# Team 18: Microfabricated Scaffold for Stem Cell Derived Neural Organoid in Epilepsy Therapy

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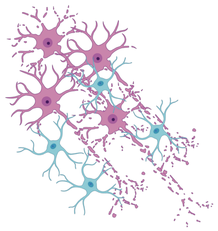
## Healthcare problem

- Epilepsy is the 4th most common neurological disorder that causes seizures.
- Current treatments:
  - Sometimes ineffective
  - Mainly provide symptomatic relief
- Long term use of treatments limited
  - Present severe side effects
  - Economic burden on patients
- Current models for epilepsy
  - In vivo rodent models have lower accuracy in humans
  - 2D cell culture cannot mimic brain architecture

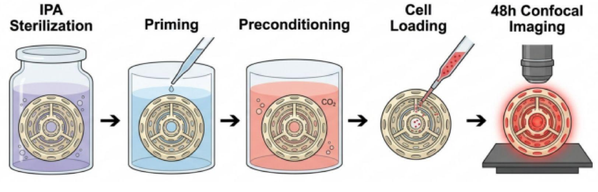


## Design Concept

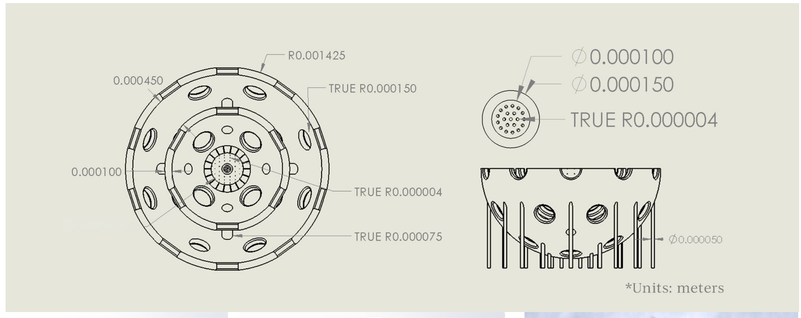
- Model epilepsy in vitro using cortical organoids
  - Pluripotent stem cells (PSCs) that will differentiate into cortical organoids
- Challenges presented for organoid models
  - Necrotic core development
  - Limited maturation
- **Design a scaffold to support cortical organoid development**
  - Porous inner media reservoir with tubes to the exterior
  - Concentric layers for cell adherence and self-organization
  - Pores between layers for cell growth throughout

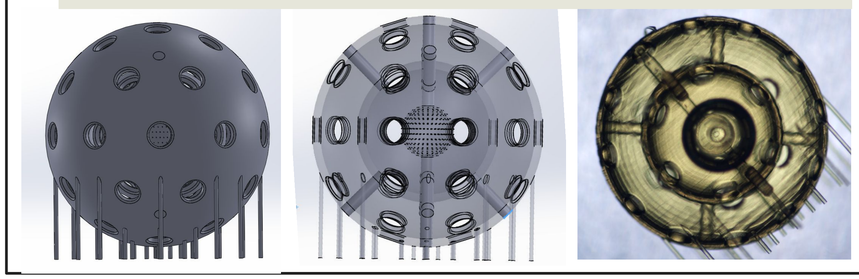
## Methods

- SolidWorks design of prototype
- Fabrication using UpNano NanoOne 3D printer with UpPhoto
- Priming of scaffold in extracellular matrix (ECM)
- Submerge scaffold in cell suspension for culture initiation
- Live imaging and multielectrode array tracking
  - 2-3 weeks of cell growth
  - Functionality tested after 100 days
- Testing considerations
  - Cell viability, self-organization, functionality




## Prototype



## Results

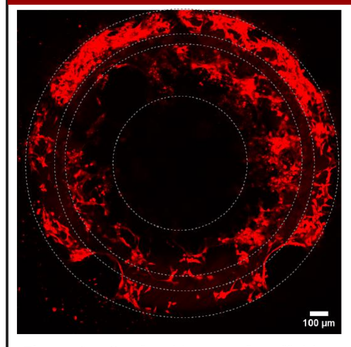



**Figure 1a.** Confocal image of scaffold with mCherry-expressing cells.

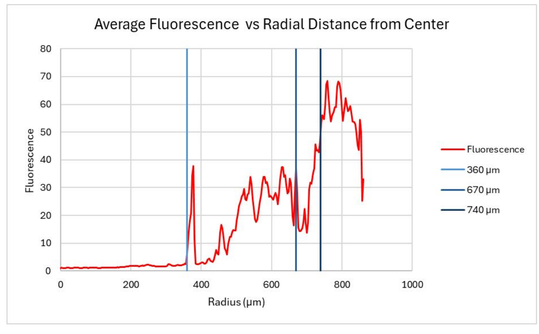



**Figure 1b.** Quantified measurements of cell integration in the concentric layers of the scaffold by radial distance in µm.

- Confocal microscopy shows cell integration based on fluorescence from mCherry expression (Figure 1a).
- Figure 1b shows the average cell presence as a function of radial distance from scaffold center
- Processed fluorescent images of individual layers of scaffold in Figure 1c confirm proper cell seeding

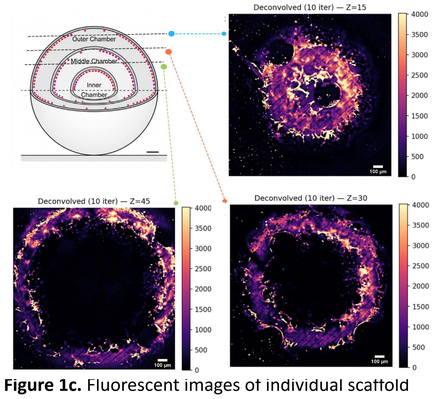



**Figure 1c.** Fluorescent images of individual scaffold layers to confirm cell seeding.

## Conclusions

- Validated 3-D printing process
  - Optimized dimensions to adapt both cell diffusion and printer objective requirements
  - Scanning electron microscopy confirmed intended dimensions of prototype
  - Post processing to remove excess resin successful
- Hashimoto-Torii Laboratory procedure to sterilize, prime, and initiate the PSC culture proved effective
- Scaffold shape supports cell viability and growth
  - Evidence of cell growth on each layer of the structure

## Future Work

### Short-term

- Optimize scaffold to achieve greatest nutrient diffusion
- Establish that scaffold can support full differentiation into cortical neuronal tissue, shown by gene expression
- Develop biodegradable scaffold to better model neuronal tissue and support growth

### Long-term

- Develop epilepsy therapies based on studies of reliable organoid models
  - Test novel therapeutics
  - Potential for implantation of healthy neuronal tissue

## Bioethical Implications

### Pro

- In vitro model avoids animal model use
- PSCs provide an alternative to embryonic stem cells

### Con

- Tumorigenicity: PSCs could potentially differentiate into mutant cells

## References

1. "Animal Models of Epilepsy." *ScienceDirect*, Elsevier, www.sciencedirect.com/topics/medicine-and-dentistry/animal-models-of-epilepsy. Accessed 27 Apr. 2026.
2. Centers for Disease Control and Prevention. (n.d.-d). Epilepsy facts and stats. Centers for Disease Control and Prevention. https://www.cdc.gov/epilepsy/data-research/facts-stats/index.html
3. Examining the economic impact and implications of epilepsy | AJMC. (n.d.-b). https://www.ajmc.com/view/examining-the-economic-impact-and-implications-of-epilepsy
4. Place, T. L., Domann, F. E., & Case, A. J. (2017). Limitations of oxygen delivery to cells in culture: An underappreciated problem in basic and translational research. Free radical biology & medicine, 113, 311–322. https://doi.org/10.1016/j.freeradbiomed.2017.10.003
5. Wahab A. Difficulties in Treatment and Management of Epilepsy and Challenges in New Drug Development. Pharmaceuticals (Basel). 2010 Jul 5;3(7):2090-2110. doi: 10.3390/ph3072090. PMID: 27713344; PMCID: PMC4036655.
6. What is epilepsy? | epilepsy foundation. (n.d.). https://www.epilepsy.com/what-is-epilepsy