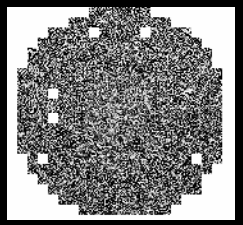

Challenges and Opportunities for Applied Nanotechnology to the Regeneration of the Central Nervous System

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Departments of Bioengineering and Ophthalmology,
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University of California, San Diego

A Working Definition of Nanomedicine

Understanding, preventing, and treating diseases using tools, materials, and approaches that take advantage of and operate at the nanoscale.

(NIH Nanomedicine Roadmap Initiative meeting, May 4, 2004)

Model of Applied Nanotechnology to Medicine and Physiology

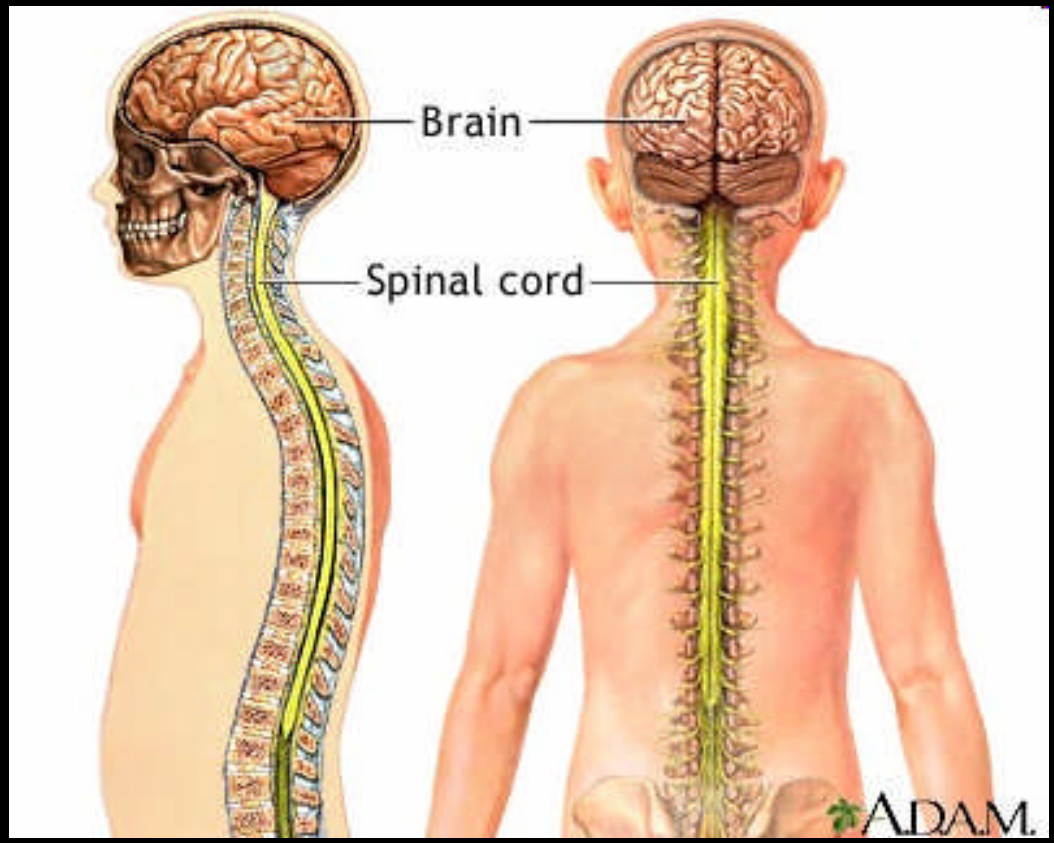
Nanoscience and Nanotechnology

Biology, Physiology, and Medicine

Our research group focuses on experimental and theoretical neural bioengineering aimed at increasing our fundamental understanding of neuroscience and developing new approaches for the clinical regeneration of the neural retina and central nervous system (CNS).

We approach this, in part, through the development and application of targeted nanotechnologies.

The Central Nervous System (CNS)



National Library of Medicine- www.nlm.nih.gov

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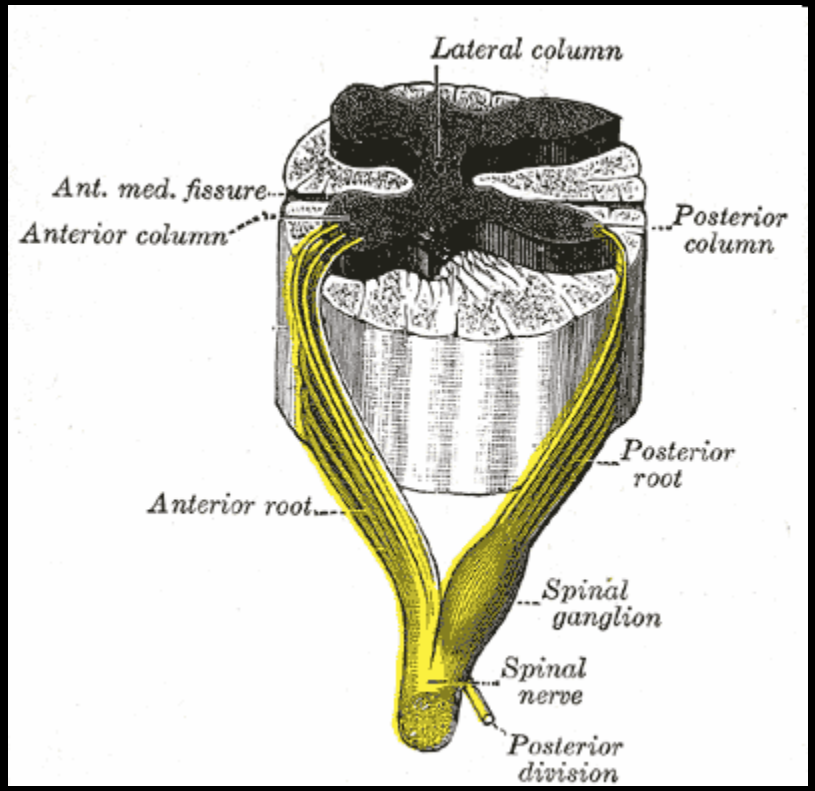

Gray's Anatomy Online- http://www.bartleby.com

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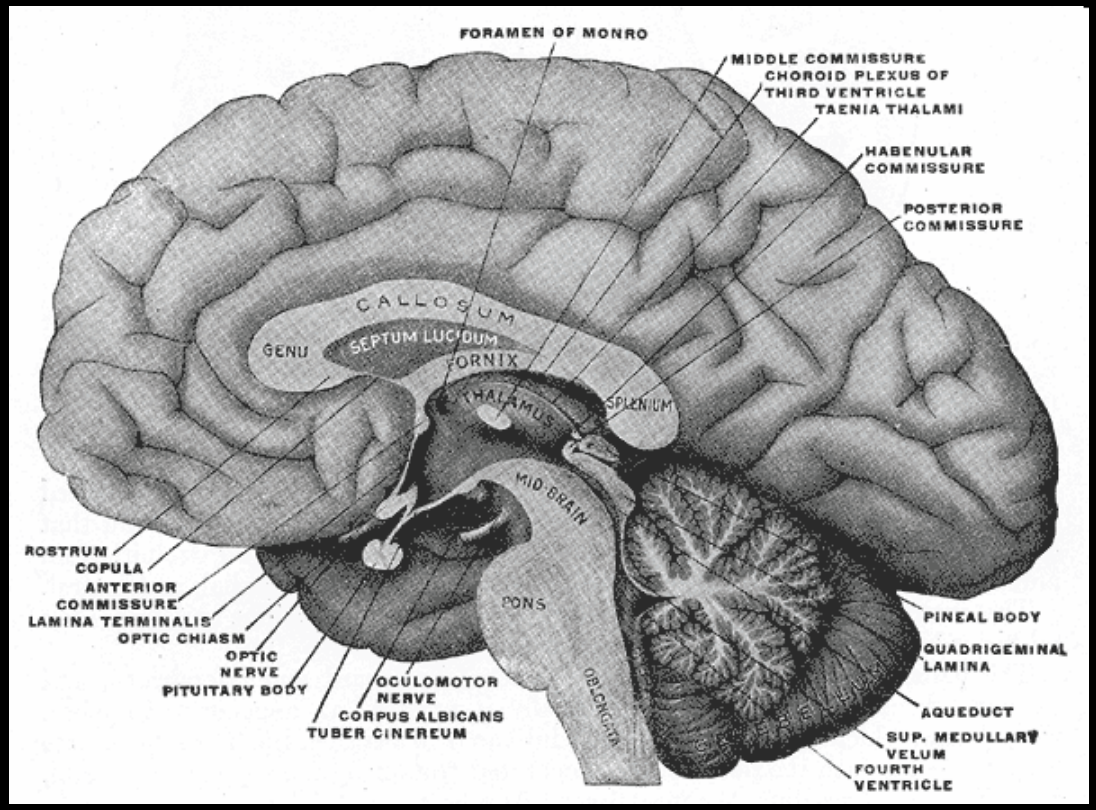

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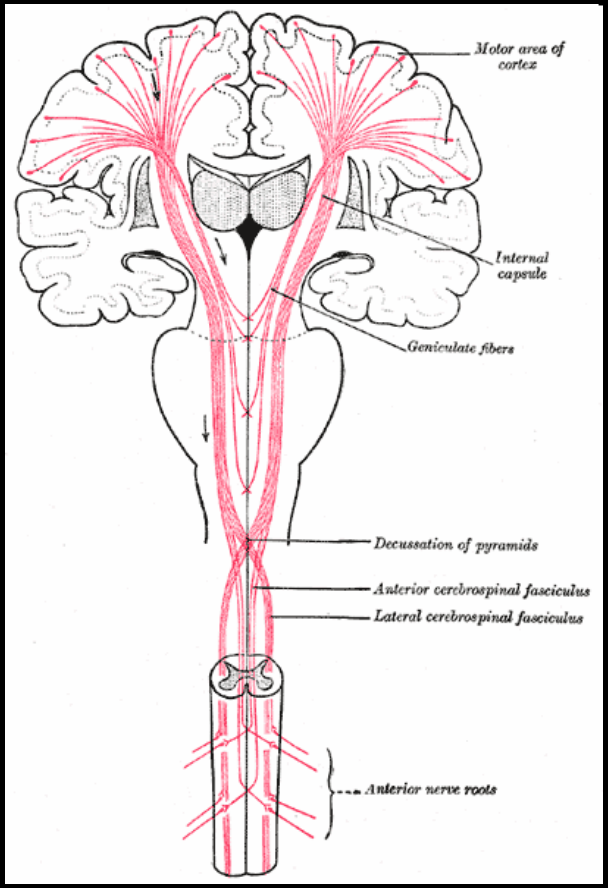

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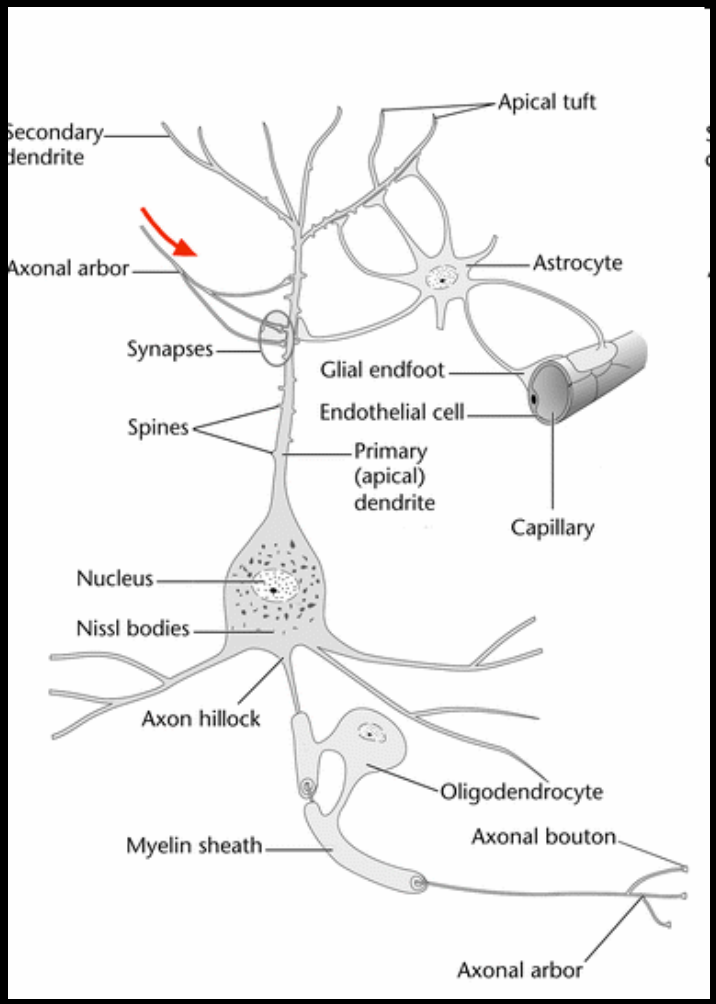
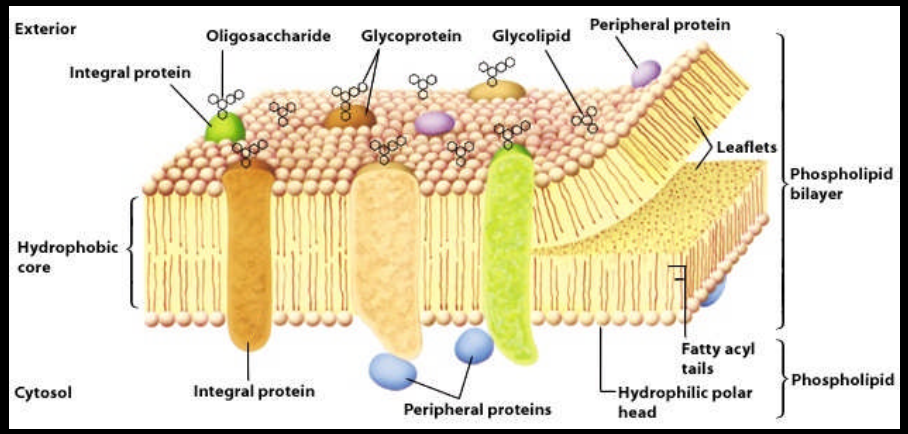
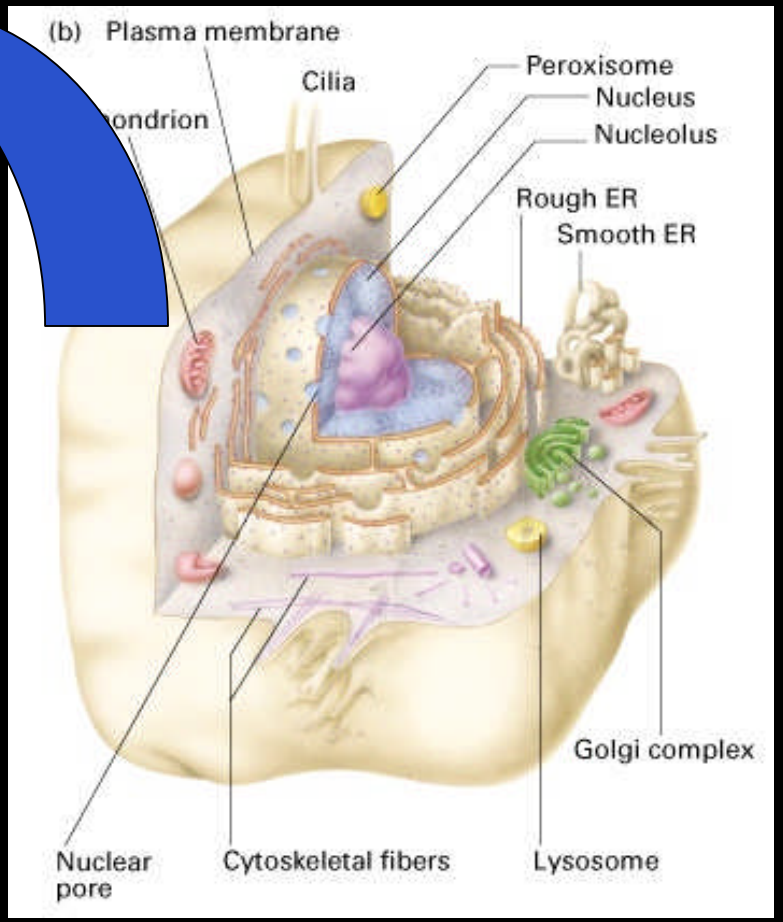


Nature Encyclopedia- http://www.els.net

The Cellular and Sub-Cellular Scales





Challenges faced by CNS Nanotechnologies

1. Integration with a highly specialized extracellular environment

2. Targeting to specific molecular elements (e.g. receptors, other proteins), in particular intracellular targets

3. A very heterogeneous cellular environment

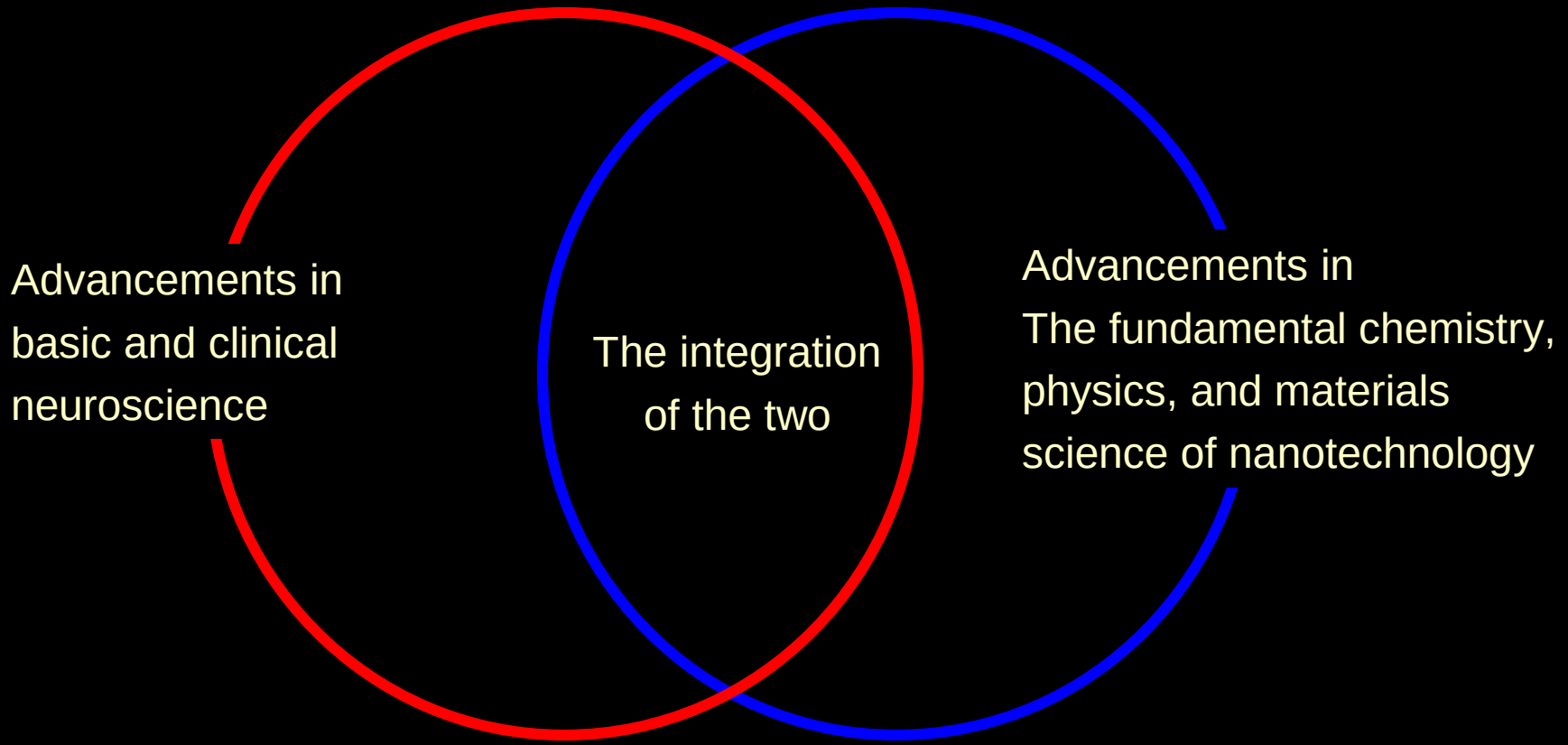
3. Highly restricted anatomical access

4. The complexity of the CNS's functional "wiring"

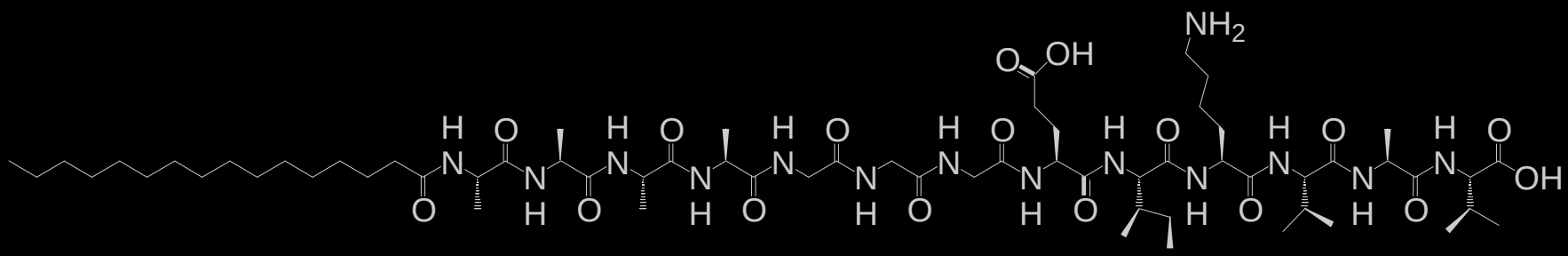
5. Multiple specific targeted effects and/or responses

6. Optimization of desired integrated responses and minimization of local and systemic "side effects"

The Successful Development Of CNS Nanotechnologies



Neural Specific Bioactive Peptide Amphiphile Networks

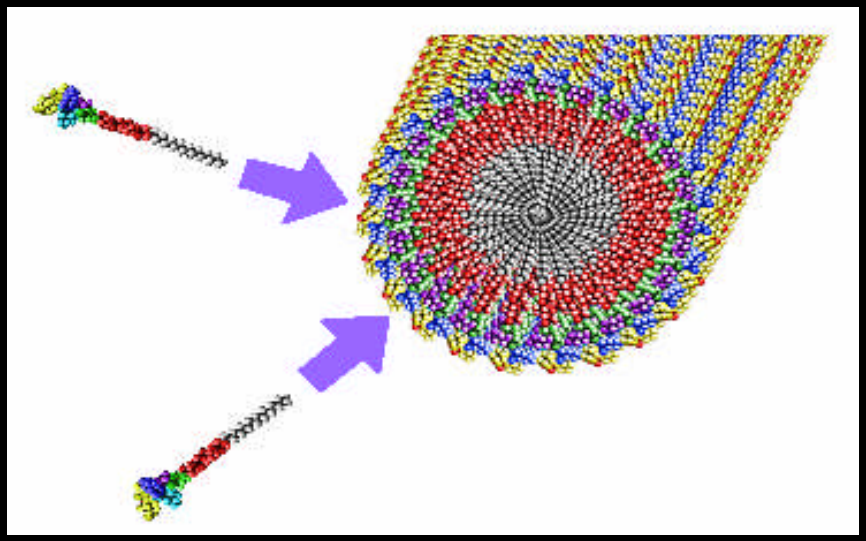


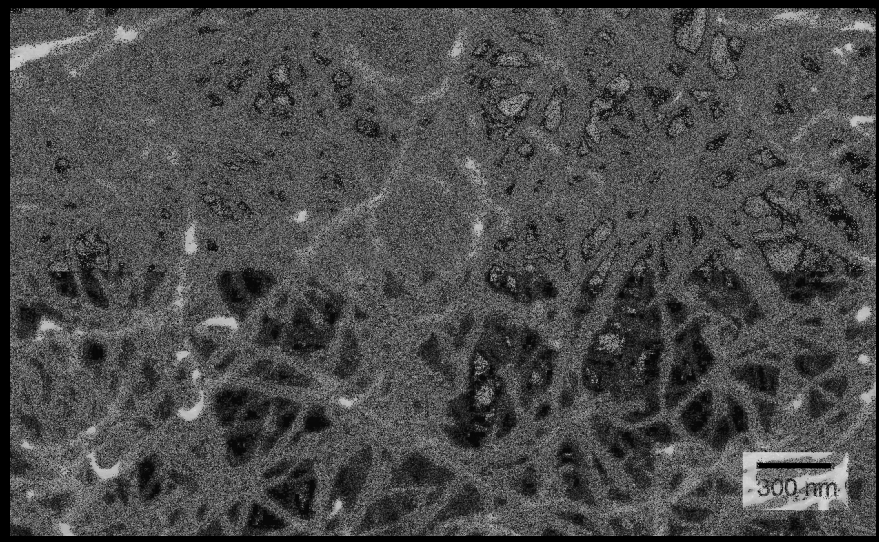
$C_{16}H_{31}O$-NH-AAAAGGGEIKVAV-COOH

Hydrophobic Tail Spacer Region Functional Peptide Region

Stupp Research Group, Northwestern University- Jeffery Hartgerink and Elia Beniash

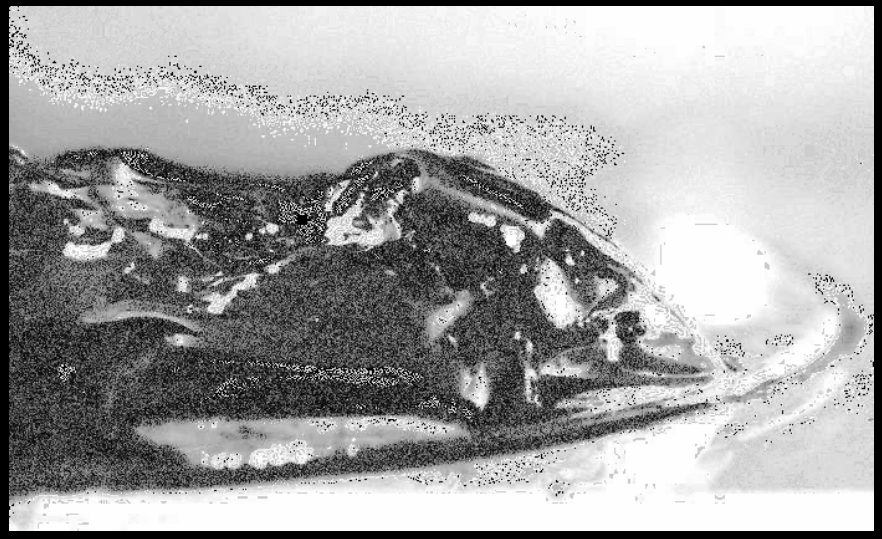
Neural Specific Bioactive Peptide Amphiphile Networks

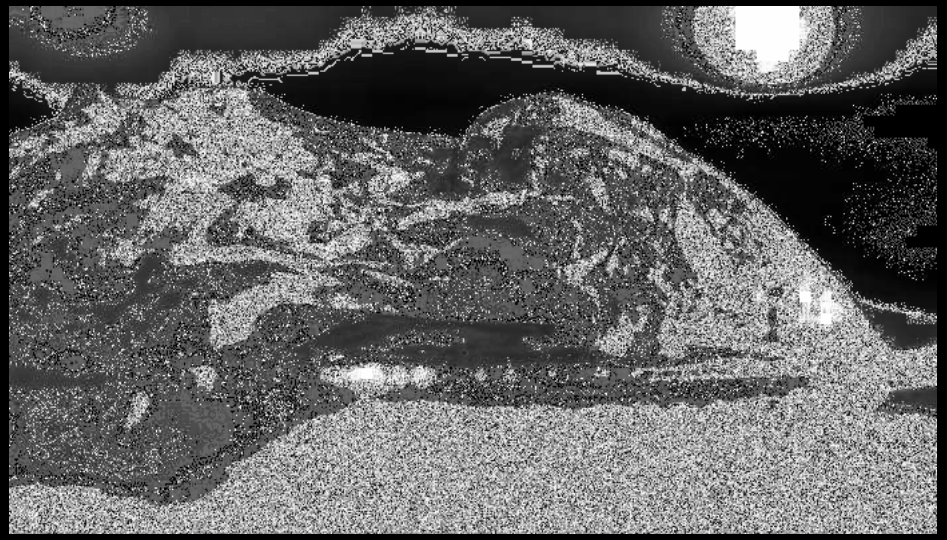




Stupp Research Group, Northwestern University- SEM by Dan Harrington

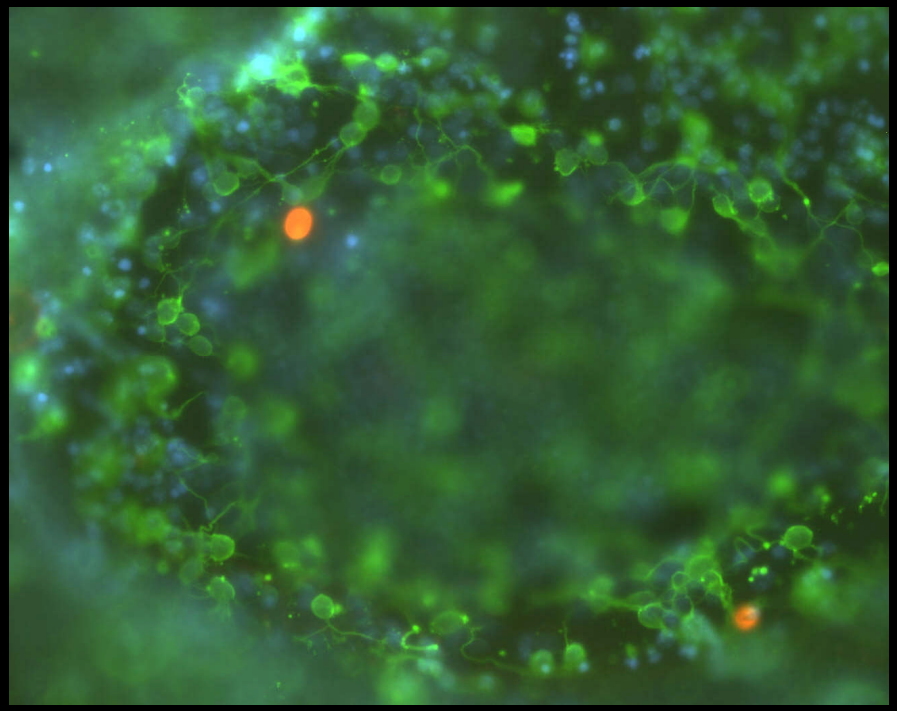
Neural Specific Bioactive Peptide Amphiphile Networks

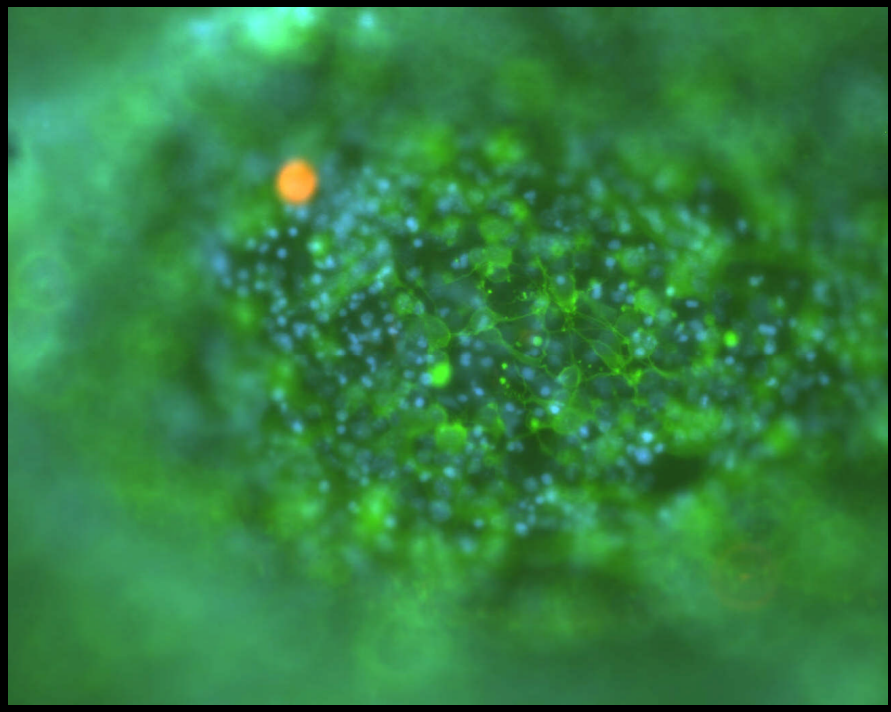




Stupp Research Group, Northwestern University- Gabriel Silva

Neural Specific Bioactive Peptide Amphiphile Networks





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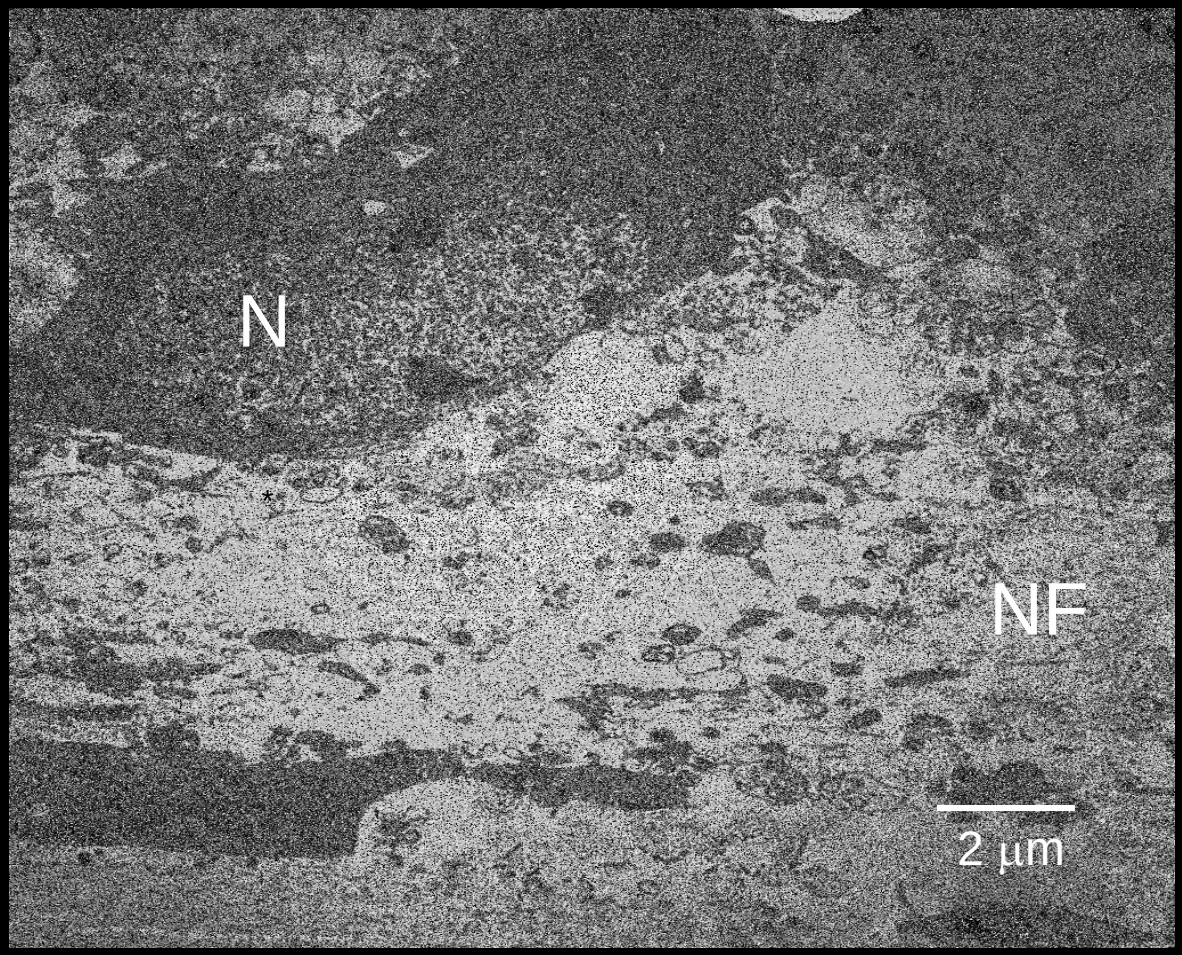
Neural Specific Bioactive Peptide Amphiphile Networks



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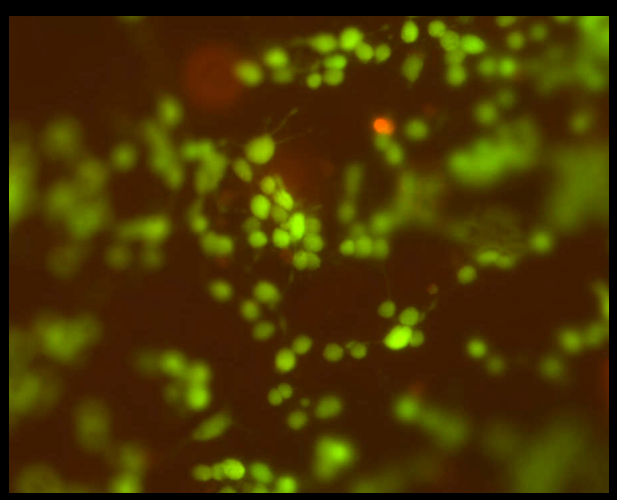
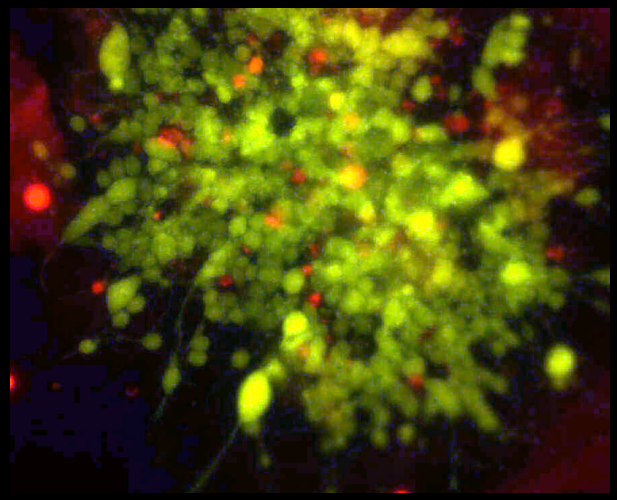
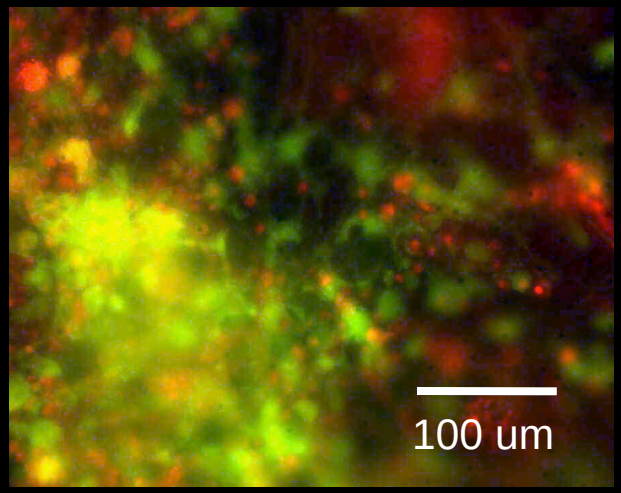
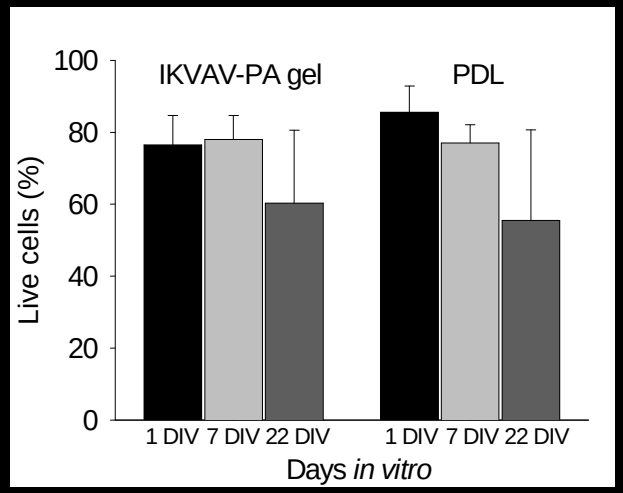
Neural Specific Bioactive Peptide Amphiphile Networks: Cell Viability/Cytotoxicity









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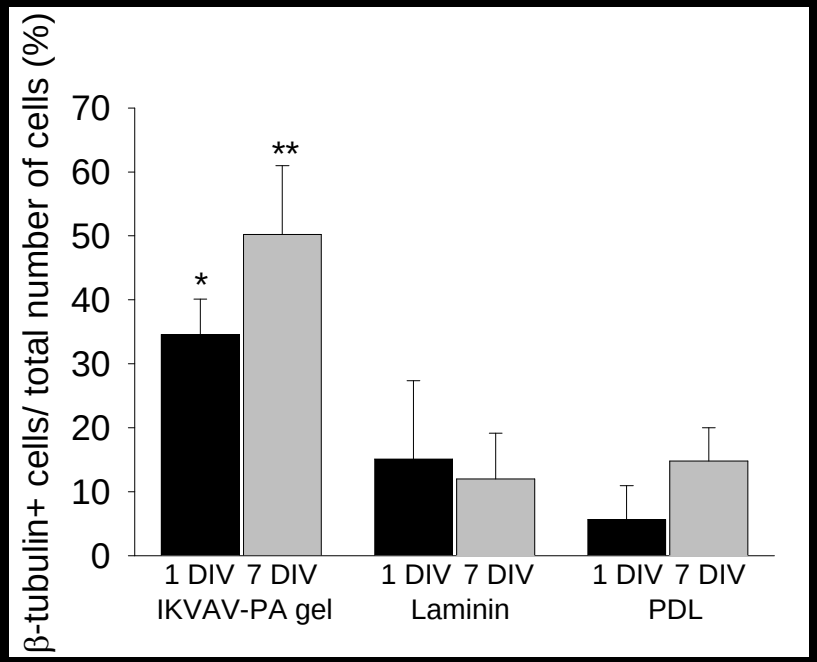

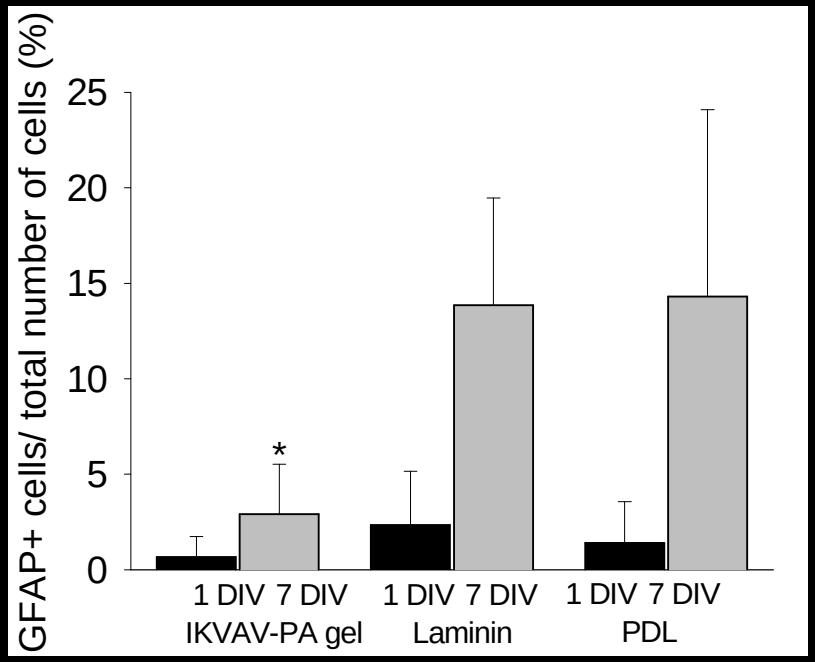

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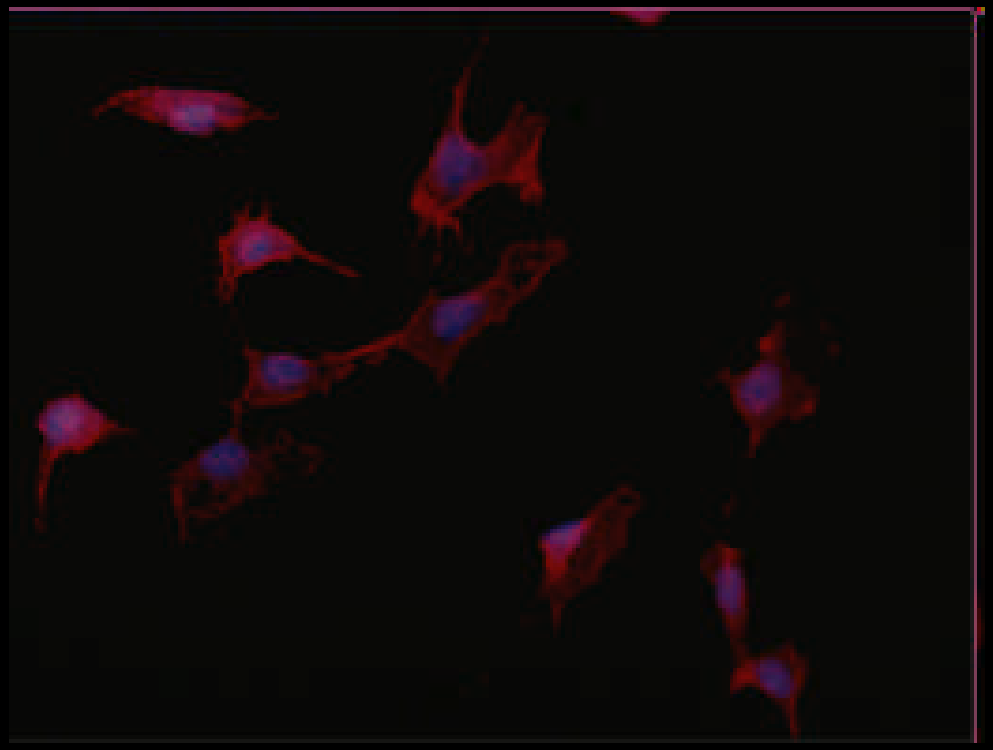
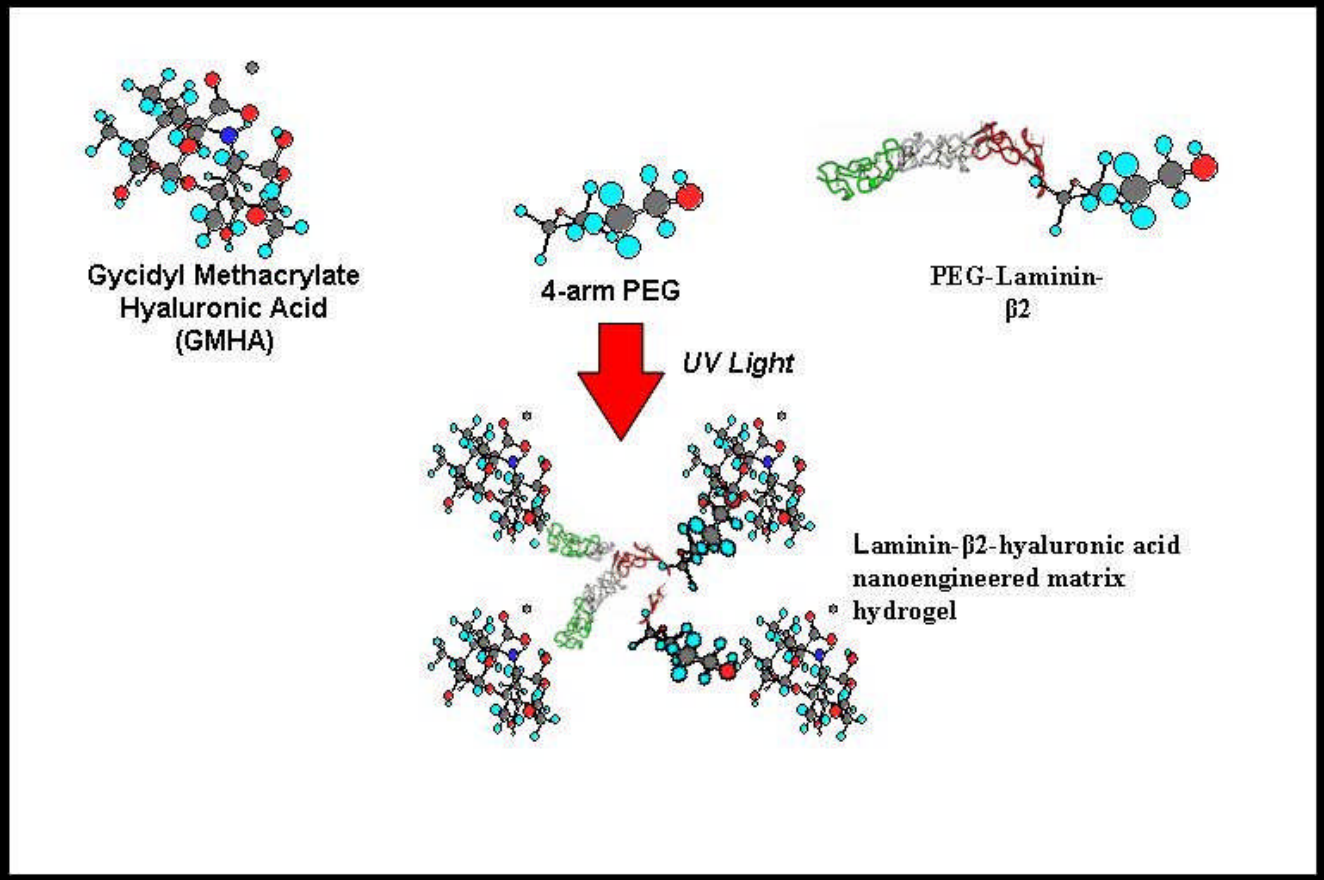
Nanoengineering Mesenchymal Stem Cells Differentiation into Photoreceptor Neurons



Silva Research Group, UCSD- Diana Yu and Mai Ho

Nanoengineering Mesenchymal Stem Cells Differentiation into Photoreceptor Neurons

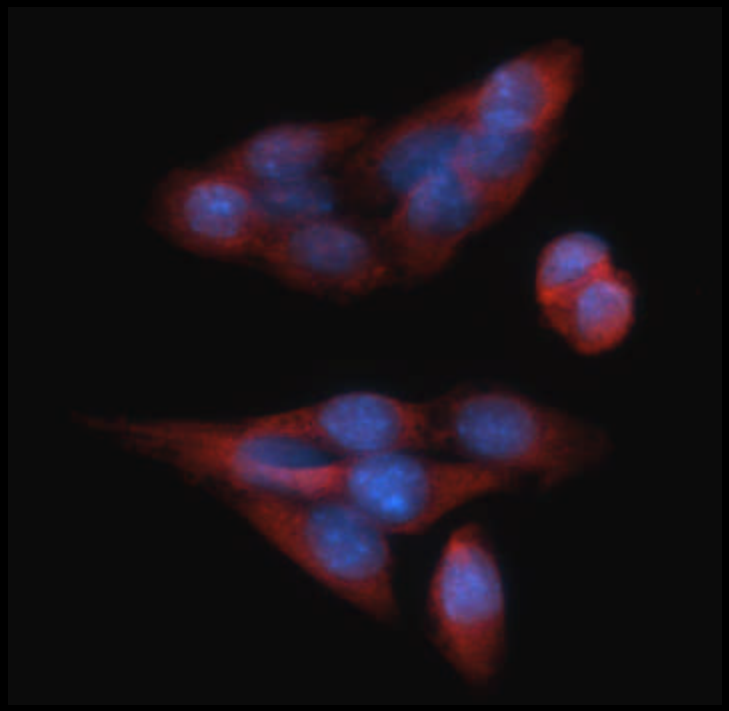


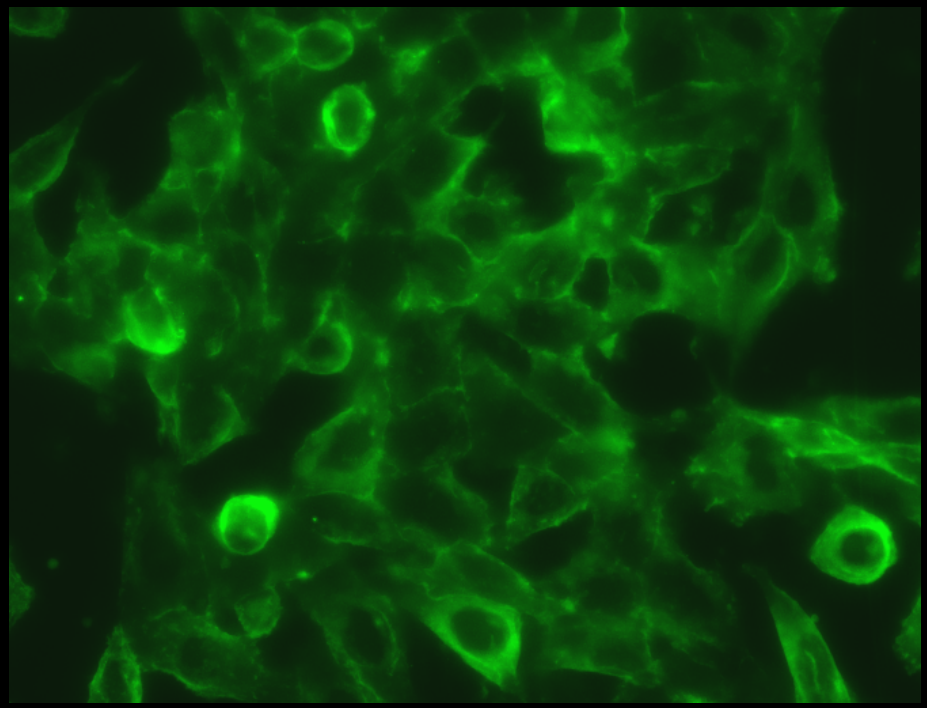
Silva Research Group, UCSD- Diana Yu and Mai Ho

Functionalized Quantum Dot Targeting of Reactive Gliosis

Silva Research Group, UCSD- Smita Pathak

Functionalized Quantum Dot Targeting of Reactive Gliosis

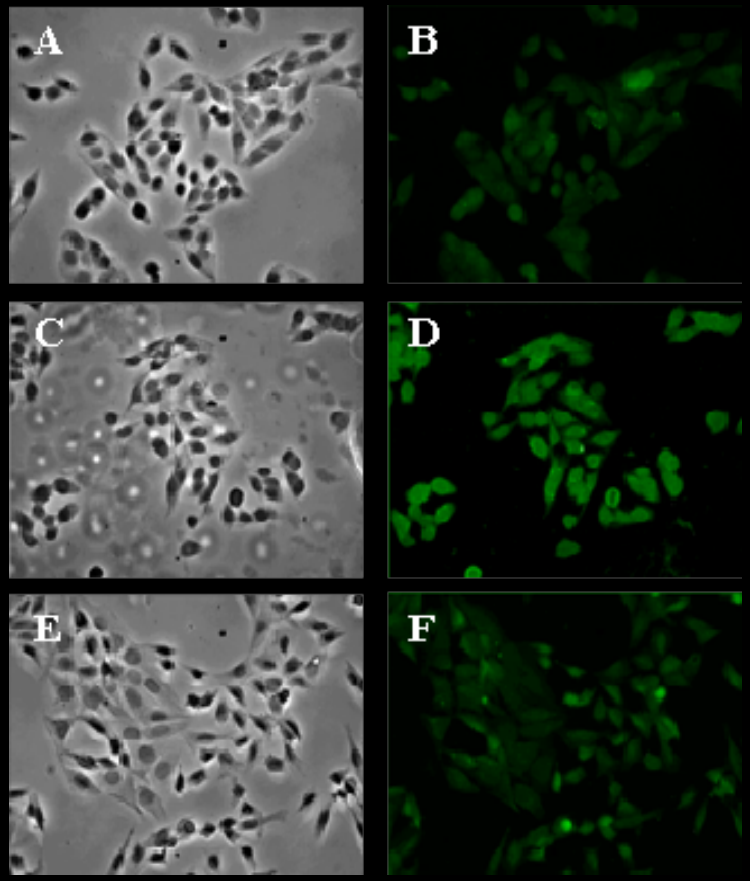




Silva Research Group, UCSD- Smita Pathak and Julie Schallhorn

Functionalized Quantum Dot Targeting of Reactive Gliosis

Culture model of reactive gliosis

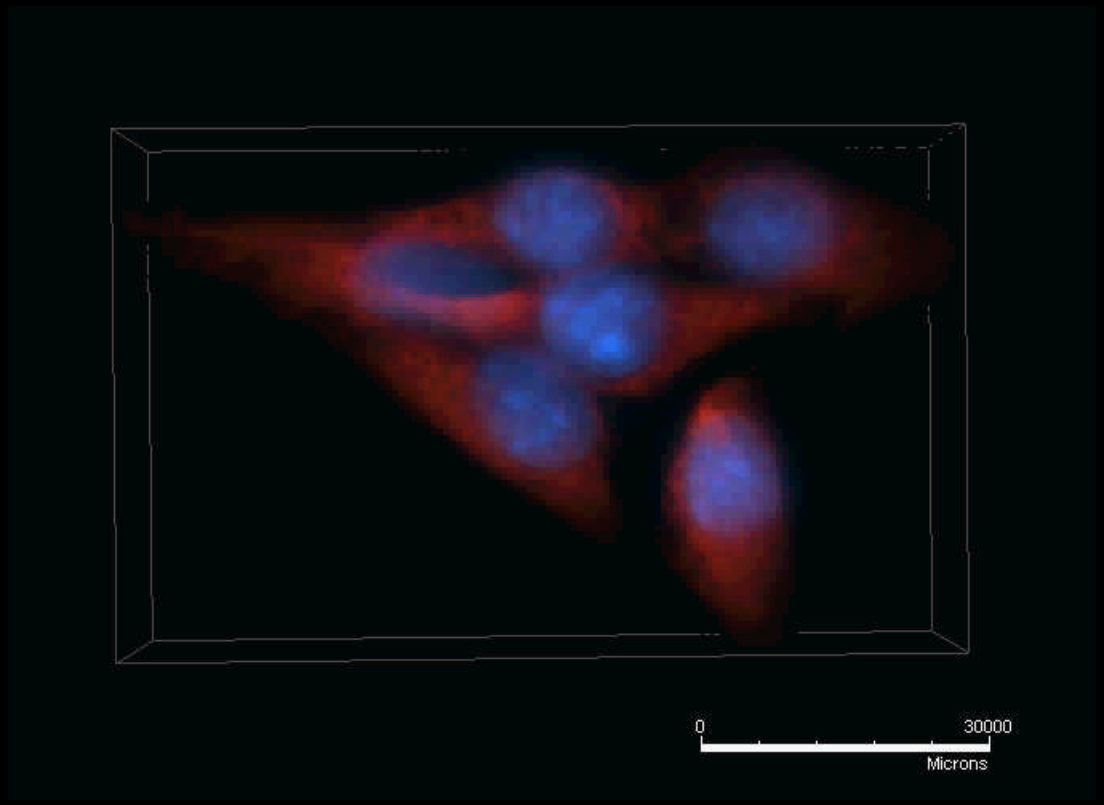


Untreated retinal glial cells

Ouabain treated retinal glial cells

Secondary treated retinal glial cells

Functionalized Quantum Dot Targeting of Reactive Gliosis



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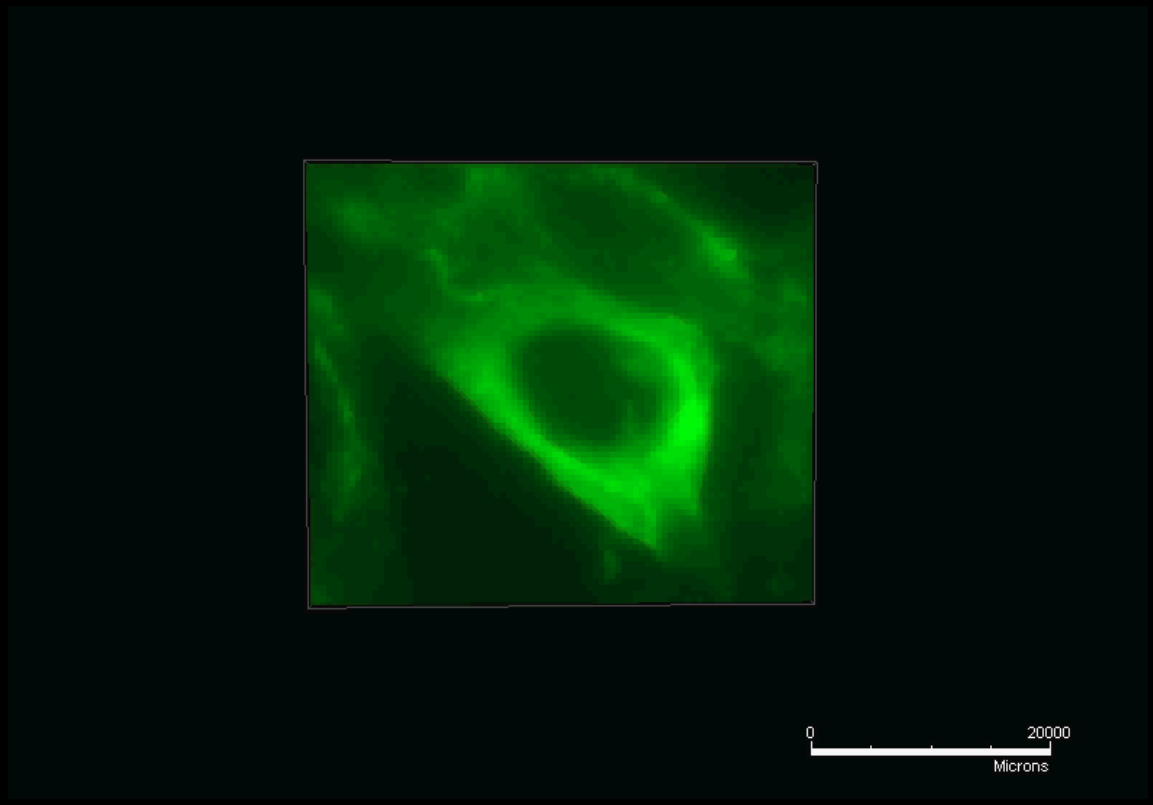

Silva Research Group, UCSD- Julie Schallhorn and Smita Pathak

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Dr. Jeff Hartgerink

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