LightSources

Methods and Mechanisms of Photonic Disinfection

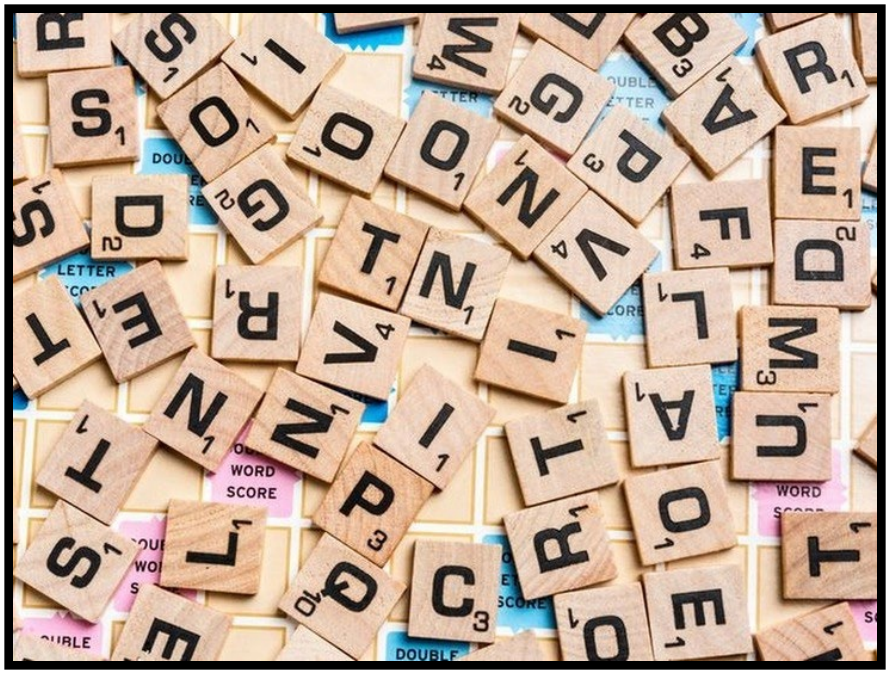
Daniel Spicer
Germicidal Sales Engineer
Light Sources Inc.

Presentation Contents

- Definitions and Word Play
  - Sterilize vs. Disinfect
  - Log Reduction Scale
  - Kills vs. Inactivate
  - 1st Law of Photochemistry
- A Brief Visualization of Biological Burden Reduction
- Mechanisms
  - DNA Disruption With UVC Wavelengths (240-300nm)
  - Blue Light Cellular Membrane Damage (400-420nm)
- Conclusion

LightSources

Definitions and Word Play



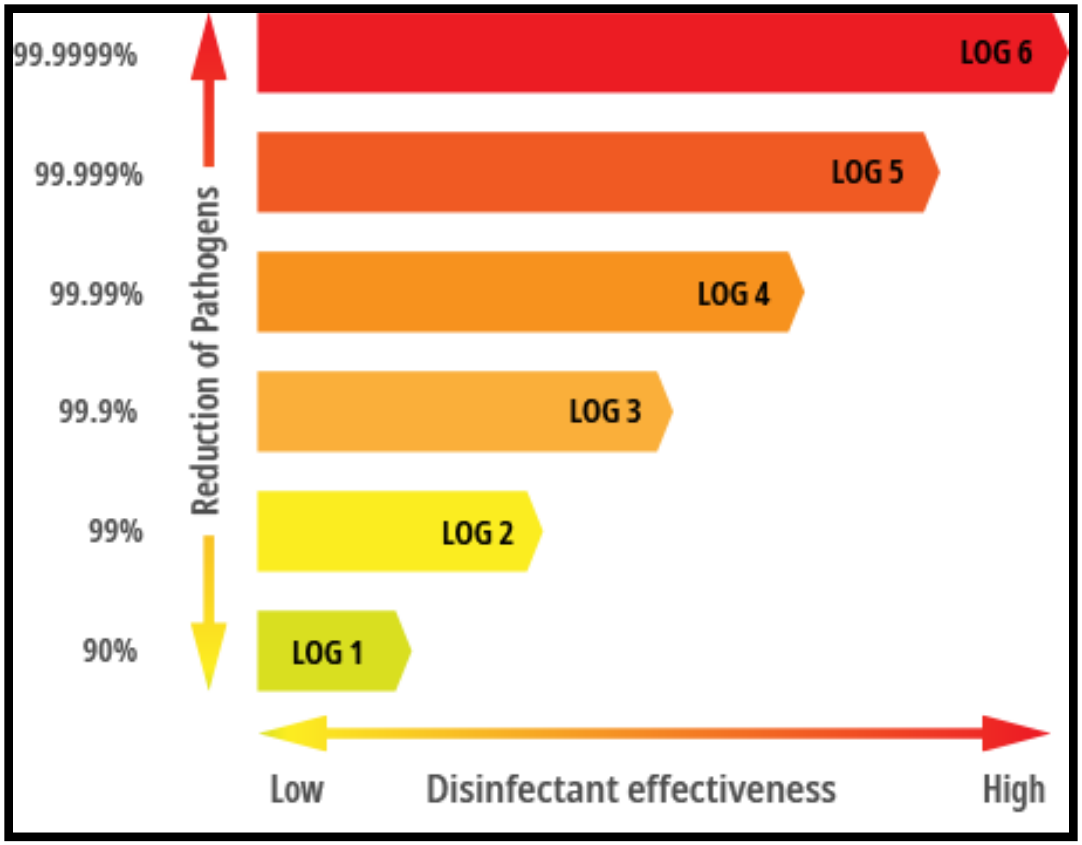
LightSources

“Disinfect” vs. “Sterilize”

- Important Distinction:
  - *Sterilization* means to free an object or substance from all life of any kind. Sterilization should be distinguished from *disinfection*
  - *Disinfection* means to kill, inactivate or remove organisms capable of causing infection. This may not necessarily result in sterilization (i.e.: some biological life may remain)

LightSources

1 Log, 2 Log, Red Log, Blue Log



LightSources

“Kill” vs. “Inactivate”

- *Kill* means to cause the death of (a person, animal, or other living thing)

- *Inactivate* means to make inactive or inoperative. (Better Word Choice)

LightSources

1st Law Of Photochemistry

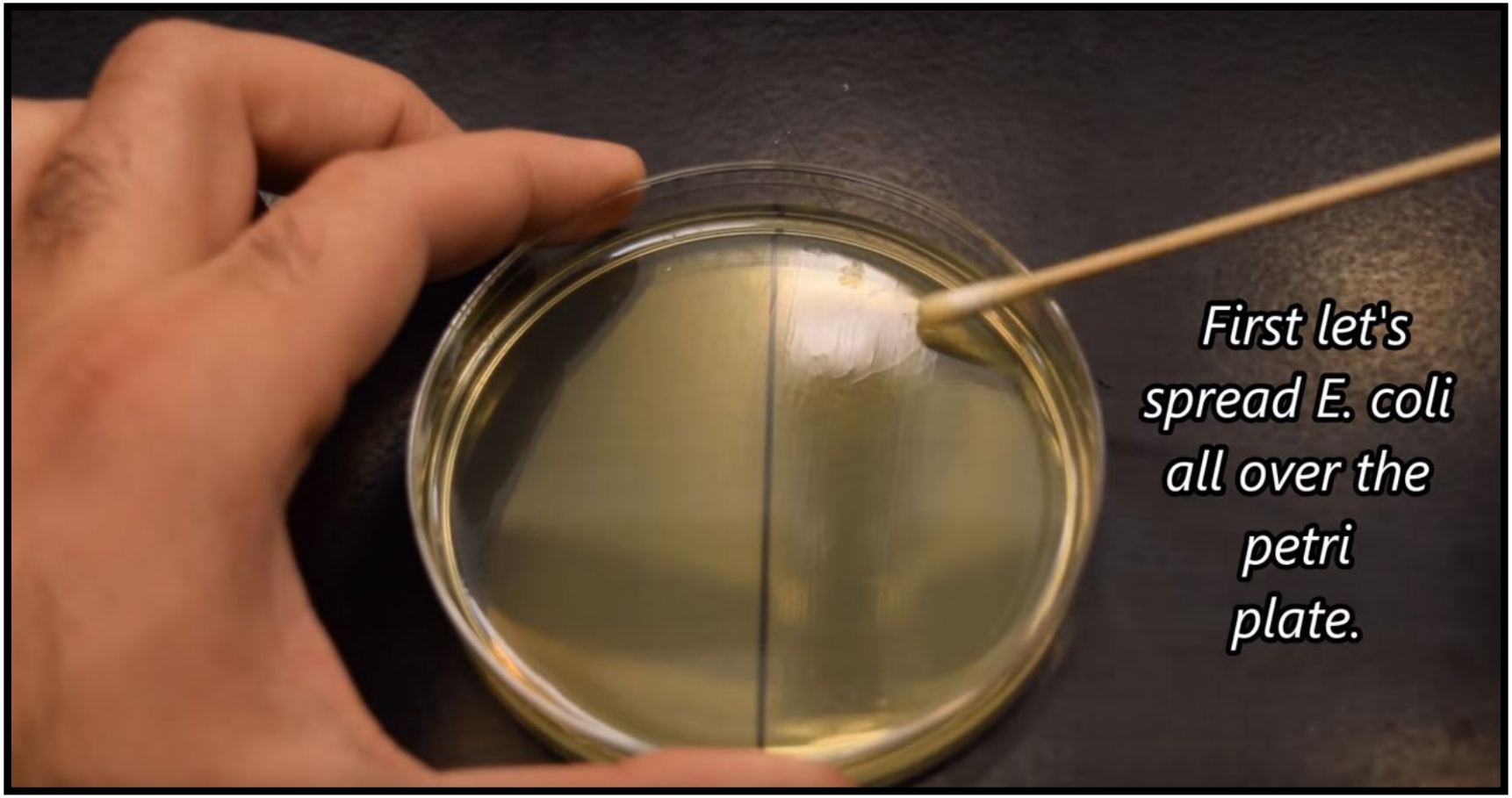
- Also known as the Grotthuss-Draper Law:

Light must be absorbed by a chemical substance in order for a photochemical reaction to take place

A Brief Visualization of Biological Burden Reduction

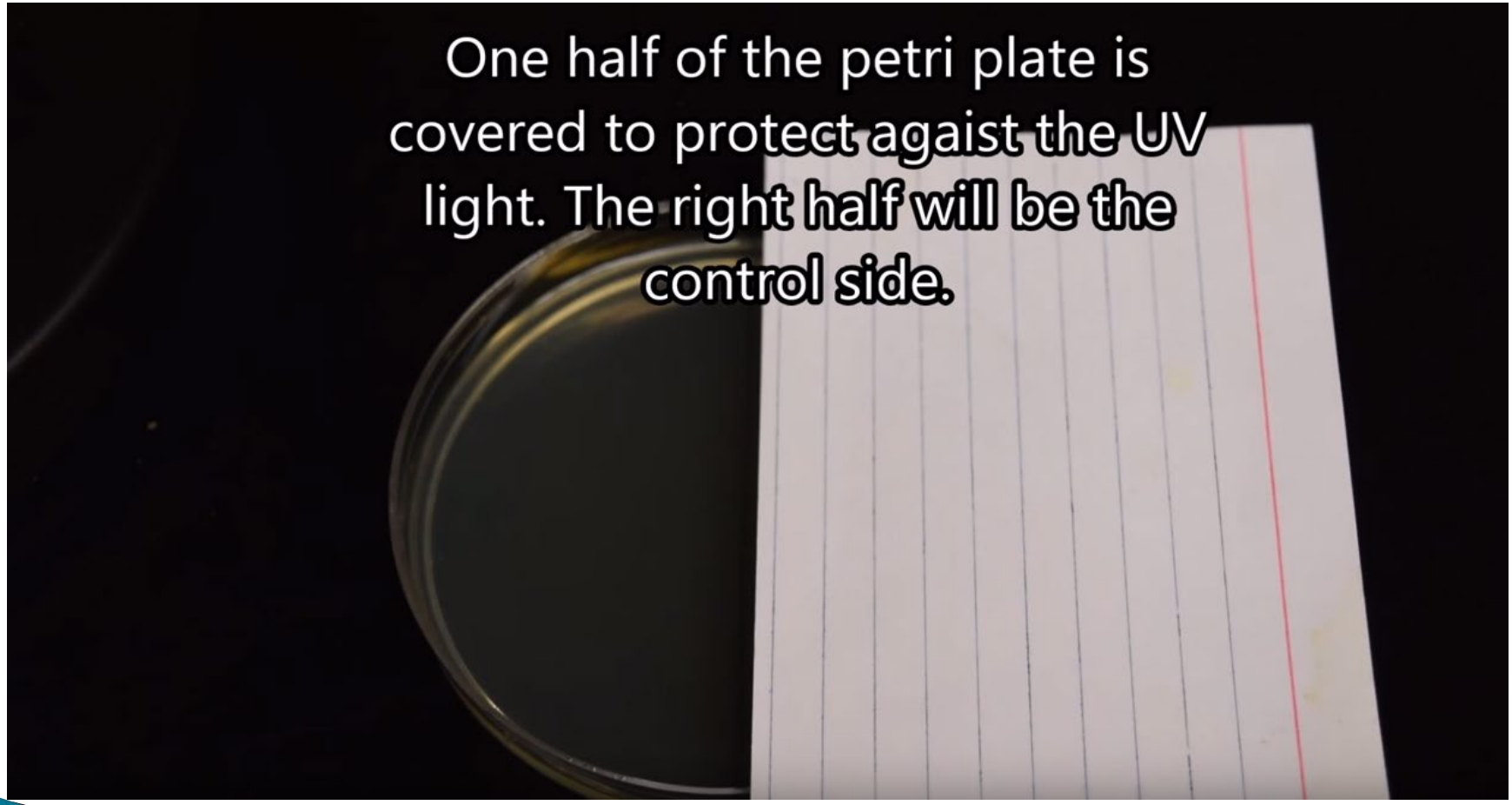
LightSources

Photonic Disinfection = A Cumulative Effect



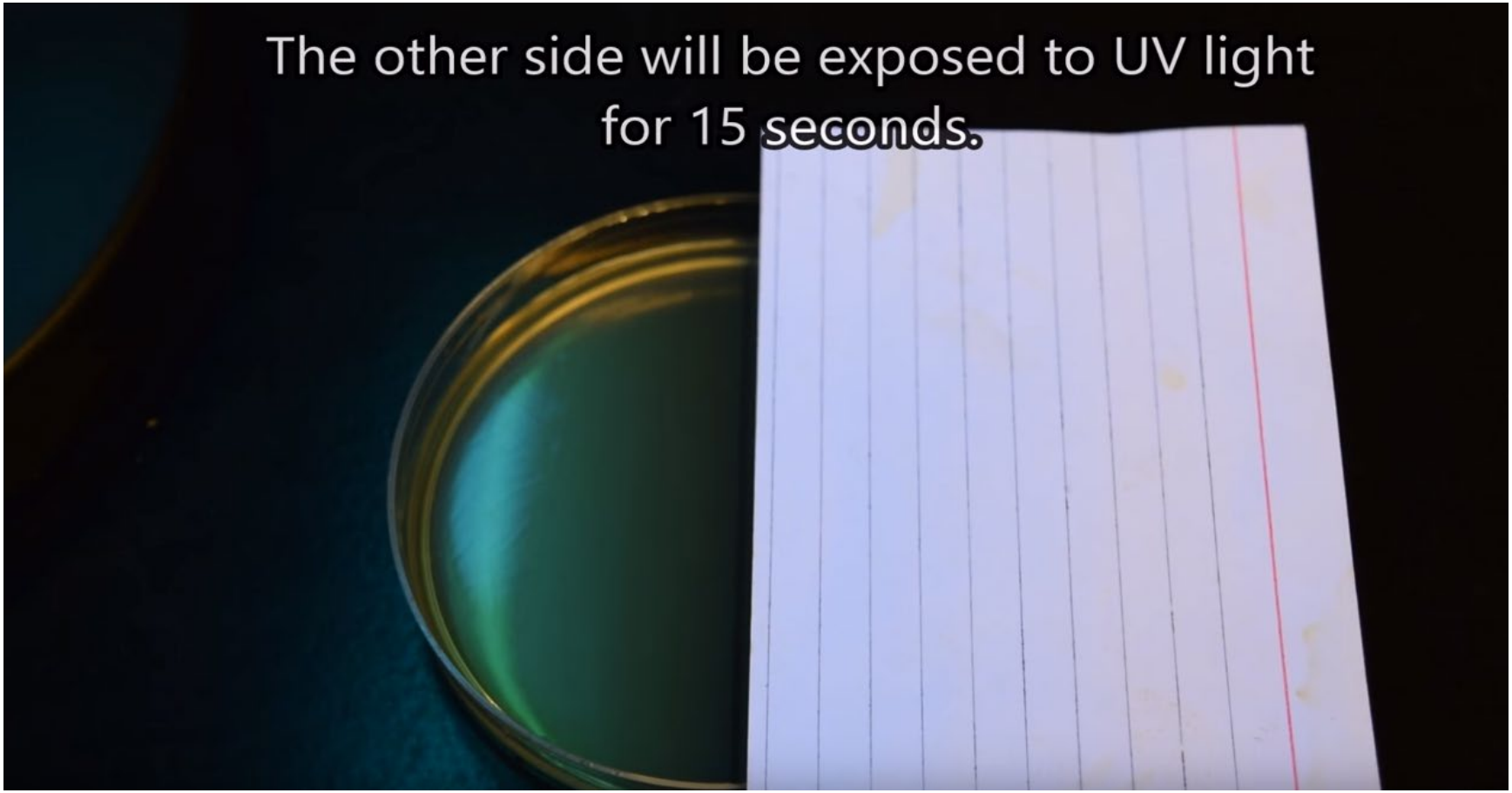
LightSources

Photonic Disinfection = A Cumulative Effect



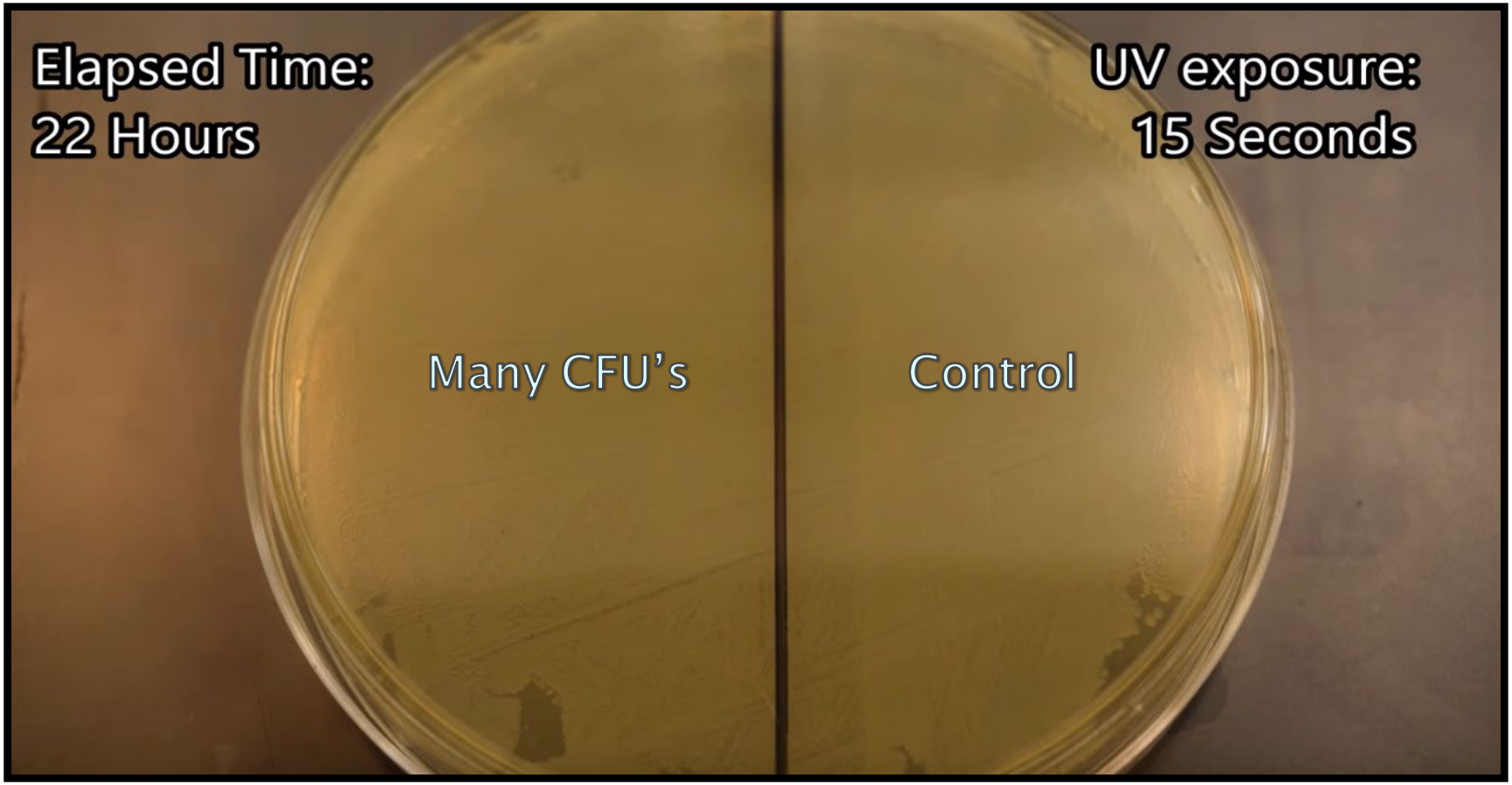
LightSources

Photonic Disinfection = A Cumulative Effect



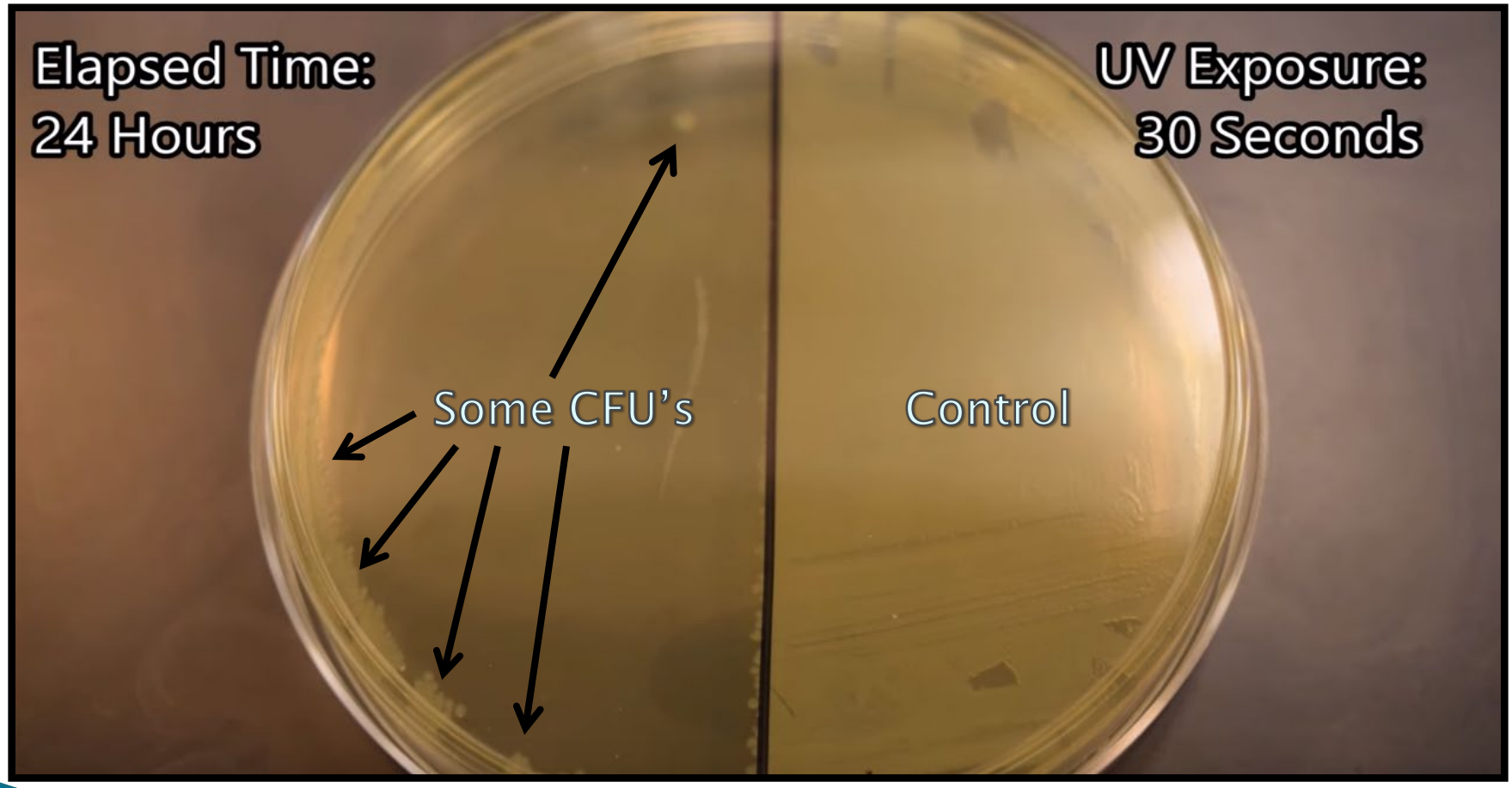
LightSources

15 Second Exposure @ 254nm



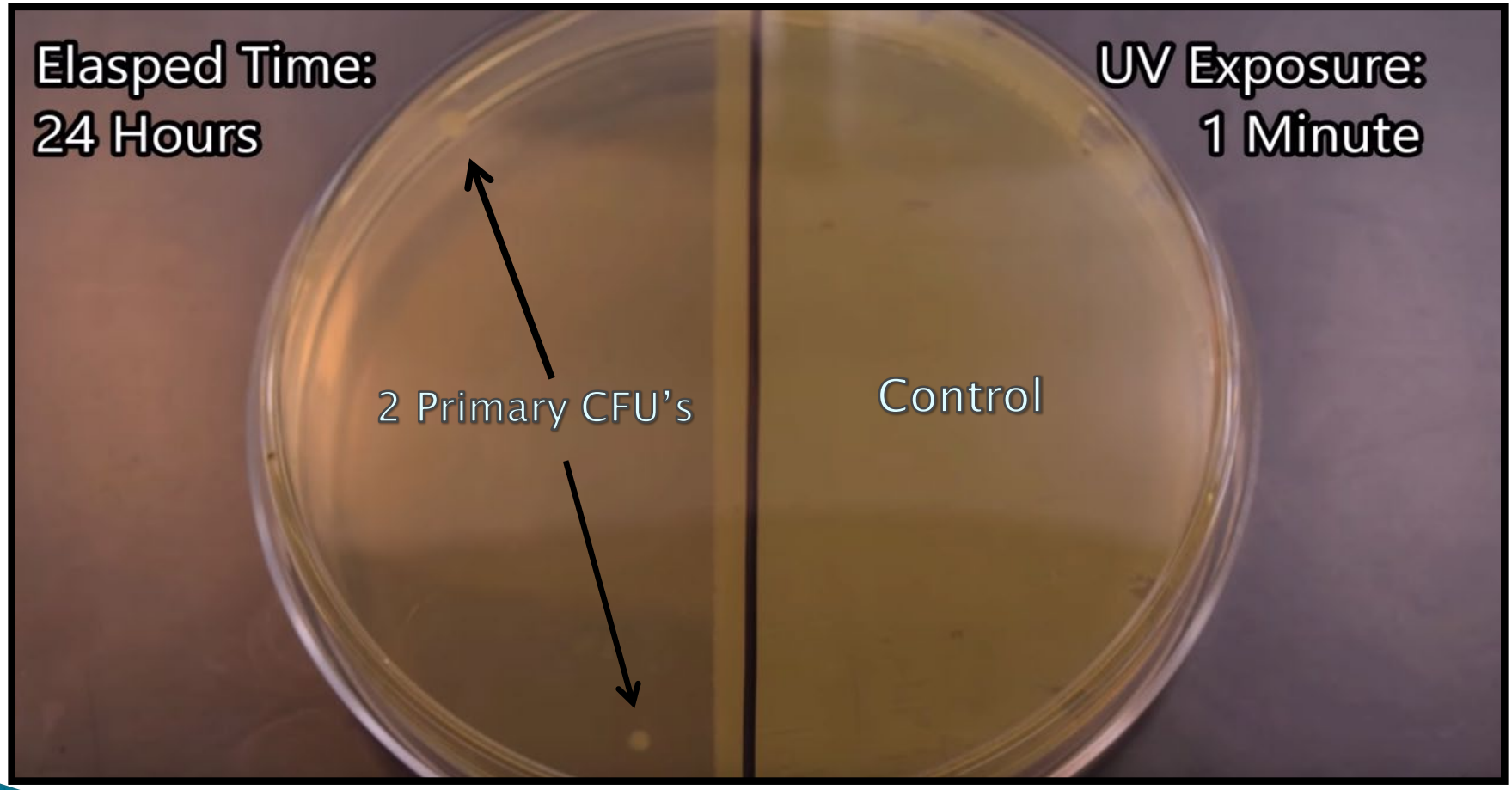
LightSources

30 Second Exposure @ 254nm



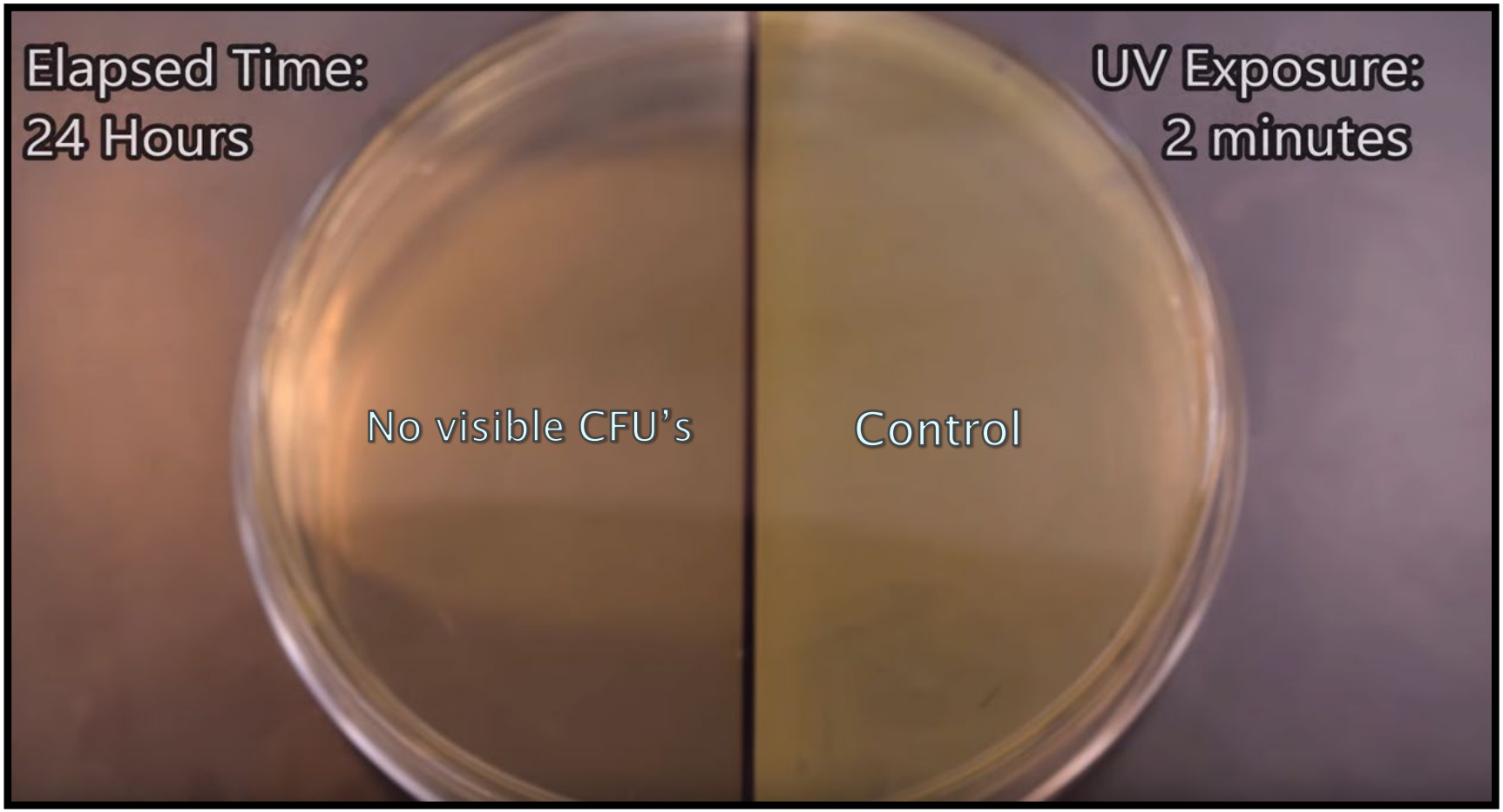
LightSources

60 Second Exposure @ 254nm



LightSources

120 Second Exposure @ 254nm



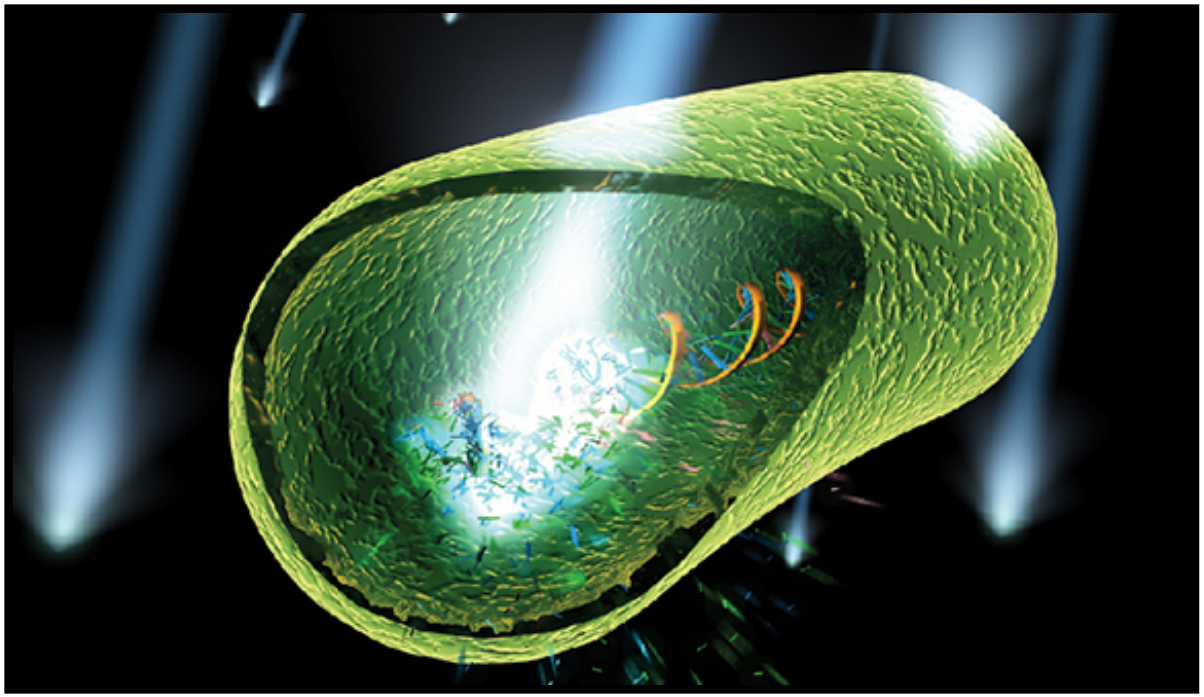
LightSources

Methods and Mechanisms

LightSources

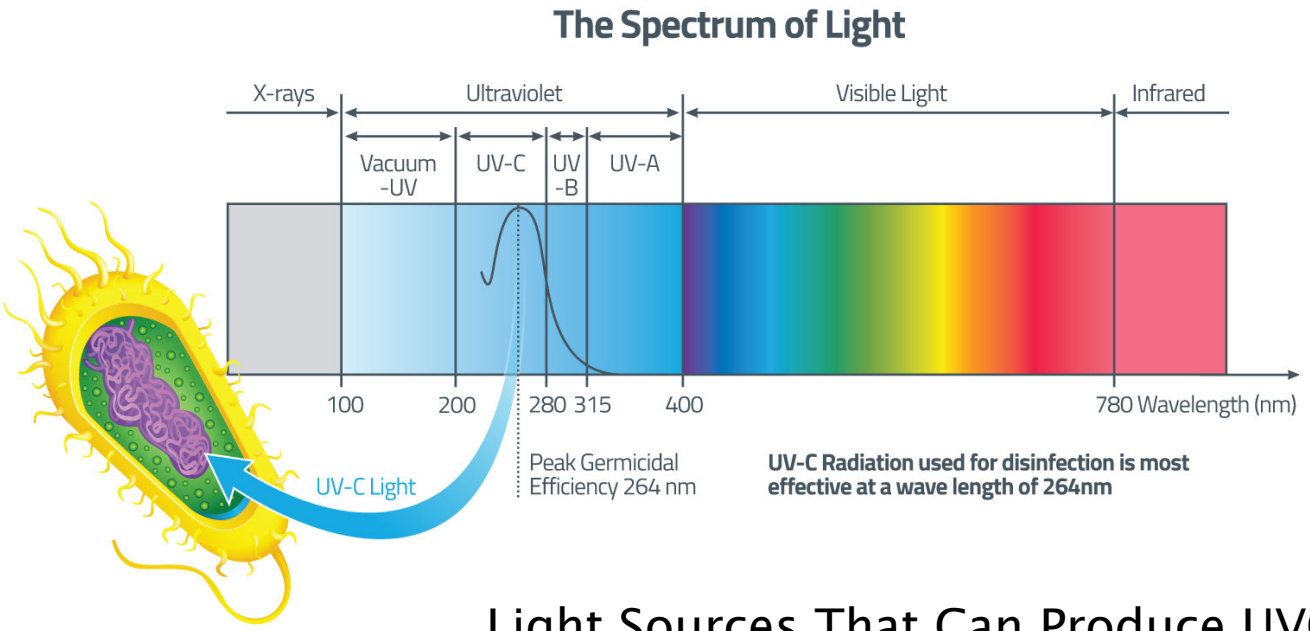
Mechanism One:

DNA Disruption Via UVC Wavelengths



LightSources

UVC Spectra (200–280 nm)



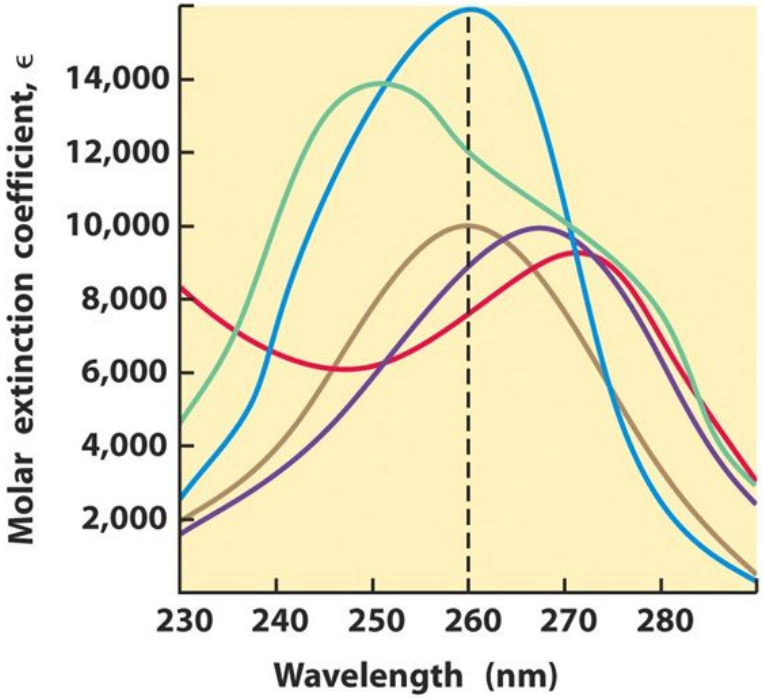
Light Sources That Can Produce UVC Wavelengths:

- Low Pressure Mercury Lamps (254nm)
- Medium Pressure Mercury Lamps (Polychromatic)
- UVC LED's (265nm, 280nm typically)
- Xenon Flash Lamps (Polychromatic)

LightSources

Absorption Spectra of DNA Constituent Bases

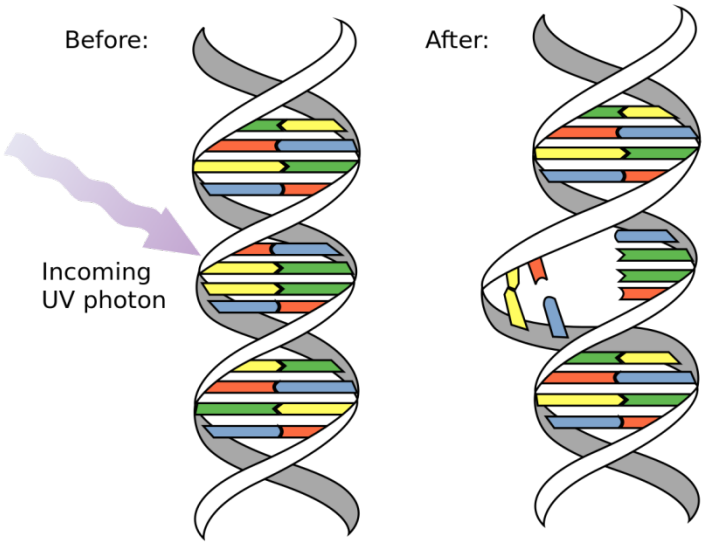
Absorption spectra of common nucleotides

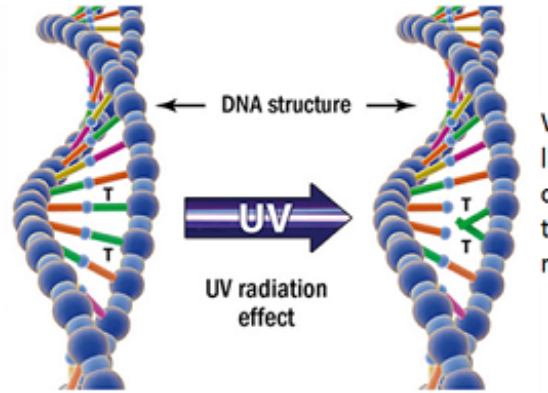


Molar extinction coefficient at 260 nm, ϵ_{260} ($M^{-1}cm^{-1}$)	
AMP	15,400
GMP	11,700
UMP	9,900
dTMP	9,200
CMP	7,500

LightSources

UVC Germicidal Action Mechanism

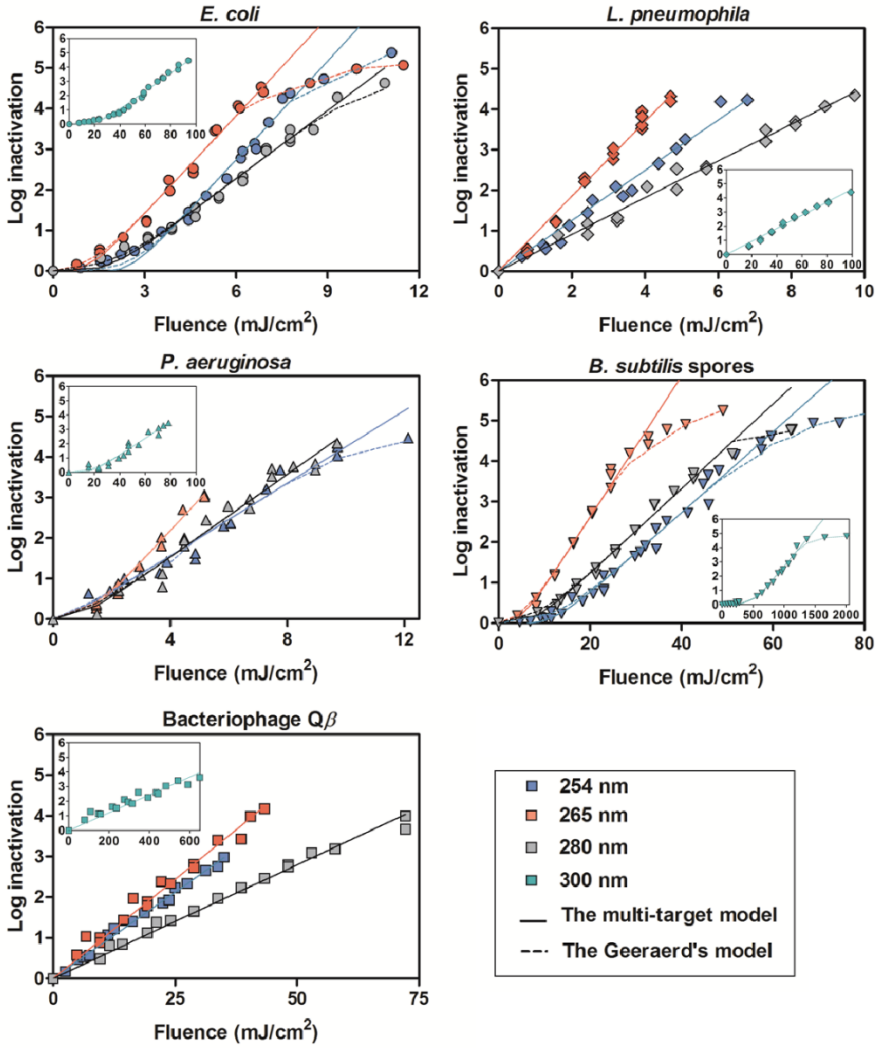




When exposing microorganisms to UVC light, the light penetrates through their cell wall and disrupts the structure of their DNA molecules, prohibiting reproduction.

LightSources

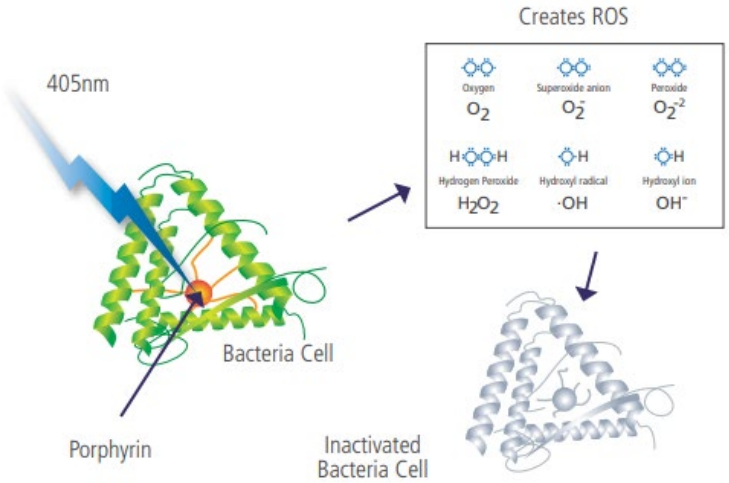
Efficacy of UVC Wavelengths



LightSources

Mechanism Two:

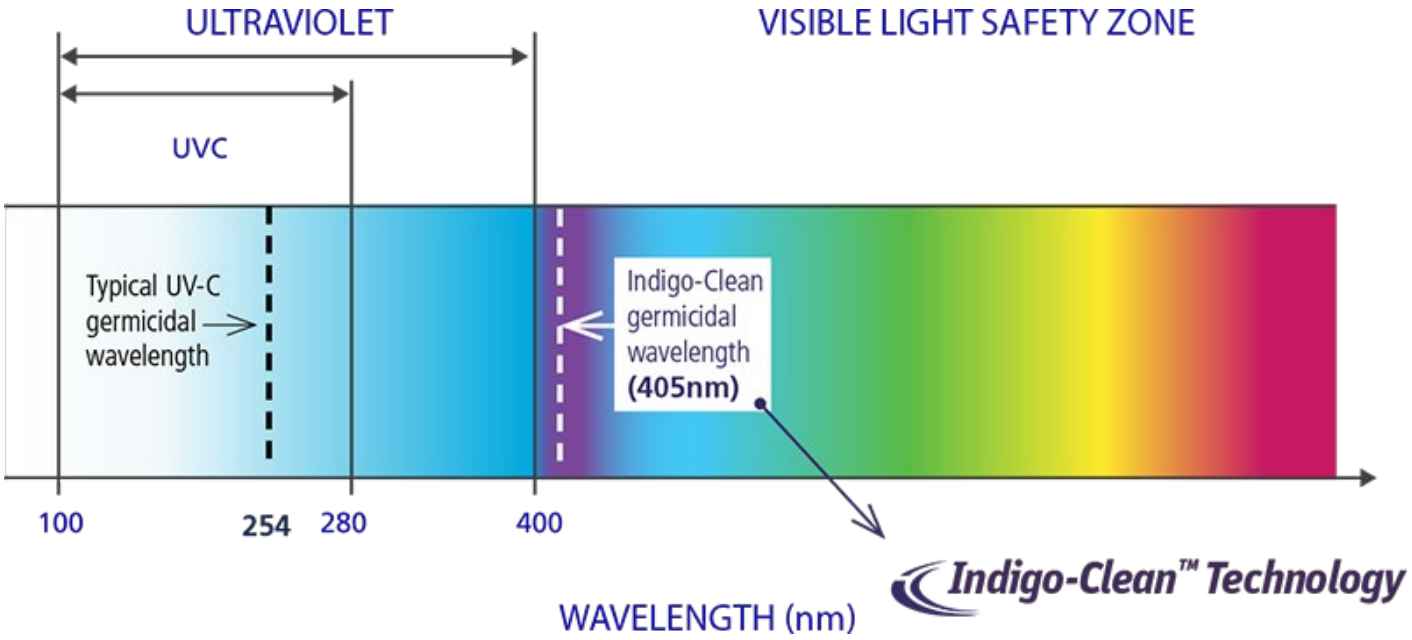
Blue Light Absorption By Porphyrins Causing Intercelluar Oxidative Damage in Bacteria



Inactivation of bacteria via visable light absorption

LightSources

Blue Light Spectra (400 to 420nm)



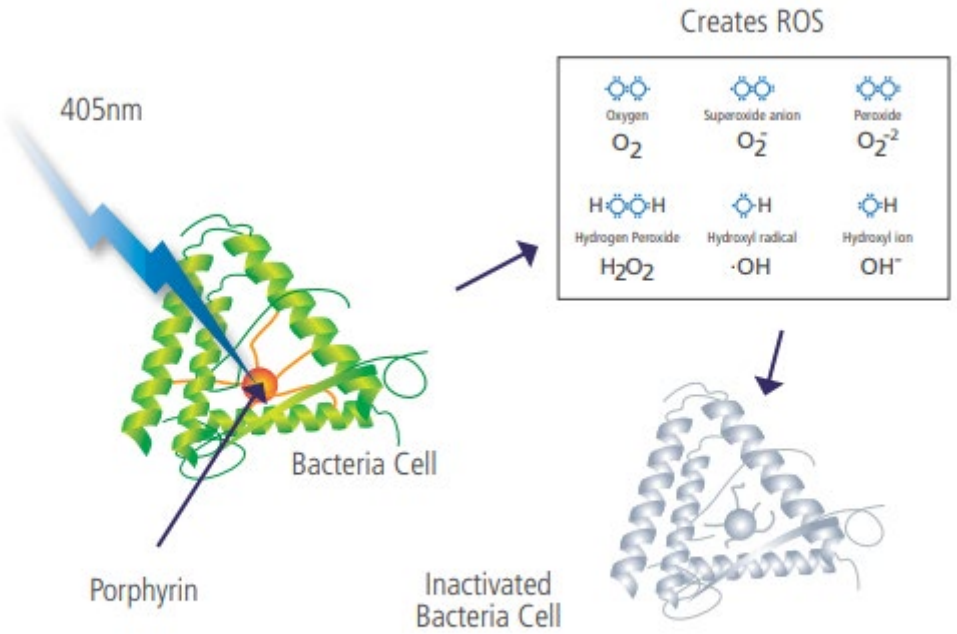
Light Sources That Can Produce UVC Wavelengths:

- 405nm LED's
- Phosphor coated low pressure mercury lamps

LightSources

Blue Light Disinfection Steps

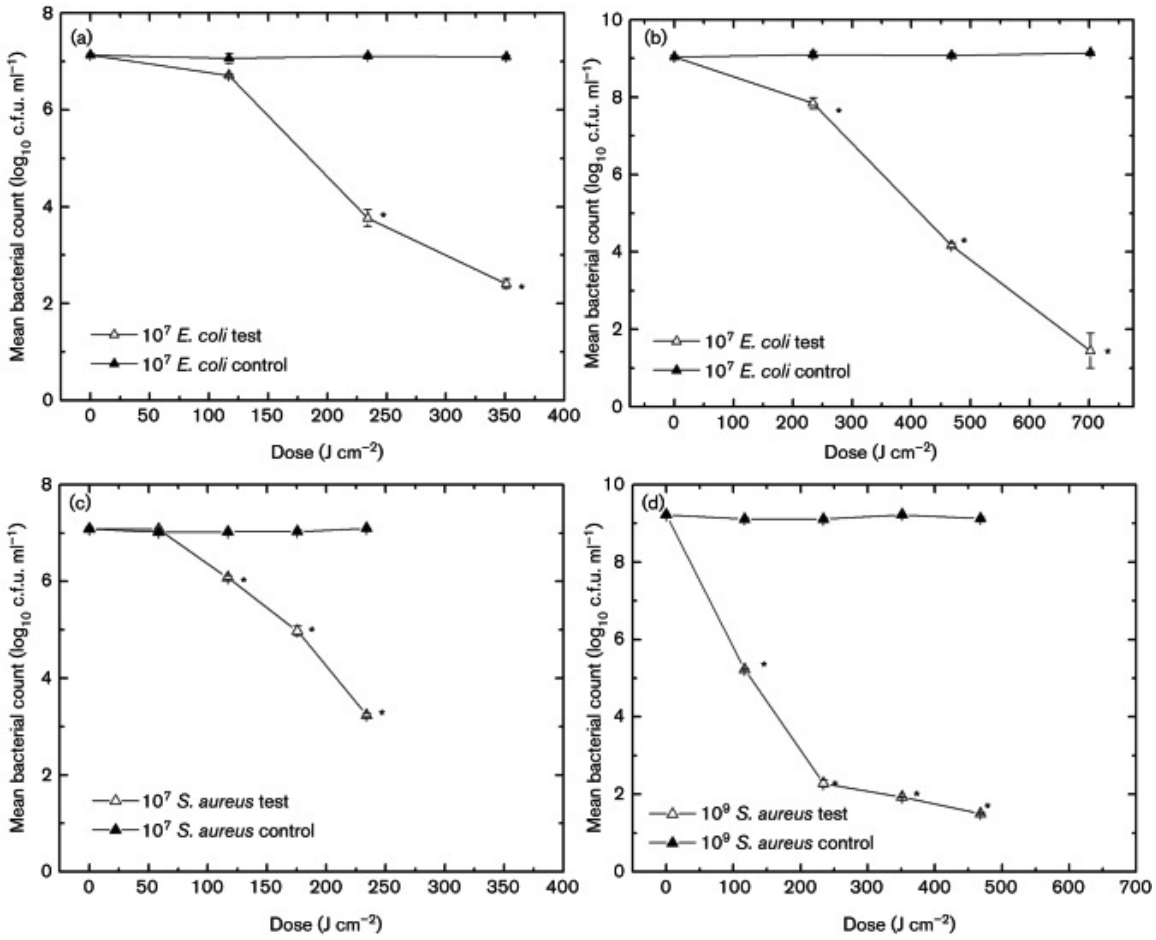
1. 405nm photons are absorbed by porphyrins which exist inside of the bacterial cell
2. The porphyrin molecules become excited
3. The prophyrin molecules produce Reactive Oxygen Species (ROS) inside the cell
4. Intercellular oxidation damage occurs
5. Cell suffers loss of bacterial membrane integrity and can no longer replicate



Inactivation of bacteria via visable light absorption

LightSources

Blue Light Disinfection Efficacy



LightSources

Questions?

LightSources