Breaking the Barrier of Neuroscience Research with Advanced Cell Models

Neurodegenerative diseases like Alzheimer's and Parkinson's affect millions globally, yet effective treatments remain elusive. Traditional research paradigms, animal models and 2D cell cultures, fail to predict therapeutic response in humans accurately.

This infographic explores how advanced cell models, including induced pluripotent stem cells (iPSCs) and 3D organoids, are breaking through barriers in neurodegenerative disease research by providing human-relevant platforms that overcome traditional limitations and improve understanding of these diseases and potential therapies.

Why traditional models fall short

Conventional approaches to neuroscience research face critical limitations, as they often miss the complex cellular interactions that drive neurodegenerative disease progression and drug response.

Animal Models:

- Species differences in brain structure and BBB composition
- Poor translation to human clinical outcomes
- Limited ability to model patient-specific disease
- Ethical concerns and regulatory pressure

2D Cell Cultures:

- Lack of 3D architecture
- Missing cell–cell and cell–matrix interactions
- Oversimplified representation of brain tissue
- Limited electrical network formation

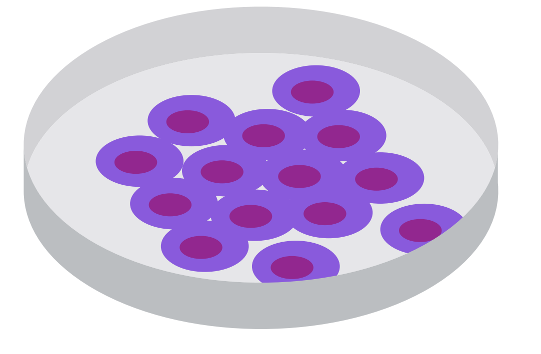
The impact

- Low predictability of drug efficacy and toxicity
- Wasted time, resources and funding
- Delayed therapeutic breakthroughs for patients

The power of advanced cell models

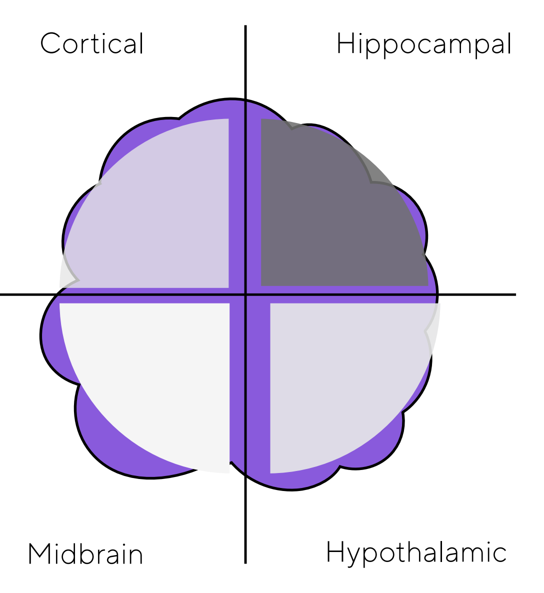
The latest brain organoid models display cellular composition and organization that simulate the developing and diseased human brain *in vivo*.[1] This gives them the power to overcome the limitations of traditional models.

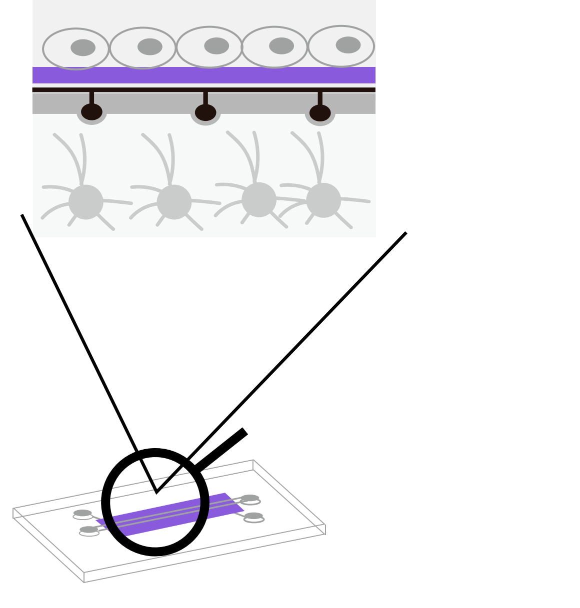
The latest cell models are derived from iPSCs



Cerebral Organoids ("Mini-Brains")

- Self-organizing 3D structures
- Derived from human iPSCs
- Recreate brain architecture with regional specificity



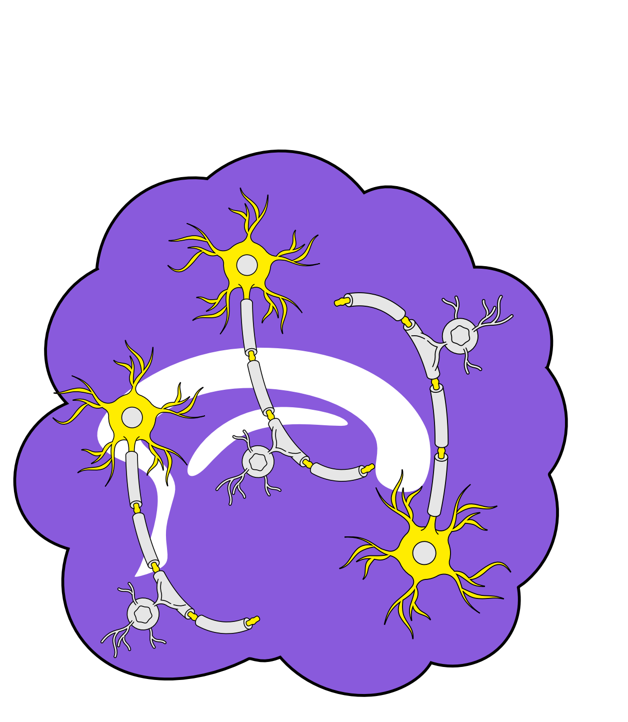


Blood–Brain Barrier (BBB) Models

- 3D microfluidic systems combining endothelial cells, pericytes and astrocytes
- Replicate selective permeability and transporter functions
- Critical for drug penetration studies

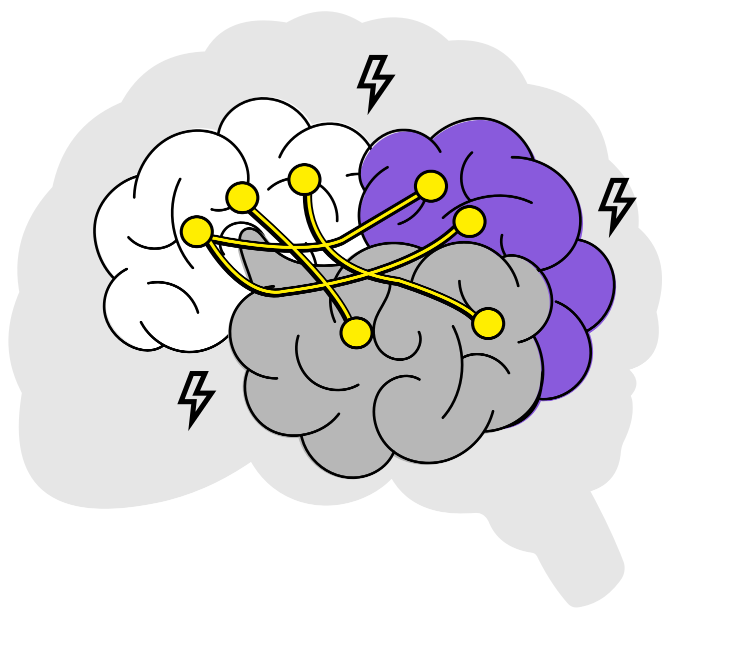
Neurospheroids

- Simpler 3D aggregates with controlled composition of neurons, astrocytes, microglia and oligodendrocytes
- Ideal for high-throughput screening and toxicity testing



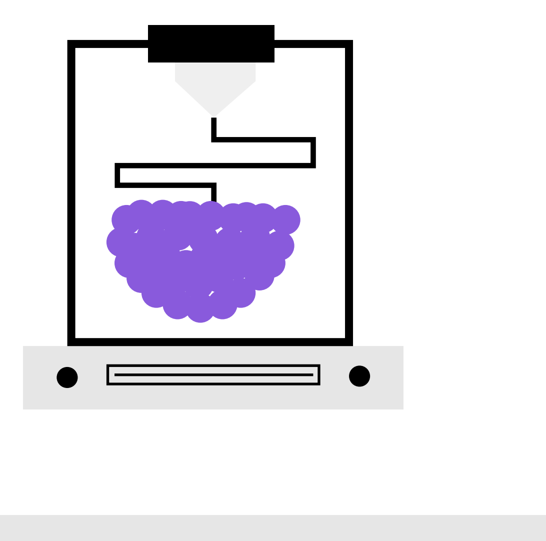
Assembloids

- Multiple organoids fused together to model circuit formation and connectivity
- Examples include cortical-spinal cord assembloids for motor circuit studies and cortico-striatal connections in Huntington's disease research



Bioprinted Neural Tissues

- Precisely patterned tissues with multiple cell types in customizable, layer-specific neuronal organization
- Emerging models enable patient-specific disease modeling with controlled vasculature



The effect

- More accurate efficacy/toxicity ratios
- Improved understanding of polypharmacology
- Reduces animal model use by >80% through longitudinal studies

The Sartorius advantage

Sartorius provides integrated solutions for advanced cell model research. From iPSC culture to functional characterization, Sartorius platforms enable comprehensive analysis of complex cell models. While Incucyte® Live-Cell System monitors intact organoids over time non-invasively, iQue® High-Throughput Screening (HTS) by Cytometry delivers cellular heterogeneity data through high-throughput cytometry analysis. This complementary approach enables data integration, allowing researchers to correlate single-cell states with organoid-level function.

Optimized culture systems:

- High-quality growth factors and cytokines for reproducible iPSC culture
- Specialized media formulations (NutriStem® hMSC XF)
- Animal-free reagents for consistent, scalable results (NexaGel®).

Real-time analysis:

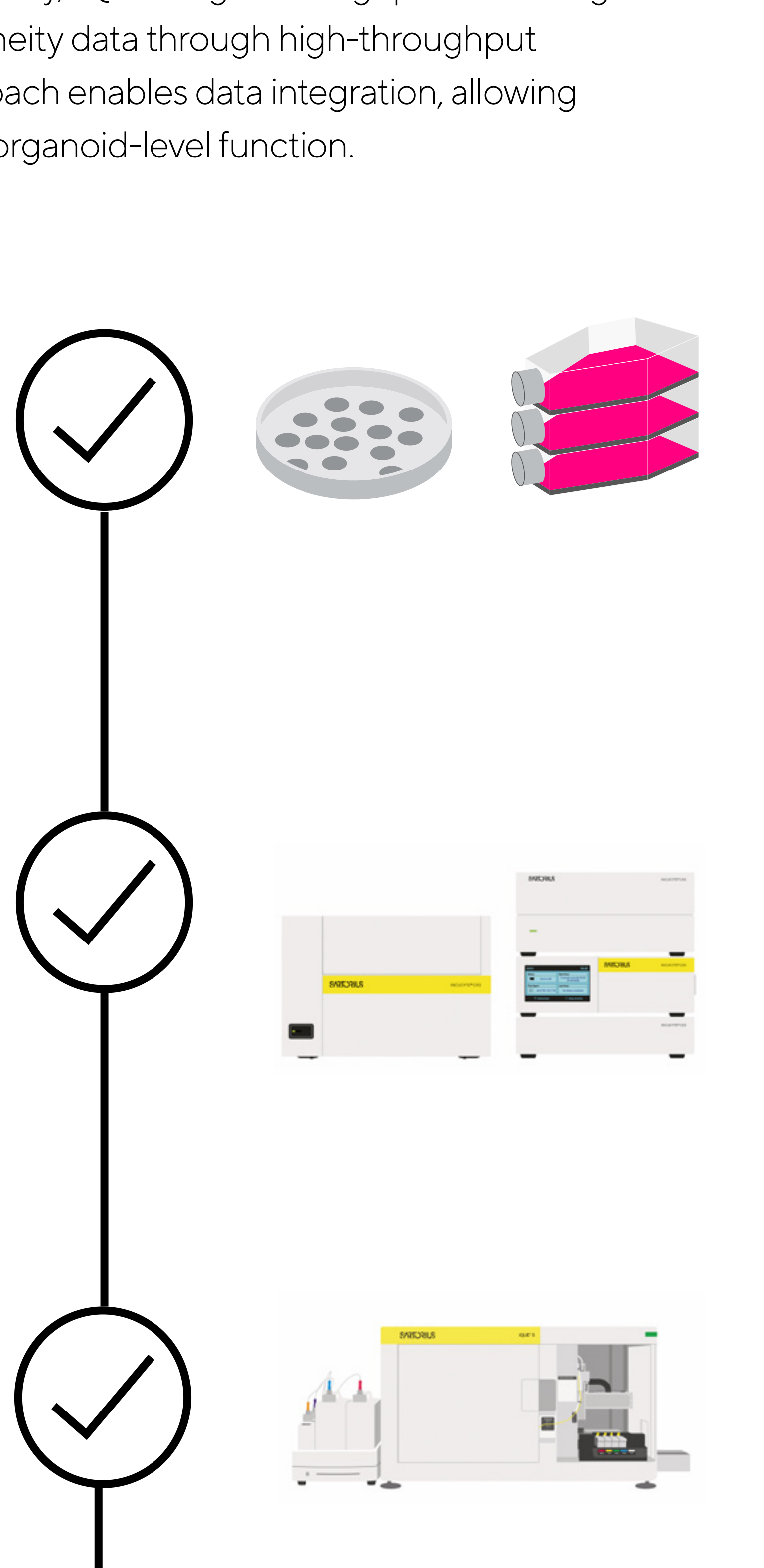
- Incucyte® Live-Cell Analysis System for continuous, non-invasive monitoring of cell health, morphology and function within the incubator
- Label-free quantification of organoid growth, AI-powered phenotyping, morphology and viability
- Assessment of neuronal activity, differentiation, synapse formation and network complexity

High-throughput characterization:

- iQue®5 Cytometry Platform for high-throughput, multiplexed marker expression analysis and neural subtyping
- Minimal sample requirements preserve precious cells
- Secreted protein analysis for inflammatory responses

Standardized workflows:

- Validated protocols for iPSC maintenance and differentiation
- Integrated analysis software for objective quantification
- Scalable approaches from research to production



Ready to advance your neuroscience research?

Explore our integrated solutions today at sartorius.com

References

1. Sainz A, Pérez-Cerdá F, Pérez-Samartín A, Panicker M, Ruiz A, Matute C. Pros and Cons of Human Brain Organoids to Study Alzheimer's Disease. *Aging Dis.* 2025;16(6):3483–3504. doi: 10.14336/ad.2024.1409