Research milestone
By Professor Chennupati Jagadish

Dementia Australia™
Research Foundation

> **The first step in finding a cure or treatment for any disease is its understanding.**
>
> - Professor Chennupati Jagadish, AC

Scientists grow mini brains from stem cells in the quest to understand Alzheimer's disease

What was the focus of the research?

Professor Jagadish combined technologies in stem cell research with artificial intelligence to grow mini brains, which they used to better understand the function of a healthy brain versus the brain of someone living with dementia.

Why was it important?

The results of this cutting-edge project are expected to open a new chapter for therapeutic treatment of Alzheimer's disease – the most common form of dementia. Alzheimer's disease is a neurodegenerative disease that steals memories from people and causes significant heartache for family and friends in the process. It can also affect behaviour, language, judgement, mood, emotion, attention and thinking.

The fact that we know so little about such a devastating disease, and that it has no treatment, prevention or cure, can be difficult for families to come to terms with. Professor Jagadish brought together an incredibly diverse team to tackle this highly ambitious project. It consisted of early and mid-career researchers across neuroscience, stem cell biology, nanotechnology and computer science, who all worked towards a common goal.

How did it happen?

Stage 1: stem cells were generated from living people with and without Alzheimer's disease and used to grow a brain organoid, aka, mini brain.

Stage 2: those stem cell-derived mini brains were studied closely, as they essentially modelled brain function.

Stage 3: artificial intelligence-based analyses were used to identify key functional differences between normal and Alzheimer's disease mini brains, and to predict stimulation parameters that may promote normal brain function.

What were the results?

- Identification of differences between Alzheimer's disease and non-diseased neurons, and how alterations affect the communication between brain neurons.
- New insights into how microglia, the brain's immune cells, function in Alzheimer's disease.
- Development of innovative bioengineering technologies to measure how neurons generated from stem cells and cultured in a dish can form networks and send signals to each other, which somewhat mimics brain connectivity.

What are stem cells?

Stem cells have unique characteristics that make them invaluable in the medical field. They can become many different cell types during growth and divide (in-effect, double) almost limitlessly, to repair other, damaged cells.

These characteristics mean that when stem cells divide, one part can become a cell type that repairs damage, while the other remains a stem cell and continues dividing. This makes them very useful for building tissue.

What does this mean for the future?

- A greater understanding of Alzheimer's disease.
- A strategy for diagnosis and treatment of Alzheimer's disease. If an epigenetic mechanism goes wrong during cell division, it can cause disease.

Who undertook the research?

Professor Chennupati Jagadish AC, Australian National University

Professor Jagadish is a distinguished professor at the Australian National University's Research School of Physics. He was the founding director of the Australian National Fabrication Facility, ACT node (2007-2020) and convenor of the Australian Nanotechnology Network. Professor Jagadish is the current president of the Australian Academy of Science and served as president of the IEEE Photonics Society (2018, 2019) and Australian Materials Research Society.

He holds honorary appointments at various institutions in India, China, Japan, UK and USA, and has received countless awards and fellowships in Australia. In 2016, Professor Jagadish received Australia's highest civilian honour, Companion of the Order of Australia (AC) for eminent service to physics and engineering, particularly in the field of nanotechnology.

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The title of Professor Jagadish's project is *Use of brain organoids and artificial intelligence for understanding dementia.*