

A Biomimetic Device to Restore Lost Vision to the Blind

Cynthia Montanez

Oxnard College

Chemical Engineering major

Lab mentor: Dr. Matthew Pevarnik

Faculty advisor: Dr. Luke Theogarajan

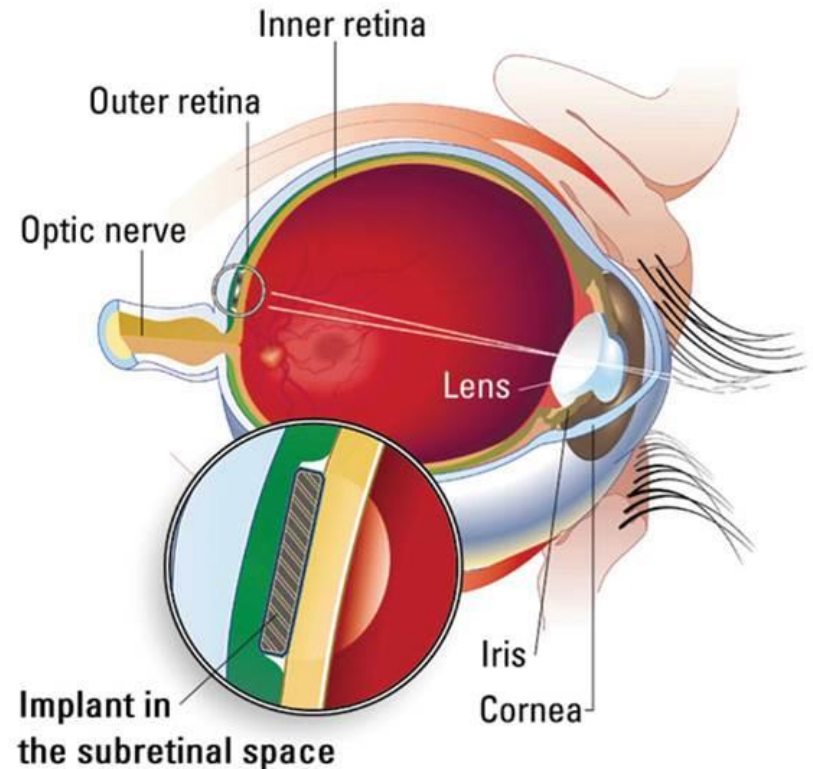
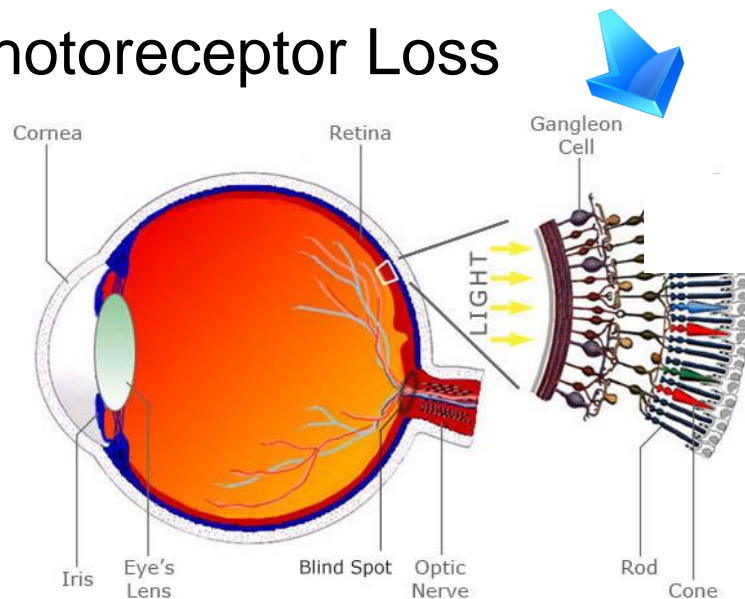
Department of Electrical and Computer Engineering (ECE)

National Institutes of Health (NIH)

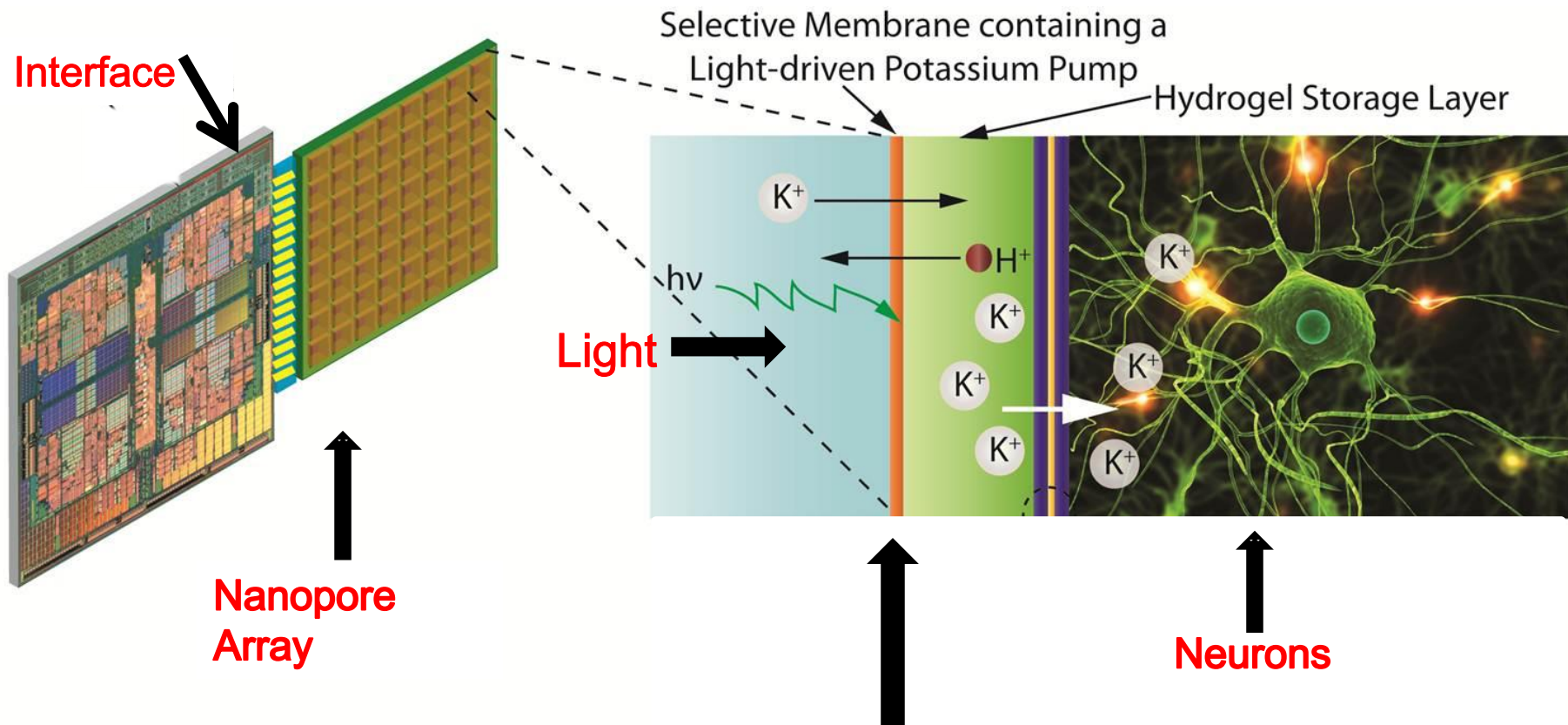
The Big Picture

- ❖ World-wide 285 million are visually impaired, of whom 39 million are blind
- ❖ Retinitis Pigmentosa and Macular Degeneration leading causes in U.S.

Photoreceptor Loss

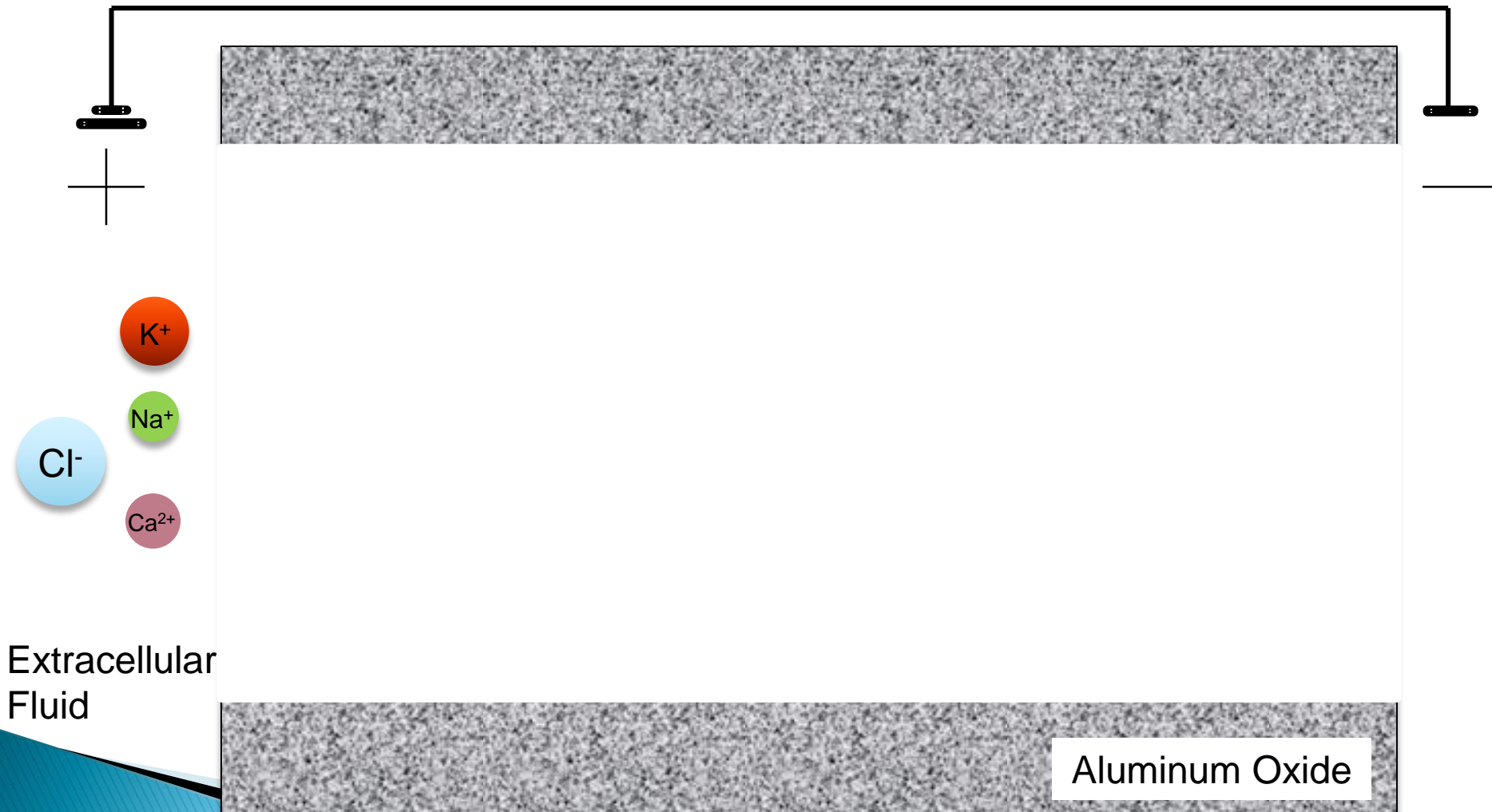


Strategy to Restore Vision

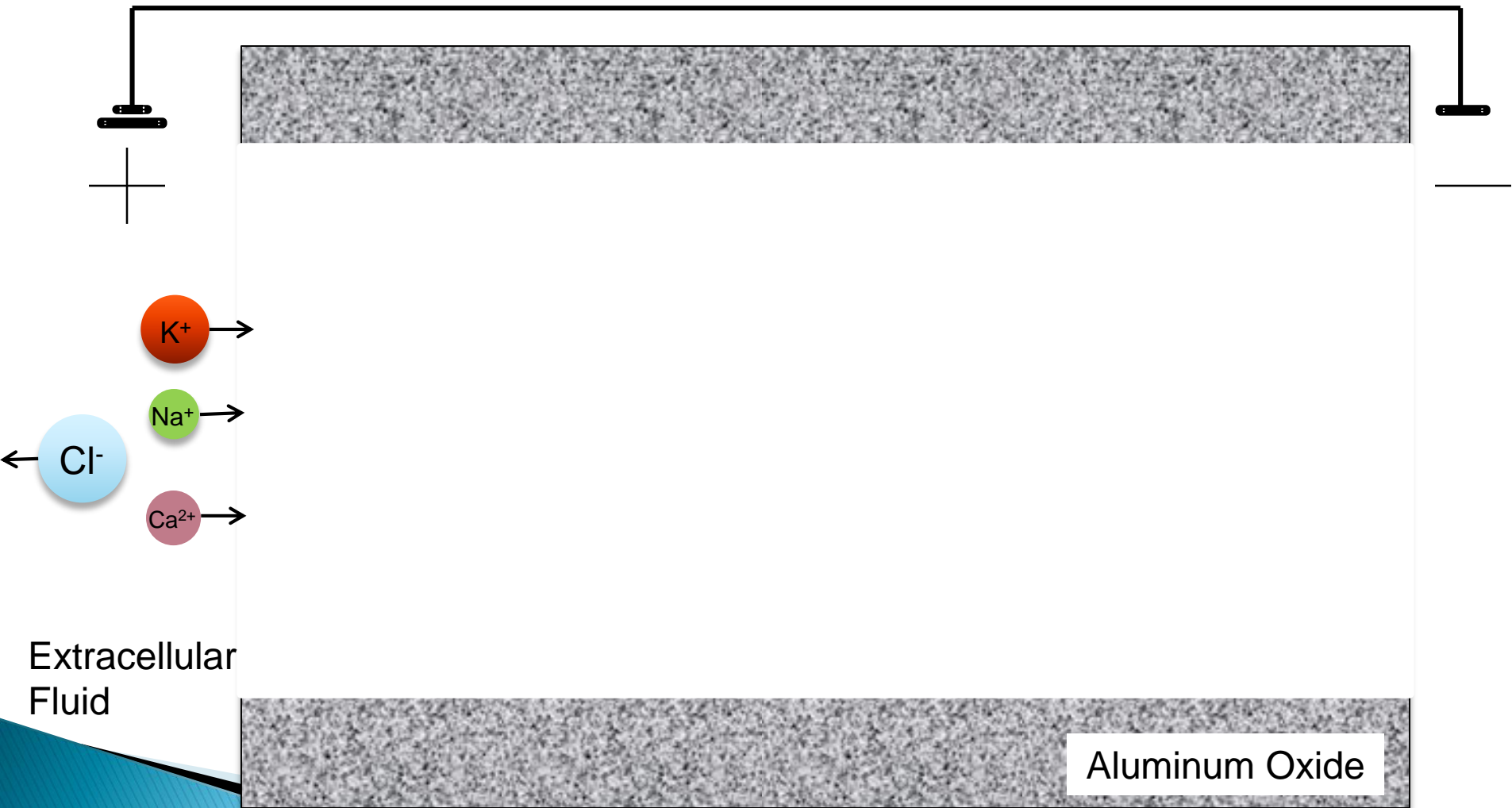


Need Potassium selective channel!!!

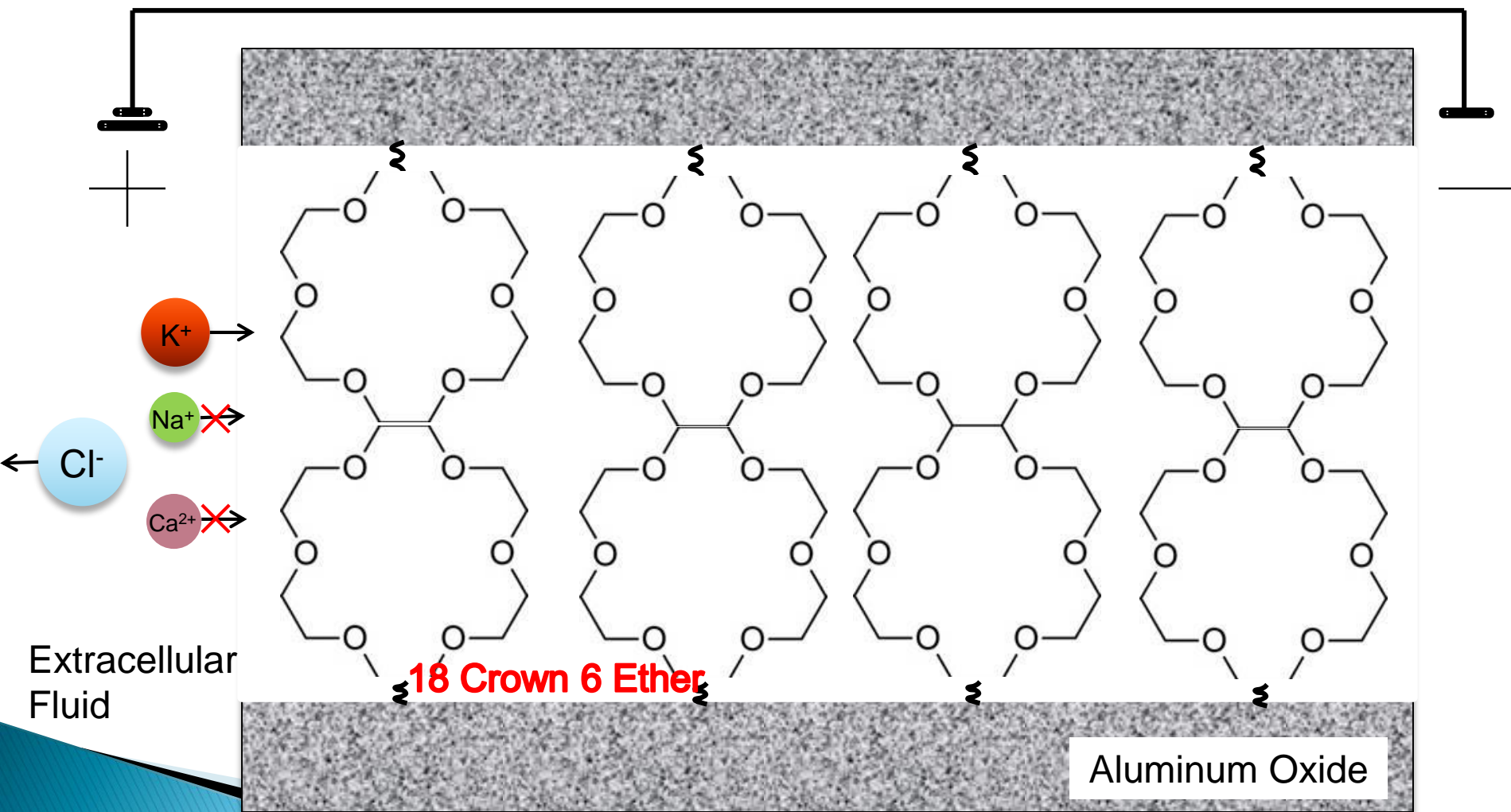
How we will get a Potassium selective Channel



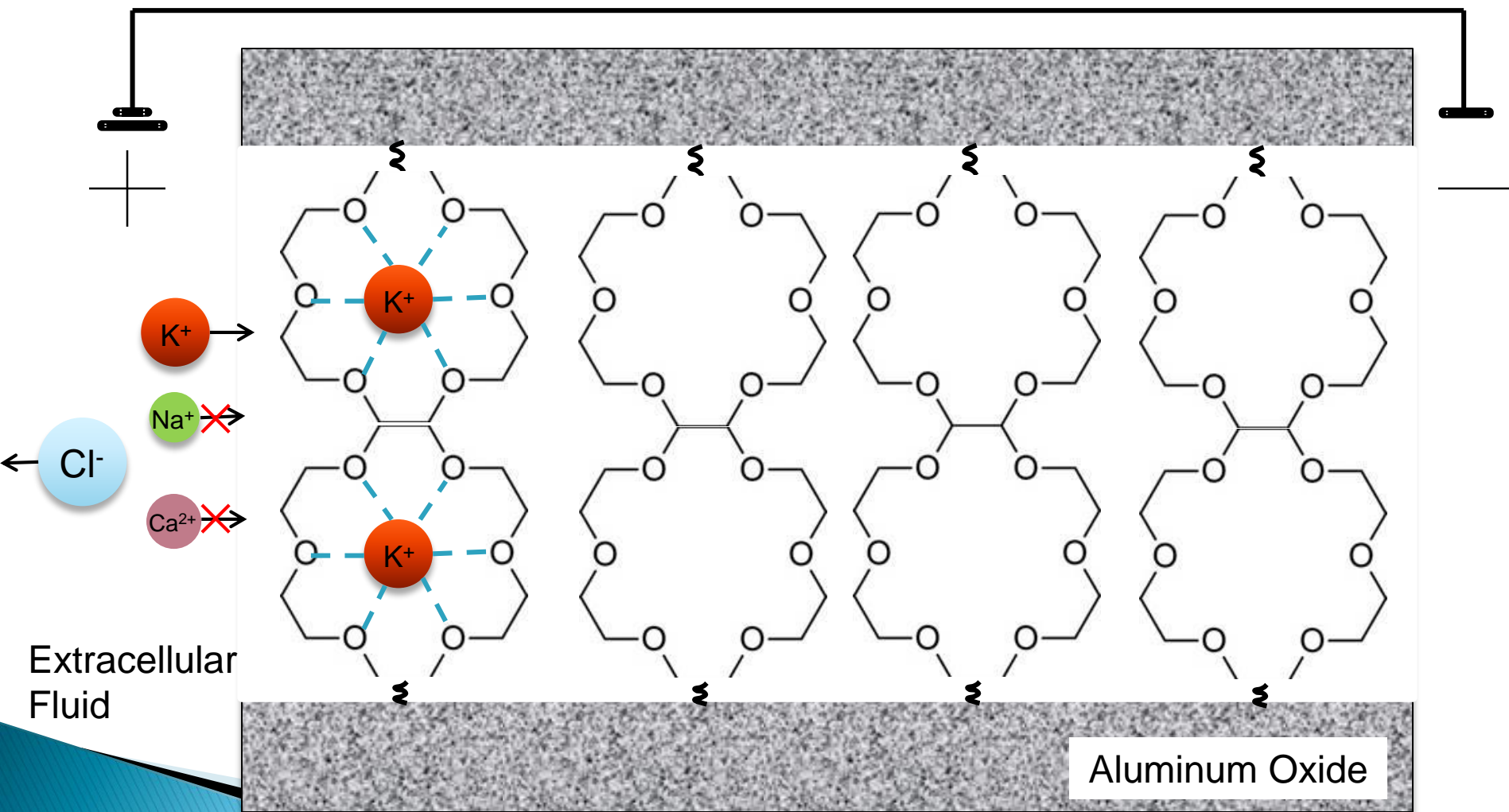
How we will get a Potassium selective Channel



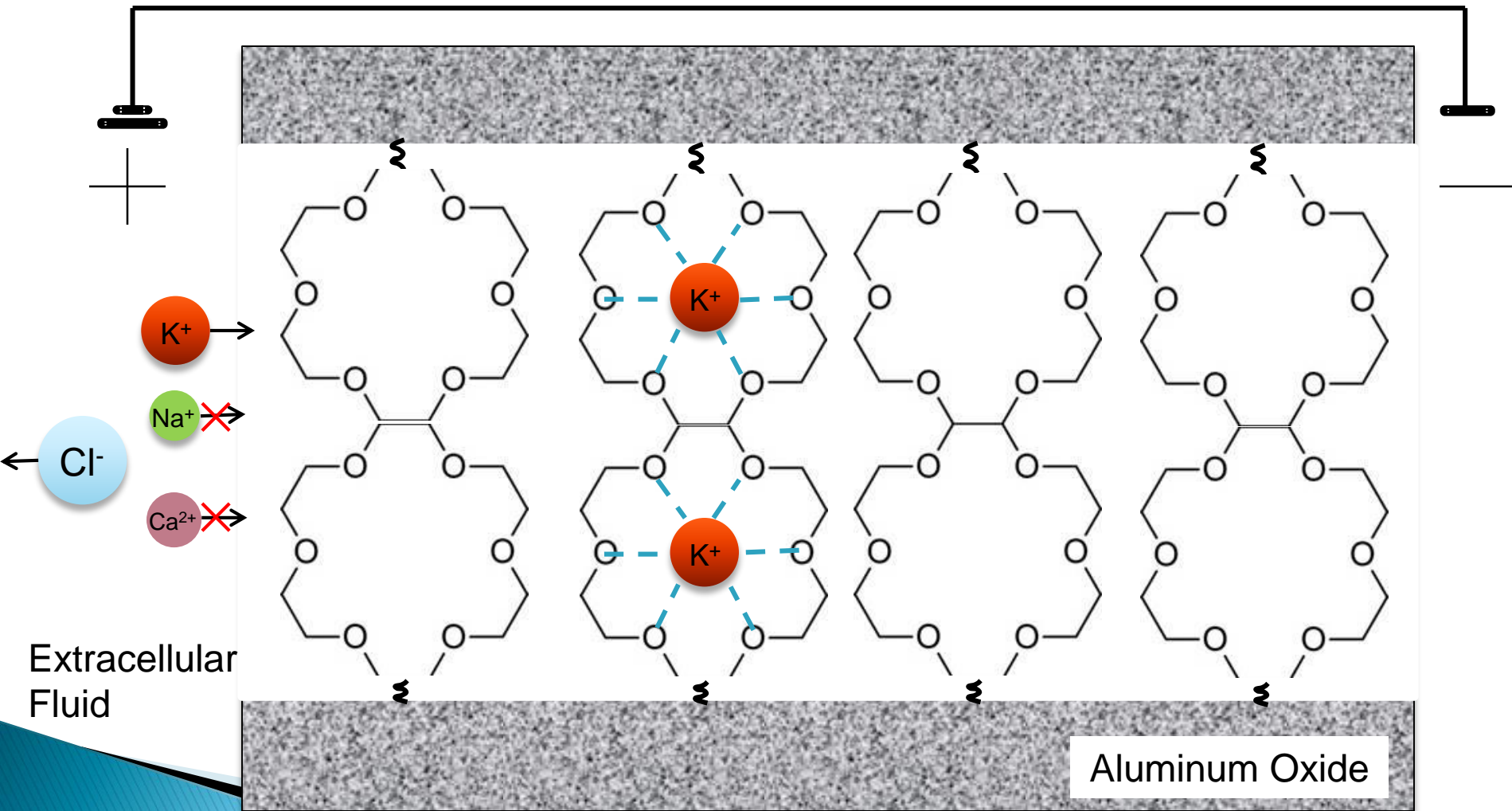
How we will get a Potassium selective Channel



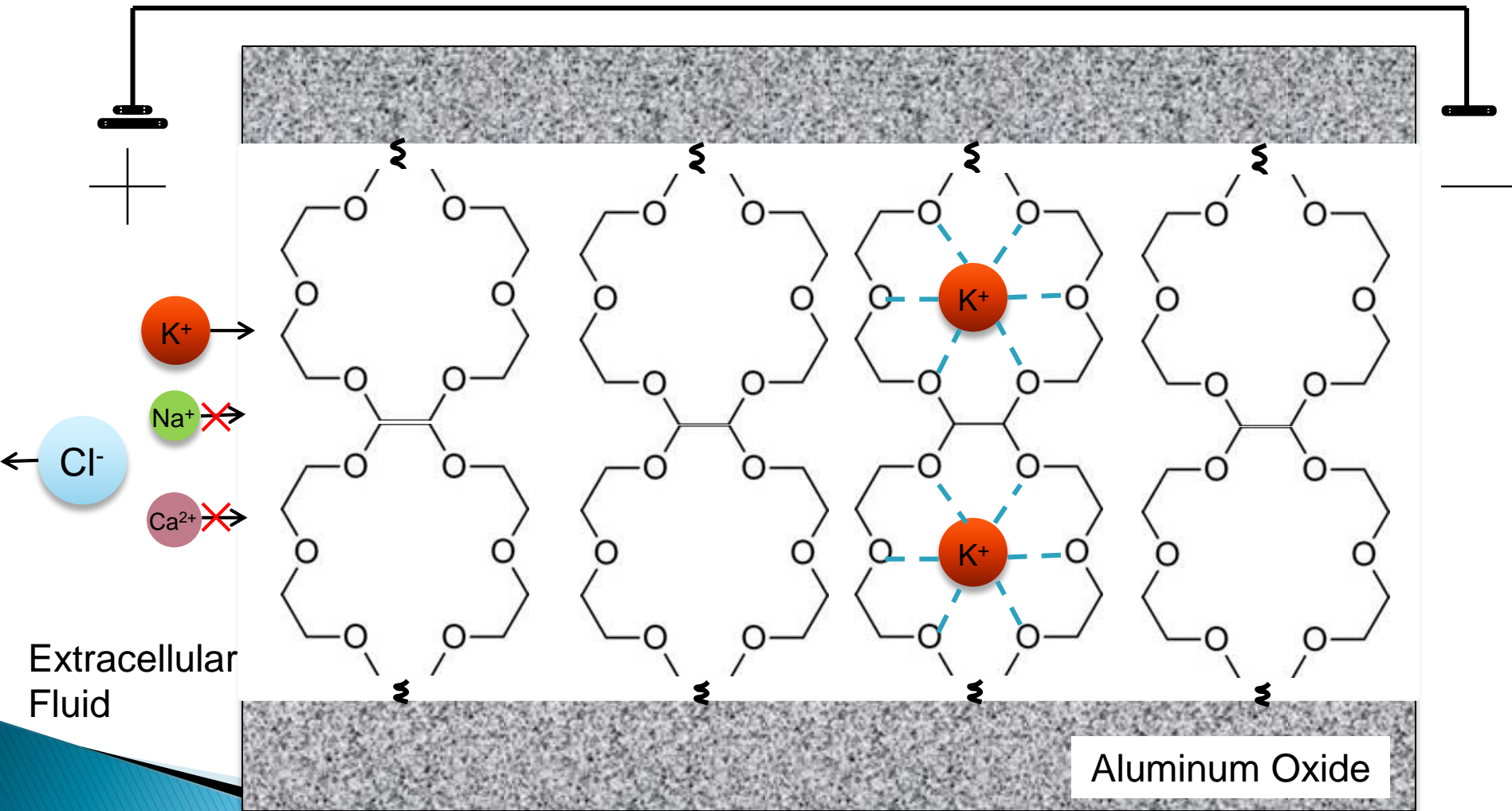
How we will get a Potassium selective Channel



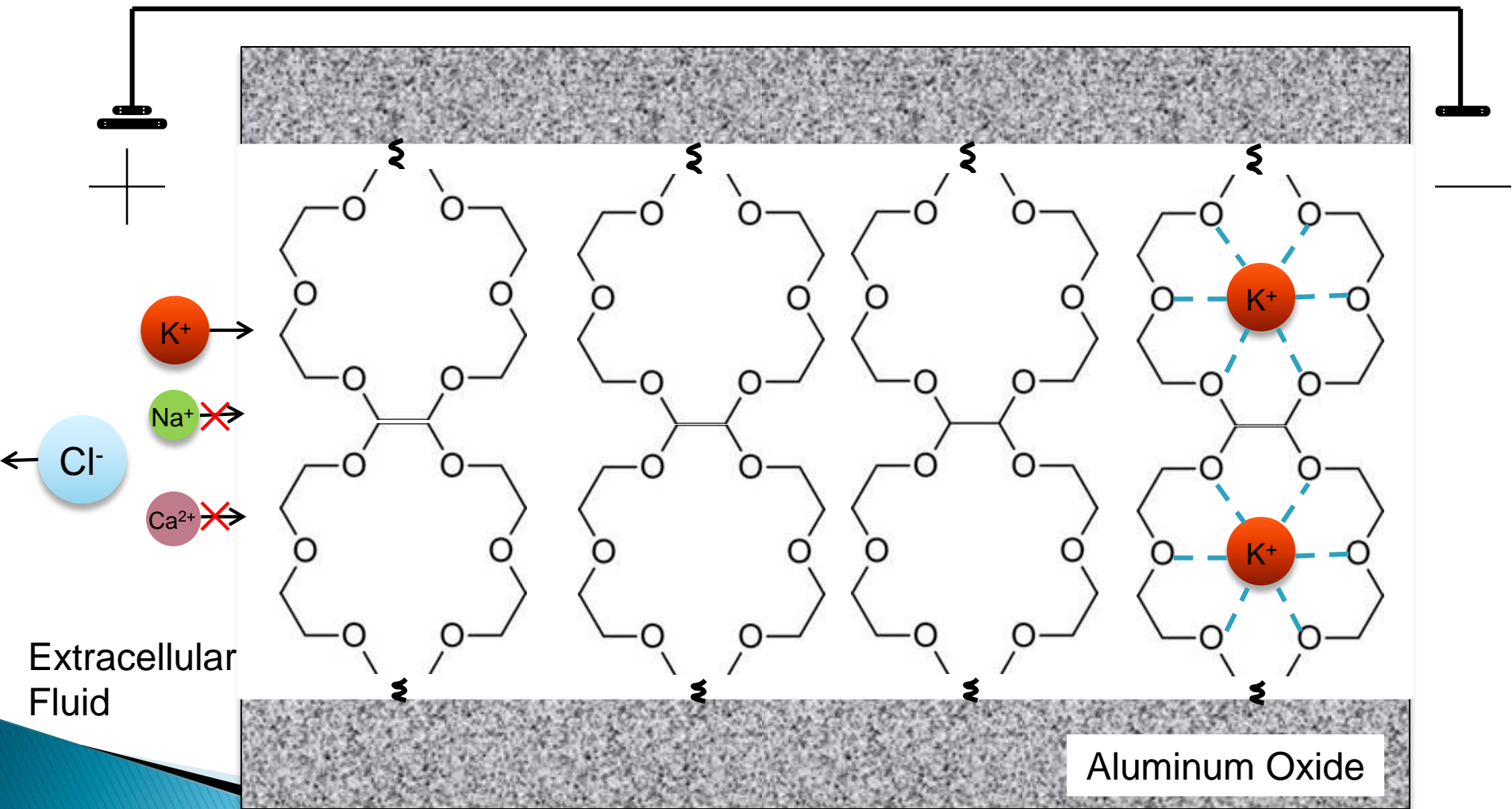
How we will get a Potassium selective Channel



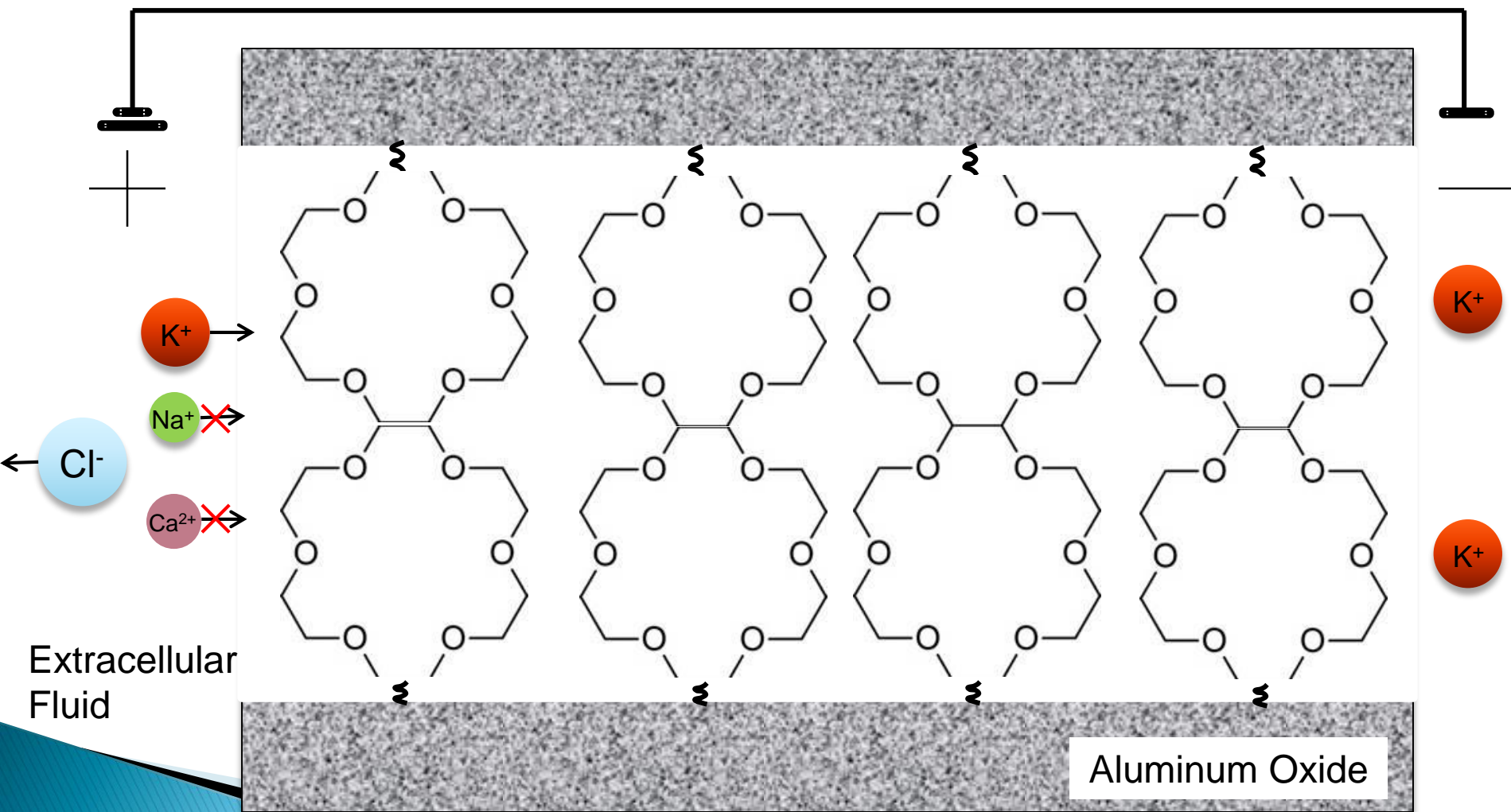
How we will get a Potassium selective Channel



How we will get a Potassium selective Channel

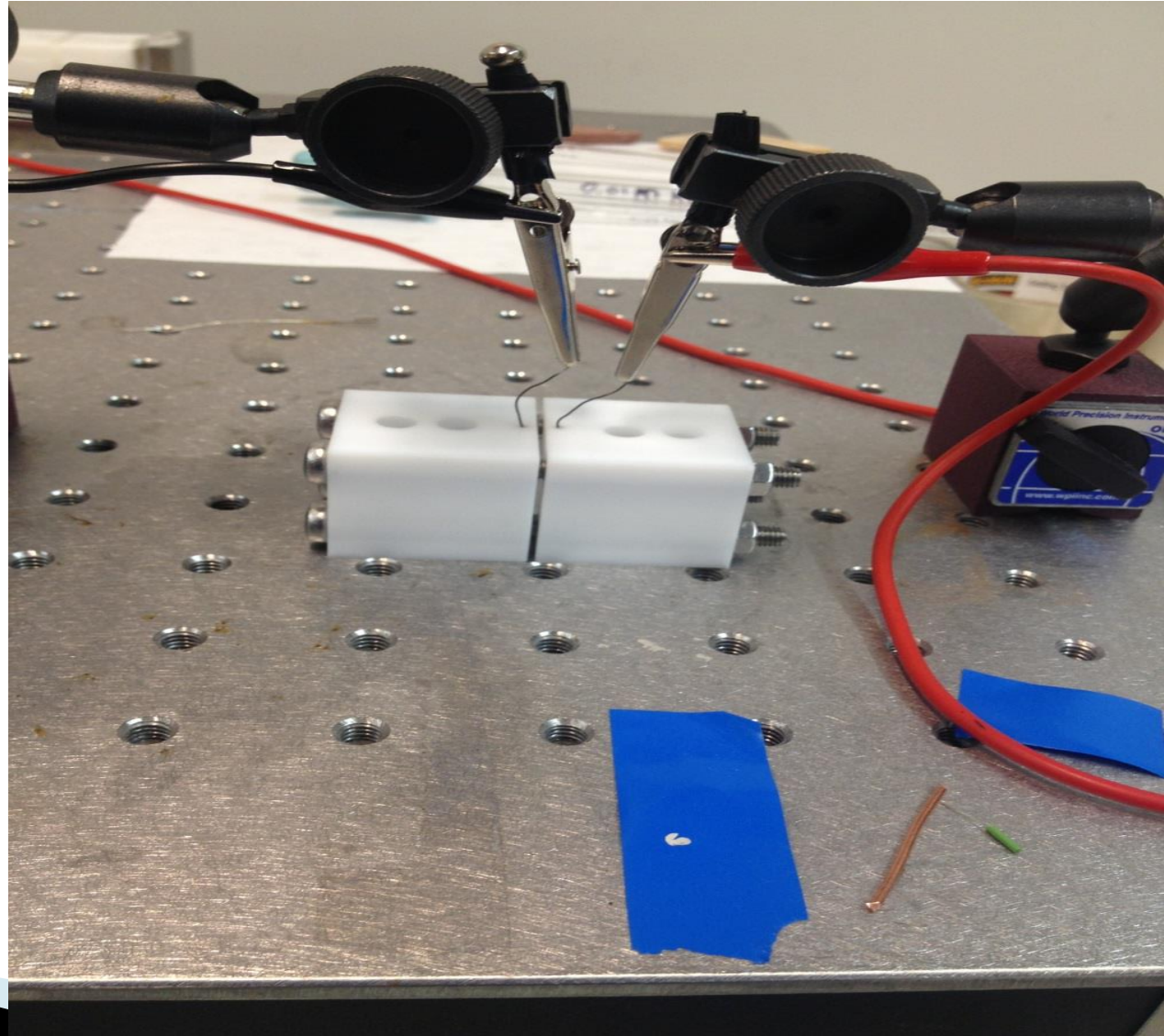


How we will get a Potassium selective Channel

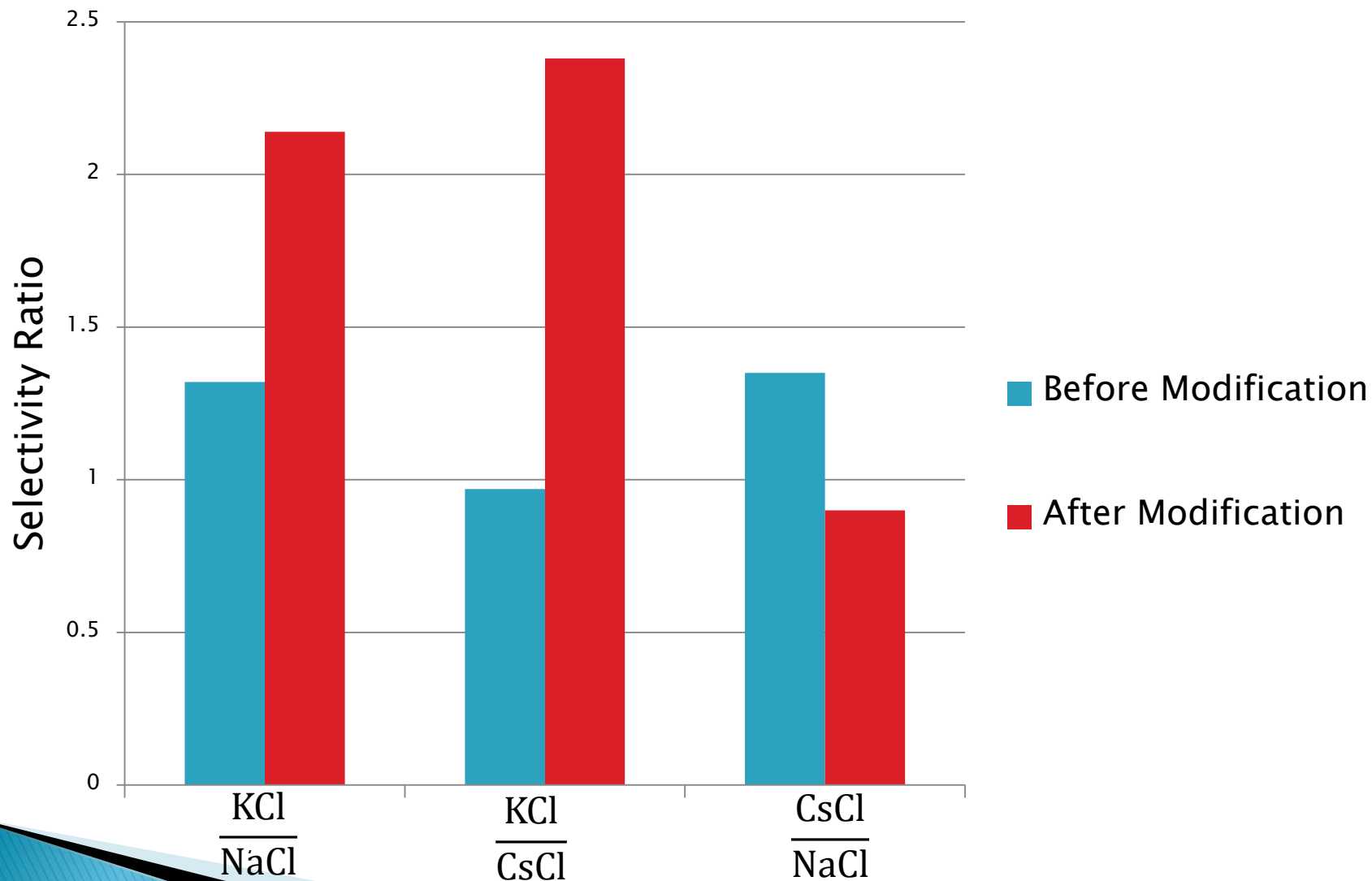


Experimental Setup

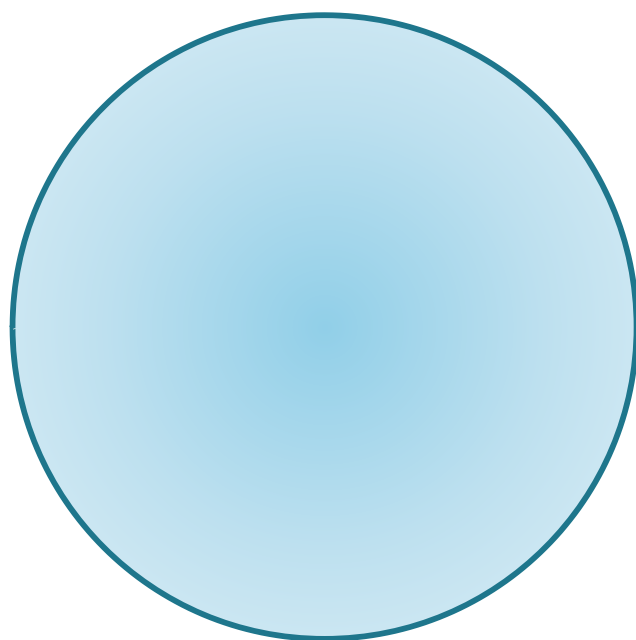
- Fluids (KCl, NaCl, CsCl)
- Ions pass only through the nanopore we create
- Cyclic Voltammetry Test
- Compare current-voltage curves before and after modification



Pore with 18-Crown-6 Ether



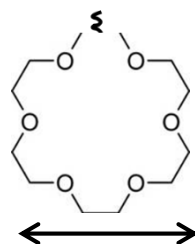
Pore with 18-Crown-6 Ether



10 nm

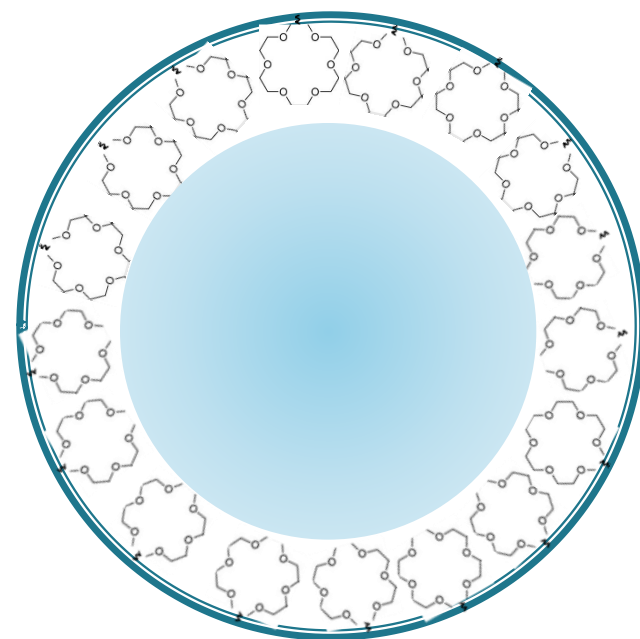
Pore

+



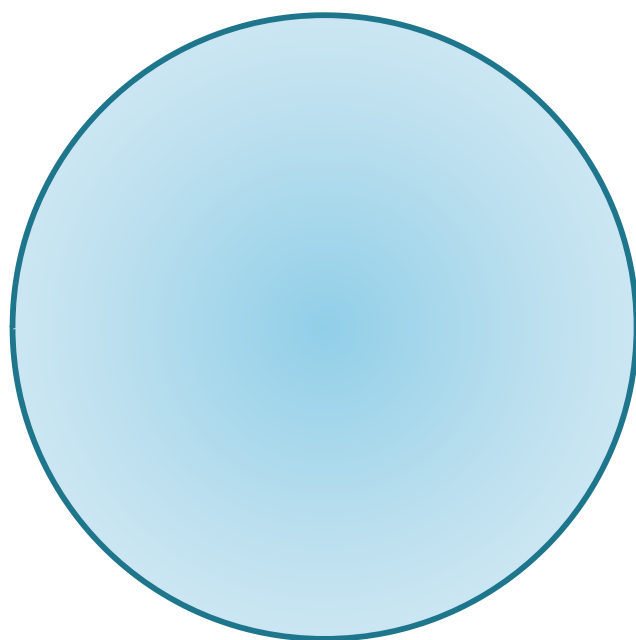
1 nm

18-Crown-6
Ether



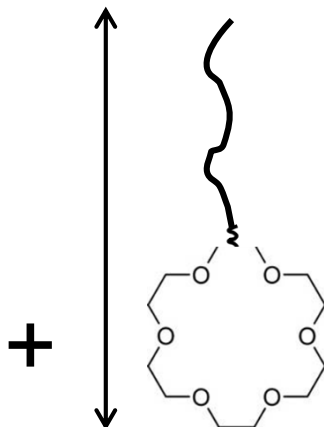
Pore functionalized
with 18-Crown-6 Ether

Pore with 18-Crown-6 Ether and Polymer



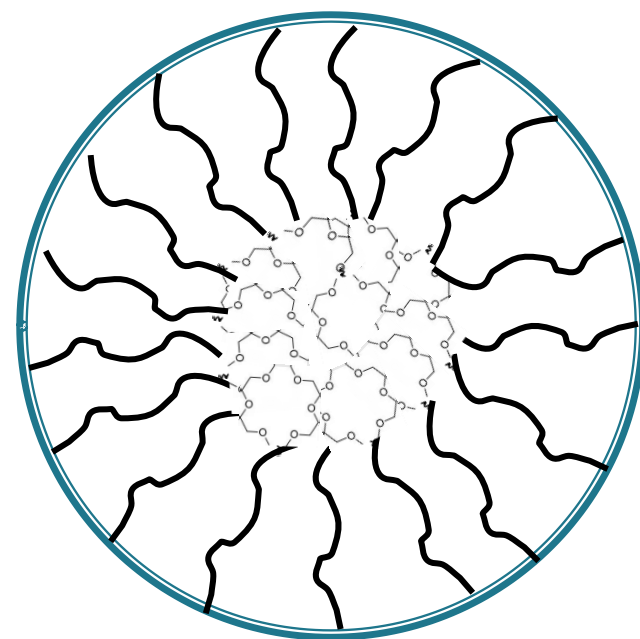
10 nm

Pore



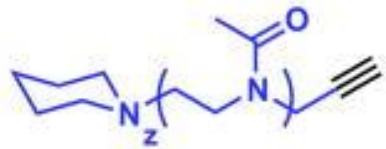
4-5 nm

18-Crown-6
Ether with
Polymer Chain



Pore functionalized
with 18-Crown-6 Ether
and Polymer Chain

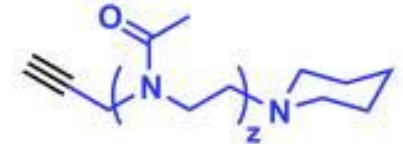
Pore with Flexible Polymer



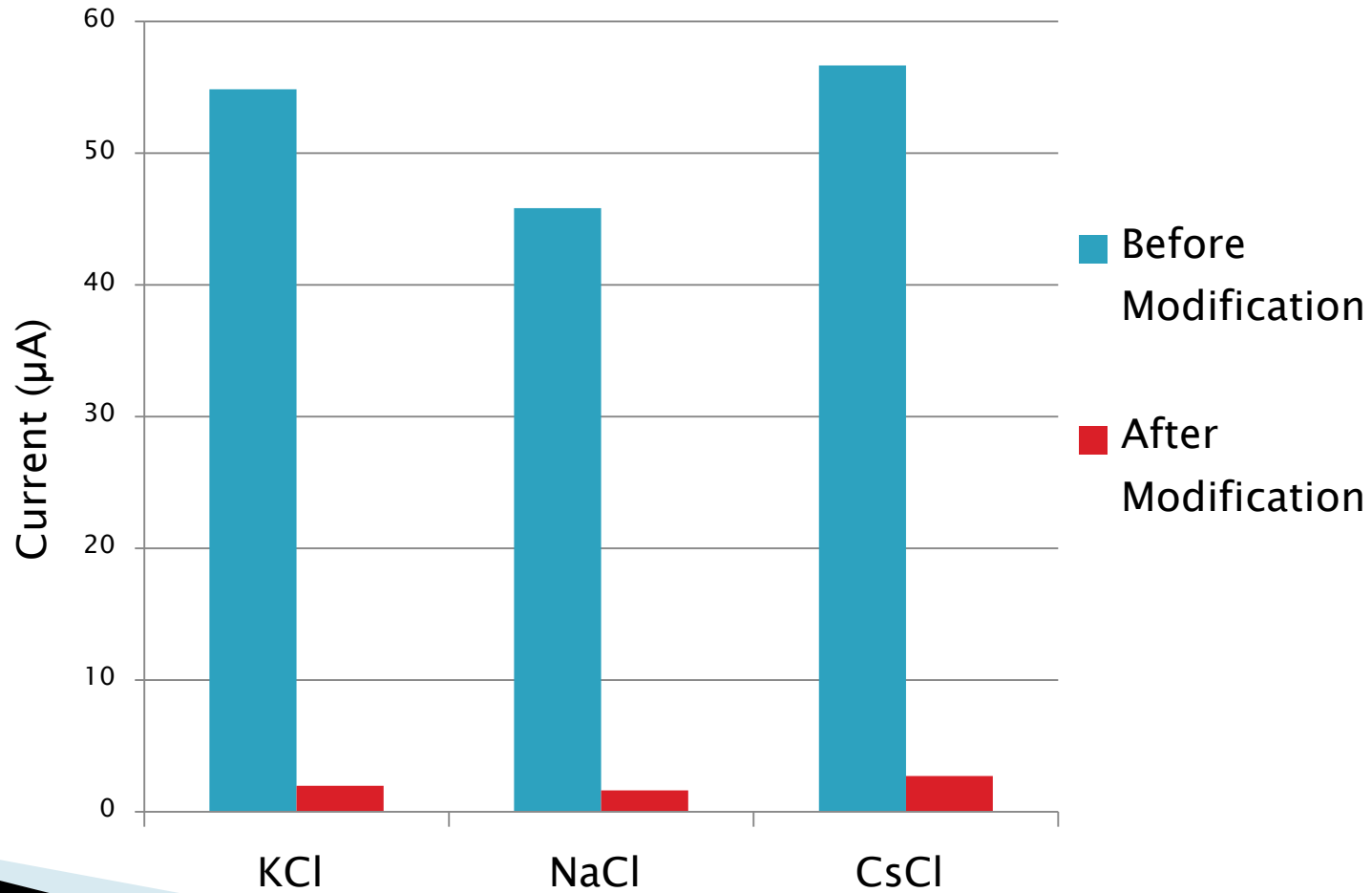
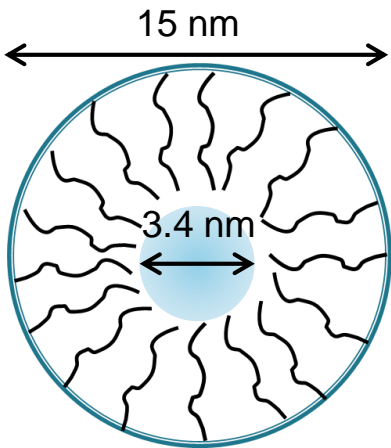
Poly(methyloxazoline) A-block



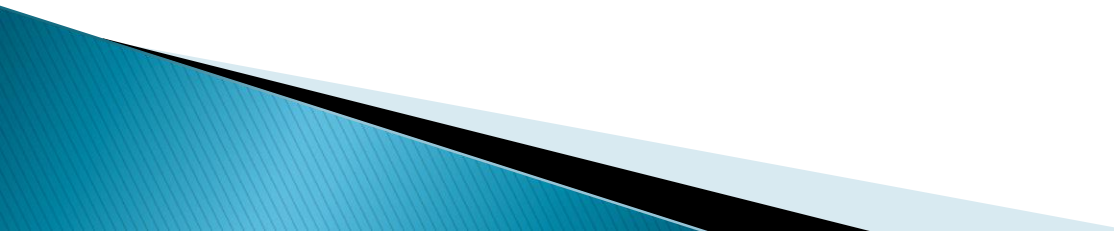
Poly(siloxane) B-block



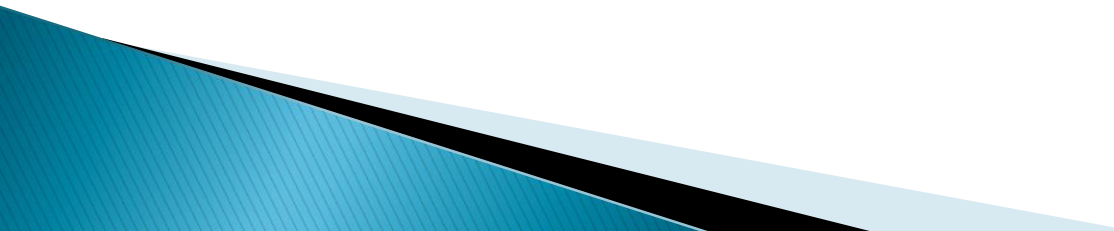
Poly(methyloxazoline) A-block



What the Future Holds

- ▶ Combine polymer blockage with 18-Crown-6 selectivity for ultra selective channels
 - ▶ Expand from single pore to multipore array
 - ▶ Implement with Complimentary Metal-Oxide Semiconductor (CMOS) technology
 - ▶ Restore lost vision to those affected by Retinis Pigmentosa and Macular Degeneration
- 

Acknowledgments

- ▶ Dr. Luke Theogarajan and his team
 - ▶ Dr. Matthew Pevarnik
 - ▶ Dr. Weibin Cui
 - ▶ Justin Balter
 - ▶ National Institutes of Health (NIH)
 - ▶ Internships in Nanosystems Science, Engineering and Technology (INSET)
- 

What It's Like



This is how a street scene looks with normal vision.



Example of Retinitis Pigmentosa

What It's Like



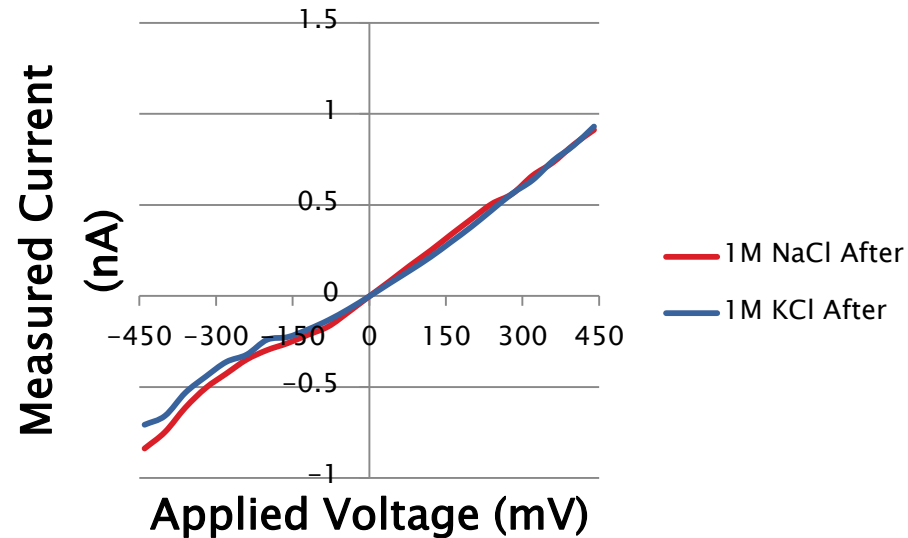
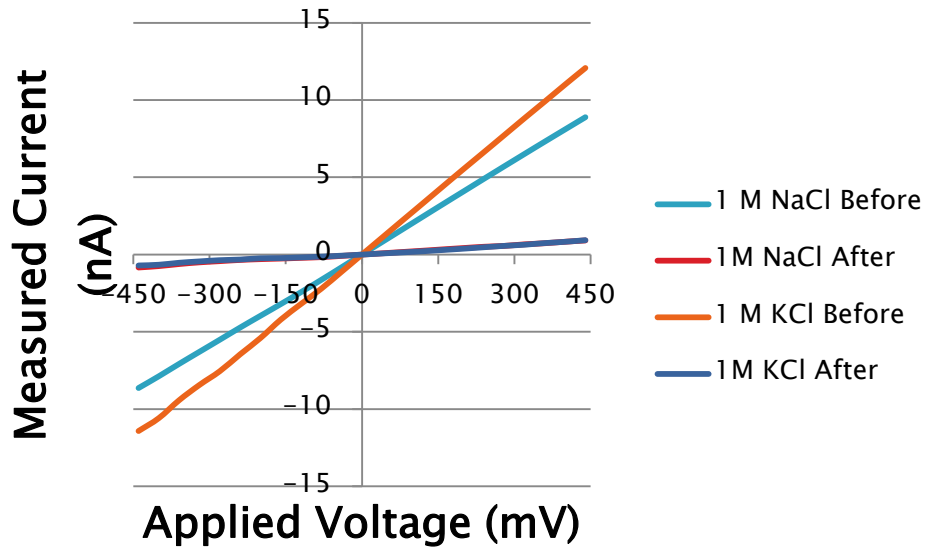
This is how a street scene looks with normal vision.



Example of a Macular Degeneration

Why we use 18-Crown-6

- First experiments with 15-Crown-5
 - Test ability to attach Crown Ethers to nanopore
 - 15-Crown-5 is cheaper



5x16 Nanopore After Modification

