



# Antibiotics Degradation and Bacteria Inactivation in Water by Silver Nanoparticles



CENTRE FOR  
ENVIRONMENTAL AND  
MARINE STUDIES

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Universidade de Aveiro

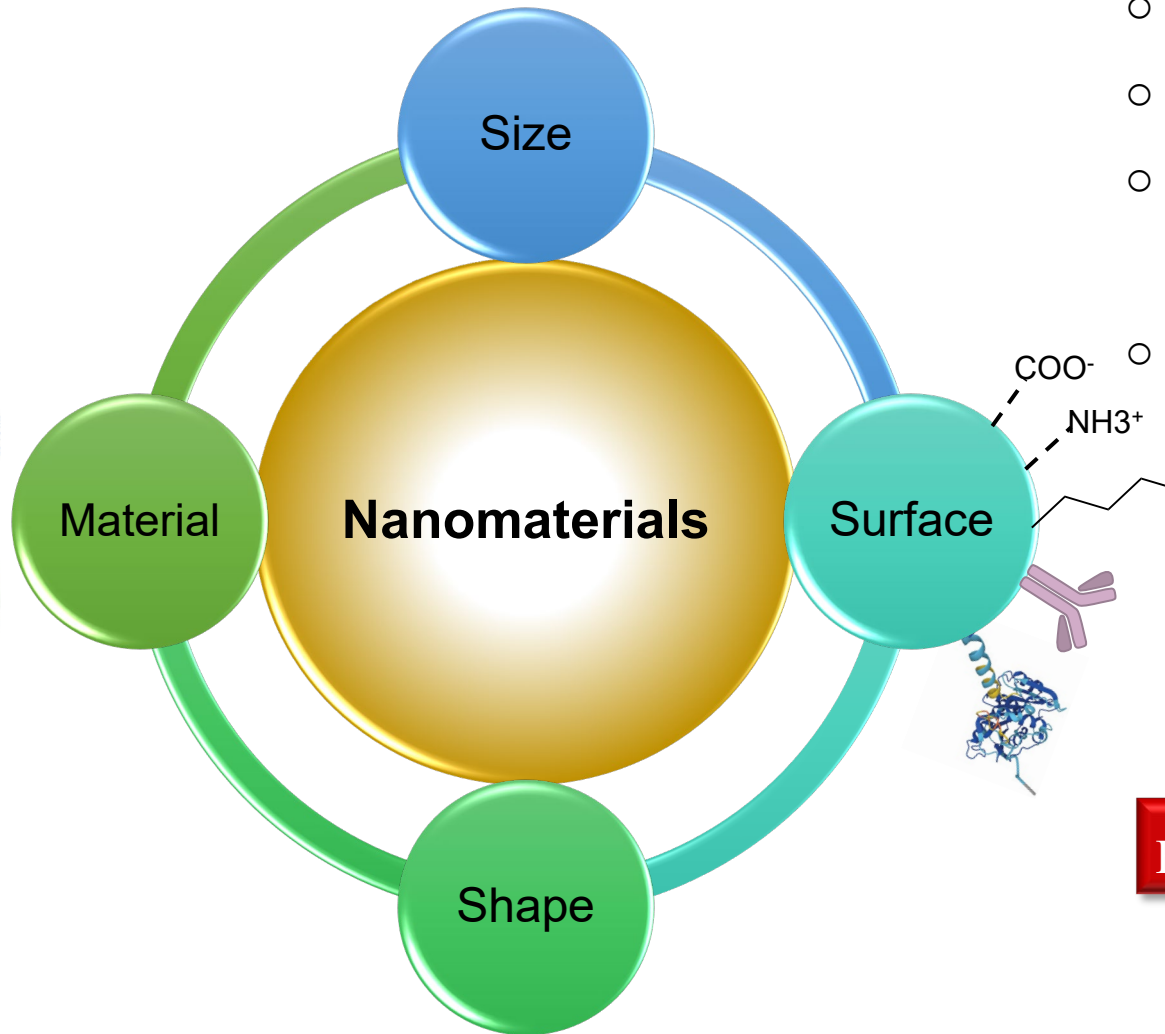
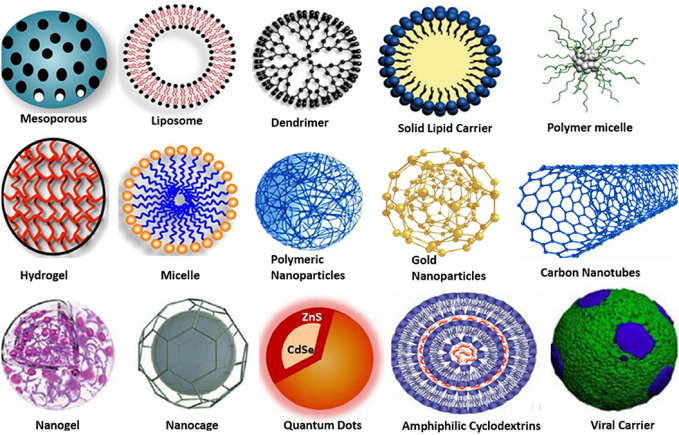


Fundação  
para a Ciência  
e a Tecnologia



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# Nanomaterials



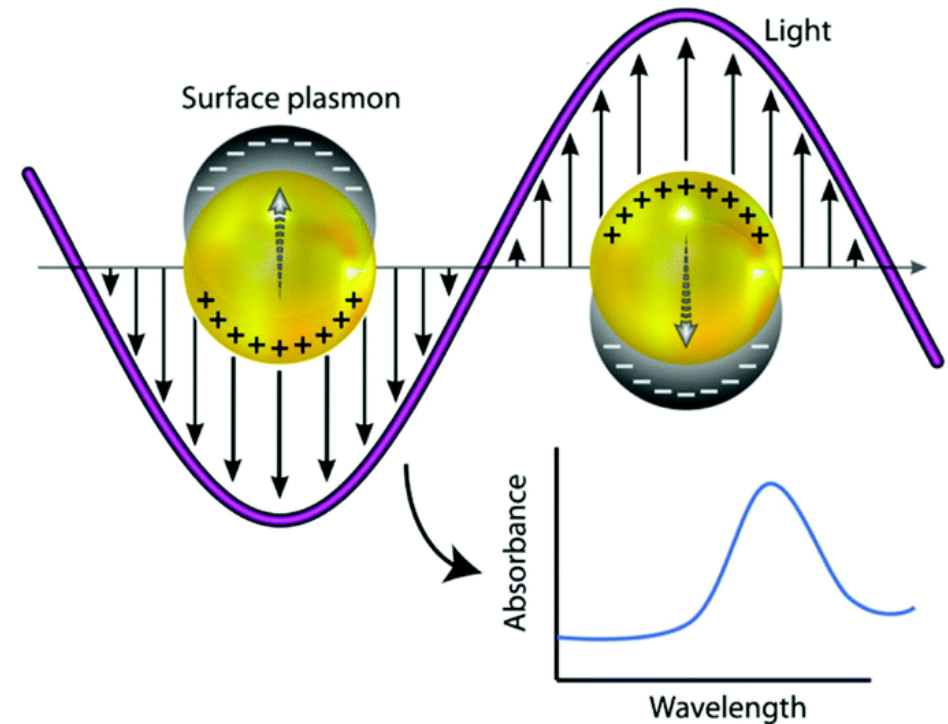
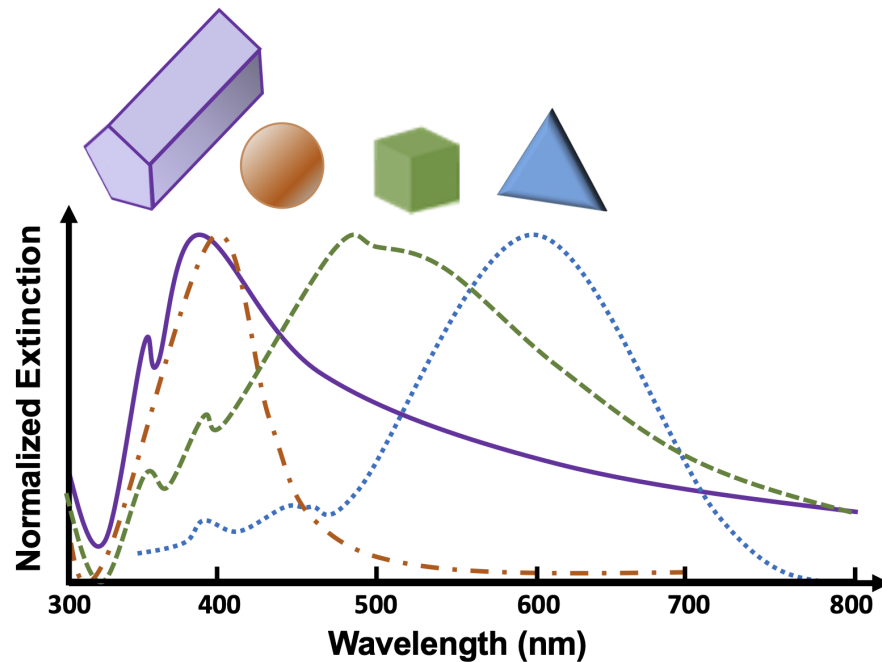
- Small sizes;
- High surface area/volume ratio;
- Control of their size, shape, and composition;
- Control of their properties;

**Environmental applications.**

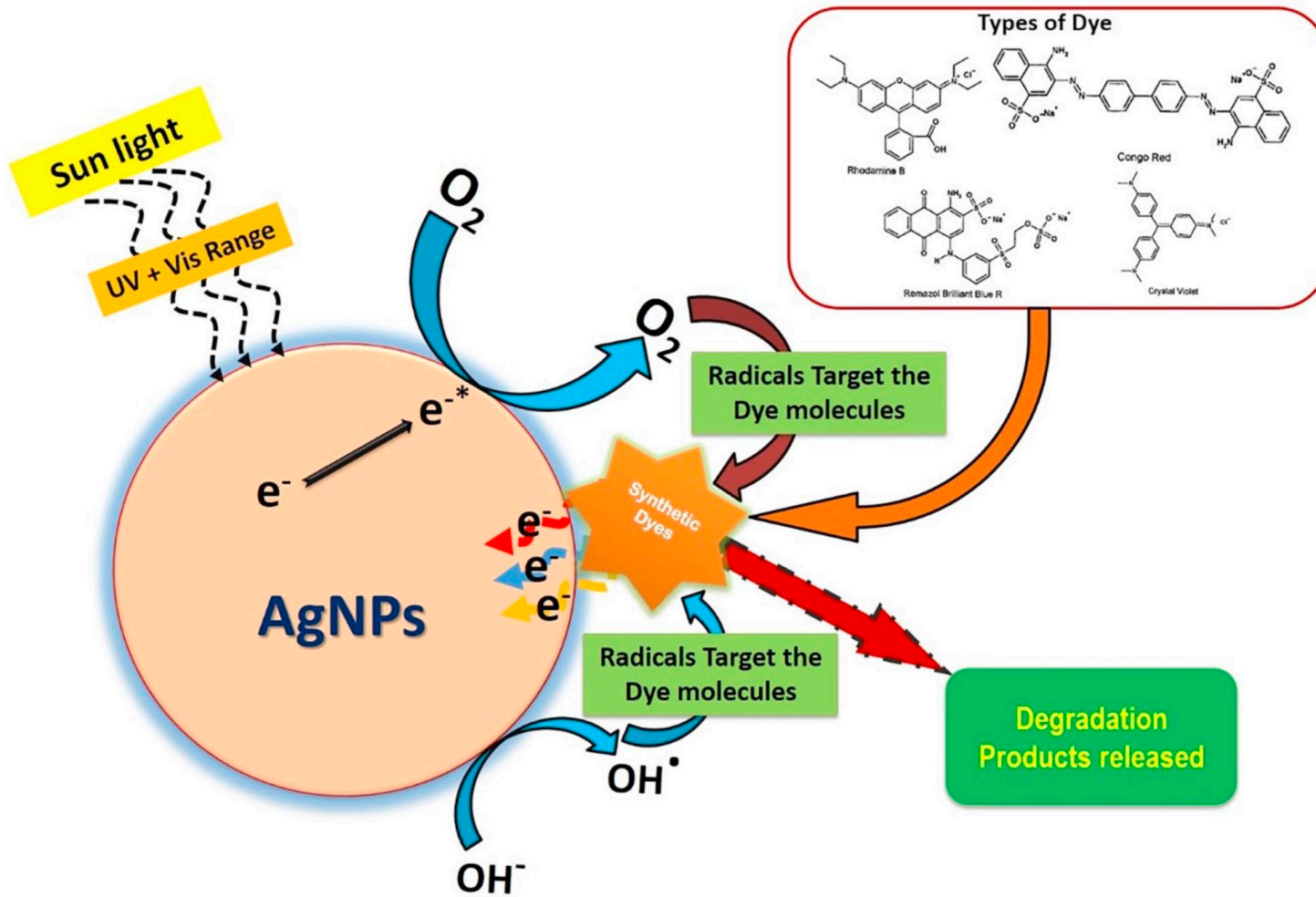


# Silver Nanoparticles

- Widely used in biomedicine as antibacterial agents;
- Surface plasmonic resonance;
- Absorption band tunned by their shape.



# Silver Nanoparticles



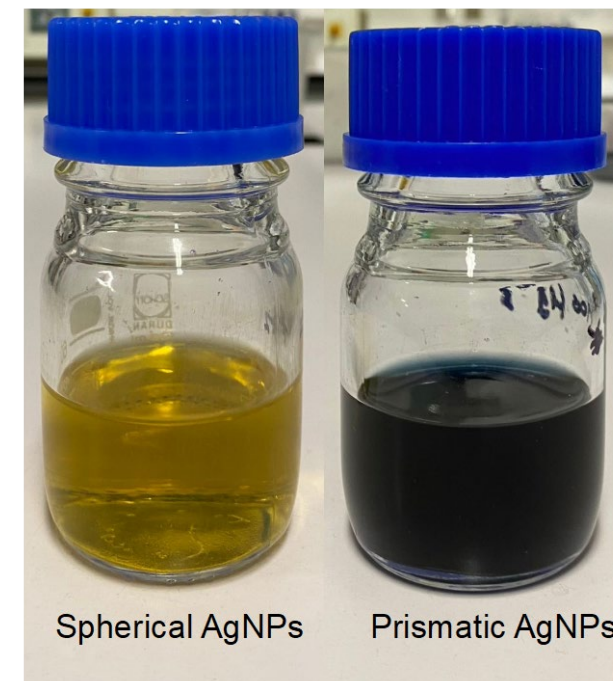
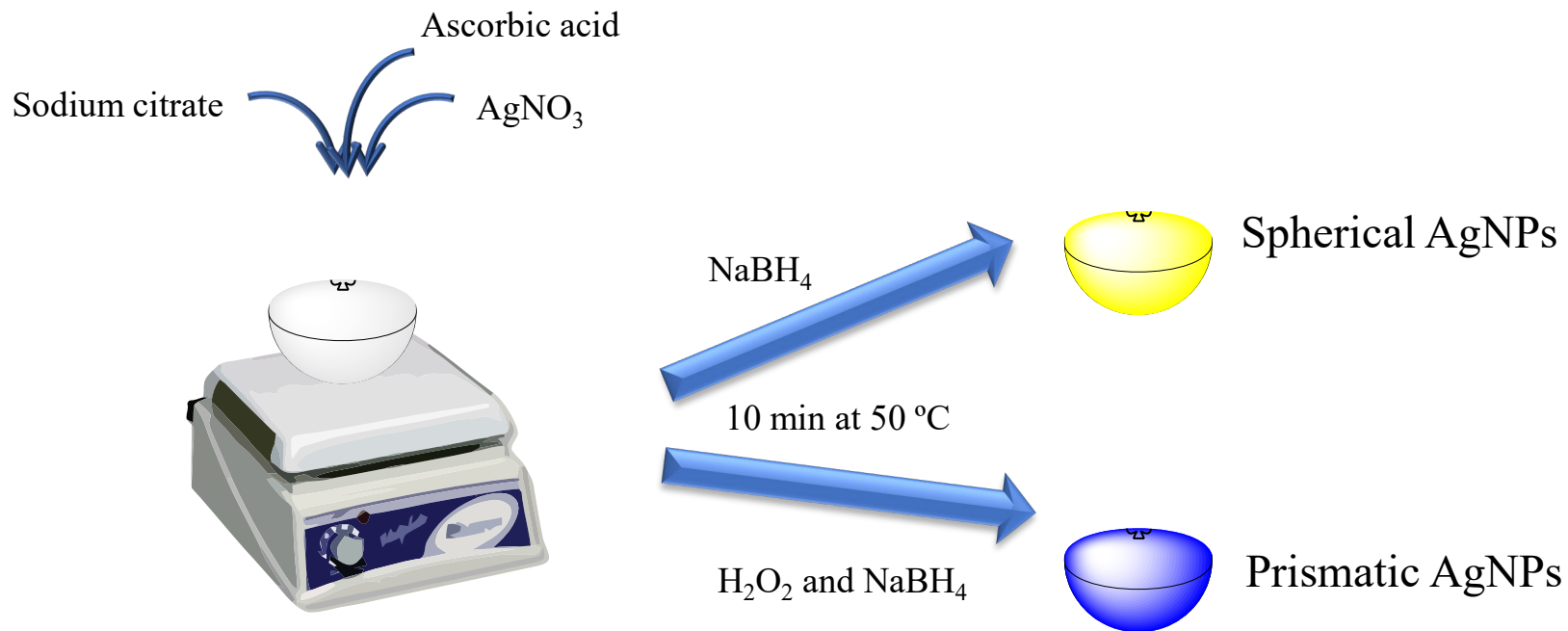
- Environmental applications:
  - Photodegradation of pollutants
  - Inactivation of microorganisms

↓  
Improve water treatment systems

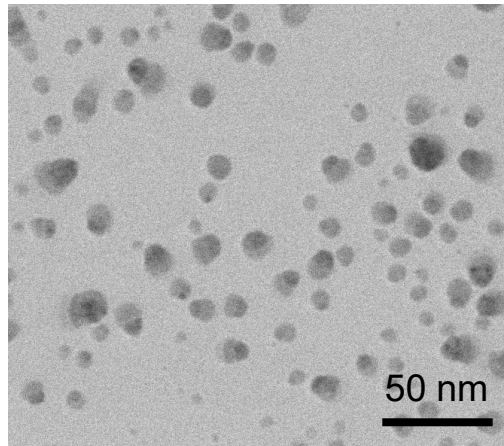
## This work

Evaluate the efficiency of spherical and prismatic AgNPs in the photodegradation of the antibiotic ciprofloxacin (CIP), under sunlight irradiation, and for the inactivation of bacteria.

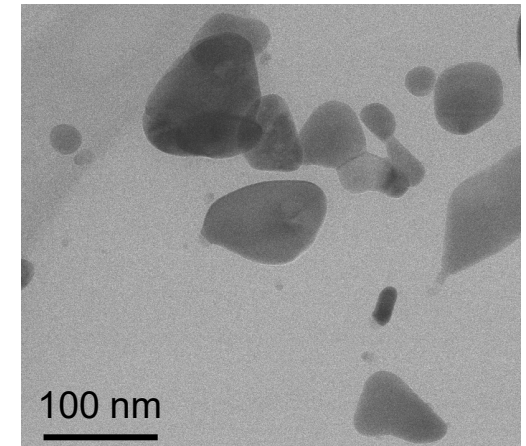
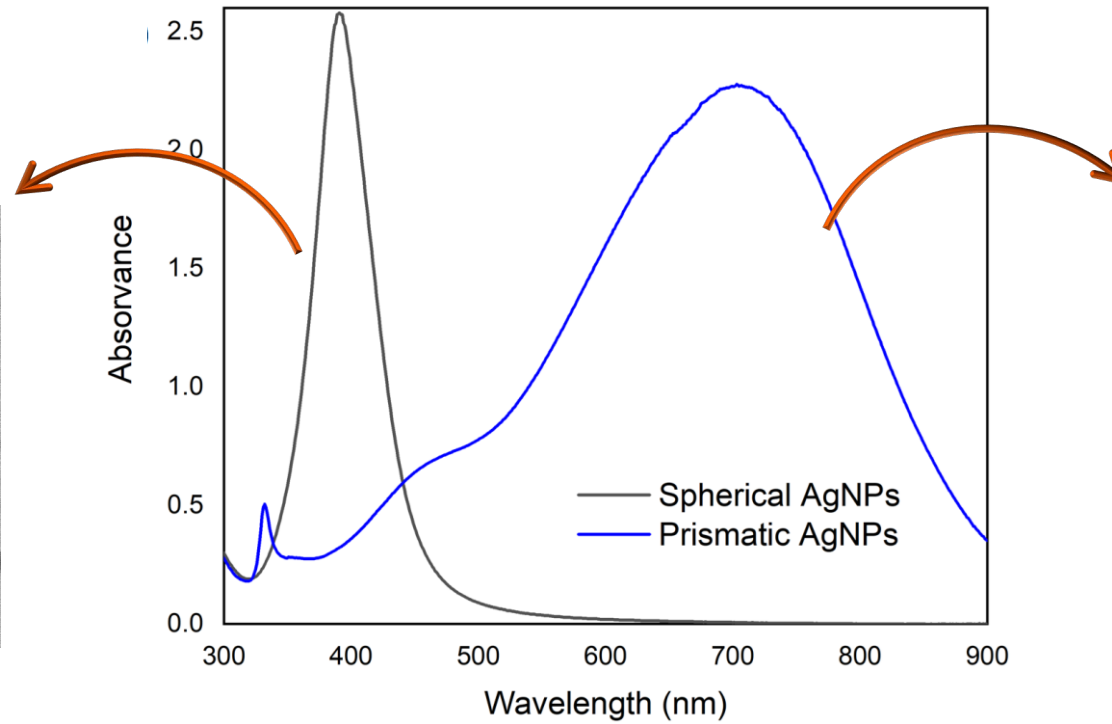
# Synthesis of AgNPs



# Synthesis of AgNPs

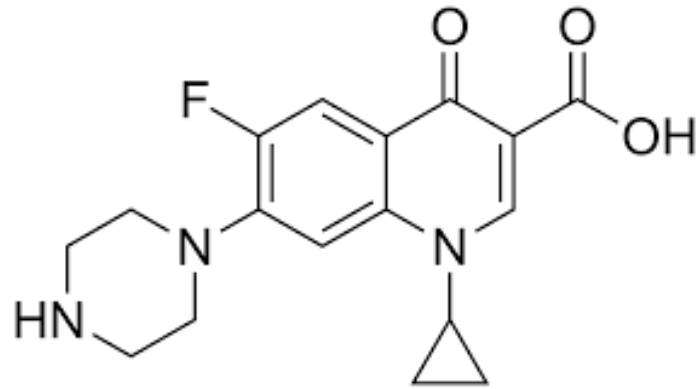


Average size of 10 nm

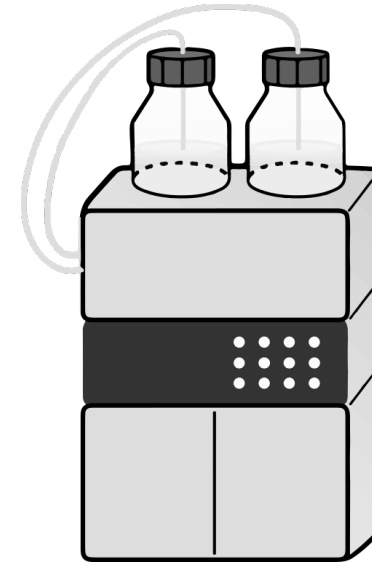


Average Size of 55 nm

# Antibiotics Degradation



**Ciprofloxacin**  
10 ppm



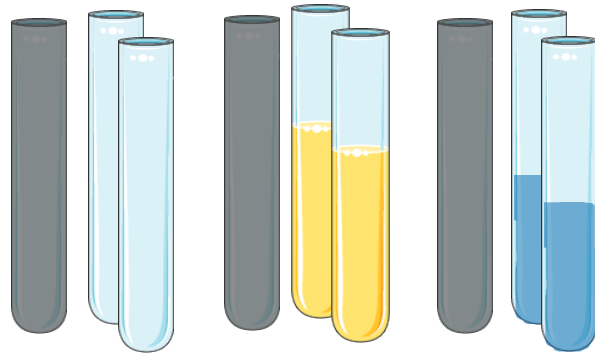
Analysis:

- HPLC
- Calibration curve:  $y = 117401x - 1536.8$   
 $R^2 = 0.9994$
- Linear range:  $0.1 - 10 \text{ mg.L}^{-1}$
- LOD =  $0.13 \text{ mg.L}^{-1}$
- LOQ =  $0.40 \text{ mg.L}^{-1}$



# Antibiotics Degradation

## Photocatalytic assays



Irradiation time: 0 – 15 min

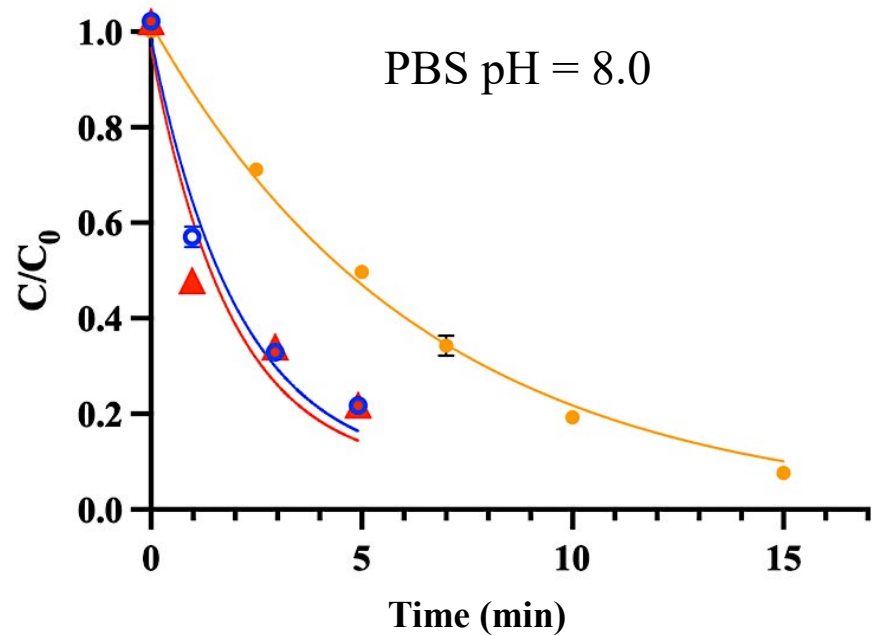


Irradiation:  $24 \text{ W m}^{-2}$



Matrix: PBS ( $0.001 \text{ mol.L}^{-1}$ ; pH 8.0)  
and River water (pH 8.09)

# Antibiotics Photodegradation



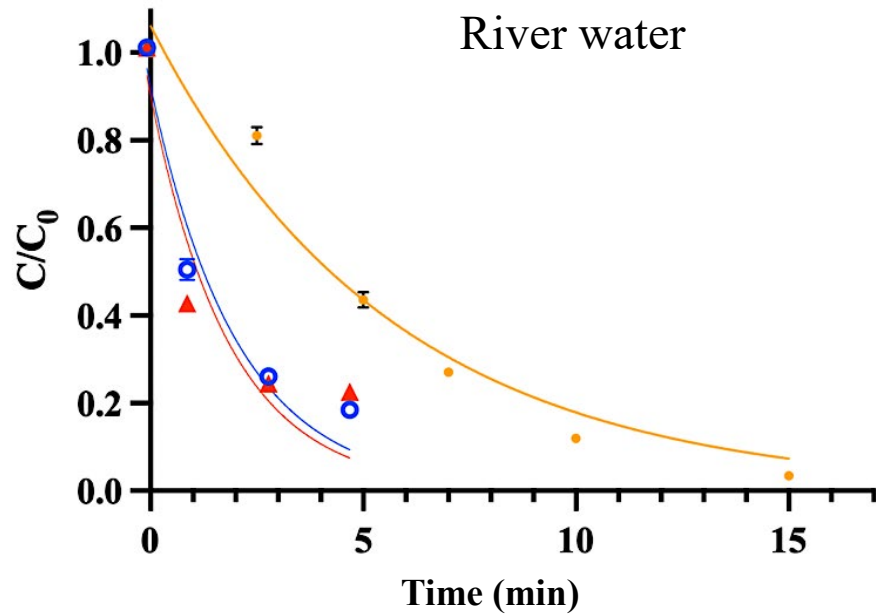
● Without AgNPs   
 ◻ Spheric AgNPs (500 mg.L<sup>-1</sup>)   
 ▲ Prismatic AgNPs (500 mg.L<sup>-1</sup>)

	Without AgNPs	Spheric AgNPs	Prismatic AgNPs
<b>k (min<sup>-1</sup>)</b>	0.196 ± 0.004	0.47 ± 0.05	0.51 ± 0.09
<b>t<sub>1/2</sub> (min)</b>	3.54 ± 0.07	1.5 ± 0.2	1.2 ± 0.2

Enhancement in CIP degradation:

- Spheric AgNPs: 30%
- Prismatic AgNPs: 44%

# Antibiotics Degradation



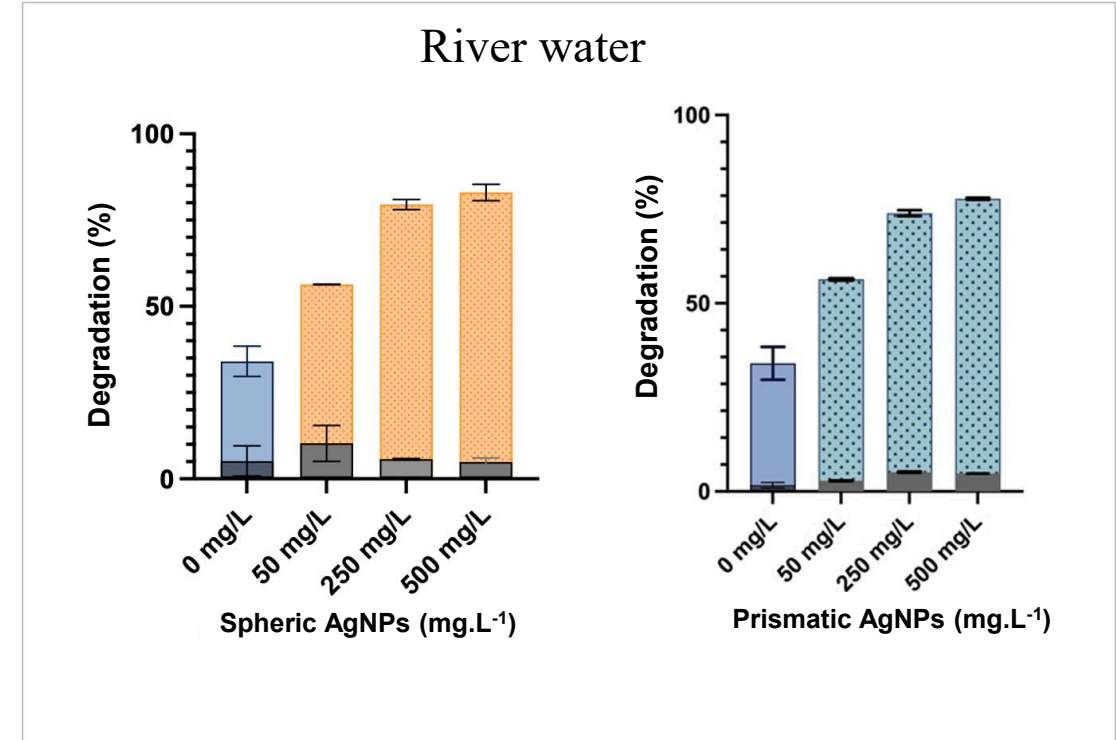
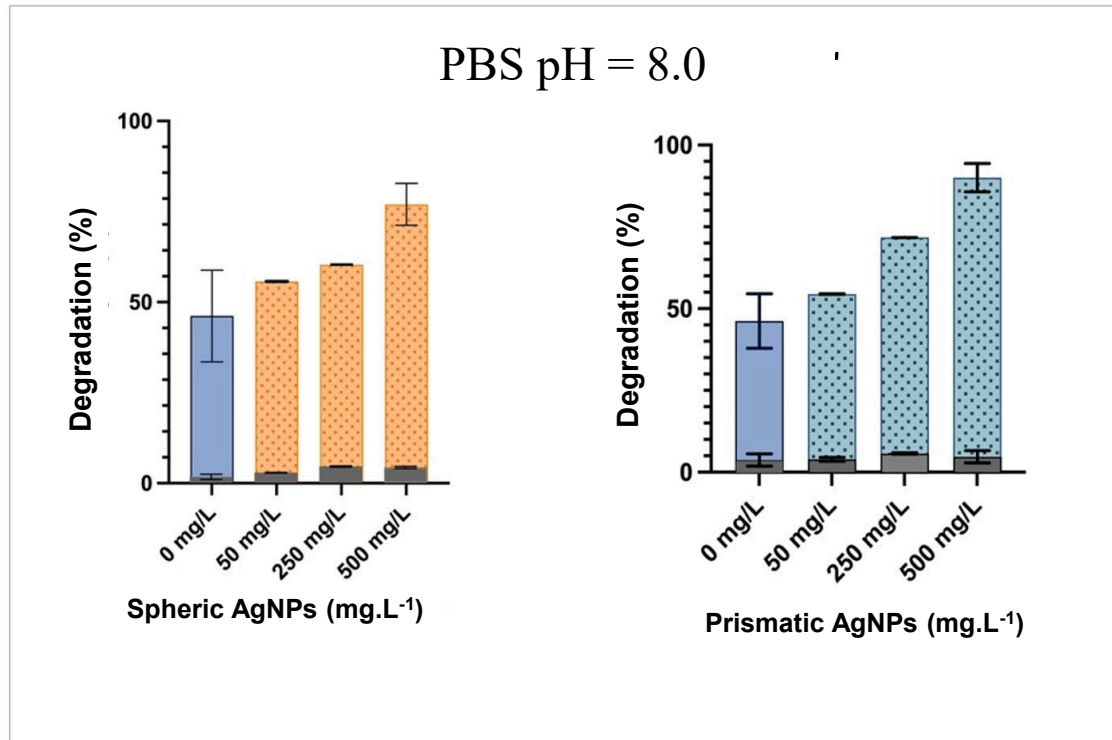
— Without AgNPs    ▲ Prismatic AgNPs (500 mg.L<sup>-1</sup>)    ○ Spheric AgNPs (500 mg.L<sup>-1</sup>)

	Without AgNPs	Spheric AgNPs	Prismatic AgNPs
<b>k (min<sup>-1</sup>)</b>	0.139 ± 0.004	0.47 ± 0.04	0.52 ± 0.07
<b>t<sub>1/2</sub> (min)</b>	5.0 ± 0.1	1.5 ± 0.1	1.3 ± 0.2

Enhancement in CIP degradation:

- Spherical AgNPs: 50%
- Prismatic AgNPs: 44%

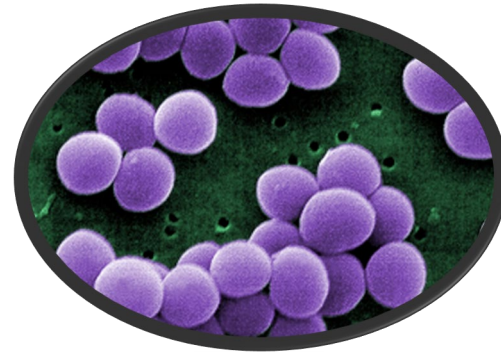
# Antibiotics Degradation



# Bacteria Inactivation



*E. coli*  
(ATCC 25922)  
Gram-negative



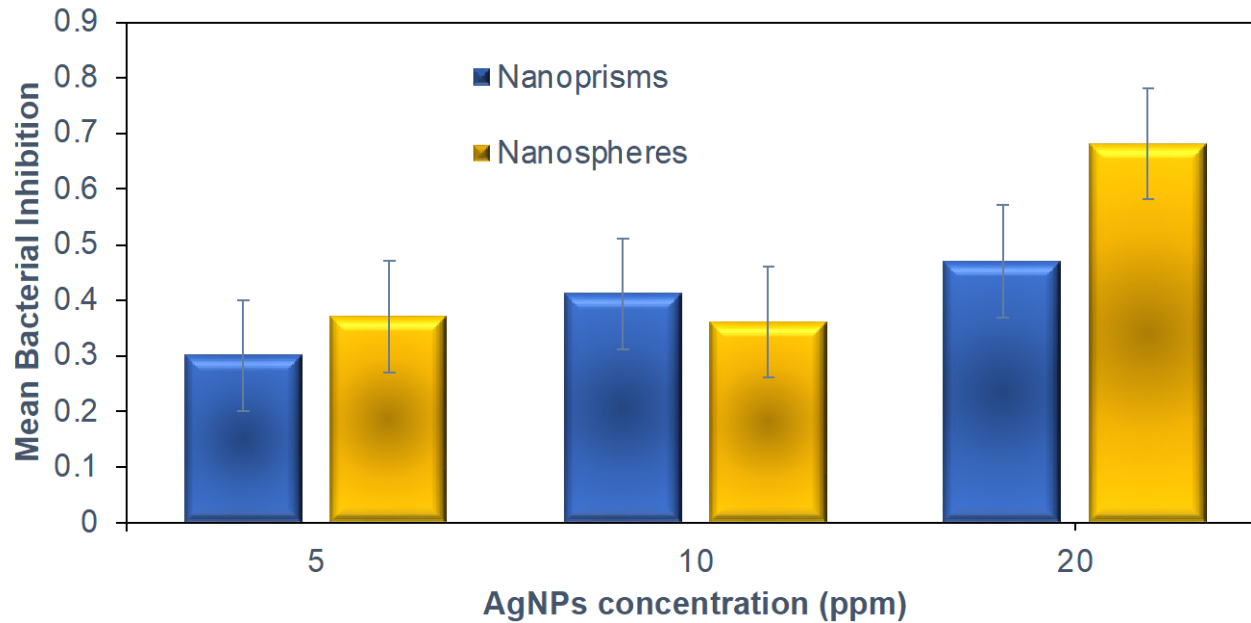
*S. aureus*  
(ATCC 6538)  
Gram-positive



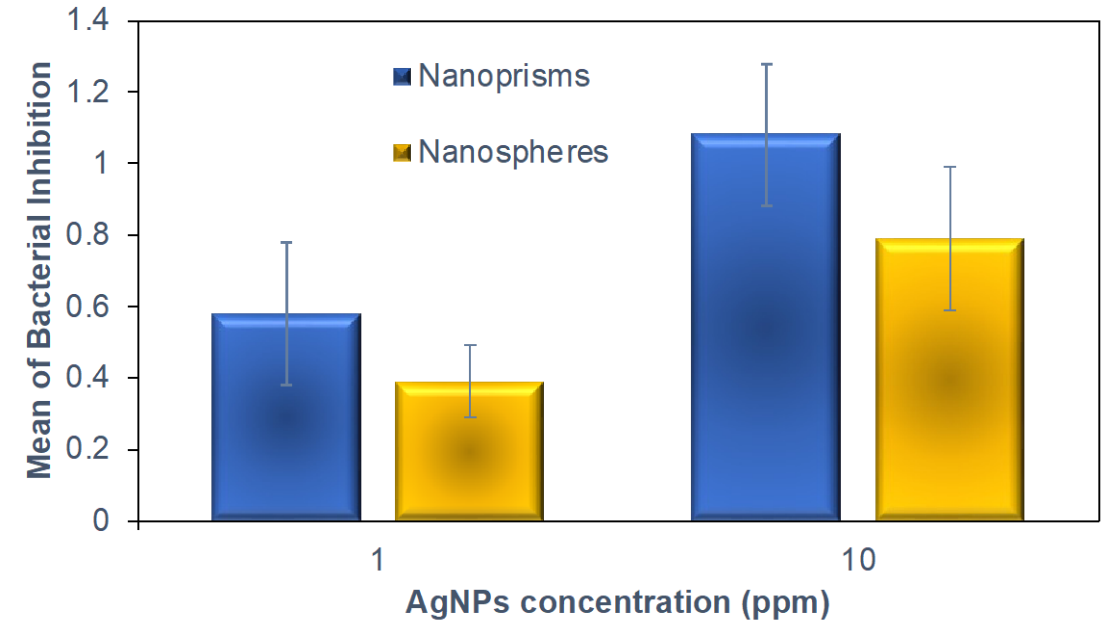
Evaluation of microbial inactivation by surface inoculation and well diffusion method

# Bacteria Inactivation

*E. Coli*



*S. Aureus*



Study done in triplicate. Error bars: standard deviation.

# Conclusion

- Silver nanoparticles were obtained in spherical and prismatic shapes.
- AgNPs enhanced the photodegradation of ciprofloxacin in PBS and river water.
- All NPs showed the ability to inactivate *E. coli* and *S. aureus* bacterial proliferation.
- AgNPs are a highly promising alternative for bioremediation of contaminated waters.



## Analytical Sensors & Applied Eco-Chemistry (ASAEC)

<https://www.linkedin.com/company/asaec-rg/>

**OBRIGADO  
THANK YOU**

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