Nanoparticle Synthesis for Drug Delivery

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Natural barriers between circulatory system and nervous system

- Central nerves: Blood-Brain Barrier (BBB)
- Central cerebrospinal fluid (BCSFB)
- Peripheral nerves: Blood-Nerve Fiber Barrier (BNFB)

http://www.nature.com/nrmicro/journal/v6/n8/images/nrmicro1952-f1.jpg
Background

- Many psychoactive drugs cannot be therapeutic
  - Barrier impermeability
  - Metabolism before reaching target
  - Nonspecific perfusion

- Demand for designer therapeutics that match drug with specific delivery system
What is Nanotechnology?

- Nanotechnology is the manipulation of matter between the atomic and the cellular scale
  - Technically 1-100nm in diameter, though can be larger
  - Biomedical applications include visualization and drug delivery

http://www.ecosox.com/nanoparticles.jpg
Relevance to Molecular Neurobiology

- Advances in biomedical engineering can be applied to research and skills in a basic research lab
  - Effective noninvasive delivery of drugs and other substances
  - Visualization and quantification
- Goal: Identify and explore biomaterials and drug delivery as they relate to molecular neurobiology

http://www.nature.com/nrn/journal/v10/n9/fig_tab/nrn2685_F2.html
Drugs and large molecules can be delivered to the brain from an intravenous injection

- Nanoparticles can cross the BBB and degrade
- Current issues include specific uptake by the reticuloendothelial system

Project Proposal

• Two main goals
  ○ Determine whether novel materials can be incorporated into this nanoparticle structure for brain delivery
  ○ Modify the particles for more efficient delivery to the brain
Possible Implications

Materials Science
- Reduce RES Uptake
- Reproducible Encapsulation
- Modulate Drug Release Curve
- Surfactant Characterization

Pharmacology
- Steroid and Drug Delivery
- Neurogenesis Modulator Delivery
- Alternative Alzheimer’s Model
Many neuroactive steroids are not viable for therapeutics
  - Solubility
  - Toxicity

Targeted nanoparticles provide an efficient vehicle for delivery
Neurogenesis Modulator Delivery

- Neurogenesis can be altered and the effects on spatial memory over time analyzed
  - Invasive injection of rotovirus into brain
  - Ineffective intravenous or intraperitoneal delivery
- Targeted nanoparticles can deliver large drugs or, with modification, genes
Alternative Alzheimer’s Model

- Alzheimer’s disease is a common form of dementia
  - No known cure
  - Formation of plaques, cause or effect unknown
  - Causes breakdown of BBB

- Targeted nanoparticles can deliver amyloid to the brain, creating plaques and generating a new experimental model

http://www.sigmaaldrich.com/medium/structureimages/77/mfcd00056177.png