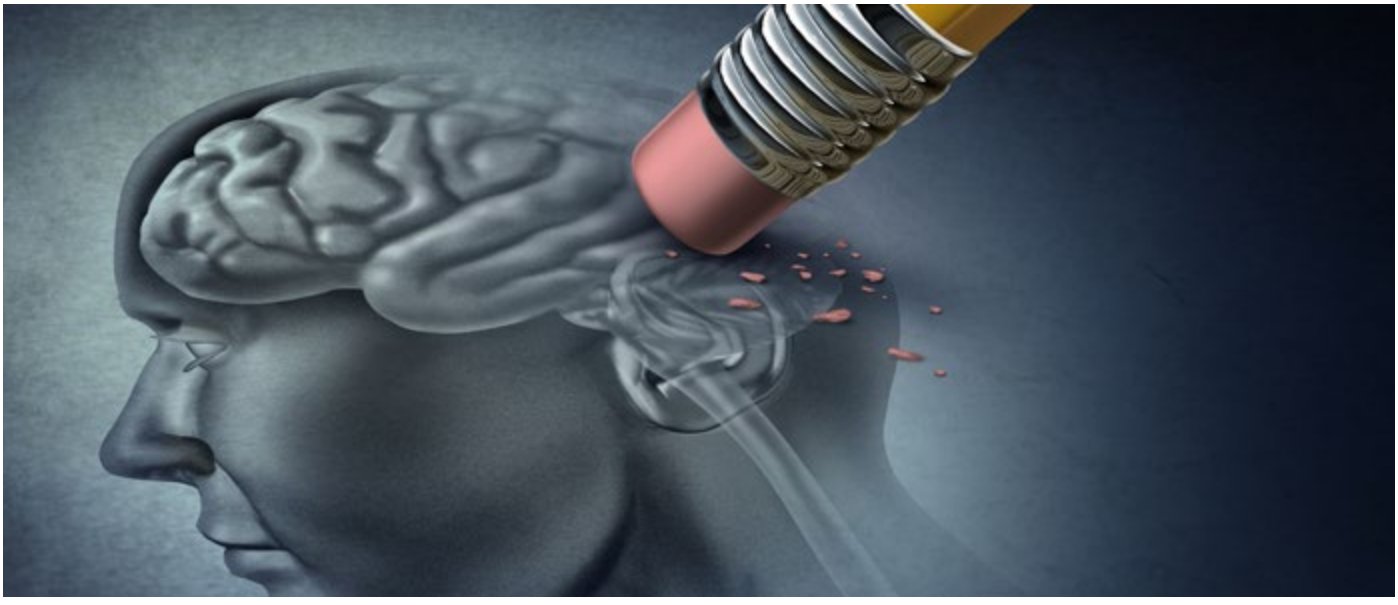

Alzheimer's research reset

After some costly and disappointing drug trial failures, the field welcomes a funding surge, tools for tracking disease, and interdisciplinary collaborations to tackle one of science's most stubborn puzzles. **By Kendall Powell**

In the last five years, as several large clinical trials testing drugs for Alzheimer's disease failed, the field came to a stark conclusion: These approaches did nothing to slow down—let alone reverse—the course of the disease once patients already exhibited symptoms of early dementia.

"We think now that the disease develops over 25 years or so," says **Eric McDade**, cognitive neurologist at Washington University in St. Louis School of Medicine, and a coinvestigator on an 11-year observational study of 500 patients who have inherited mutations that put them at risk for early-onset forms of Alzheimer's disease.

The failed trials, along with the dawning realization that the disease unfolds over decades, have put the entire field on a reset—to develop and test interventions that can be used much earlier, to discover new targets beyond misfolded amyloid and tau proteins, and to fund large, interdisciplinary, big data collaborations.

Advances in understanding the role of neuroinflammation, new biomarkers and research tools, and an influx of research funding mean it's a good time to make a career move into the Alzheimer's field. As history has shown, there won't be any easy answers, and advances will come only through large collaborations that require a hefty dose of teamwork and heaping amounts of perseverance.

"Most people who have thought about the role of amyloid in Alzheimer's know that we'll also need to identify different ways of intervening," says McDade, also associate director of the Dominantly Inherited Alzheimer Network Trials Unit (DIAN-TU), a worldwide collaboration that connects researchers studying the unique population of people at high risk for early-onset disease. "There's never been a better time for moving into Alzheimer's research."

Multifaceted disease, many approaches

Worldwide, 47 million people have Alzheimer's disease or related dementias, and that number is predicted to double in the next 20 years. Aging is by far the biggest risk factor for developing Alzheimer's—if everyone lived to be 85, one in two people would develop dementia. The lion's share of Alzheimer's research and drug discovery to date has focused on misfolded amyloid and tau proteins, which aggregate to form plaques (amyloid) and tangles (tau) in the brain. But the body's attempt to clear the sticky proteins might also be contributing to or causing the neurodegeneration. Drug trials have almost exclusively sought to use antibodies targeted toward these two proteins to try to attack and clear the misfolded forms or mop up soluble forms, or to inhibit enzymes responsible for generating the miscreant peptides.

Ricardo Dolmetsch, global head of neuroscience for Novartis in Cambridge, Massachusetts, paints a rosier view of the field's failures as representing big leaps in understanding Alzheimer's. "We've learned a lot from the trials, and our capacity to measure disease progress is getting much better," he says. "There are a lot of really exciting experiments to do now."

Because those experiments run the gamut from nearly every imaginable corner of biomedical science, researchers with any biology or clinical background, or even training in engineering and computational science, can find a way to move into Alzheimer's work. Expertise in neuroscience and protein folding alone are no longer ideal, or even absolutely required.

cont.>

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> *"There's never been a better time for moving into Alzheimer's research."*
> — Eric McDade

"It's very exciting in terms of careers, because we need people doing biochemical analysis and mass spectroscopy, geneticists, cell biologists, pathologists, and those running animal studies," says **Paul Aisen**, director of University of Southern California's Alzheimer's Therapeutic Research Institute (ATRI) in San Diego.

Projects in progress

At the Alzheimer's Drug Discovery Foundation (ADDF), a nonprofit charity based in New York City, diversity is reflected in the research projects being funded there. "We're really seeing every type of different approach to Alzheimer's disease and related dementias," says **Lauren Friedman**, director of scientific affairs at ADDF. The areas being explored include the vascular system, epigenetics, neuroprotection, synaptic health, immunity and inflammation, and metabolic dysfunction, among others.

Neuroinflammation and proteostasis, or the management of proteins within cells, are trending areas of research in ADDF's portfolio. Researchers investigating proteostasis would like to find ways to boost the cell's "garbage disposal" systems, which identify misfolded, clumping proteins and chew them up for recycling.

Like other companies, Novartis is exploring targets in inflammation and the immune system. Dolmetsch notes that the field has just begun to sort through all of the activated inflammatory cells that show up in Alzheimer's patients' brains and to characterize their various states of activity and exhaustion. Exhausted microglia, the custodians of the brain, for example, start pumping out cytokines to call up more cells (T cells, B cells, macrophages), which leads to chronic inflammation.

Such an inflammation might be fine for a temporary response to an injury in, say, the finger. But as a chronic state, "it doesn't work so well in your brain," Dolmetsch says. For neuroinflammation projects, Novartis looks for scientists who have training with overlaps between neuroscience, immunology, and bioinformatics.

The George & Anne Ryan Institute for Neuroscience at the University of Rhode Island in Kingston investigates underexplored factors in brain health, including the roles of vasculature, immunology, and neuroinflammation as well as lifestyle and environment in Alzheimer's disease and other neurodegenerative disorders. Behavioral neuroscientist **John Robinson** works on rodent models of how exercise might play a role in modifying or preventing Alzheimer's. "The biggest risk factor for Alzheimer's is age," he notes, which is, unfortunately, not modifiable. "But we often say that what's good for the heart is good for the brain."

Another booming area of Alzheimer's research is the development of biomarkers and diagnostic tests to monitor disease presence and progression. Radioactive positron emission tomography (PET) tracers enable physicians to image and measure amyloid and tau proteins in the brains of living patients. Other biomarkers can be measured precisely from collecting cerebral spinal fluid. However, both types of tests are invasive, and PET scans are expensive.

"We need a blood test like [the one] we have for cholesterol that can be done in any doctor's office quickly and inexpensively," says Friedman. To spur such development, ADDF has teamed up with Bill Gates and other philanthropists to fund the Diagnostics Accelerator program. Friedman says the program anticipates awarding about $10 million in the first round of funding. So far it has funded projects for blood tests and tests that detect amyloid or vascular changes in the retina, and is reviewing applications for digital tests that use a smartphone or tablet to monitor disease signs or symptoms.

Big data requires big money

Dedicated Alzheimer's research funding levels have never been higher. "There has been a dramatic boost in funding during the last few years," says **Laurie Ryan**, chief of the Dementias of Aging Branch of the National Institute on Aging (NIA) in Bethesda, Maryland, adding that the U.S. National Institutes of Health (NIH) funding specifically for Alzheimer's and related dementias research has blossomed from around USD 440 million in 2011 to USD 2.3 billion this year.

In 2012, the United States launched the National Plan to Address Alzheimer's Disease and set a goal of treating and preventing Alzheimer's and related dementias by 2025. In support of the National Plan, NIH developed a research framework to enable the development of therapies for individuals at all stages of the disease. **Suzana Pentanceska**, director of the Office for Strategic Development and Partnerships in NIA's Division of Neuroscience, says the increased funding and new framework bring many opportunities for Alzheimer's researchers in both academia and small businesses—ranging from basic, discovery research to all stages of therapy development.

One of those opportunities, the Accelerating Medicines Partnership Alzheimer's Disease Project, or (AMP)-AD, is a public–private partnership that brings together six NIA-funded academic teams, four biopharmaceutical companies, and five nonprofit organizations. Co-led by Ryan and Petanceska, the five-year, USD 185 million collaboration is focused on the discovery of new therapies and biomarkers for Alzheimer's by harnessing the power of big data and enabling rapid data sharing.

NIA requires prepublication release of data to the wider research community through the AMP-AD Knowledge Portal and the associated web-based interactive platform Agora, where biologists can peruse 500 predicted target genes that one or more teams have identified to date as well as the data backing up those predictions.

There's no embargo on the secondary use of the data by other laboratories, says Petanceska, who leads the cont.>

Featured participants

AbbVie
www.abbvie.com

Accelerating Medicines Partnership Alzheimer's Disease Project (AMP-AD)
fnih.org/what-we-do/programs/amp-ad

Alzheimer's Drug Discovery Foundation (ADDF)
www.alzdiscovery.org

Alzheimer's Therapeutic Research Institute (ATRI)
keck.usc.edu/atri

Dominantly Inherited Alzheimer Network Trials Unit (DIAN-TU)
dian.wustl.edu

Eisai
www.eisai.com

George & Anne Ryan Institute for Neuroscience
www.uri.edu/uri-tv/george-anne-ryan-institute-for-neuroscience

National Institute on Aging
www.nia.nih.gov

Novartis
www.novartis.com

target discovery arm of the AMP-AD. "It's empowering young investigators to tap into resources that would take years for a single lab to generate," she says.

Similarly, ADDF has a partnership with Harrington Discovery Institute to help academic scientists spin their good ideas into drugs that could be tested in the clinic. Grant awardees, who receive up to USD 600,000 for two years, will be connected to industry consultants to help shepherd their research through drug discovery and preclinical phases to develop potential therapies.

Another innovative NIA translational program, the Alzheimer's Clinical Trials Consortium (ACTC), was launched in 2017 with nearly USD 70 million in support for five years, to accelerate studies of Alzheimer's and related dementia therapies. The ACTC helps researchers with new therapeutics connect to leading Alzheimer's clinical experts at 35 sites around the United States. The program solicits ideas first, and then, for those approved, collaboratively develops those ideas into a clinical trial NIA R01 grant application.

This effort also promotes open science with data-sharing requirements. For pivotal clinical trials, participants in the consortium are required to make their patient screening and prerandomization data available within 12 months of enrollment completion and to make their postrandomization data and biosamples available upon trial completion, regulatory approval, or within 18 months, whichever comes first. Making the data available not only honors trial participants, says Ryan, but gives the field much-needed information to solve an incredibly complex problem. "It's a heterogeneous disease and we need as many eyes on the data and as many minds focused on solving the problem as possible."

Pharmaceutical company Eisai brought Aricept,one of the first Alzheimer's drugs, to market; Eisai also has two anti-amyloid compounds in Phase III clinical trials and is investing in more research as well. In July, Eisai opened the Center for Genetics Guided Dementia Discovery, dedicated to exploratory immunodementia research. The facility, located in Cambridge, Massachusetts, will host 130 employees, including new hires, interns, and postdocs, and an incubator for Cambridge-based startup companies in neuroscience therapeutics.

McDade notes that there's a shortage of people with M.D./Ph.D.s who have the medical training necessary to do clinical research, run clinical trials, and develop appropriate diagnostic tests. He encourages any early-career researchers with an interest in the field to find collaborators. "It's extremely bullish—this is the time to come into the field."

Wanted: Diverse skills

With the emergence of so many new avenues of Alzheimer's studies, researchers can come from a wide variety of biomedical backgrounds, experts say. **Mike Gold**, vice president of neuroscience development at the biopharmaceutical firm AbbVie in North Chicago, Illinois, notes that his company and others working on solutions for Alzheimer's want to recruit from biology backgrounds in molecular genetics, systems biology, electrophysiology, cell biology, bioinformatics, and beyond. "Do you have an interest in radiochemistry to develop new diagnostic ligands? Are you someone who wants to develop animal models to look at protein transition?" he asks. "We have a place for you."

But the interdisciplinary and "collaboratory" nature of these projects requires that early-career researchers also "firm up their soft skills," says Petanceska. Young investigators working in large consortia who become versed in the various languages of computational biologists, clinicians, or drug discovery experts will be better placed to contribute to projects and eventually lead teams. Friedman agrees that researchers must have strong communications skills. Any scientist should be able to boil down the complexity of their project into why it's important for funders, investors, other scientists, and the public in a honed elevator pitch.

"Collaboration has been essential, and it's going to be even more so," says Robinson. He advises graduate students and postdocs to practice the art of collaboration early. **Neriman Botas**, Eisai's executive vice president of human resources and corporate communications in Woodcliff Lake, New Jersey, says that one way to practice collaboration is to have a "beginner's mindset" when you are in a meeting. "That means you focus more on what you don't know, no matter how much of an expert you are, [and try] to ask questions and be tolerant and respectful when seeking input from others."

Similarly, Novartis, recruiters look for emotional resilience in workers. These are key qualities for a field where most things fail and often fail big, says Dolmetsch.

Botas encourages candidates to be prepared for "behavioral interviewing"—that is, to have anecdotes and examples ready that show how they persisted to overcome a problem in their graduate or postdoctoral work, or how they worked collaboratively in a team or drew on others' expertise to get things done.

Gold notes that despite the above-average dose of scientific frustration faced by Alzheimer's researchers, there is a bit of a trade-off for them. "You get to work alongside extraordinary people fighting the battle," he says. "We need creative scientists willing to bring different ideas to the table and try radically different approaches. That takes people with courage and a sense of adventure."

Kendall Powell is a freelance science writer based in Lafayette, Colorado.