Electronically-Controlled Drug Release for SCI treatment

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Introduction: What is Spinal Cord Injury (SCI)?

- Damage to any part of spinal cord
- 288,000 people live with SCI (NSCISC)
- Primary injury: initial trauma
- Secondary injury: inflammation
Current Treatment Options for SCI

- Early surgical decompression/stabilization
- Elevate blood pressure
- Systemic Steroids
  - Controversial
  - Systemic side effects
    - Pneumonia
    - Sepsis
    - GI bleed
    - Etc.
Focus of the Saigal Lab: Bioengineering materials for Spinal Cord Injury

Goal: local drug delivery

- Lower overall doses
- Higher % of drug to target tissue
- Avoid systemic side effects
Electronically-controlled Drug Release

Polypyrrole (PPy)
- Conductive polymer
- Drug doping: Oxidation
- Drug release: Reduction

Oxidation:

\[
A^- = \text{Drug}
\]

Reduction:
Methods

- Redox reactions
- Must include dopant, like NaDBS
- With & without stimulation

![Diagram of experimental setup with ITO slide, acrylic plate, wells, ground wire, PBS, and drug layer: Ppy +/- drug + NaDBS]
Experimental Drugs

- **Minocycline**
  - Anti-inflammatory drug

- **Quipazine**
  - Serotonin receptor agonist drug
  - May assist with rehabilitation post-
    - Improves locomotion
    - Enables spinal cord neural circuitry
Experimental question:

How do varying NaDBS levels affect controlled drug release?
4 mg/mL Minocycline in NaDBS

Concentration (mg/mL) vs. Time (minutes)

- 0.02 M NaDBS (drug)
- 0.2 M NaDBS (drug)
- No NaDBS (drug)
- 0.2 M NaDBS (no drug)

Stimulation
0.5 mg/mL Quipazine in NaDBS

Concentration (mg/mL) vs. Time (minutes)

- 0.2 M NaDBS (drug)
- 0.02 M NaDBS (drug)
- No NaDBS (drug)
- 0.2 M NaDBS (no drug)

Stimulation
Conclusion: How does NaDBS affect release?

Minocycline

- Minimal levels of NaDBS allow maximum drug release

Quipazine

- High levels of NaDBS may be beneficial
- Release may change with higher initial drug concentration

Future Work

- Current students are developing implants using polypyrrole
- Further explore parameter space to optimize release
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> Any questions?