
Infrared Laser Technology: Label-free Photothermal Imaging and Nerve Stimulation

Michelle Y. Sander

msander@bu.edu

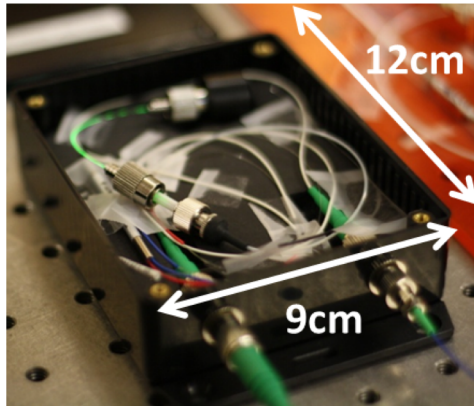
Assistant Professor,
Electrical and Computer Engineering,
BU Photonics Center, Materials Science and Engineering

BU Technical Wonders: Potential Biomedical Applications

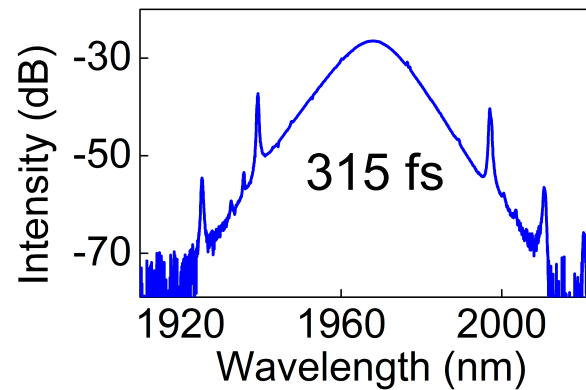
March 28, 2018

Customized Fiber Laser Development

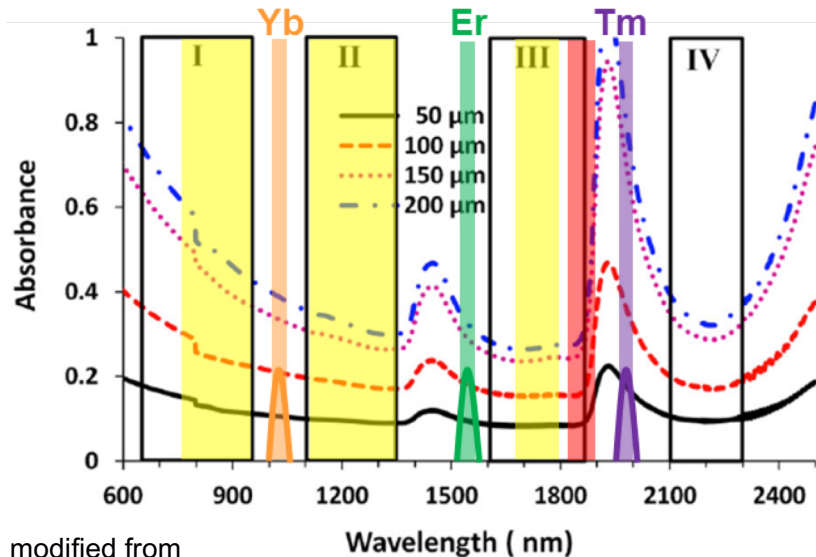
Compact, Robust, All-Fiber Femtosecond Lasers



Thulium Lasers

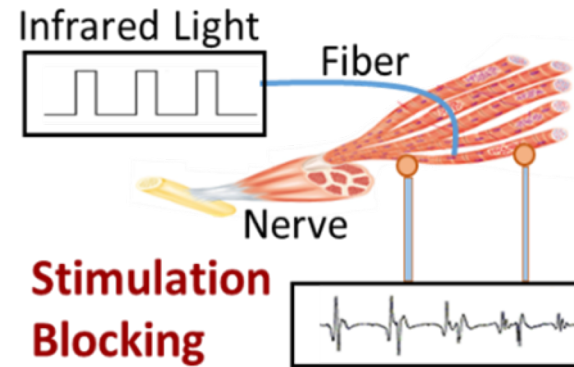


Biological Imaging Windows



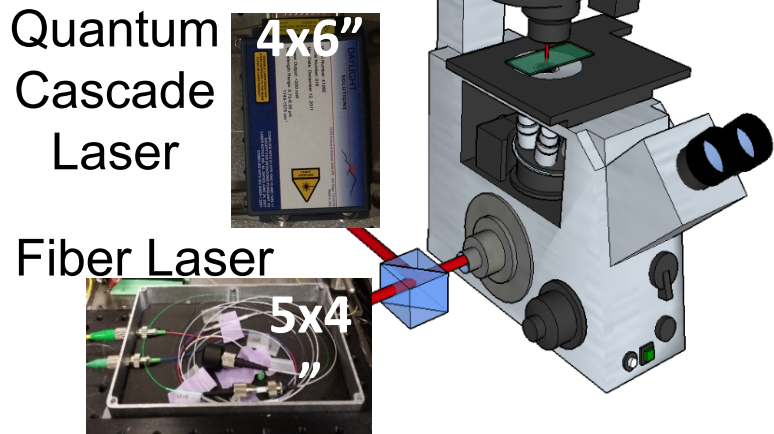
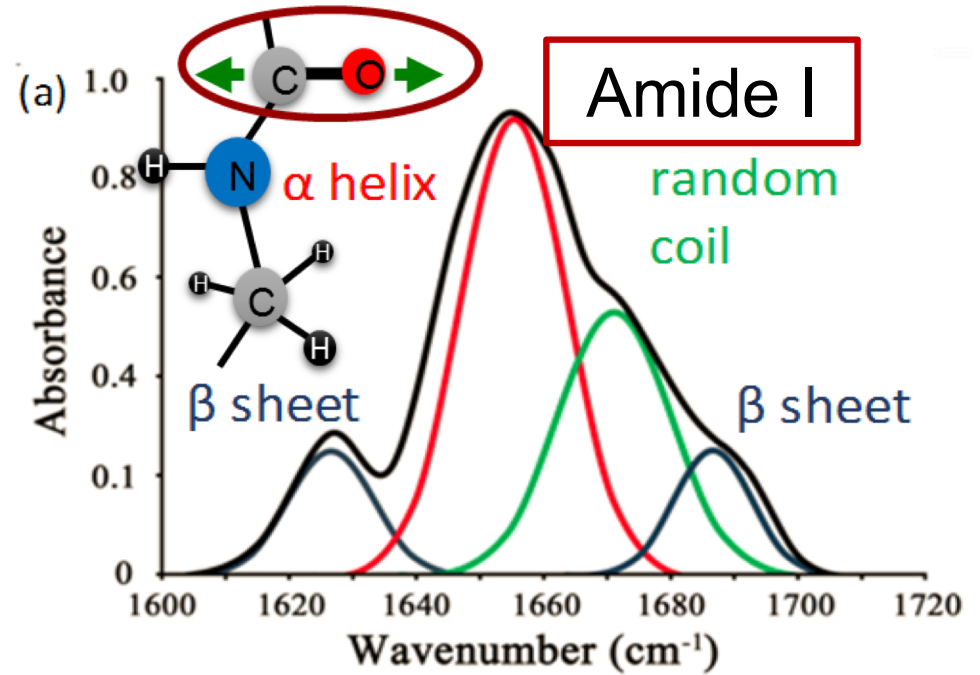
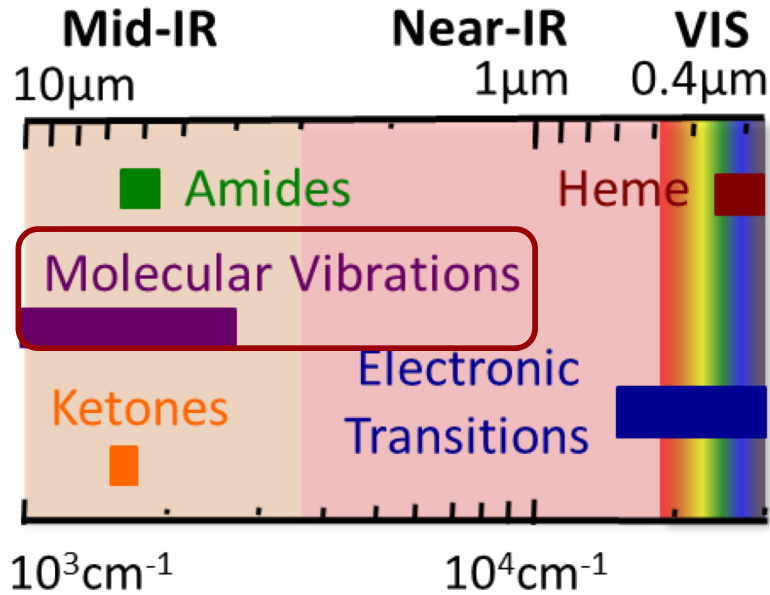
modified from <http://www.kurzweilai.net/images/absorbance-for-four-windows.jpg>

Infrared Nerve Stimulation

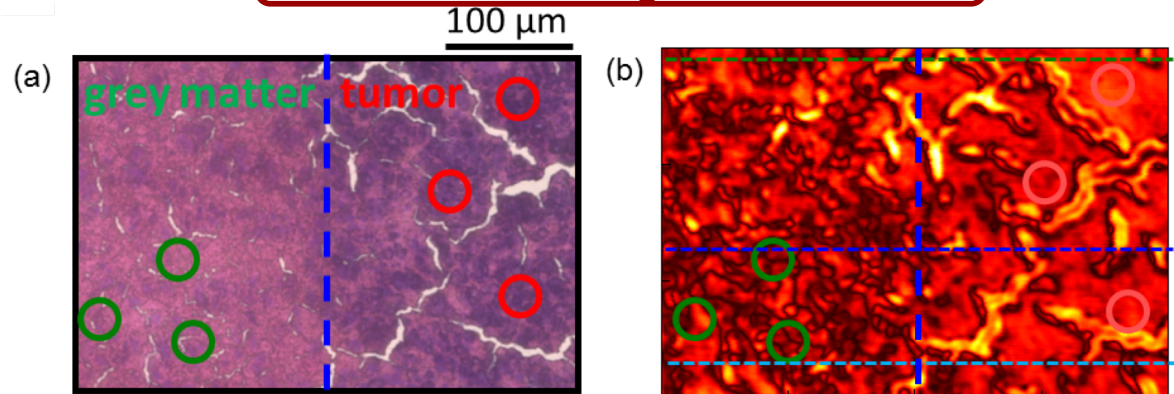


- High spatial selectivity
- No electrode contact
- No electrical stimulation artefacts

Label-Free Photothermal Imaging



Molecular Margin Detection



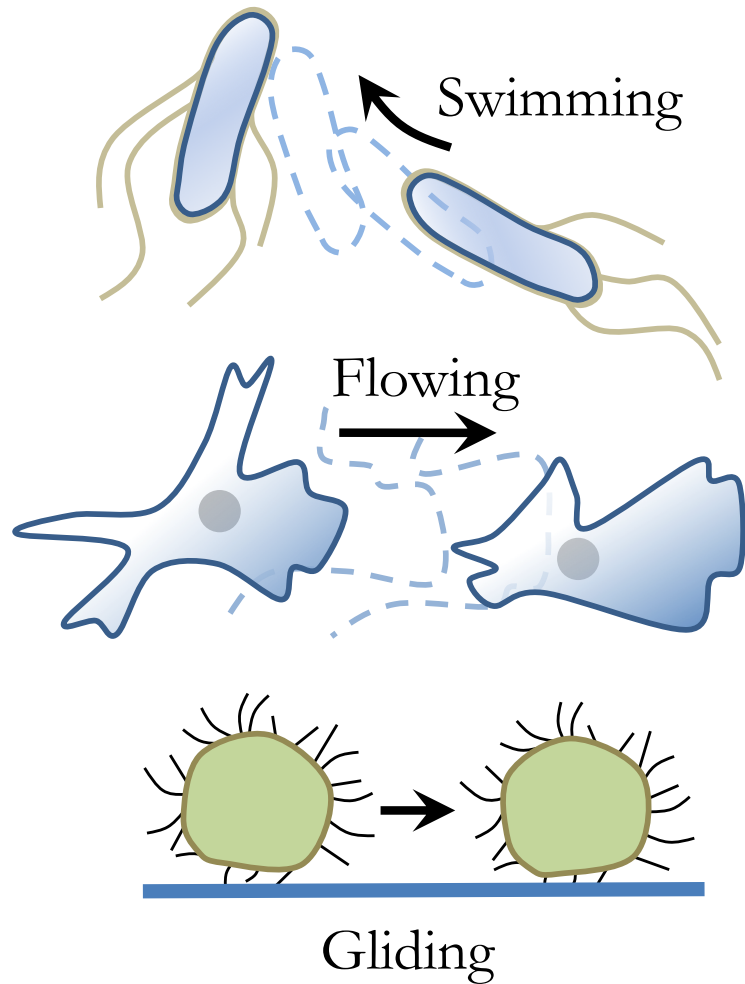
Harnessing Nanomechanical Fluctuations of Cells for Drug Susceptibility Testing

Kamil L. Ekinci
Mechanical Eng.

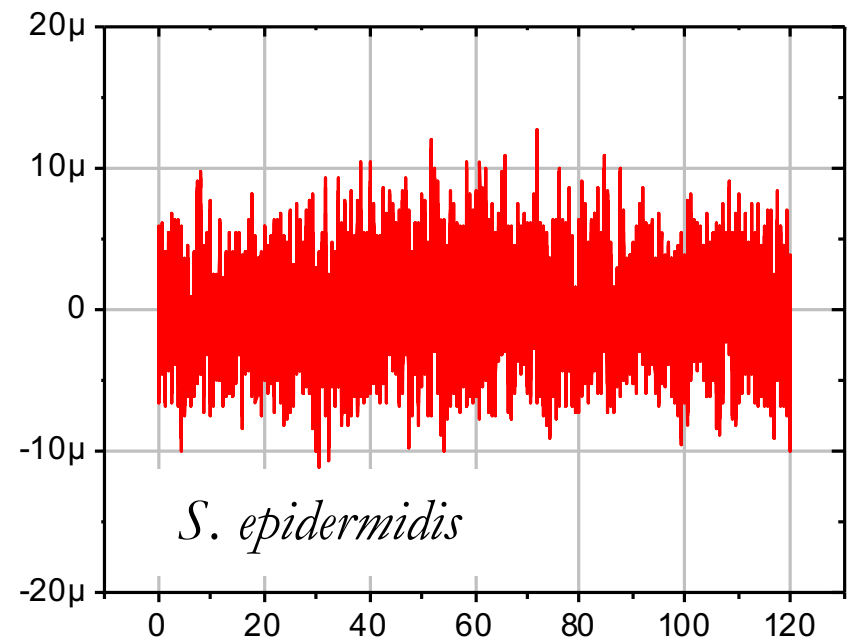
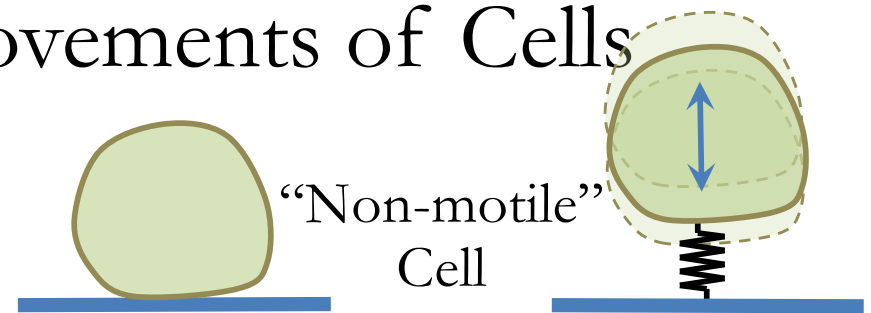
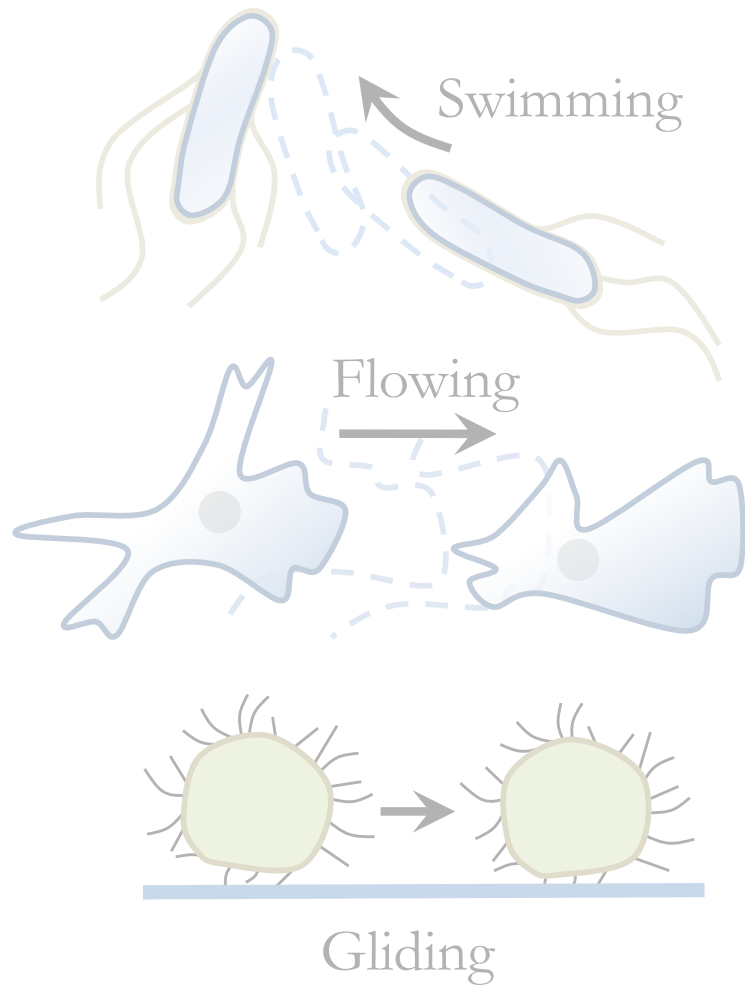
Cells exhibit nanomechanical fluctuations.

Hypothesis: Nanomechanical fluctuations are correlated with cell viability and drug susceptibility.

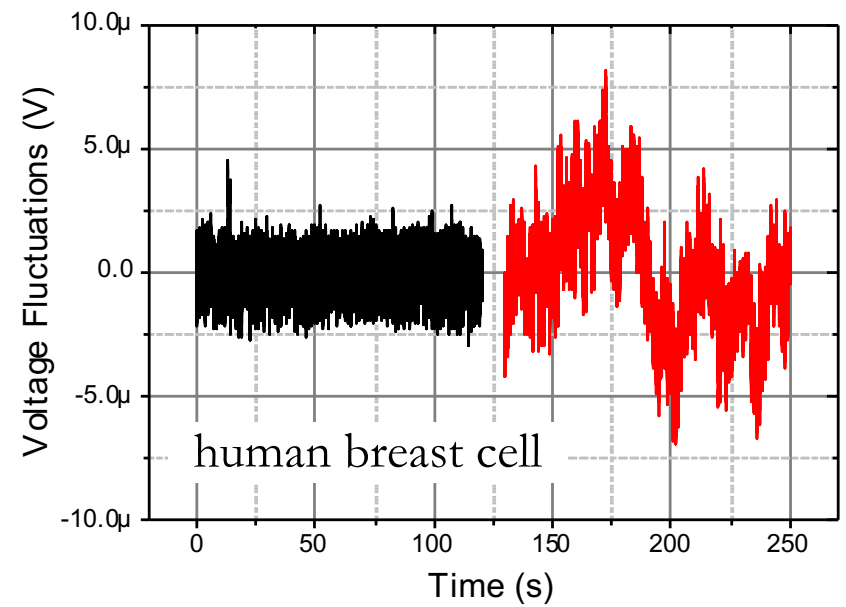
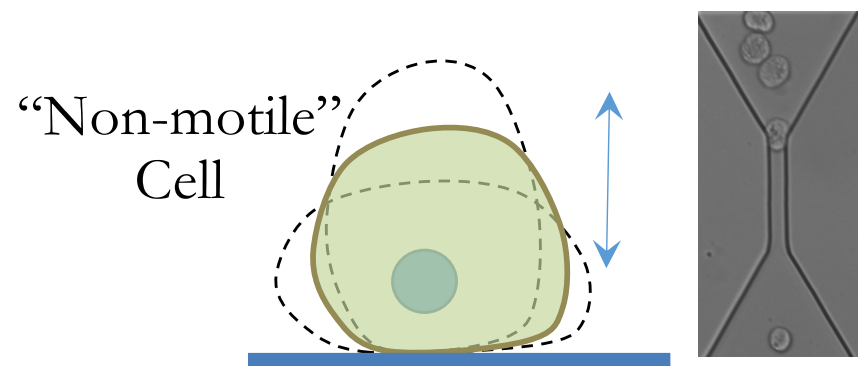
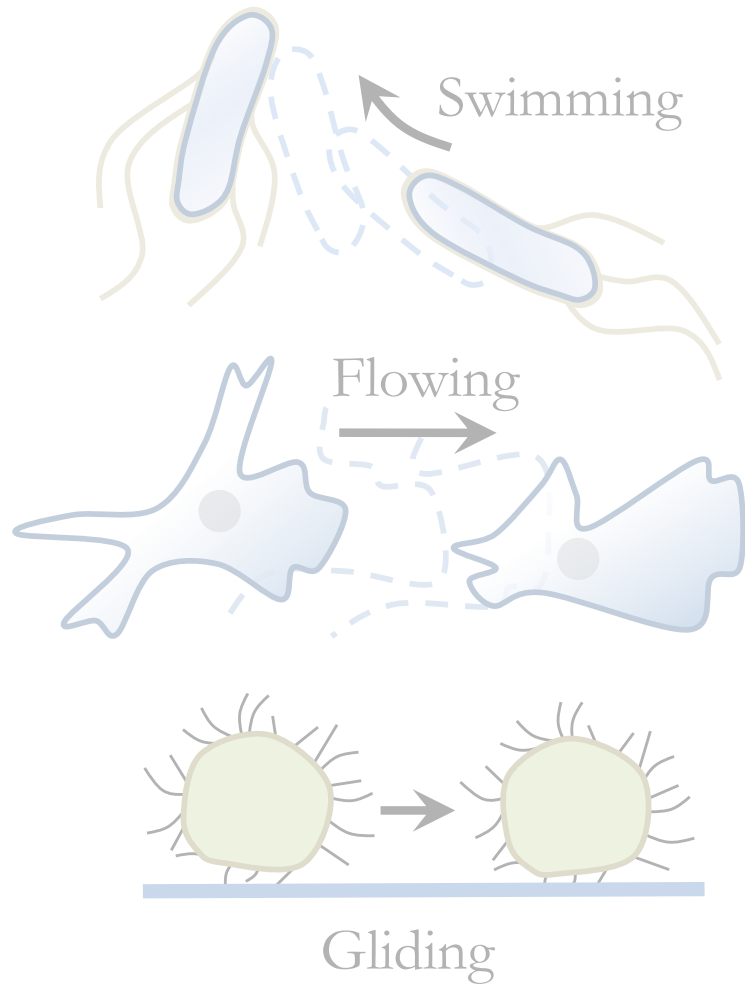
Nanomechanical Movements of Cells



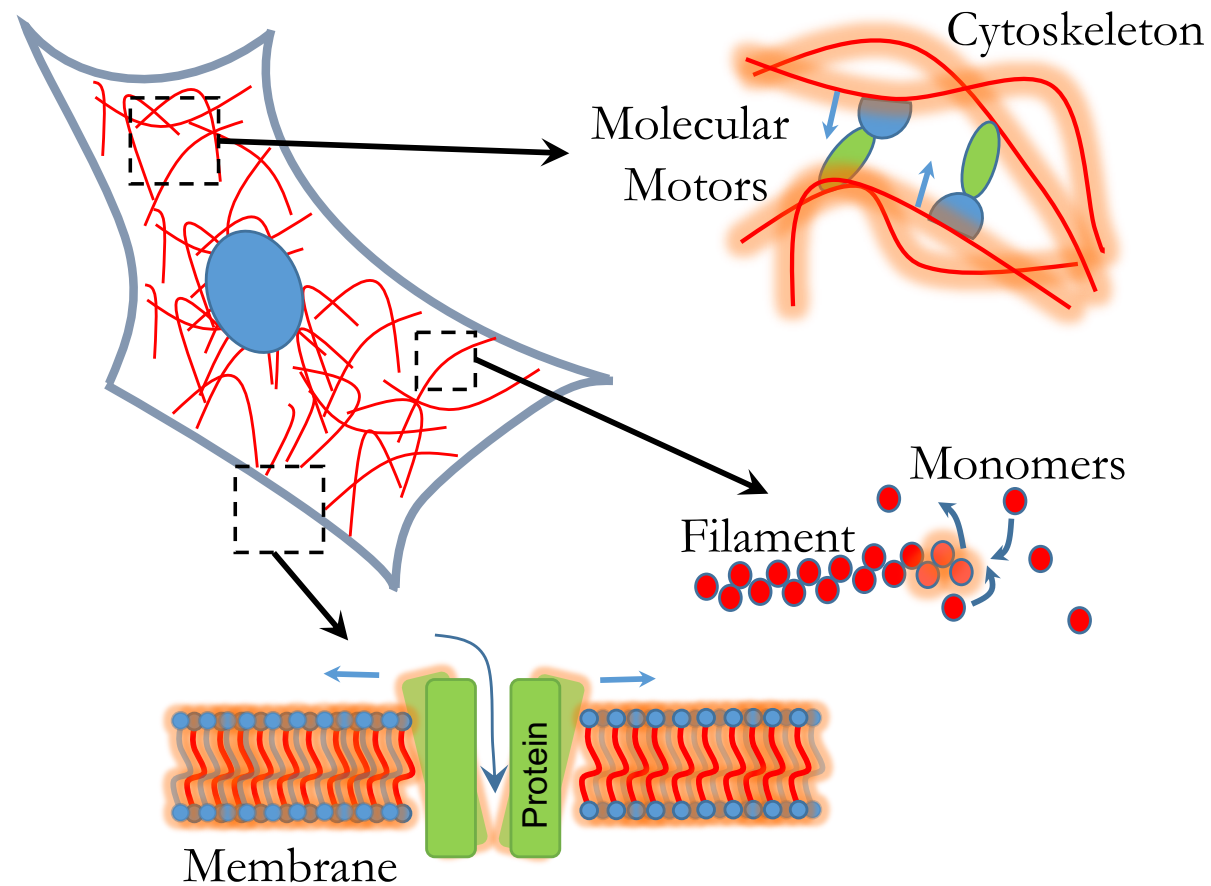
Nanomechanical Movements of Cells



Nanomechanical Movements of Cells



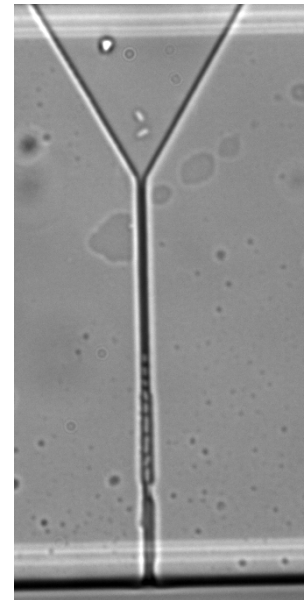
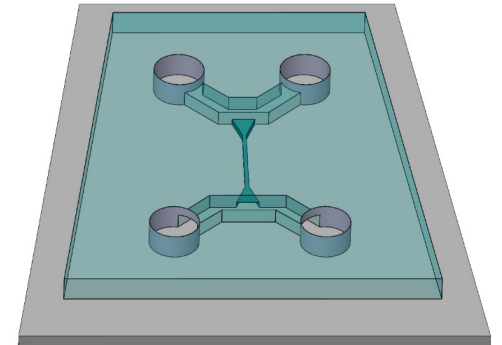
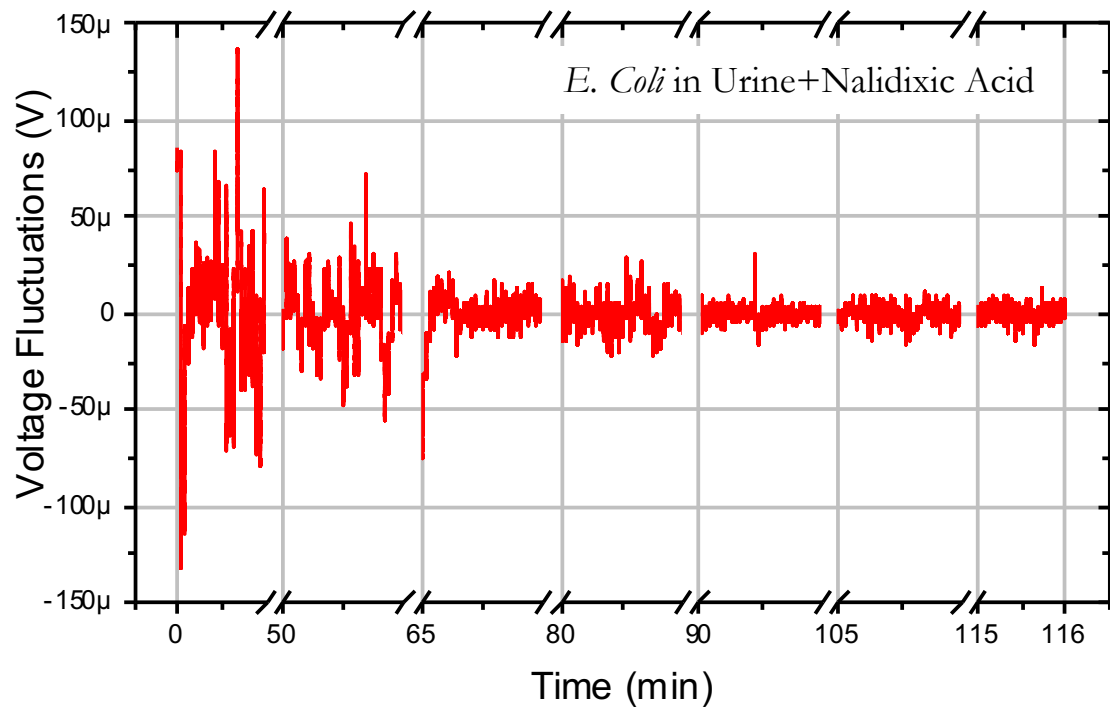
A Living Cell is a *Non-equilibrium* System



Cells exhibit nanomechanical fluctuations.

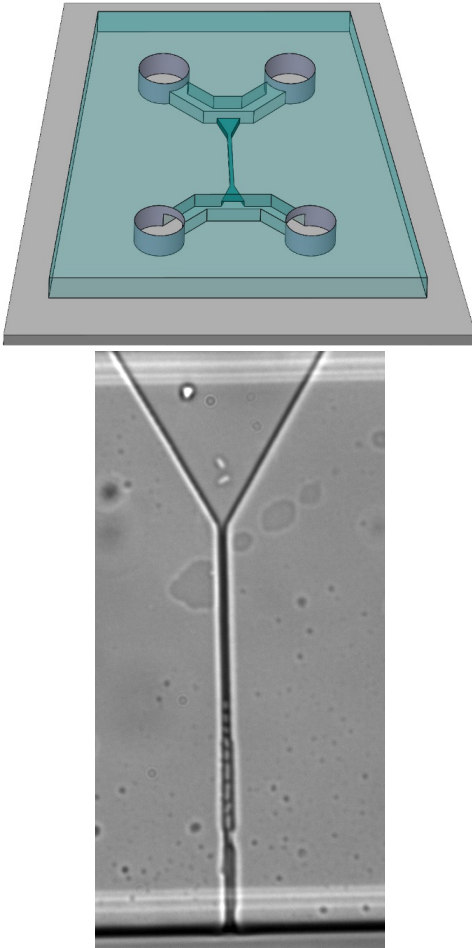
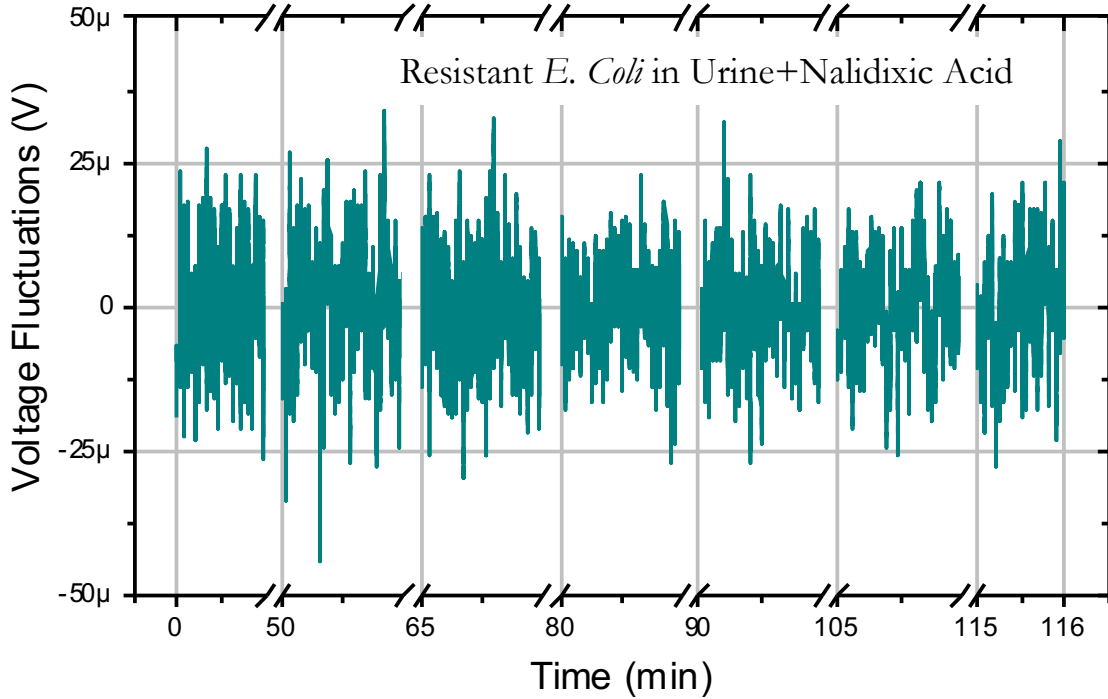
Hypothesis: Nanomechanical fluctuations are correlated with cell viability and drug susceptibility.

Bacteria Fluctuations in Antibiotics



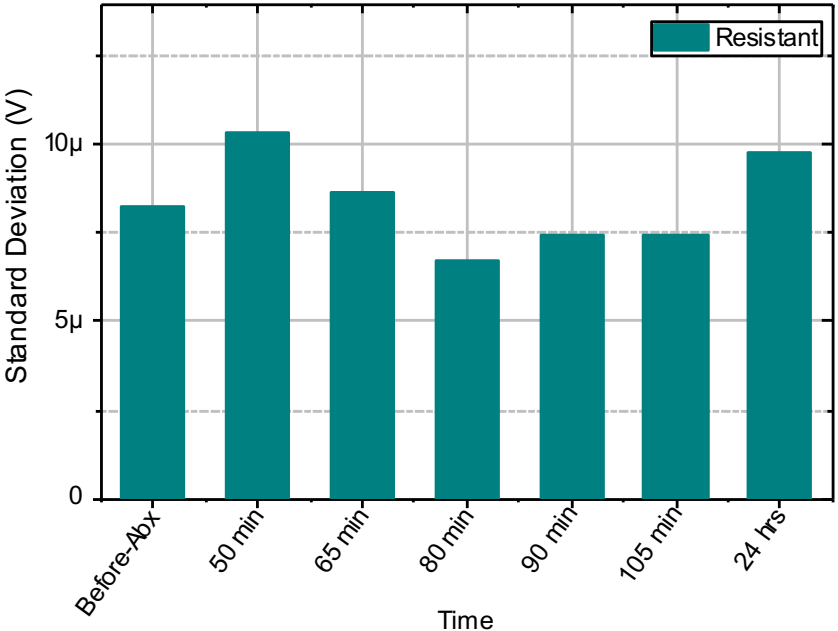
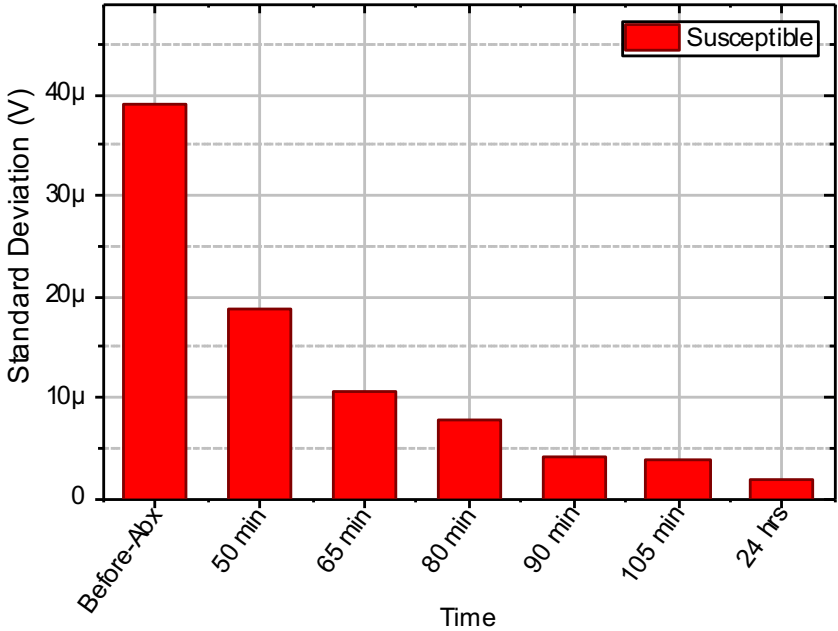
Kara et al., Lab Chip (2018).

Bacteria Fluctuations in Antibiotics



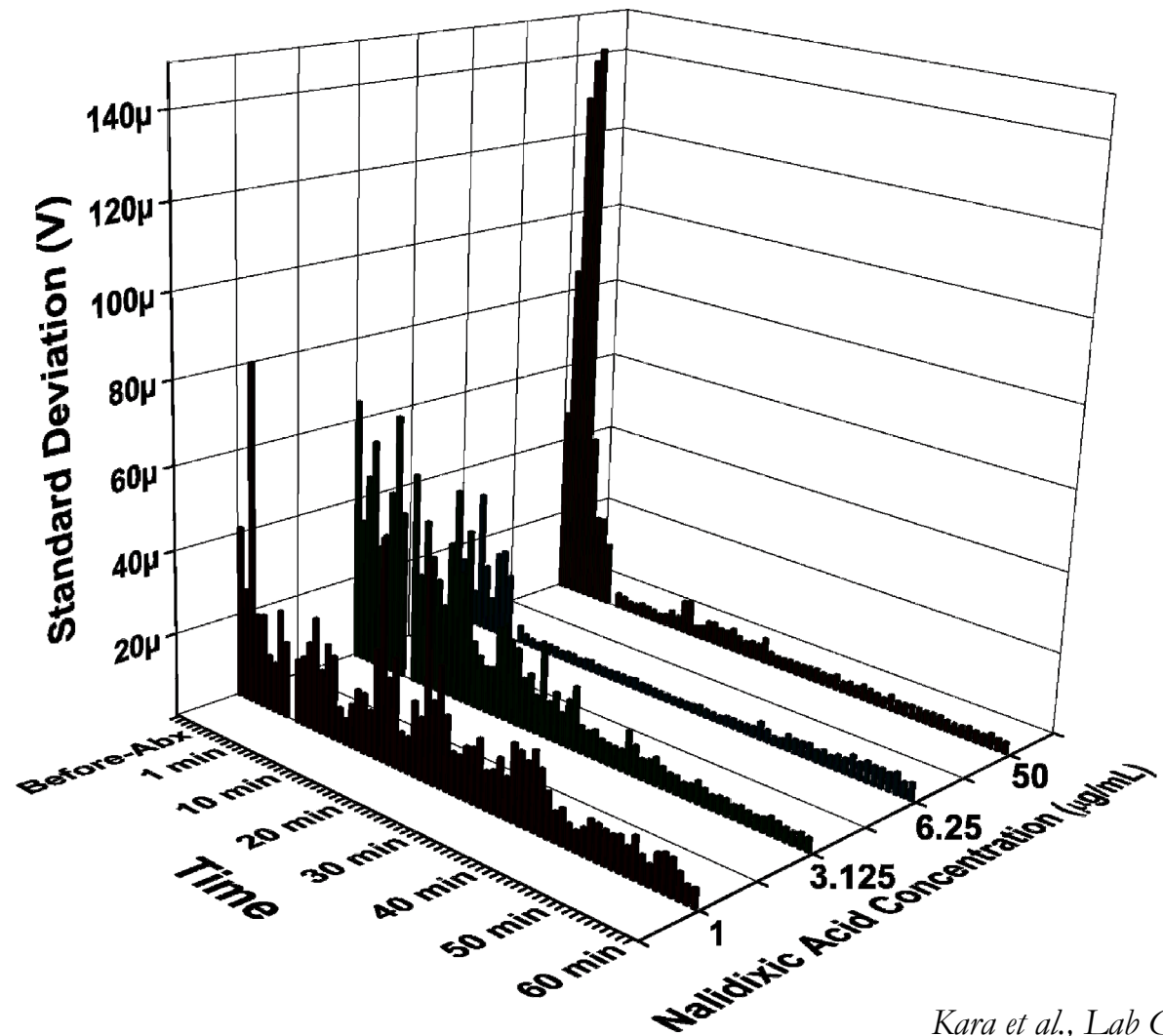
Kara et al., Lab Chip (2018).

Bacteria Fluctuations in Antibiotics



Kara et al., Lab Chip (2018).

Dose Response



Kara et al., Lab Chip (2018).

Acknowledgements

Dr. Vural Kara

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Prof. Joe Tien (BU BME)

Prof. Chuanhua Duan (BU ME)

BU DCA

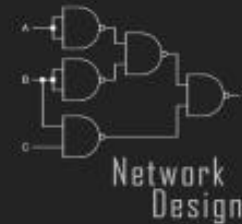
BU Ignition Award

BU Coulter

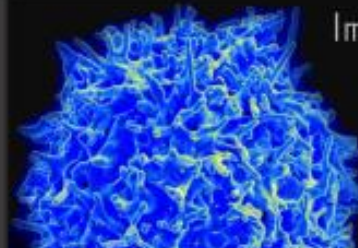
NIH 1R03AI126168-01

Synthetic biology in cancer cellular immunotherapy

WONG LAB
@ Boston University



Developing the NEXT GENERATION
of SMART cancer therapy
with SYNTHETIC BIOLOGY



Immunology

Synthetic
Biology

Wilson W. Wong

Department of Biomedical Engineering
Biological Design Center
Boston University



17 Conflict of Interest



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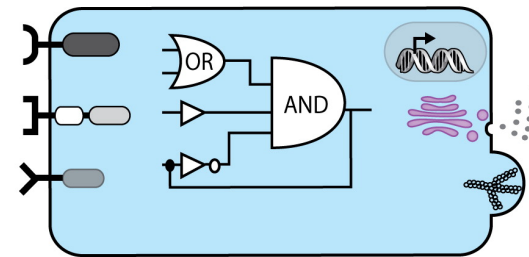
Programming mammalian cells for therapeutic applications



INPUTS

- Disease antigens
- Microenvironment
- Pathogenic signals
- User-controlled signals

Sense disease



Sensors Processing Response

OUTPUTS

- Cell killing
- Antibodies
- Remodel local microenvironment
- Communicate with immune system
- Proliferation/death

Treat disease

Fischbach ,M., et al. Sci. Transl. Med. 179ps7 (2013), Roybal, K., Lim, W. Annu. Rev. Immunol, 35:229-53 (2017)

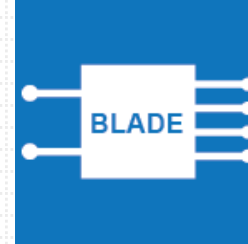
19 Develop genetic tools (Apps) to impart high-level control over mammalian cell functions

Sensors



Smart Tumor Sensors[&]
Improve safety and specificity

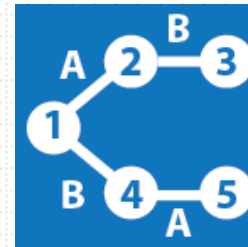
Computers



Combinatorial Logic[^]
Improve specificity



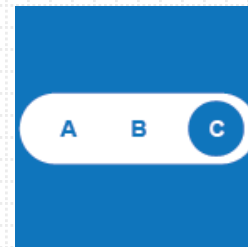
miRNA sensor^{*}
Improve control



Temporal Logic
Decipher seq. of events



ON/OFF Switch
Improve safety by tuning activity



Multistate Switch
Tune threshold/Level

[&]JH Cho, JJ Collins, **WW Wong**. 2018 Cell (In Press)

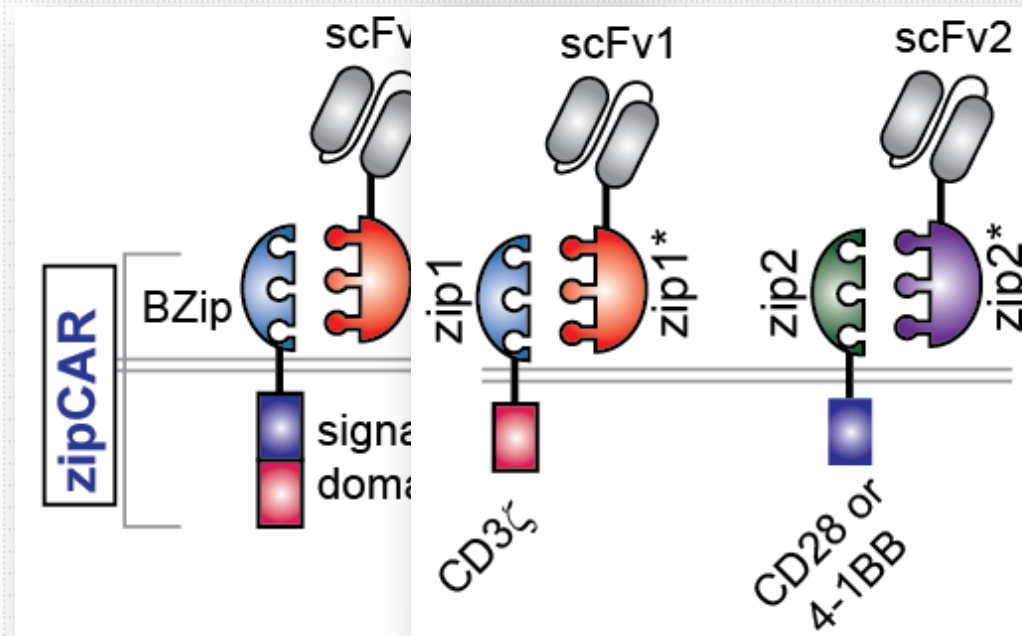
[^]BH Weinberg... **WW Wong**. 2017 Nature Biotechnology 35(2), 788-795

^{*}MK Sayeg, BH Weinberg, SS Cha, M Goodloe, **WW Wong**[#], X Han[#]. 2015 ACS Synthetic Biology 4 (7), 788-795

20 Split, Universal, Programmable (**SUPRA**) tumor targeting receptors

Feature-rich universal CARs for Multiplexed and Logical Control

SUPRA CARs



Jang Hwan
Cho

Applications: Flexible targeting

Tunability

ON/OFF switch

Combinatorial logic

In Press, Cell

Wilson Wong

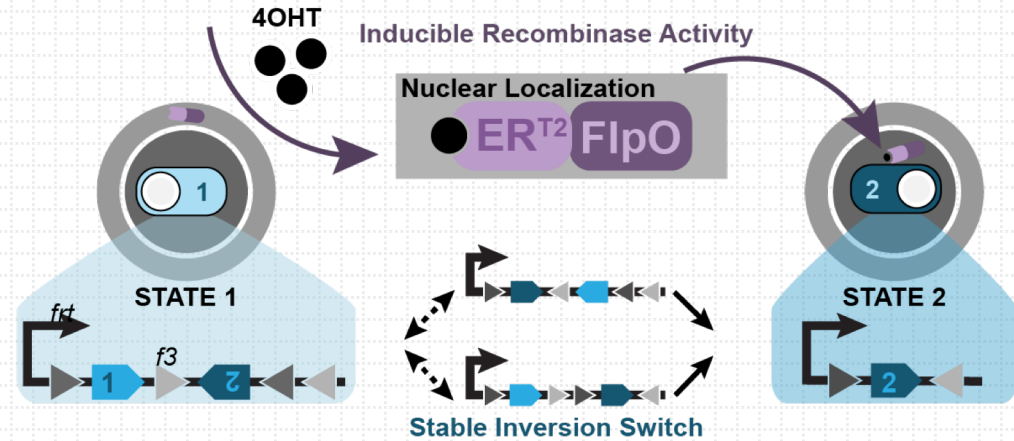
610 Commonwealth Ave, Boston
wilsonwonglab.org



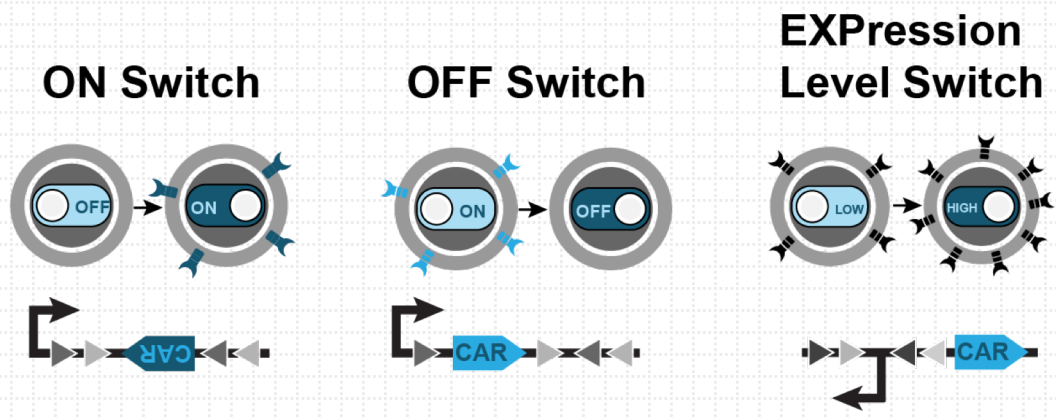
BOSTON
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Gene switches with memory inducible with a FDA approved drug

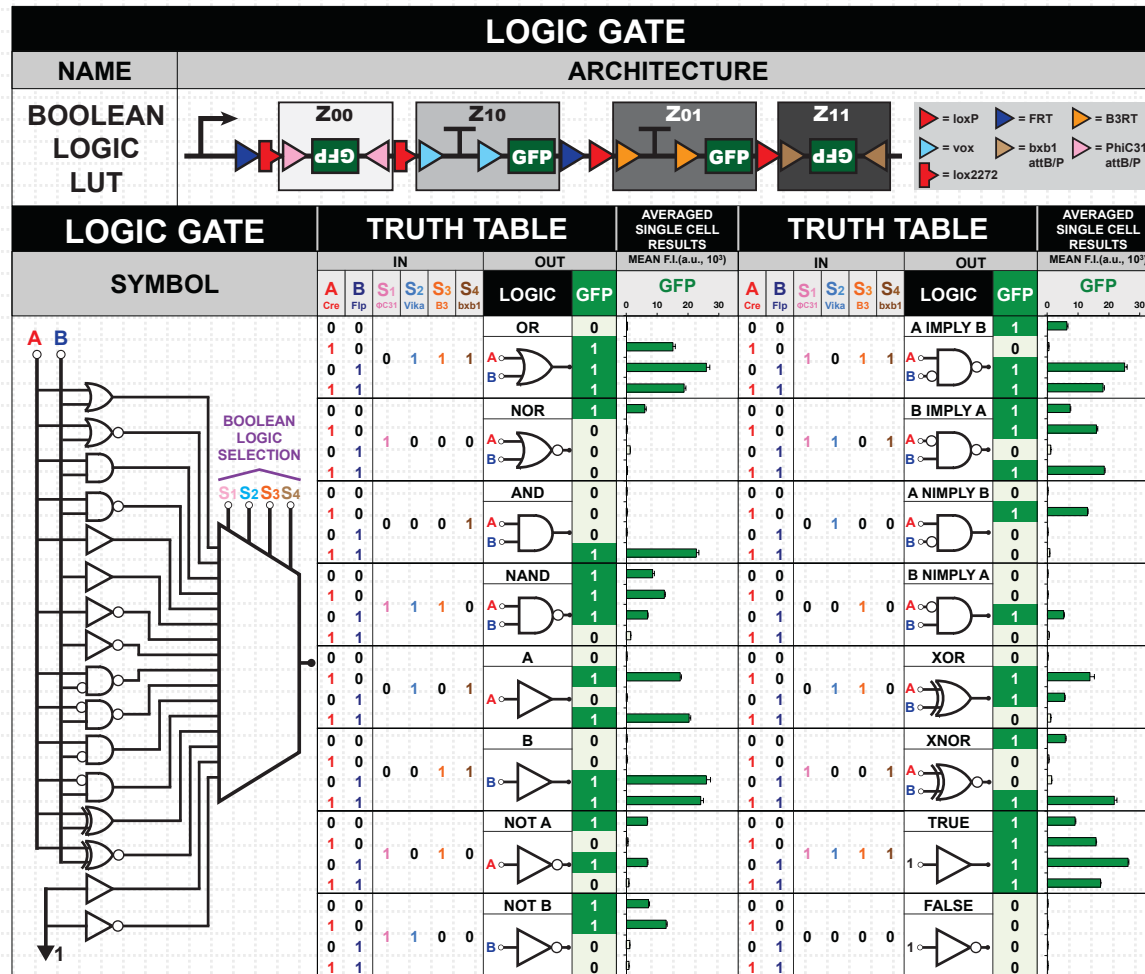
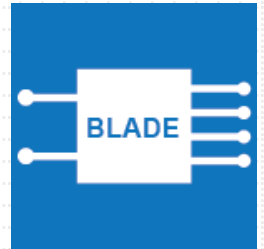


(b)



Applications: Gene expression control in gene or cellular immunotherapy

Complex Biocomputers in mammalian cells

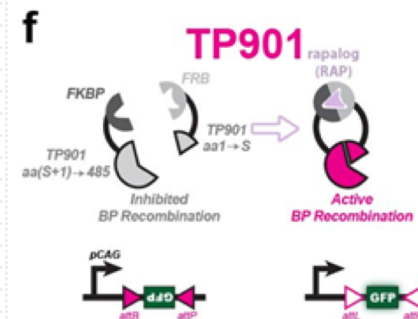
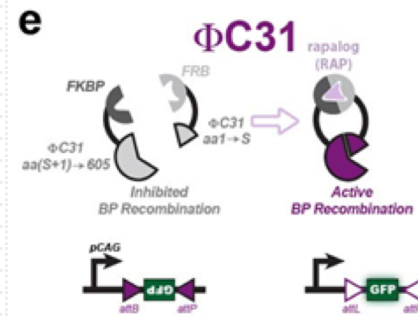
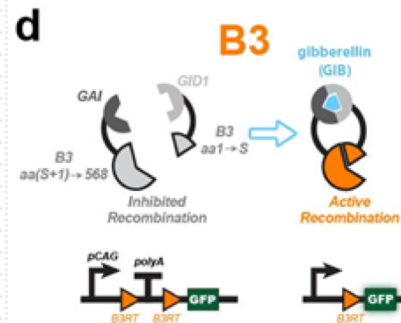
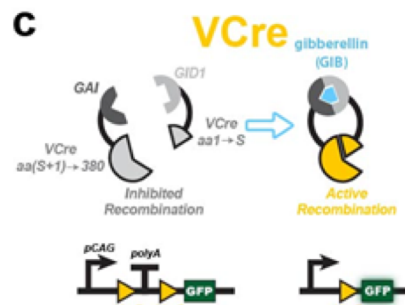
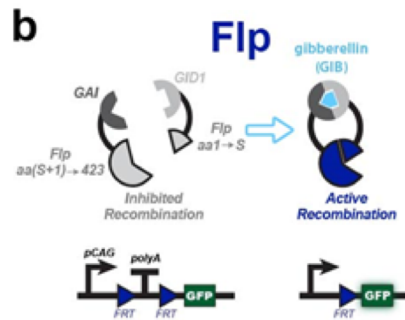
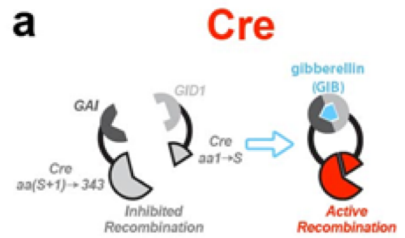


Applications: Engineering cell lines for drug screening/toxicology

Tissue engineering

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Library of drug/light inducible recombinases



>20 different inducible recombinase systems.

Applications: Animal model development

