses autistic disorder, Asperger's syndrome, and childhood dis-integrative disorder. With about one in 100 people affected worldwide, this disorder can manifest in many ways, leaving some highly functioning, with others requiring constant assistance. Economists expect ASD to cost the United States $461 billion annually beginning in 2025, for expenses such as adult medical care and loss of productivity by both individuals and caregivers.

Families are desperate for answers on how to prevent and treat ASD.

Lieber Institute researchers are studying gene variations that we know contribute to the risk and severity of autism.

In particular, they've examined a rare disorder called Pitt-Hopkins Syndrome that is caused by a genetic mutation that alters brain function. LIBD scientists also have found that people with ASD have a cellular abnormality that impairs the production of myelin, a fatty substance that creates an insulative sheath around nerve fibers in the brain that allows them to communicate with each other efficiently. Producing myelin is part of a biological process critical to early brain development.

Key Publication

NATURE NEUROSCIENCE, 2020

A myelin-related transcriptomic profile is shared by Pitt–Hopkins syndrome models and human autism spectrum disorder.

Authors: Phan, B.N., Bohlen, J.F., Davis, B.A. et al.

Description: Research on Pitt-Hopkins identifies how genetic mutations harm the formation of myelin, a fatty substance that insulates the brain's neurons.

"I study syndromic forms of autism, which typically arise from single-gene mutations. We model these disorders by using patient-derived human stem cells and mouse models with specific gene mutations. We generate complex cellular models of the disease, to study how different types of neurons from the cortex develop, connect, and communicate differently in patients."

Brittany Davis, PhD, Postdoctoral Fellow

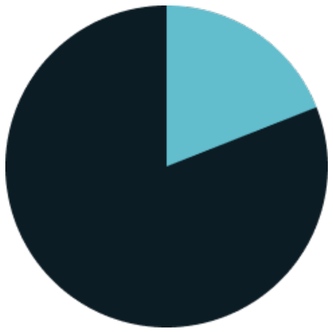
ADDICTION

20.3 million people aged 12 or older had a substance use disorder in the past year

In 2020, about 2.7 million people aged 12 or older in the U.S. had an opioid use disorder in the past year

700K drug overdose deaths in the U.S. since 2000

The federal government budgeted $35 billion for drug control in 2020



19.4% of people have used illicit drugs at least once

New Hope for Families

Addiction is a national public health crisis that can have devastating consequences for patients and their families. The COVID-19 pandemic has only made the situation more desperate. In 2020, the U.S. set a record for the most overdose deaths in a year—more than 93,000 people died of an overdose that year, up almost 30% from the year before.

Addiction treatment is expensive, and techniques and results vary widely. Medications like methadone and buprenorphine can help with opioid addiction. Cognitive behavioral therapy can help people cope with cravings. Group therapy and 12-step programs are popular as well. But people who are addicted to drugs or alcohol often suffer from social, family, and legal problems. They may also have mental health conditions that require treatment. And many people who abuse drugs or alcohol abuse more than one substance. For all these reasons, treatment and recovery are complicated.

As with many public health problems, prevention is the key.

That's why Lieber Institute scientists are examining the biological mechanisms that lie at the root of addiction. They've analyzed the genetics from human postmortem brain tissue, trying to determine what portion of addiction is heritable, passed down through generations in a family. Identifying the genes that make people prone to addiction and the mechanisms that regulate the expression of those genes in the brain could provide therapeutic targets to more effectively treat and prevent addiction.

"Using advanced molecular neurobiological techniques, we are studying postmortem human brain tissue to better understand the molecular identity and spatial relationships of cells necessary for motivated behavior and reward processing. We can also ask if these cells and circuits are particularly vulnerable to genetic risk for psychiatric and substance use disorders to identify targets for prevention and treatment. In particular, we use advanced techniques such as single-cell sequencing and spatial transcriptomics to define the molecular neuroanatomy of critical brain structures. We are also committed to providing tools and resources to the broader scientific community to advance their own studies."

Kristen Maynard, PhD, Investigator

Key Publications

NATURE NEUROSCIENCE, 2021

Transcriptome-scale spatial gene expression in the human dorsolateral prefrontal cortex.

Authors: Maynard, K.R., Collado-Torres, L., Weber, L.M. et al.

Description: While regions of the brain have long been known to have specific roles, a new study finds that tissue layers within a brain region also vary in gene expression and function.

NEURON, 2021

Single-nucleus transcriptome analysis reveals cell-type-specific molecular signatures across reward circuitry in the human brain

Authors: Tran, M., Maynard, K., Spangler, A., et al.

Description: Researchers used advanced genetic technologies to establish similarities between cell types in the areas of the human and mouse brain associated with reward and addiction, affirming that mouse studies can be re-interpreted to reveal insight about human disorders.

POST-TRAUMATIC STRESS DISORDER (PTSD)

Trauma That Lasts a Lifetime

Post-traumatic stress disorder (PTSD) affects people who experience a traumatic event beyond ordinary day-to-day stressors. It's normal to feel anxious and frightened in the moment, but people with PTSD carry that fear—and their body's reactions to it—long after their trauma.

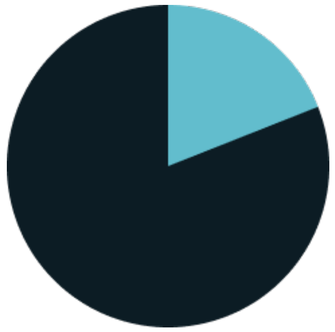
PTSD can affect people who have experienced violence, lost a loved one, or lived through a disaster, accident, abuse, or even combat. It can be devastating to those who suffer from it, harming their ability to sleep, giving them vivid, terrifying flashback-like memories of their trauma, causing anxiety attacks and making them feel numb to their surroundings. Doctors use antidepressants and talk therapy to treat the disorder.

Not everyone who suffers a trauma will experience PTSD. About seven or eight out of every 100 people will experience PTSD in their lifetime. About 500,000 veterans of the Iraq and Afghanistan wars have screened positive for the condition.

PTSD is more common in women than in men

About 8% of people will experience PTSD in their life

Twenty U.S. military veterans die by suicide every day—more than die in combat



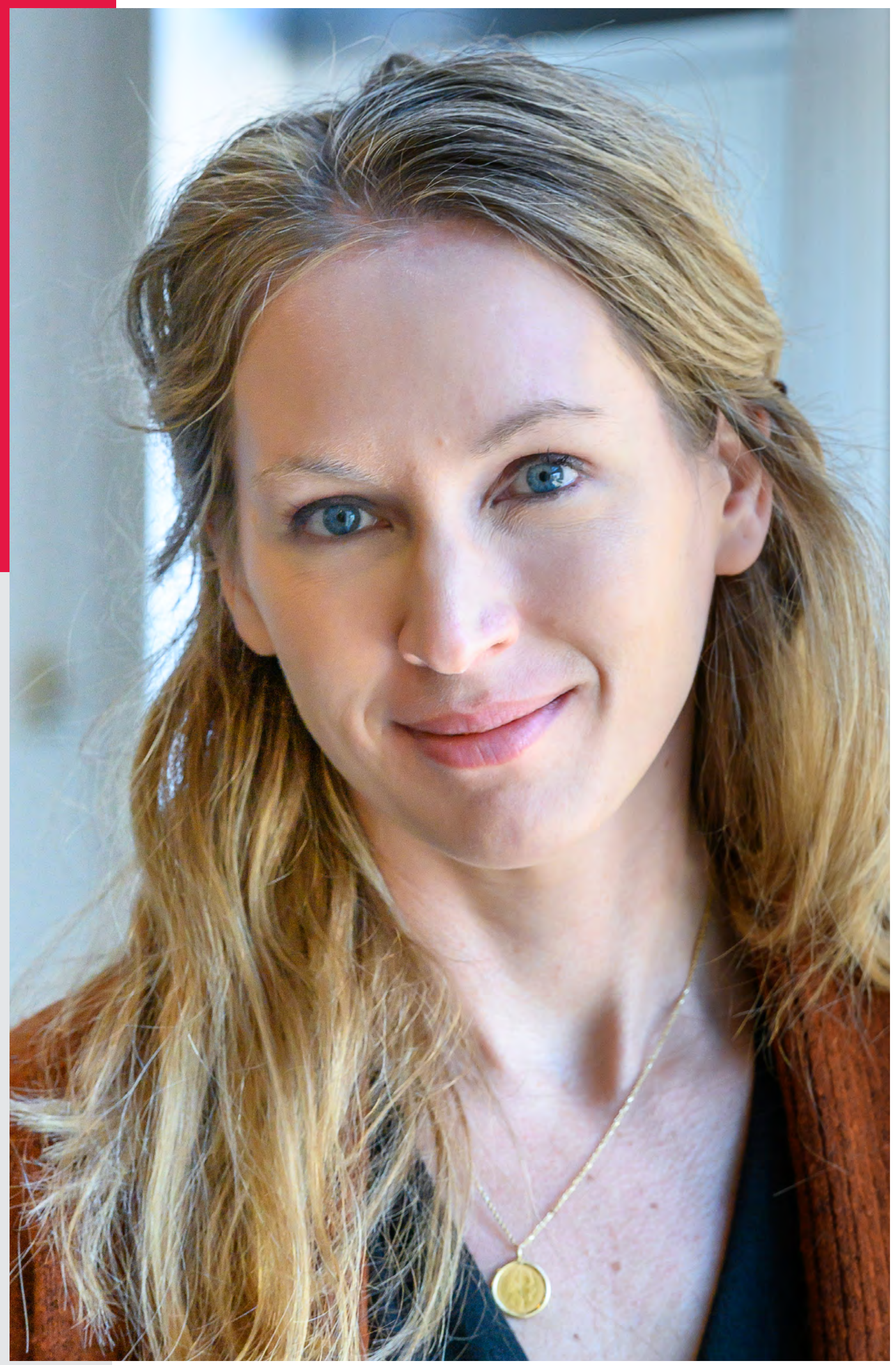
As many as 30% of veterans of the Iraq and Afghanistan wars have screened positive for PTSD

PTSD is a fascinating case for the field of epigenetics, the intersection of genes and the environment, since all people with the disorder have experienced an environmental trigger at the start of their illness. Many of the samples in the Institute's postmortem brain collection come from people who had been diagnosed with PTSD, giving scientists an unprecedented look into the biological roots and effects of the disorder.

Lieber scientists are specifically studying fear regulation, a phenomenon seen in patients with PTSD and anxiety. They're examining the brain circuits involved in fear by first looking at animal models and then applying their observations to Lieber's collection of postmortem brains. They've found that animals with fear regulation problems seem to experience deficits of inhibitory neuronal communication in their fear circuits. That is, the neurons that could tamp down their fear-related feelings or memories don't fire perfectly. By identifying specific neurons tied to fear or excitability, the scientists hope to identify potential drug targets that could help anxious or traumatized people recover.

"Advances in imaging and recording technologies have led to a greater appreciation of neuropsychiatric disorders as disorders of brain circuits. Our work at Lieber capitalizes on the power of molecular genetic tools to target and manipulate cell-specific populations within behaviorally relevant circuits in models to identify circuit-specific cell types in the human brain."

Keri Martinowich, PhD, Lead Investigator



Key Publication

AMERICAN JOURNAL OF PSYCHIATRY, 2022

Decoding shared versus divergent transcriptomic signatures across cortico-amygdala circuitry in PTSD and depressive disorders

Authors: Jaffe, A., Tao, R., Page, S., et al.

Description: PTSD often occurs in conjunction with major depressive disorder, but Lieber Institute researchers have found genomic and transcriptomic distinctions between them. They also found evidence of decreased expression of genes associated with immune signaling and neuroinflammation in both conditions, the exact opposite of what has been predicted.

The Next Neuroscience Generation

Investing in the future of neuroscience means investing in the next generation of neuroscientists—our young people. The Lieber Institute's scientists have mentored countless undergraduate and graduate students and interns, giving them the opportunity to learn on the ground, in the lab, from the experts. Helping talented students connect with the potential of a career in brain science is the Institute's contribution to building a gifted, experienced, diverse workforce for the future of our field. Our students have gone on to medical school, graduate, and PhD programs with hands-on laboratory experience—and sometimes even published research papers—under their belts.

"Jenny's lab has given me a place to grow as a scientist. My main focus has been studying sex differences in schizophrenia. I was able to get involved in doing research, writing grants, and even giving talks. I have a co-first author paper coming out. I intend to apply to medical school in 2022. I'm very interested in the field of precision medicine in neurology—a research-oriented MD is what I want to pursue."

Lieber Institute Research Assistant Ria Arora joined Jenny Erwin's lab as a Johns Hopkins undergraduate student intern in 2019.

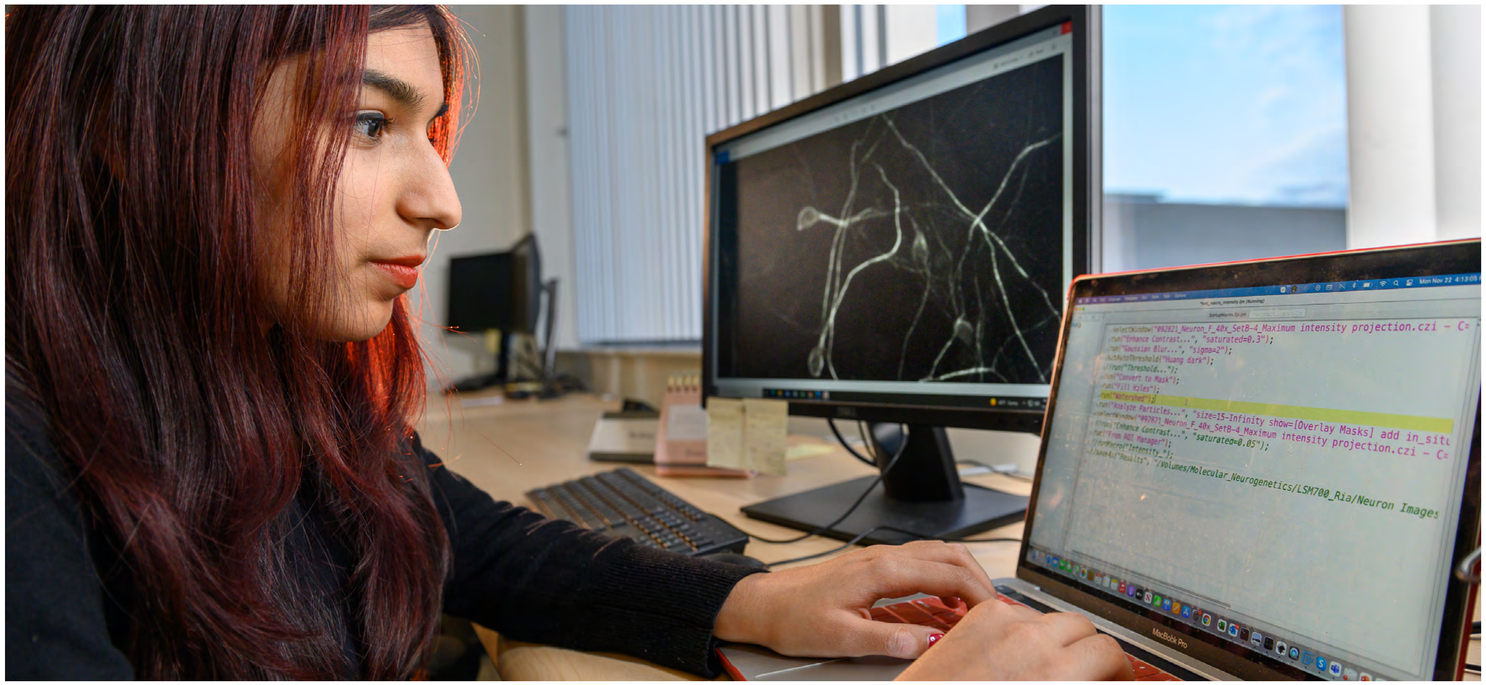
"There are not a lot of female doctors, not a lot of African American doctors. I want to be that friendly face that makes people feel comfortable no matter what they look like. I want to give back to people in my community and give girls hope that they can get their PhD and go into STEM careers. Some girls don't have those role models in their lives. Lieber's African Ancestry Neuroscience Research Initiative is pioneering."

Mattlyn Young is working at the Lieber Institute as she completes her master's thesis from Morgan State University. She plans to earn a PhD in neuroscience before attending medical school.

"I met Tom Hyde through oSTEM, the queer STEM club at Johns Hopkins University, when I was an undergrad majoring in biomedical engineering, and I joined the Lieber Institute as a student. Now I'm getting my PhD in computational biology, specifically the genomics of substance abuse. The Nature Neuroscience research I published while I was at Lieber has certainly helped my grant applications. One of the reviewers for one of my grants said my letters of recommendation practically glowed in the dark. I have my mentors at the Lieber Institute to thank for that."

BaDoi Phan is a former research assistant at Lieber and current MD/PhD student at the University of Pittsburgh and Carnegie Mellon University.

Our students have gone on to pursue advanced degrees and positions at a diverse array of institutions once they've left our mentorship. Here are a few:



Companies & Other Organizations

American Association for the Advancement of Science

Astellas

Equal Justice Initiative

Genentech, Inc.

Genomics Institute of the Novartis Research Foundation

The Heights School

Inflammatix, Inc.

SparkVision

Wilson Sonsini Goodrich & Rosati

Academic Institutions

Albany Medical College

Albert Einstein College of Medicine

Baylor College of Medicine

Boston University School of Medicine

Broad Institute of MIT and Harvard

Chinese Academy of Sciences

College of Notre Dame of Maryland

Columbia University Mailman School of Public Health

Dana-Farber Cancer Institute of Harvard University

Duke-NUS Medical School

Emory School of Medicine

Frank H. Netter MD School of Medicine at Quinnipiac University

Hackensack Meridian School of Medicine

Icahn School of Medicine at Mount Sinai

Johns Hopkins University

Johns Hopkins University School of Medicine

Lafayette College

Mount St. Joseph University

The Ohio State University College of Veterinary Medicine

Rensselaer Polytechnic University

University of Bari, Italy

University of California Berkeley School of Law

University of California San Francisco

University of California Los Angeles

University of Colorado, Boulder

University of Maryland School of Medicine

University of Miami

University of Pennsylvania

University of Pittsburgh and Carnegie Mellon University

University of Toledo College of Medicine and Life Sciences

Warren Alpert Medical School of Brown University

Weill Cornell Medical College

Wharton School of the University of Pennsylvania

Yale University

RESEARCH PARTNERS

The Lieber Institute works in partnership with many organizations and institutions around the world.

Academia

Broad Institute
Case Western Reserve University
Columbia University
Duke University
Harvard University
Johns Hopkins University
JHU Applied Physics Lab
Massachusetts General Hospital
Mount Sinai School of Medicine
National University of Singapore
RTI International
Salk Institute
Seoul National University
Peking University, China
University of Cambridge
University of Cardiff
University of Colorado
University of Oxford, United Kingdom
University of Bari, Italy
University of Edinburgh
University of Copenhagen
University of Sofia
University of London
University of Miami
University of Michigan
University of North Dakota
University of New South Wales
Yale University

Agencies

Gift of Life
National Institutes of Health
National Institutes of Mental Health
U.S. Department of Veterans Affairs
Office of Chief Medical Examiner: Maryland
Office of Chief Medical Examiner: Kalamazoo, MI
Office of Chief Medical Examiner: Santa Clara County, CA
European Institute of Oncology

Foundations

Abell Foundation
American Epilepsy Foundation
American Suicide Foundation
Brave Cove Foundation
Brain & Behavior Research Foundation
Maryland Stem Cell Research Fund
Pennington Foundation
Pitt-Hopkins Foundation
Simons Foundation Autism Research Initiative (SFARI)

Corporations

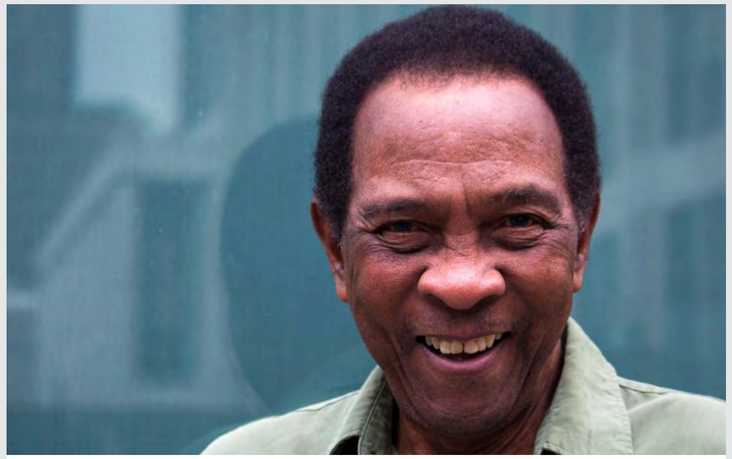
23&Me
Astellas US
AstraZeneca
Boehringer Ingelheim
Deerfield Management
Eli Lilly & Company
Johnson & Johnson
Lundbeck
Pfizer Inc.
Red Abbey Labs
Roche
Wake Network Inc.

A special thanks to our photographer, Ye "Tyler" Li, MD, PhD. Dr. Li is a Staff Scientist in LIBD's drug discovery division. He is also a professional photographer. Please find his work at: **carolirisphotography.com**

CHAMPIONS COUNCIL

The Lieber Institute Champions Council includes prominent influencers with a personal interest in the mission of the Lieber Institute.

CYNTHIA GERMANOTTA
Lada Gaga's mother, co-founder and executive director of the Born This Way Foundation



CARMAN MOORE
World-renowned composer, conductor, author, and music critic

NAOMI JUDD
Country music singer, songwriter, actress and activist

JOHN TURTURRO
Actor, writer and filmmaker

Leadership

DANIEL R . WEINBERGER, M.D.
Director and Chief Executive Officer

THOMAS M. HYDE, M.D., Ph.D.
Chief Medical Officer

SOLOMON SNYDER, M.D.
Senior Director of Drug Discovery

JAMES BARROW, PH.D.
Director, Drug Discovery

JOEL E. KLEINMAN, M.D., PH.D.
Associate Director of Clinical Sciences

ELAINE JONES
Chief Operating Officer

ANDREW MASLAN, CPA
Chief Financial Officer

JEAN DUBOSE
Chief of Staff

Board of Directors

HERBERT PARDES, M.D., Chair
New York-Presbyterian Hospital

DANIEL R. GETTS, M.B.A., Ph.D.
Myeloid Therapeutics

LANDON S. KING, M.D.
The Johns Hopkins University School of Medicine

TAMAR MALTZ
Founder

MILTON MALTZ
Founder

ROBERT F. MUSE, Esq.
Partner, Levy, Firestone, Muse, LLP

MARY RUBIN
Founder

STEVEN S. SHARFSTEIN, M.D.
President Emeritus
Sheppard Pratt Health System

GEOFFREY A. SIMON
Simon & Associates Wealth Management

DANIEL R . WEINBERGER, M.D.
Director and Chief Executive Officer

Scientific Advisory Board

JOSEPH COYLE, M.D., CHAIR
Harvard Medical School
McLean Hospital

MARK BEAR, PH.D.
MIT
Howard Hughes Medical Institute

DANIEL GESCHWIND, M.D., PH.D.
UCLA School of Medicine

PAT LEVITT, PH.D.
Keck School of Medicine, USC
Children's Hospital Los Angeles

TRUDY MACKAY, PH.D.
Clemson University

STEVEN SALZBERG, PH.D.
Johns Hopkins University

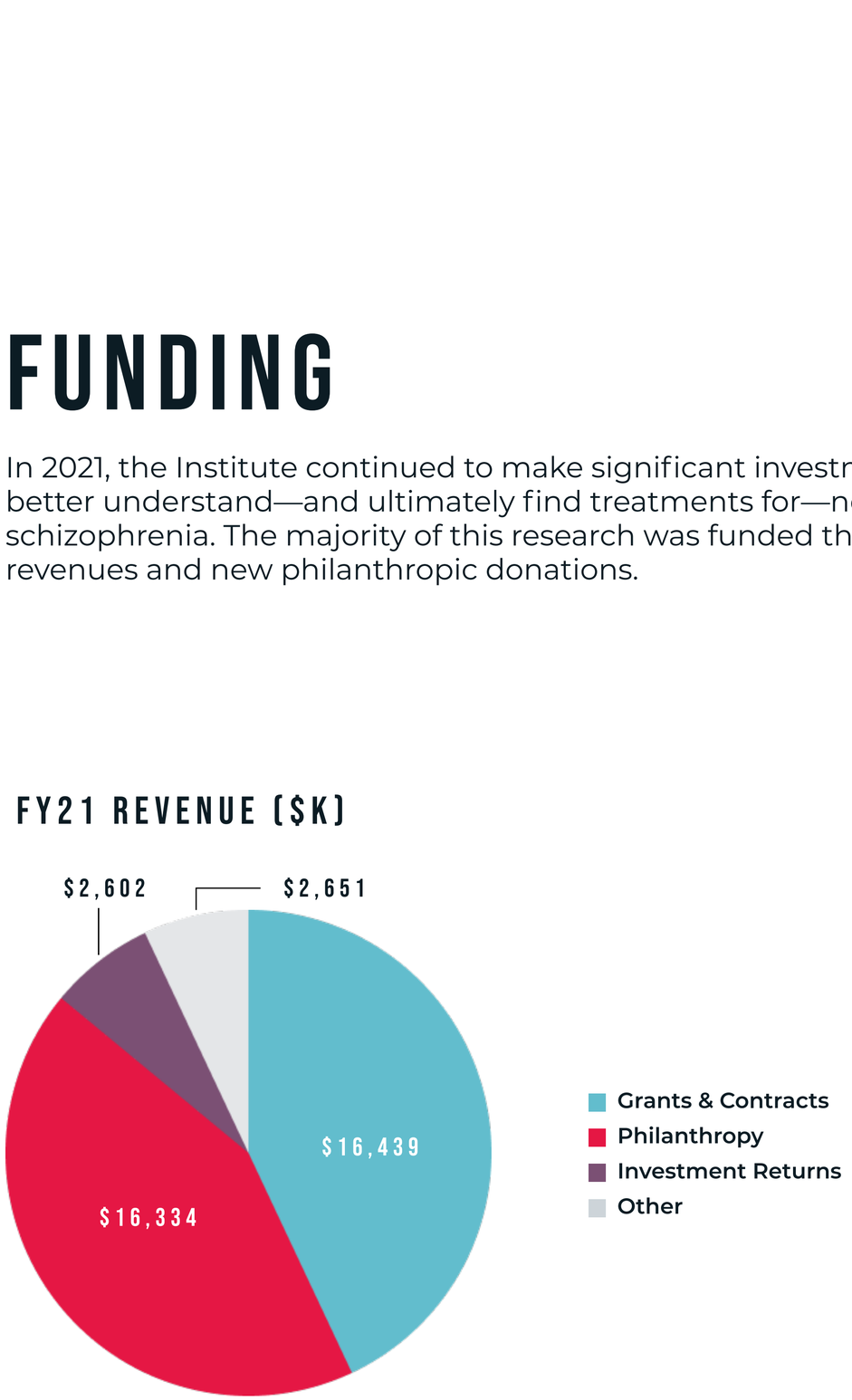
DARRYLE SCHOEPP, PH.D.
Research Consultant
Former VP, Merck

FLORA VACCARINO, M.D.
Yale School of Medicine

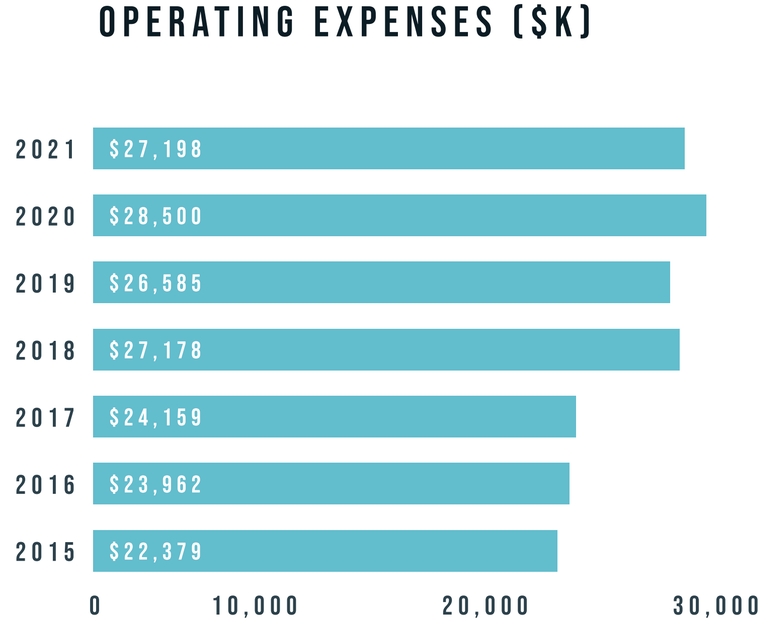
FUNDING

In 2021, the Institute continued to make significant investments in scientific research to better understand—and ultimately find treatments for—neuropsychiatric disorders, such as schizophrenia. The majority of this research was funded through grant and contract revenues and new philanthropic donations.

FY21 REVENUE ($K)

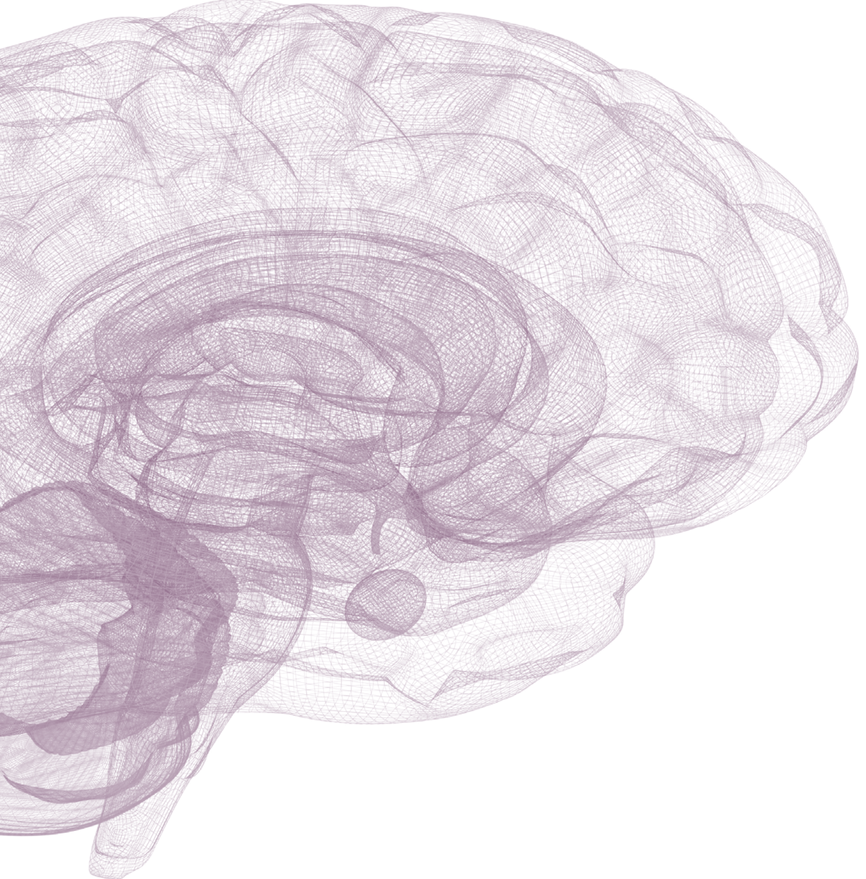


OPERATING EXPENSES ($K)



Publications

Part of the Lieber Institute's mission is to educate the public about our work. We have two key publications we use to inform the clinical community and keep our stakeholders updated on the latest news at the Institute.



neuroDEVELOPMENTS

This quarterly newsletter serves to update readers with the latest developments in neuroscience of relevance to clinical medicine. Its news articles are written and edited by the prominent scientists on its editorial board. Its content is designed to help the scientific community learn about new research into developmental brain disorders such as autism and schizophrenia. Visit our website, **libd.org/neurodevelopments**, to subscribe.

Ron McKay, PhD, Chief Editor

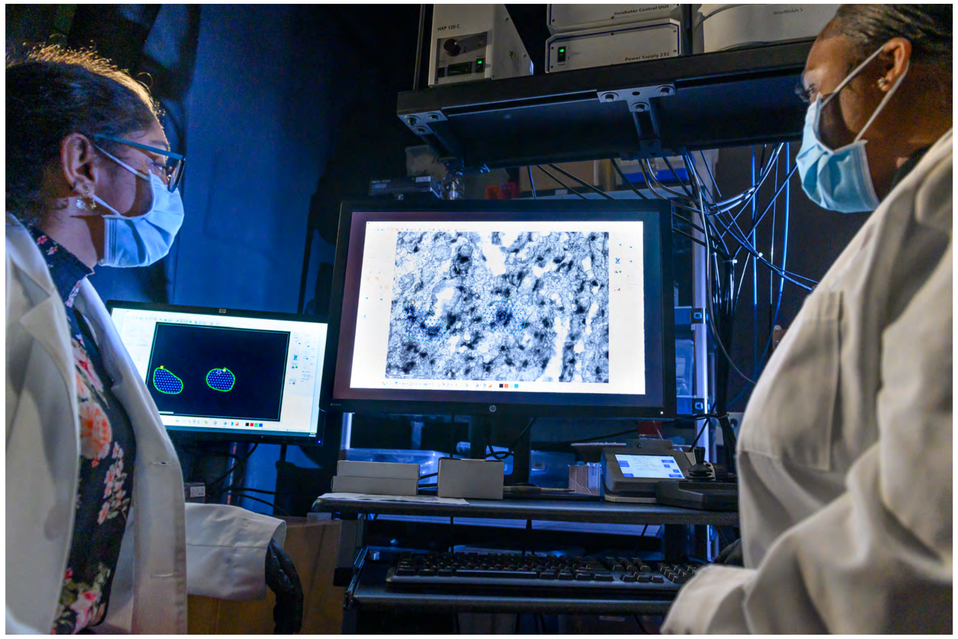
LIBD

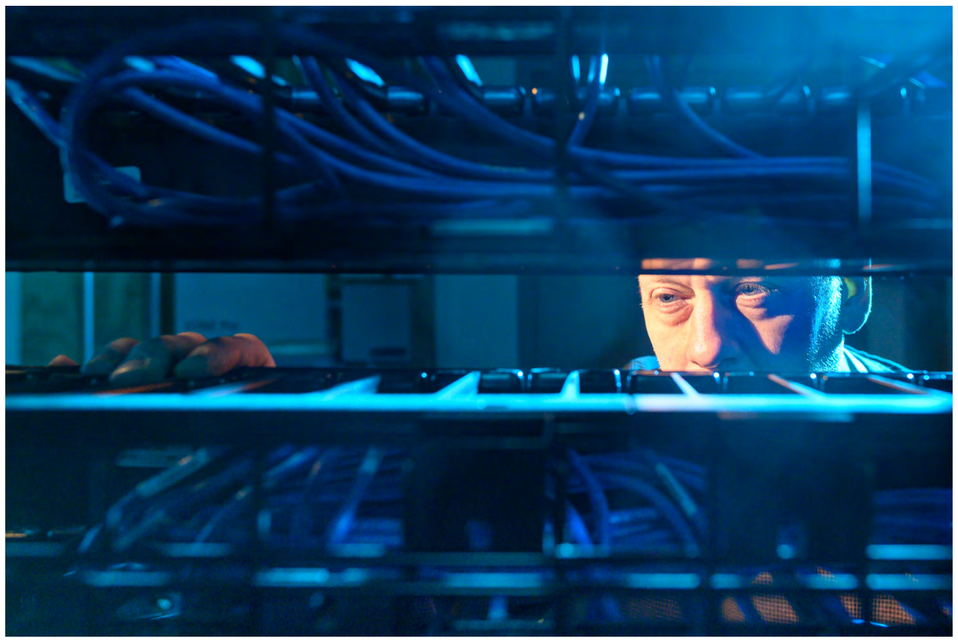
Lieber Notes

The Lieber Institute launched this quarterly e-newsletter to communicate about our latest achievements to a lay audience. We want to keep donors, policymakers, community members and other readers updated on news about the Institute, our people and our groundbreaking neuroscience research. To subscribe, email **media@libd.org**.


nVista
INSCOPIX


WYPALL
05322





JOIN US ON OUR JOURNEY TO PREVENTION

Visit libd.org to learn more about becoming an advocate and supporting our mission.

LIBD