

Photocurrent Generation by Dye-Labeled Photosynthetic Reaction Centers (RCs) Interfaced with Porous Antimony-Doped Tin Oxide (ATO)

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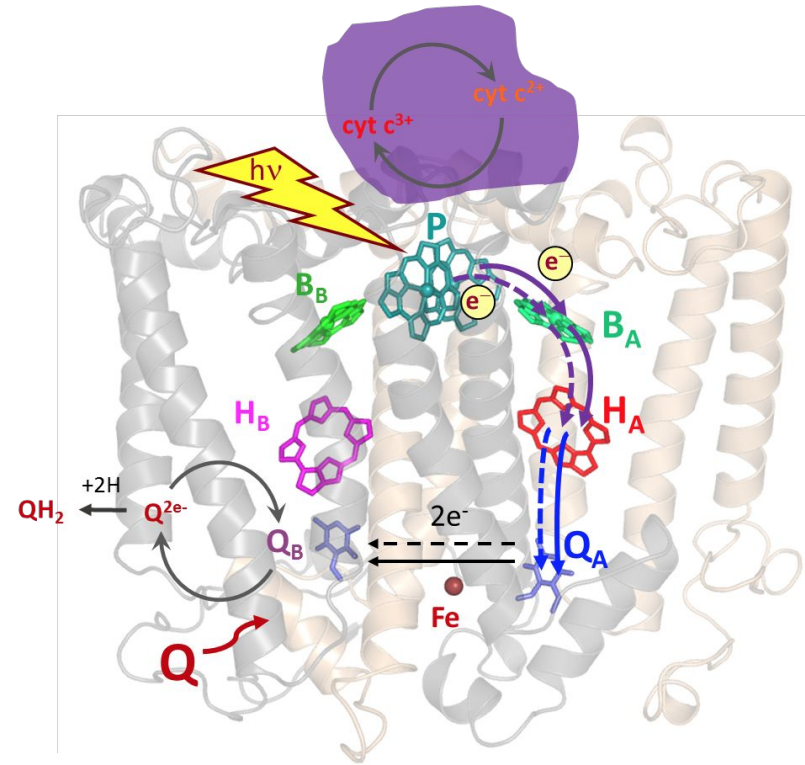
Taylor Brown, Dr. Anne Marie Carey



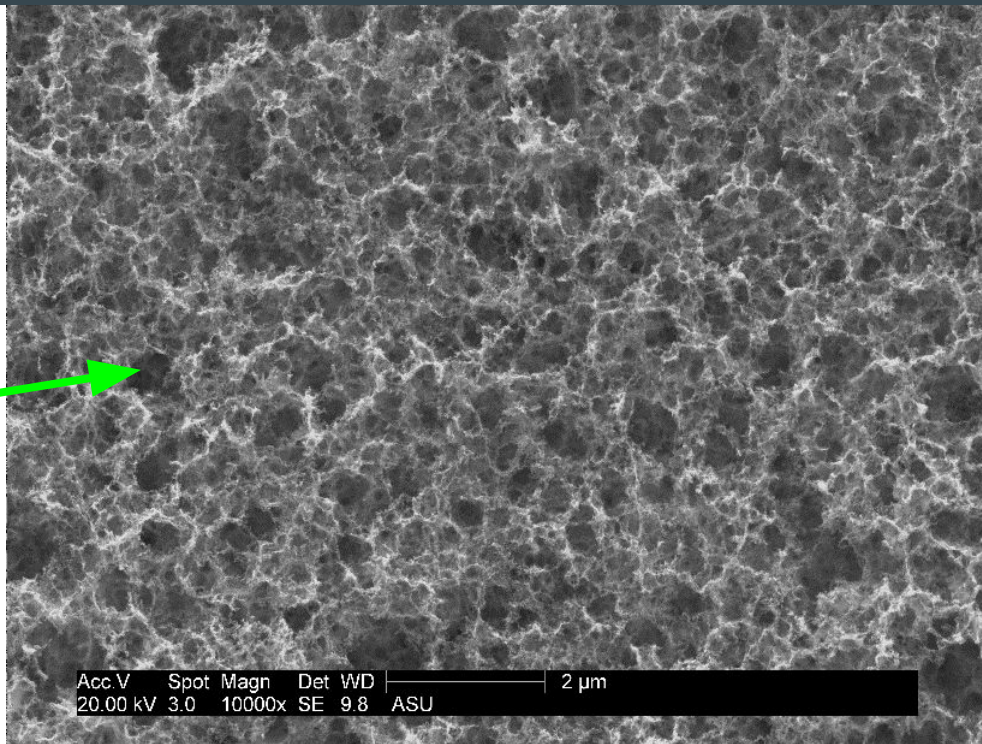
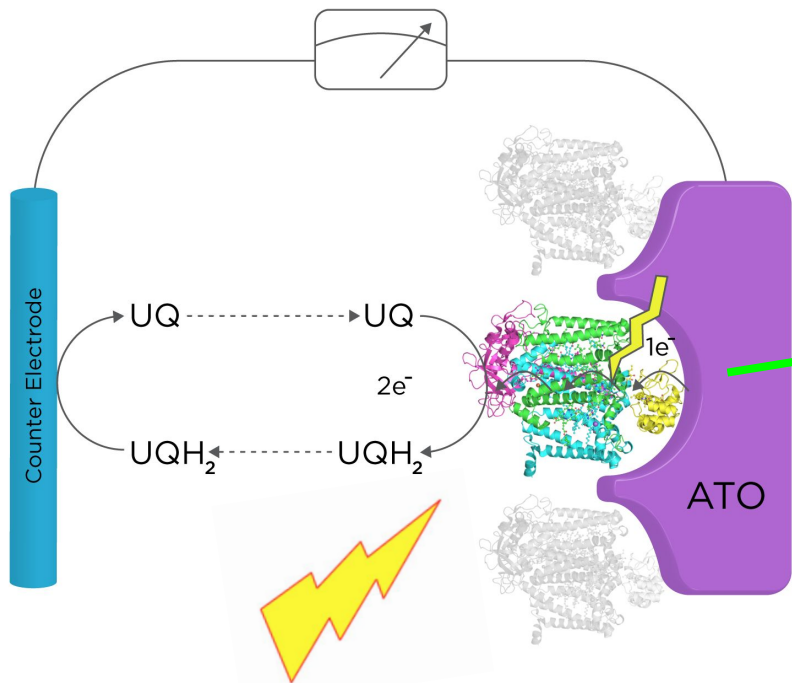
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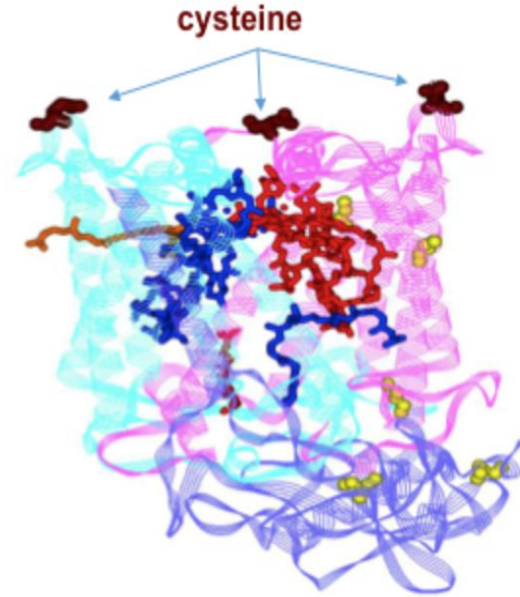
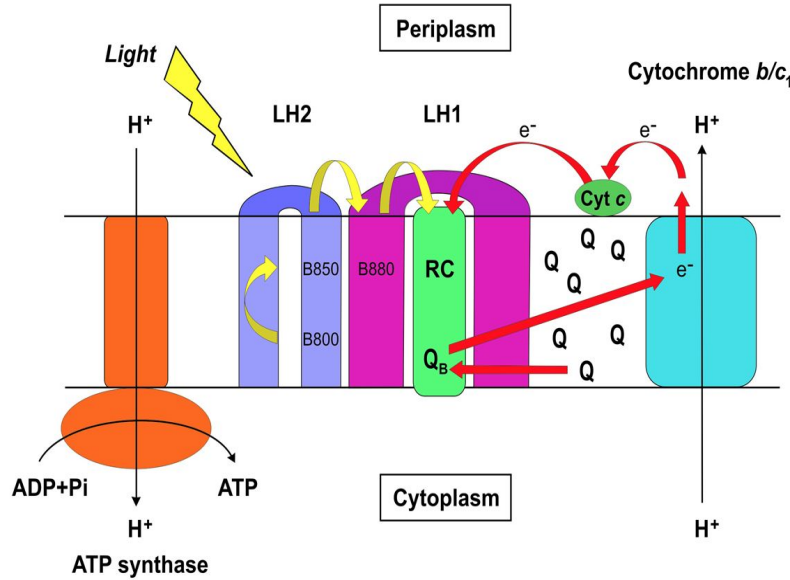
- Understanding how to interface biological components with electronic components
- Applications in:
 - ◆ Environmental Sensing
 - ◆ Biomedicine
 - ◆ Energy/Fuel Production
- Photosynthetic RC is the best model
 - ◆ Light activated
 - ◆ Multiple turnovers
 - ◆ Solar energy → chemical redox energy with ~100% quantum yield



Electrochemical Cell Setup



Improve with Synthetic Antenna



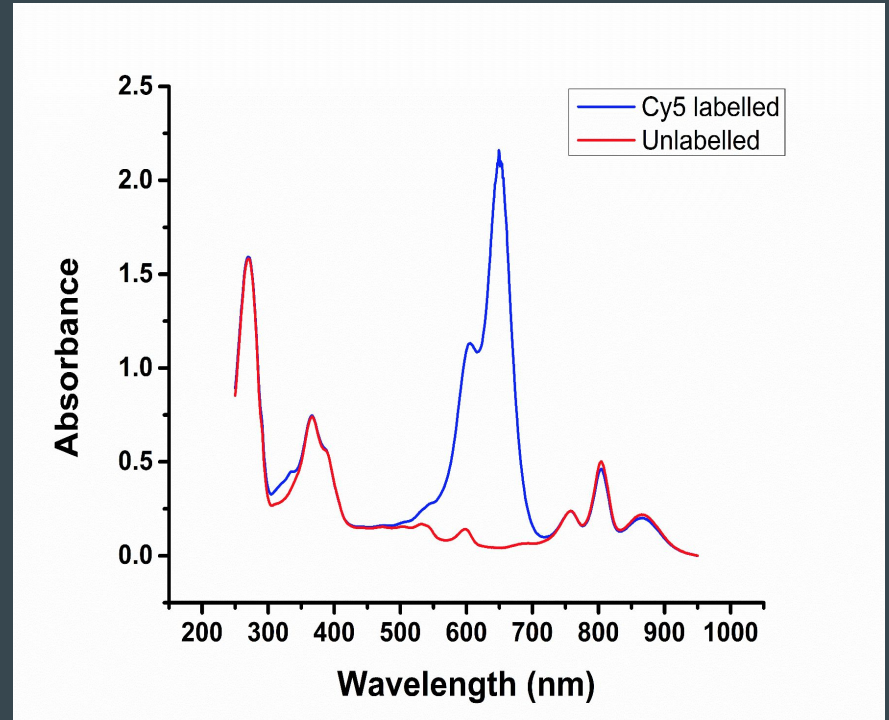
Methods

Growth and Purification

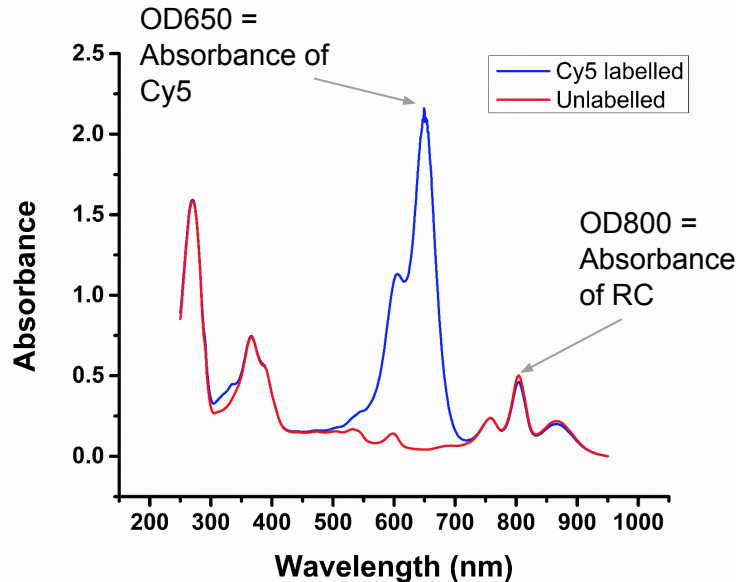
- *Rhodobacter sphaeroides* cultures were grown semi anaerobically in LB mod media
- Burst under high pressure in a French Press
- RCs were isolated using nickel affinity chromatography

Dye Conjugation

- Dyes have maleimide group which binds to Sulfhydryl of cysteines
- Incubate RC in the dye, unbound dye was washed in a centrifugal concentrator
- Purified again with nickel affinity chromatography



Methods- Beer Lambert Law



$$A = \epsilon \cdot l \cdot C \quad C = \frac{A}{\epsilon \cdot l}$$

A = Absorbance

ϵ = extinction coefficient

l = path length

C = concentration

$$\epsilon_{\text{Reaction center}} = 288000 \frac{1}{M \cdot cm}$$

$$\epsilon_{\text{Cy5}} = 250000 \frac{1}{M \cdot cm}$$

$$\epsilon_{\text{Cy3}} = 150000 \frac{1}{M \cdot cm}$$

$$\text{Ratio of Dye to RC} = \frac{C_{\text{dye}}}{C_{\text{RC}}}$$

Typical Values:

Cy 5: 2.7 dyes/RC

Cy 3: 2.4 dyes/RC

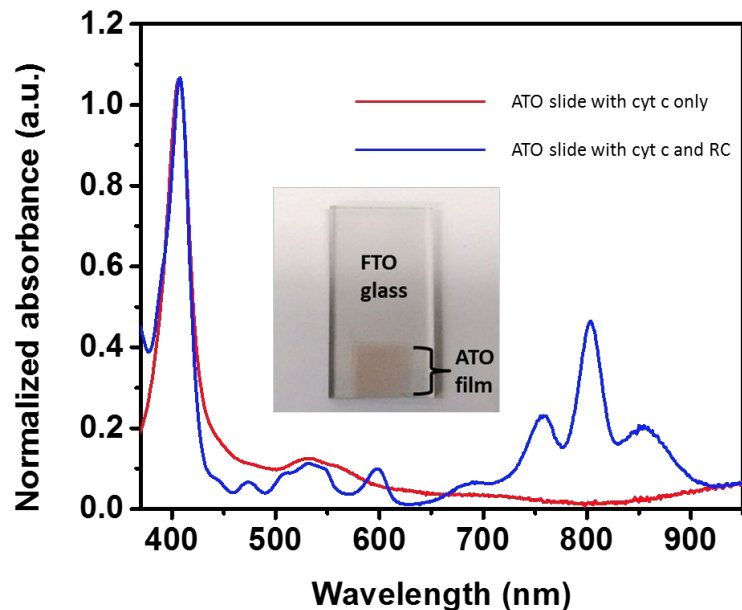
Methods

Electrochemical Cell Setup

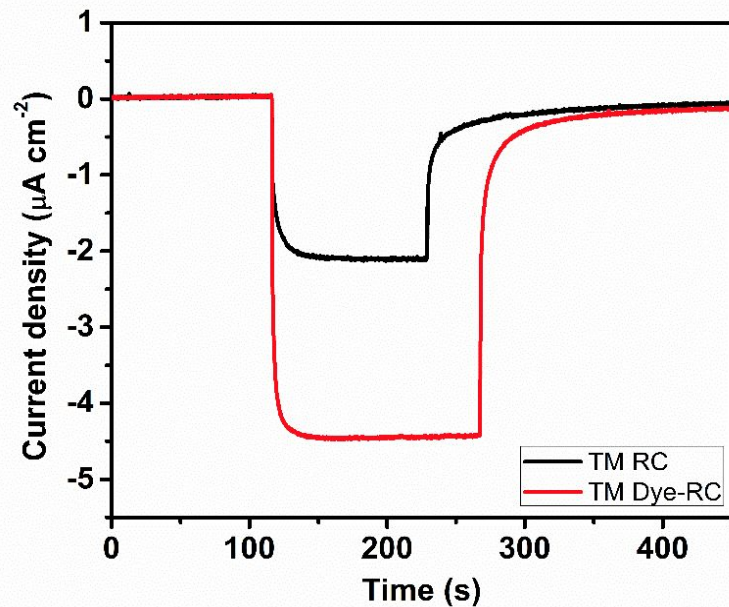
- ATO film on conductive glass
- Soak in Cytochrome C, wash away unbound Cyt C
- Apply RCs
- Incubate 4°C overnight

Current Generation Measurements

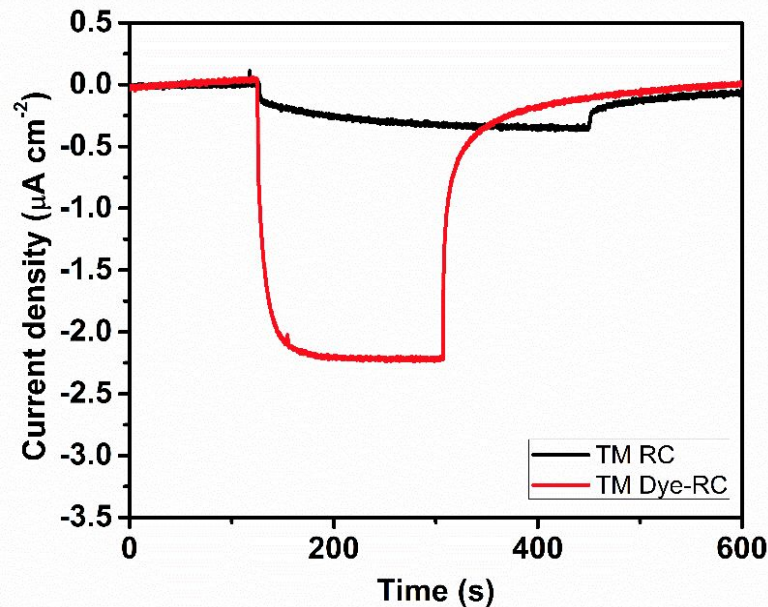
- Apply negative potential, reduce all Cyt C
- Turn on lamp
- Quinone Buffer solution
- Record Current



Photocurrent Results- TM with Cy5



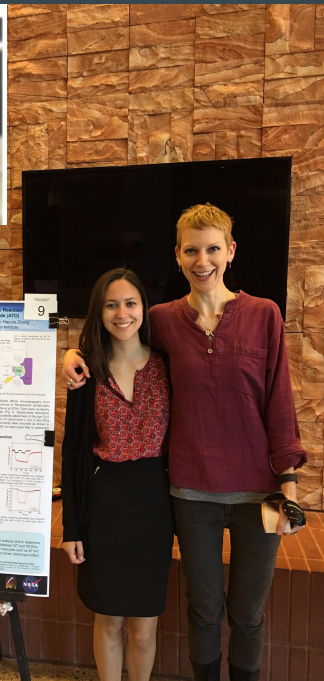
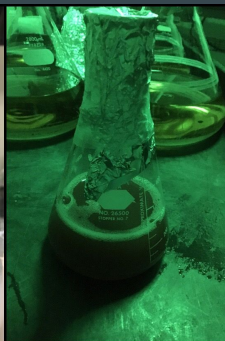
White Light



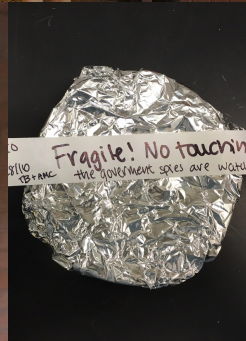
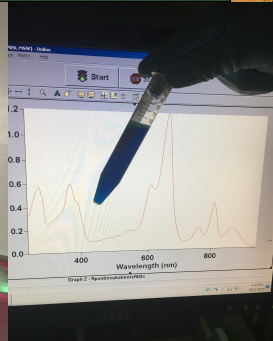
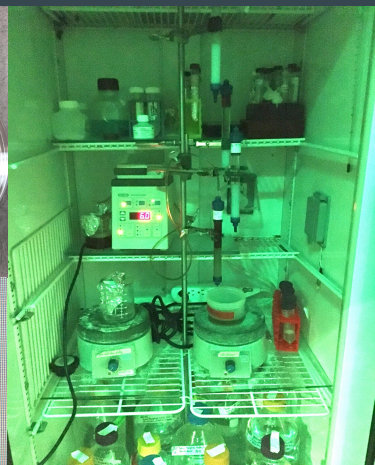
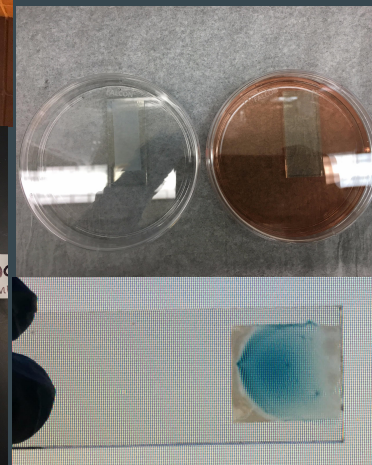
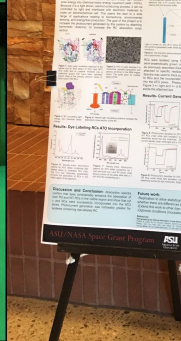
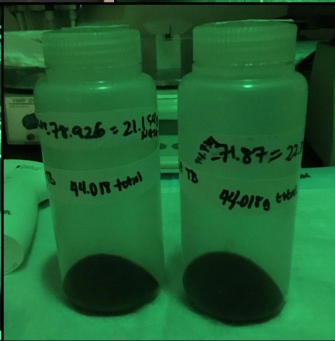
Bandpass at 650 nm (± 8 nm)

Discussion

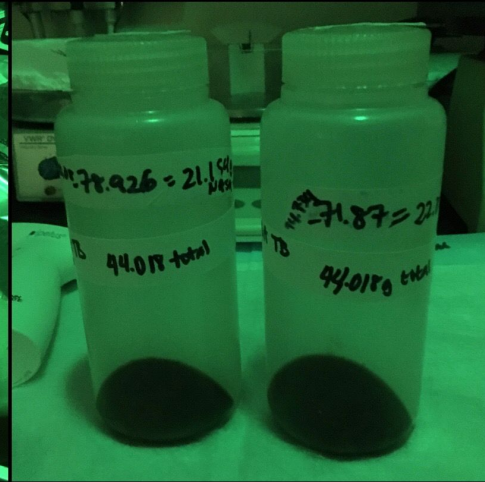
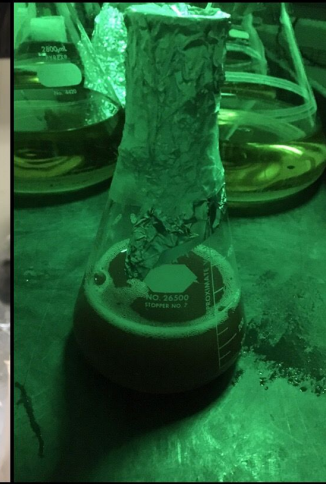
- Dyes (both Cy5 and Cy3) were successfully conjugated to TM and WT RC
- Dyes enhanced the absorption cross section
- RCs were successfully incorporated into ATO pores
- Photocurrent Increased!
- Applications relating to biomedicine, environmental sensing, and energy/fuel production
- Ongoing work: Cy3-RC photocurrent measurements

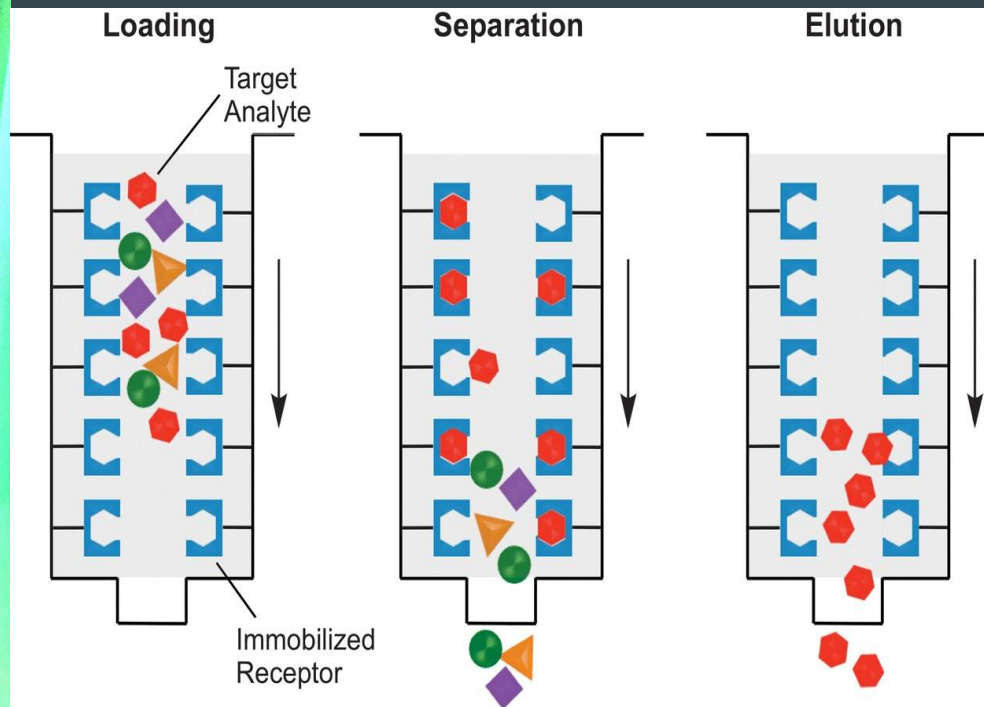


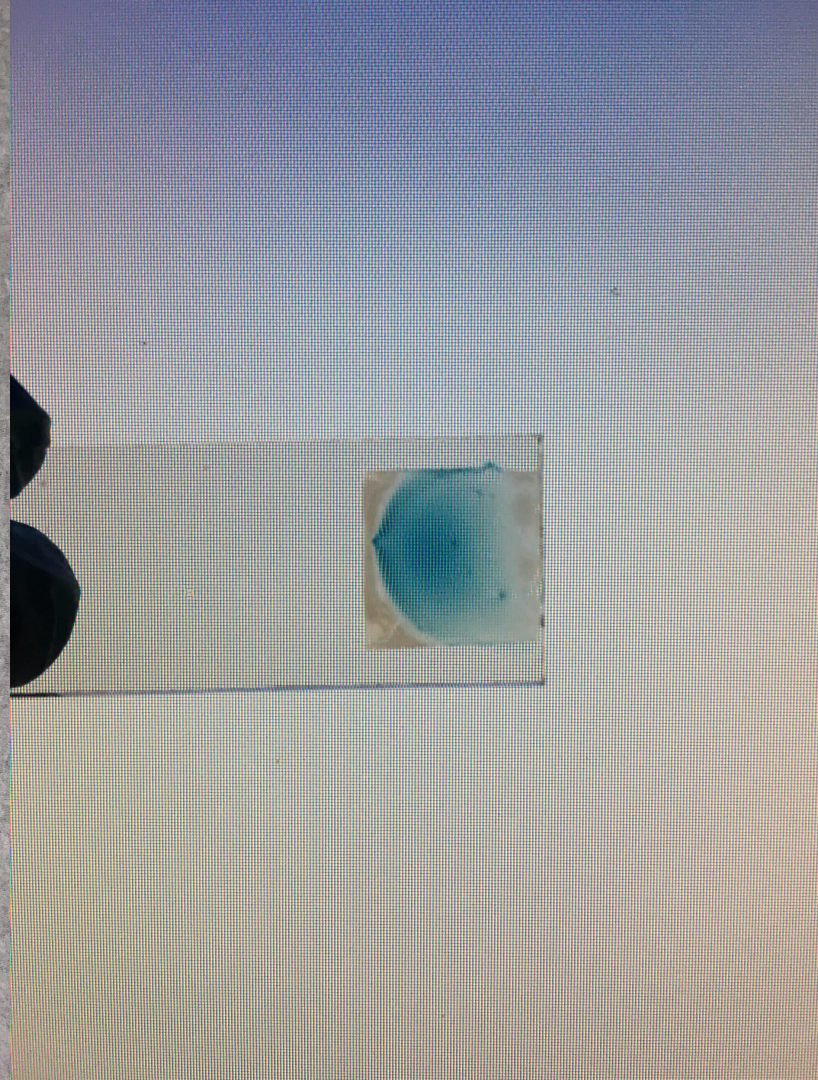
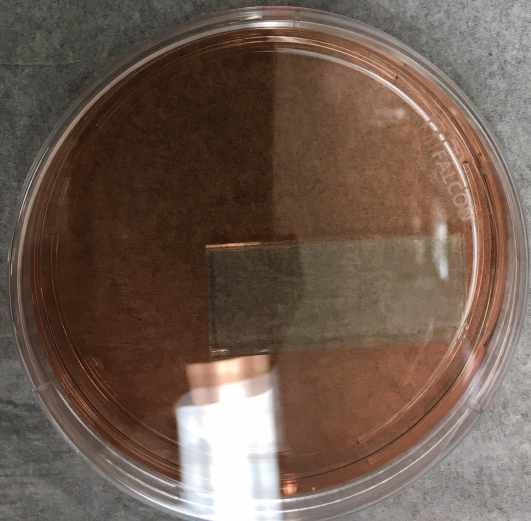
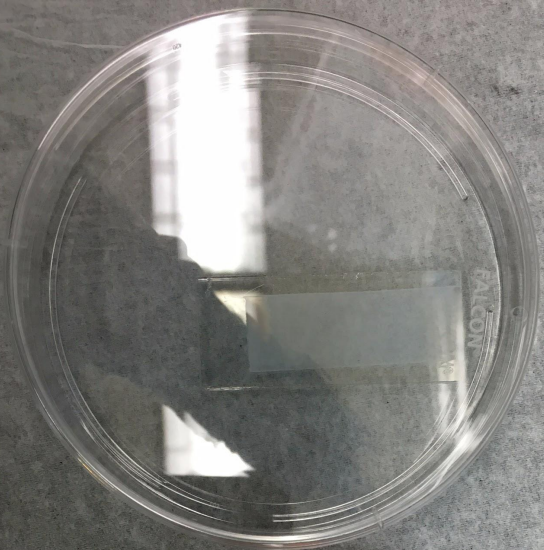
Thank You Space Grant, Anne-Marie, Lab Members, Family and Friends!

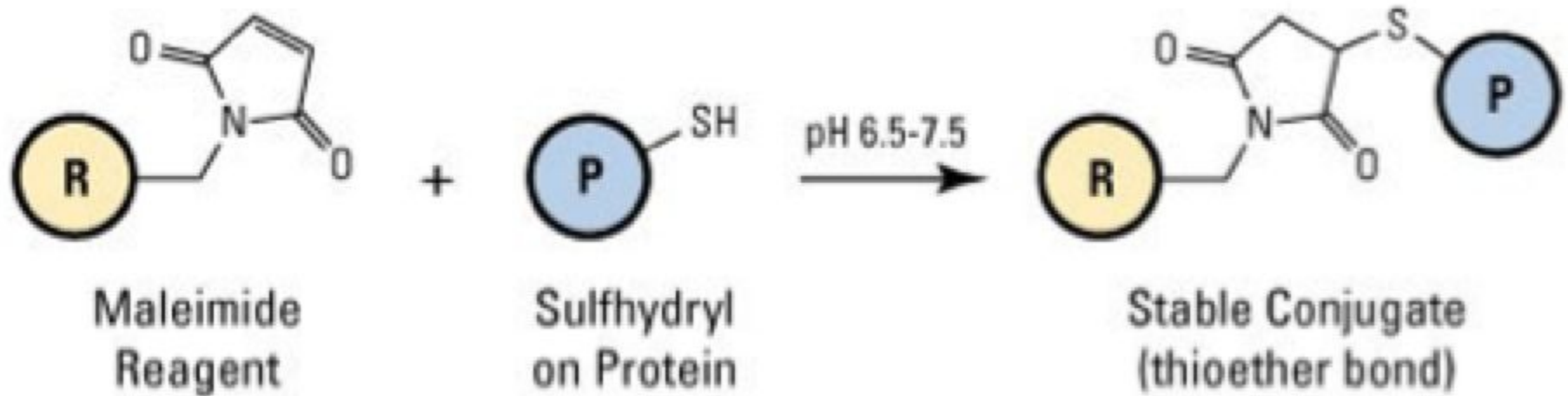


Reference Slides

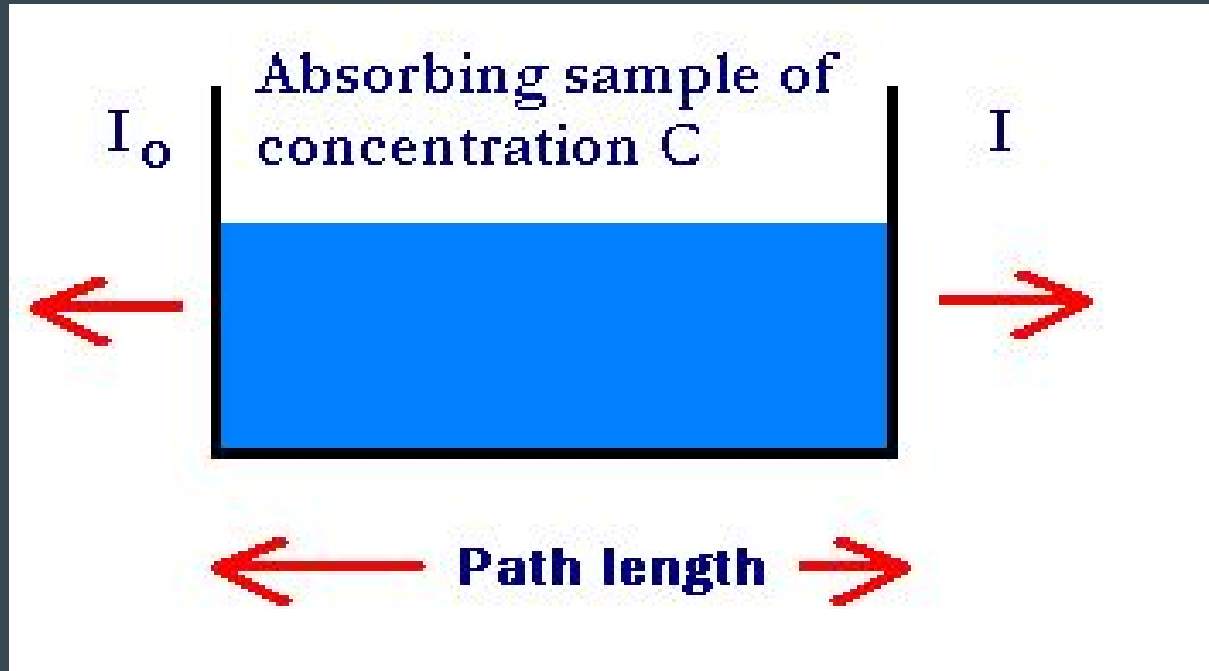


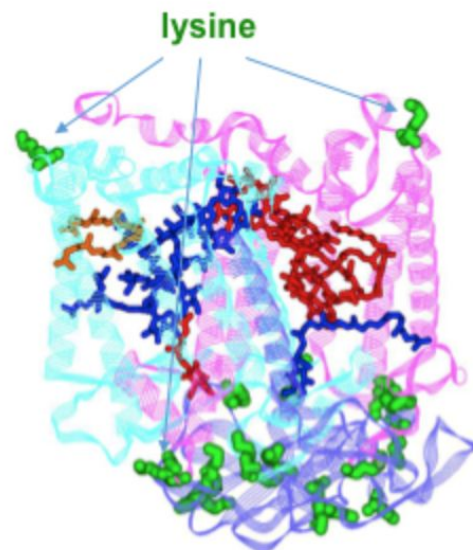
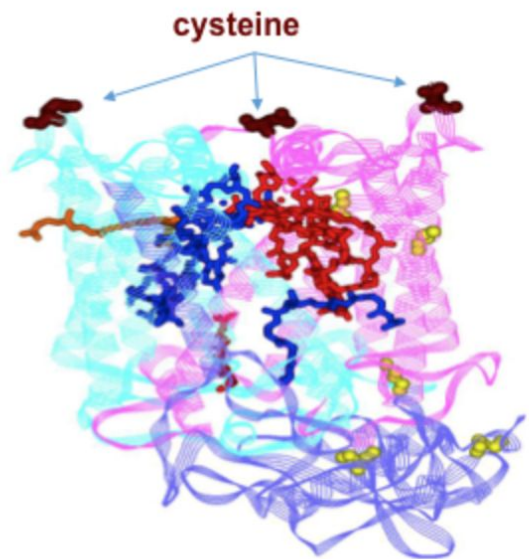




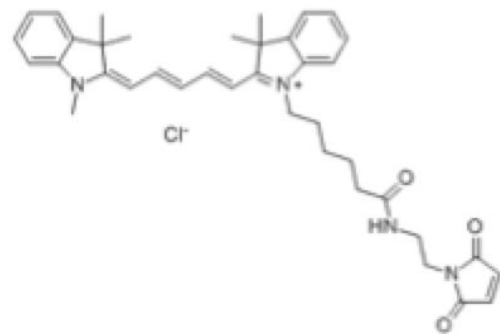
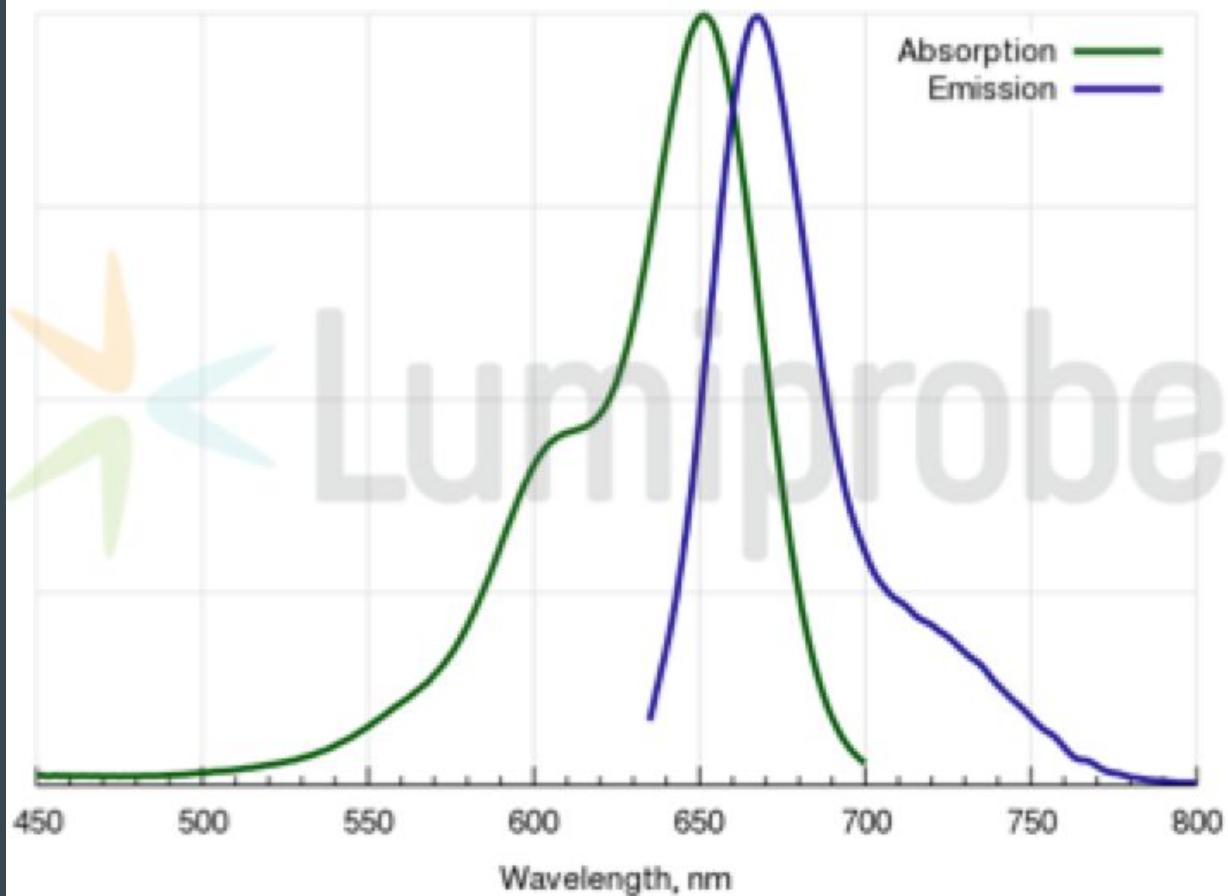


Reaction occurs at pH 6.5-7.5
Non Reversible linkage (cannot be cleaved with reducing agents)
Do not react with tyrosine, histadine or methionines



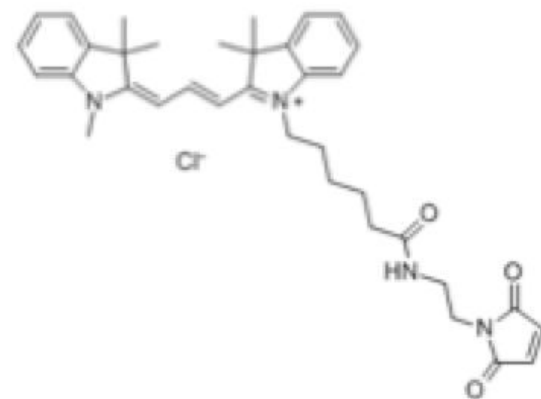
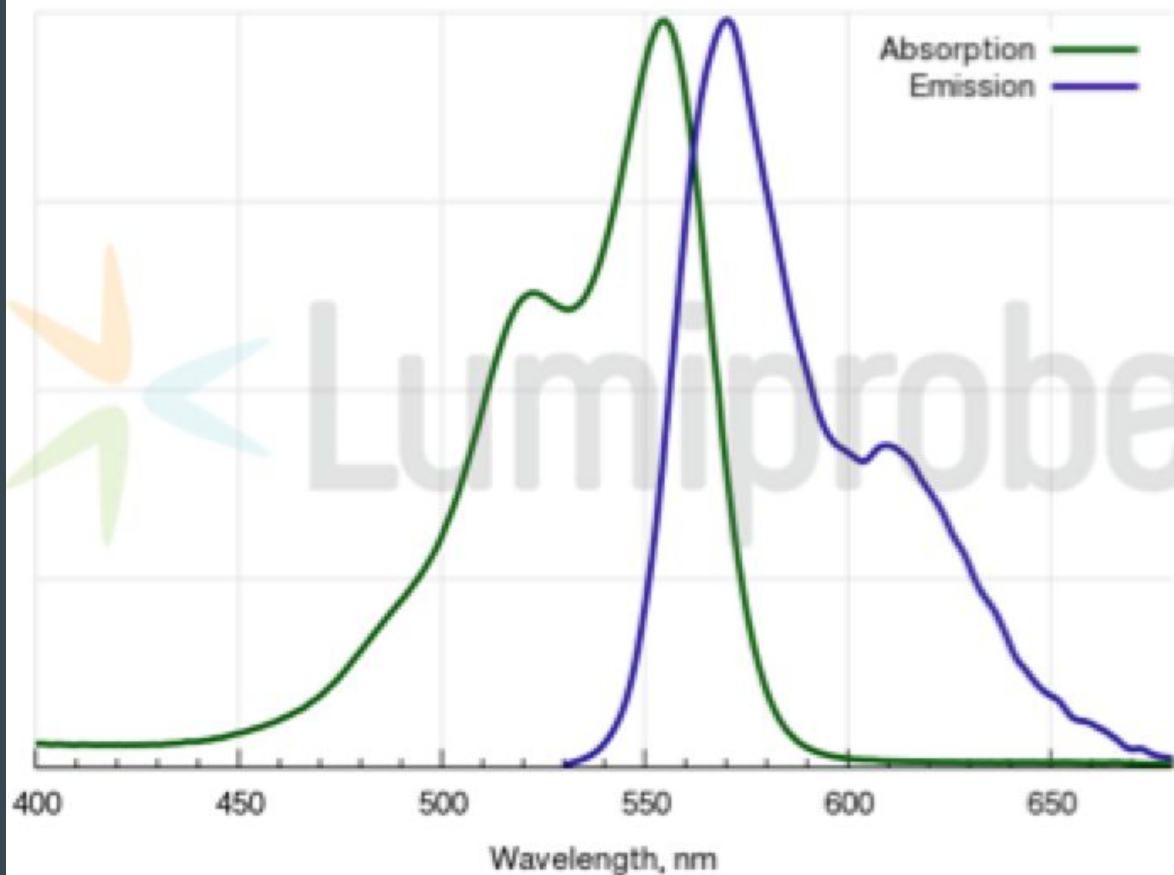


Absorption and emission spectra of Cy5 fluorophore

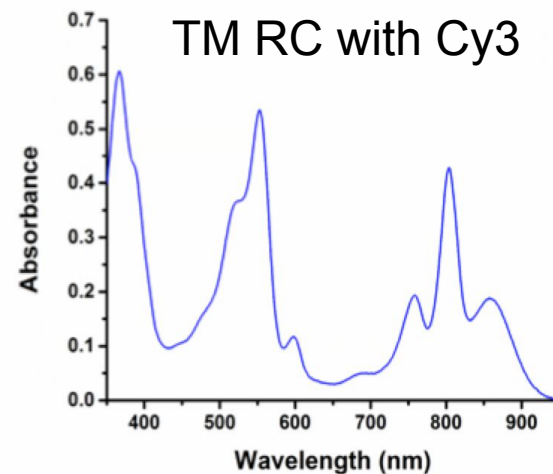
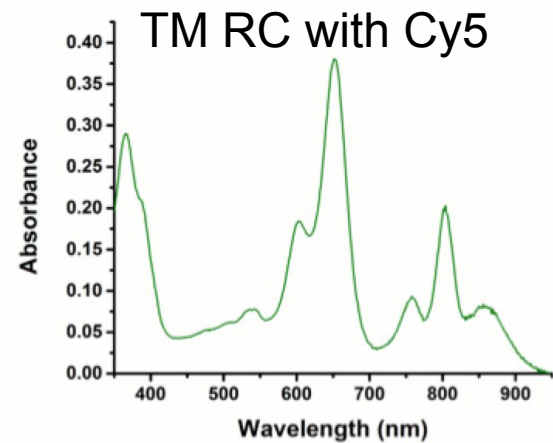
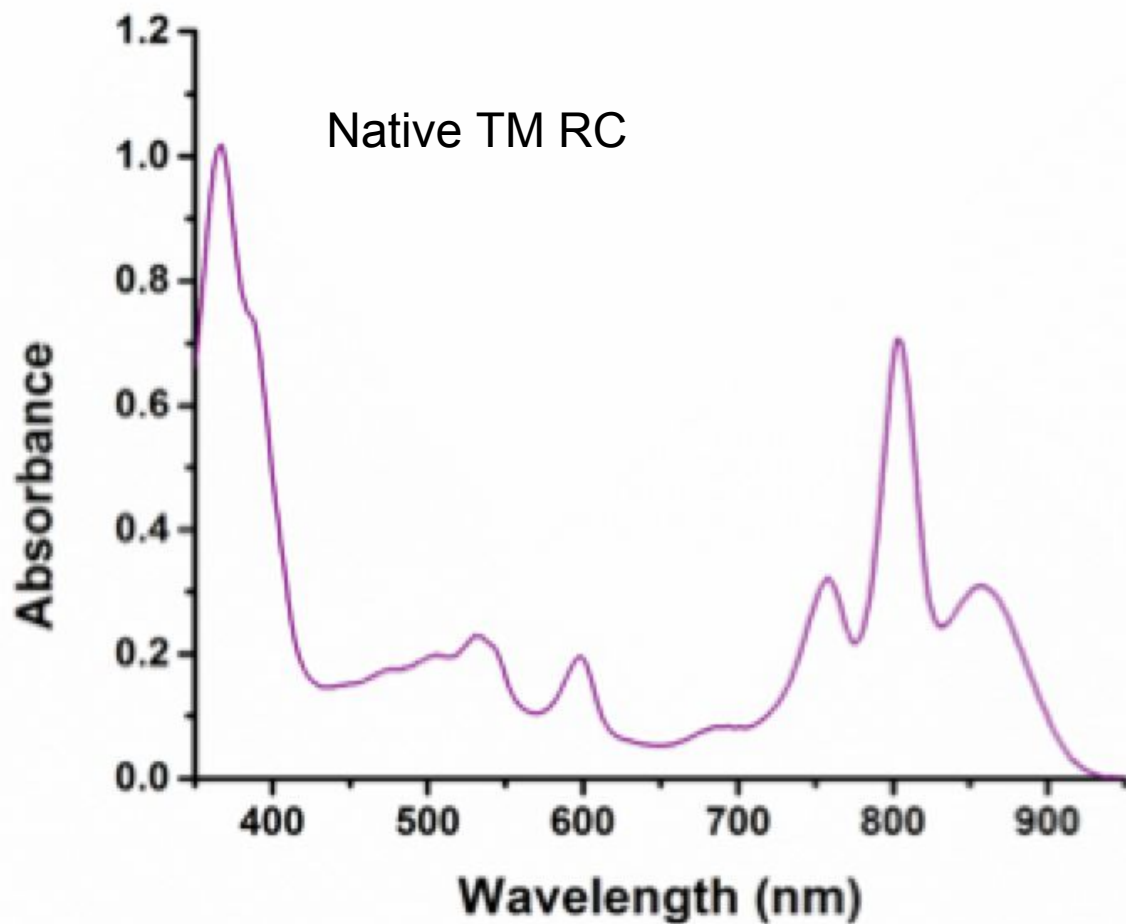


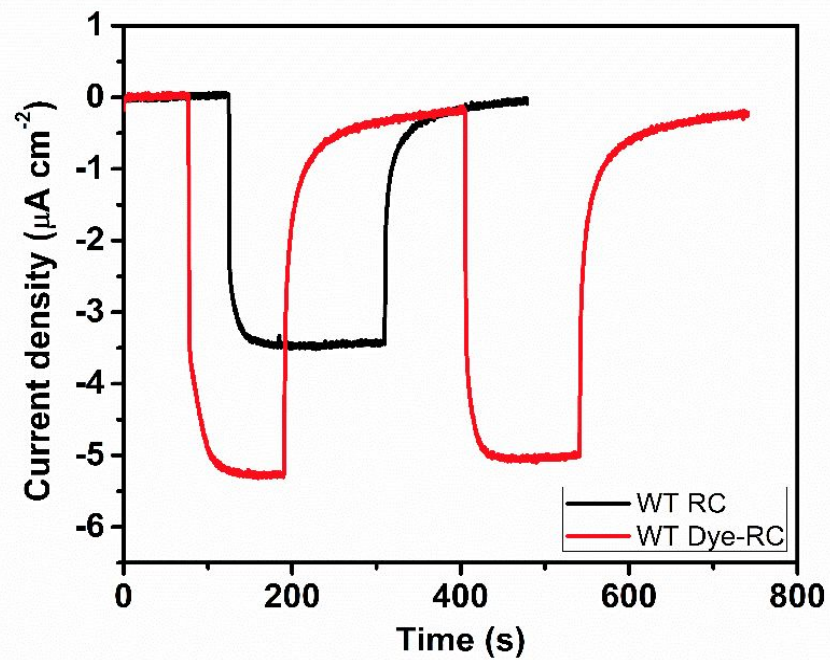
Cy 5

Absorption and emission spectra of Cy3 fluorophore

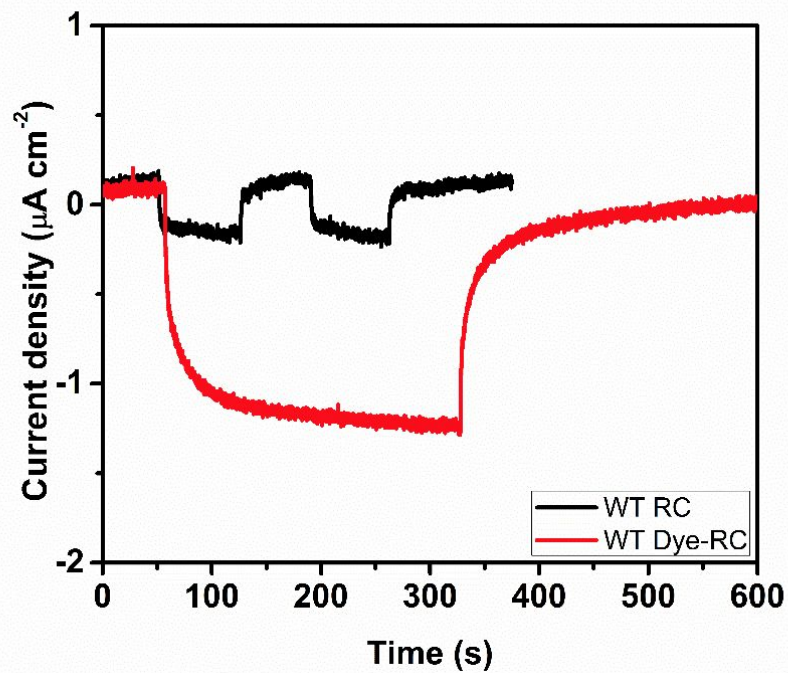


Cy 3





White light



Bandpass at 650 nm (± 8 nm)