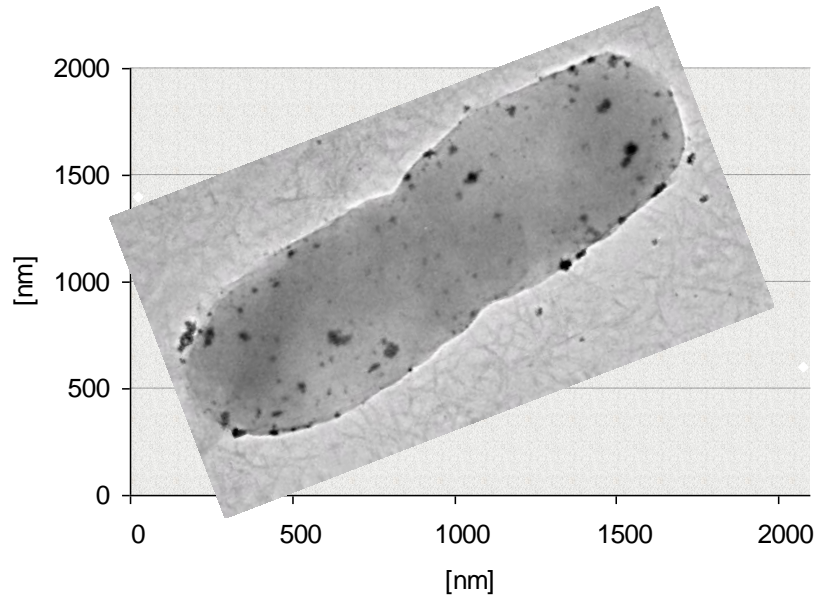


Natural moderation of biofouling formation by exposure of bacteria to silver



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Content

- Silver nanoparticles
- Biofilm - Biofouling
- Membrane filtration
- Control of bio-film formation
- Control of bio-fouling in membrane filtration apparatus



Nanoparticles

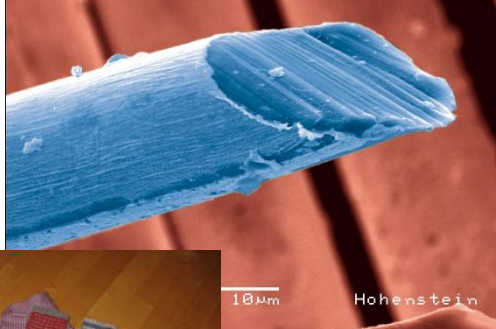
Particles in the range
of
1-100 nm

Nanoscale

10^{-9}

Products

Anti-bacterial
fabrics



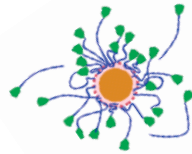
Nano Silver Laundry Detergent



Silver water Mineral
Dietary.



anti-odor, anti-bacterial socks



Colloidal Silver
nasal Spray



Paint containing
silver nanoparticles



Nano in cosmetics
and personal care

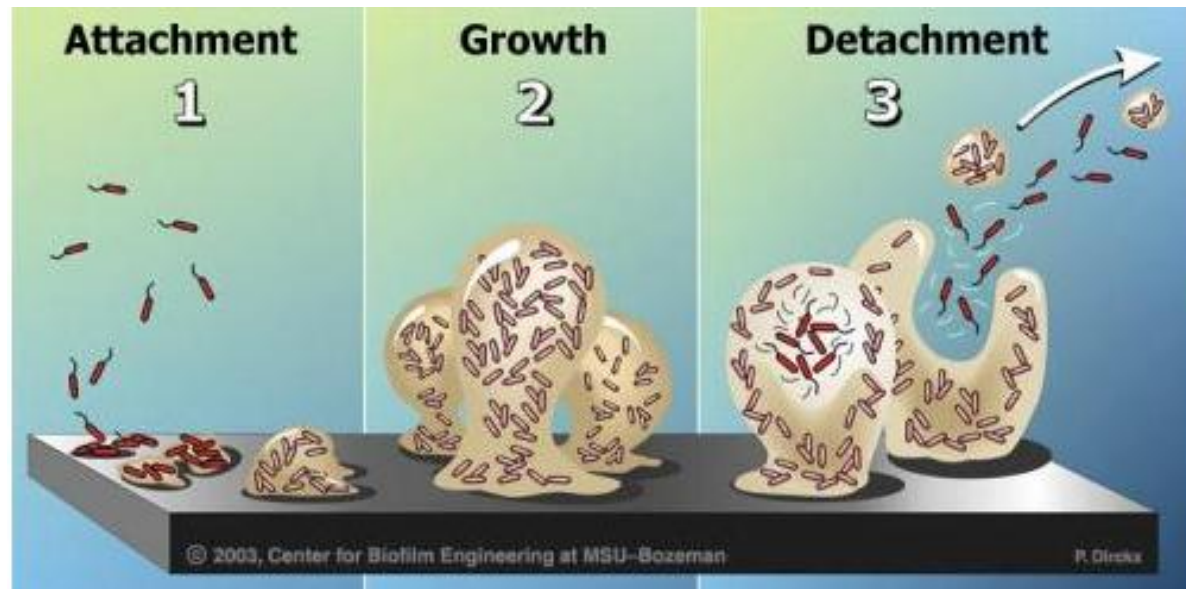
Sunscreens
Moisturisers
Anti-ageing
Razors

Bio-film



Biofilm is a collection of microorganisms surrounded by their self secretions (a matrix of protective and adhesive compounds) and attached to an inert or living surface.

wherever surfaces contact water



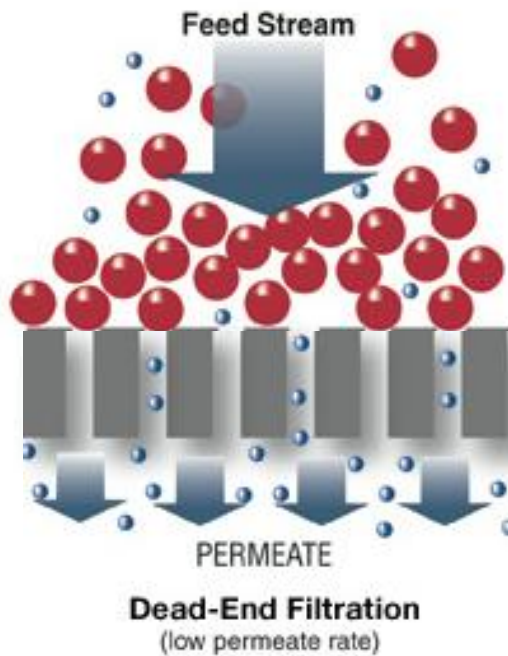
For example:

The plaque on teeth

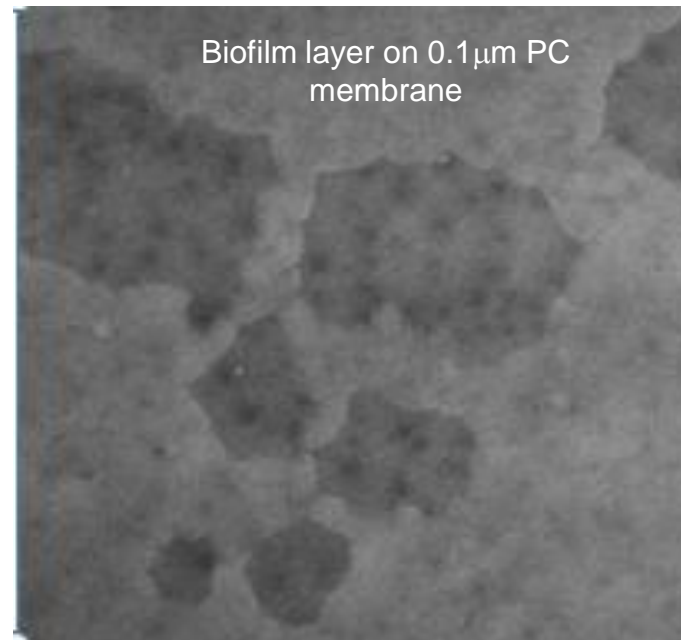
The slippery slime on river stones

The gel-like film on the inside of a vase which held flowers for a week.

Membrane Filtration



www.spectrumlabs.com/filtration/Edge.html



Research concept



Non-active bio-colloids

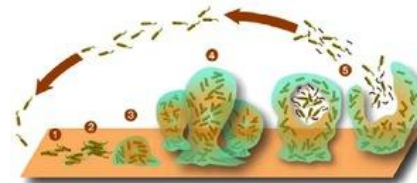


www.researchmagazine.ega.edu

Bacteria

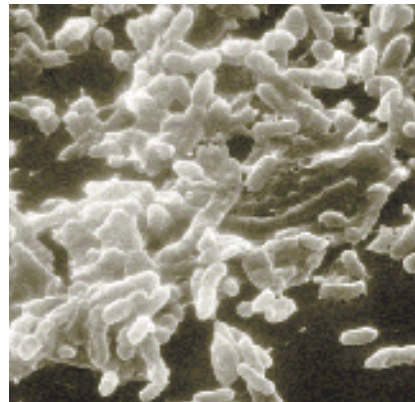
Surface attached
microbial
community bound
together by a
matrix of EPS

Biofilm



www.ivteam.com

- Disinfection
- Attachment
- Growth
- Removal



www.lennntech.com

A biofilm reactor
in the wrong place
at the wrong time

(Flemming, 2002)

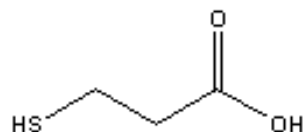
Biofouling

Synthesis of MCNPs

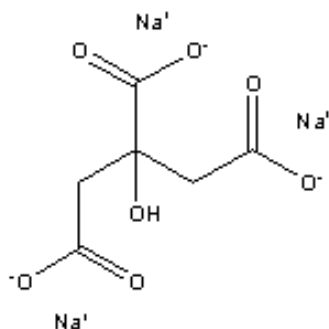
Stabilizing agents

Anionic

MPA

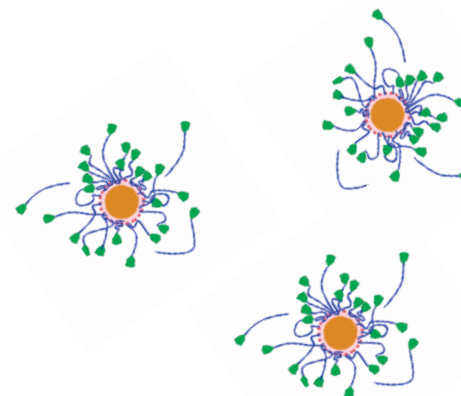
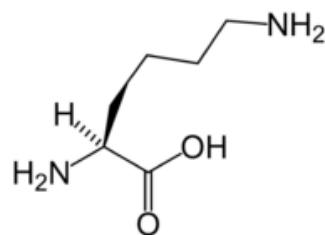


Trisodium Citrate



Cationic

Poly-Lysine



Metal ions

Silver nitrate

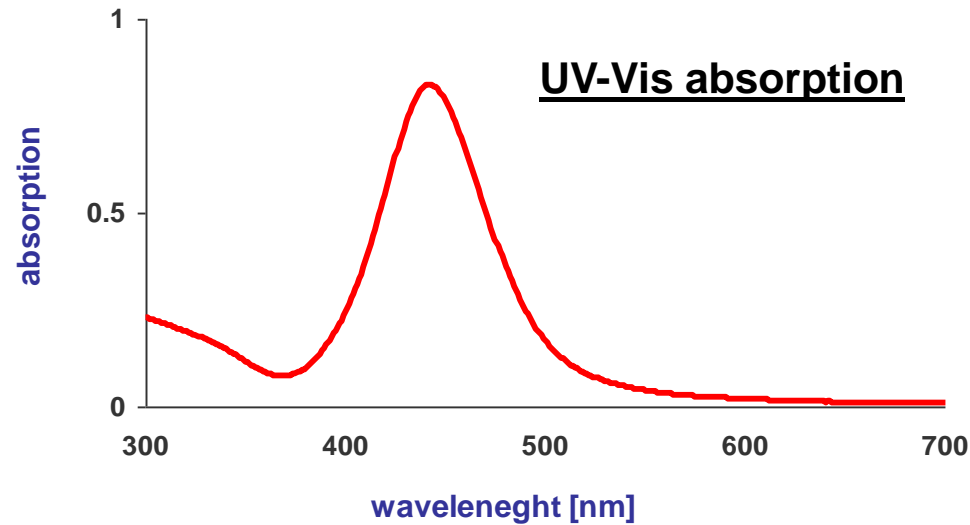
Gold chloride tri-hydrate

NaBH₄

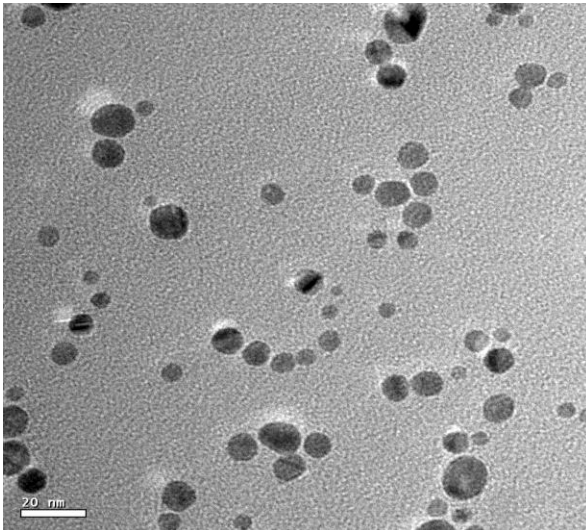


Properties of the MCNPs

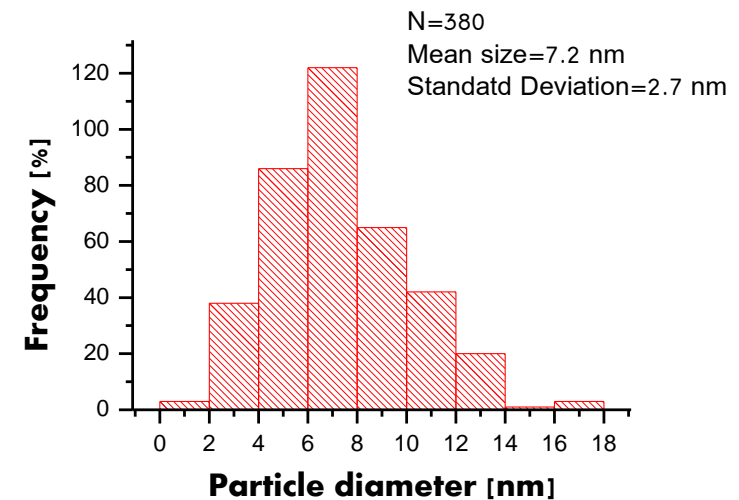
MCNPs



TEM micrograph of Ag-NPs



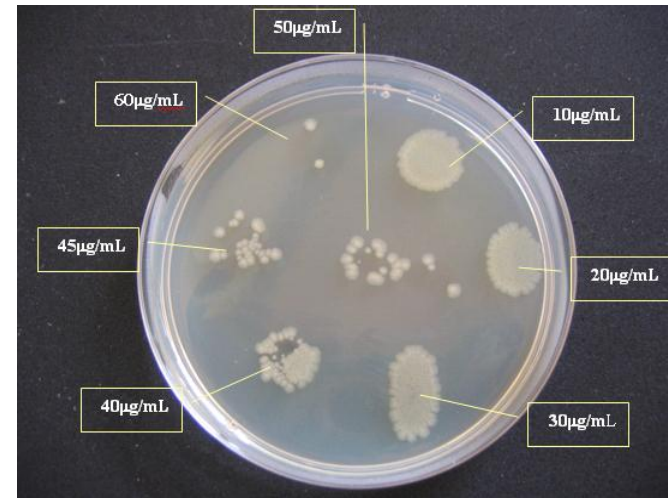
Size distribution histogram



Biocidal activity of Ag-NPs

Properties of NPs

- Concentration
- Shape
- Size



Properties of microorganisms

- Type
- Concentration

Surfactant Type	Mean Size	Charge	Zeta Potential	Number of particles
	nm		mV	#/mL*10 ¹²
Poly-Lysine	7.2	Positive	40.2	50
	12.5			9
MPA	6.7	Negative	- 46.1	60
	15			5

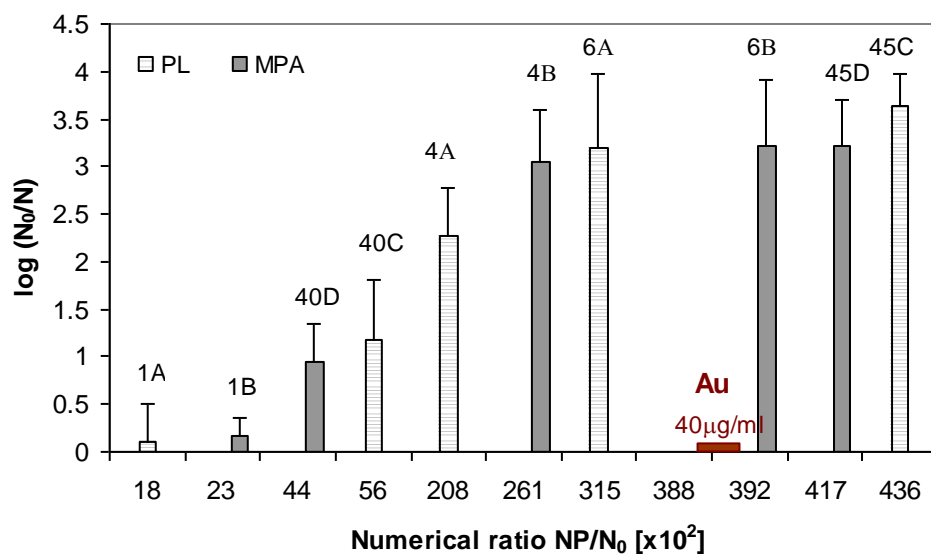
A
C
B
D

Planktonic inactivation

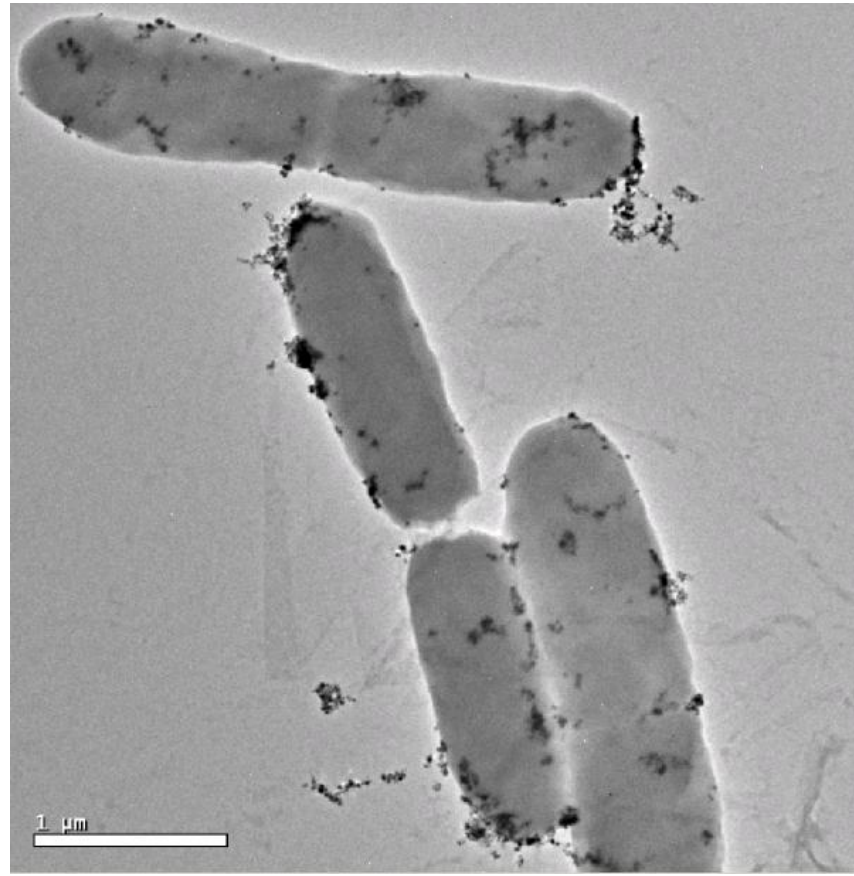
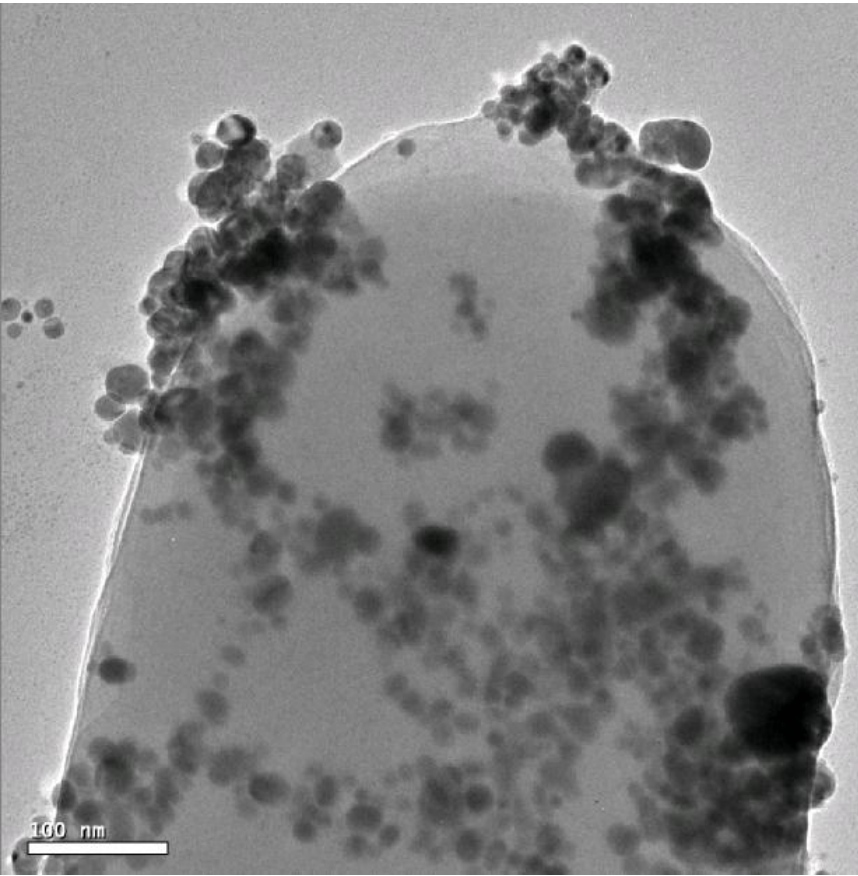
Concentration
Shape
Size

Number of NPs

Number of
bacterial cells



Interaction of *E.coli* with NPs

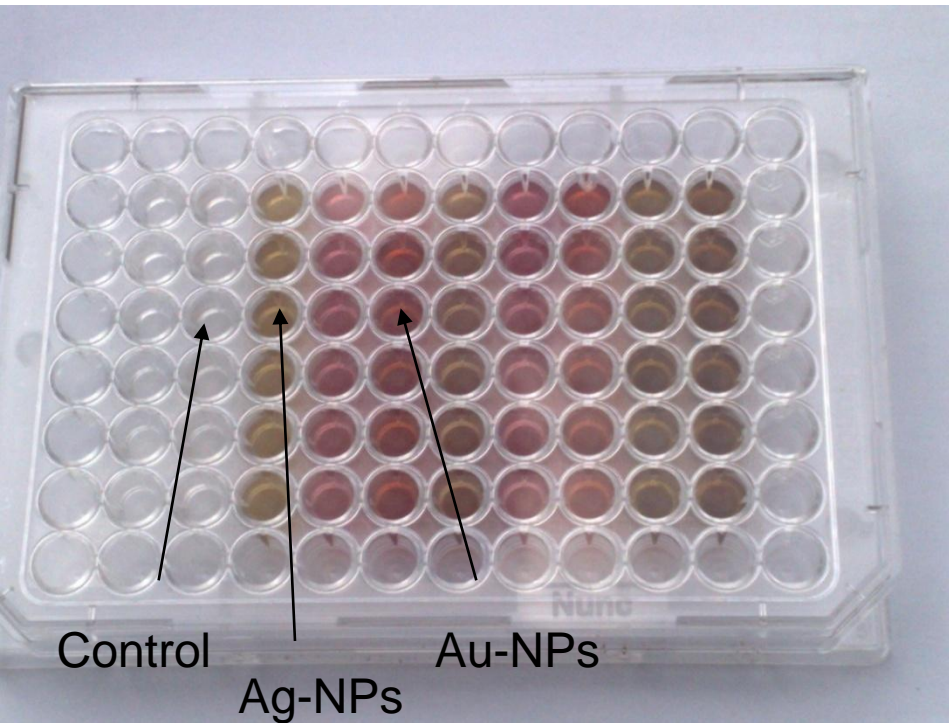


Microtiter assay to assess biofilm formation

Biofilm

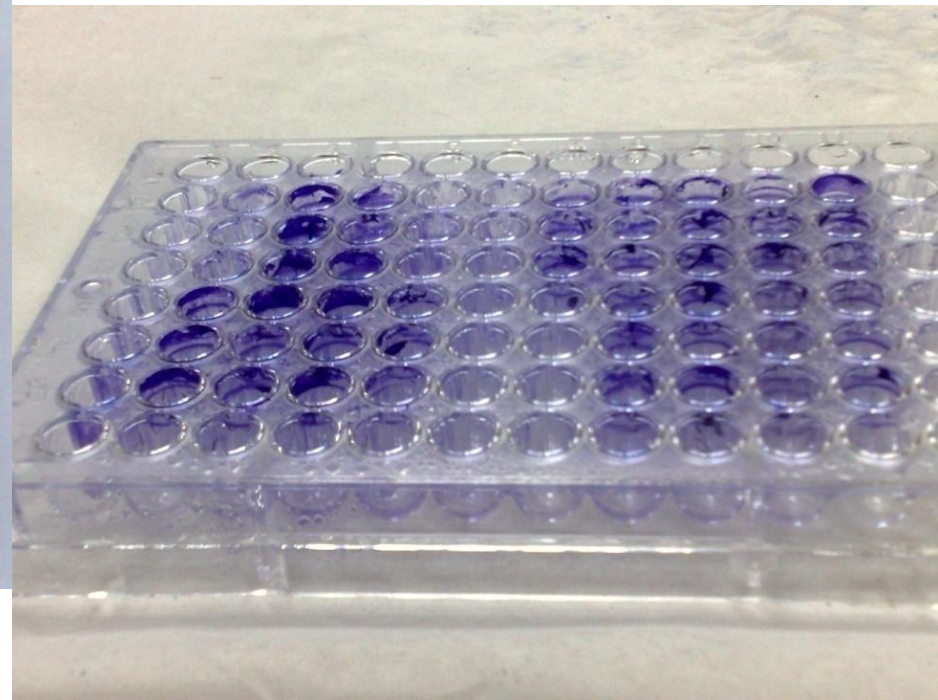
Step 1:

Bacterial suspensions with / without silver or gold NPs



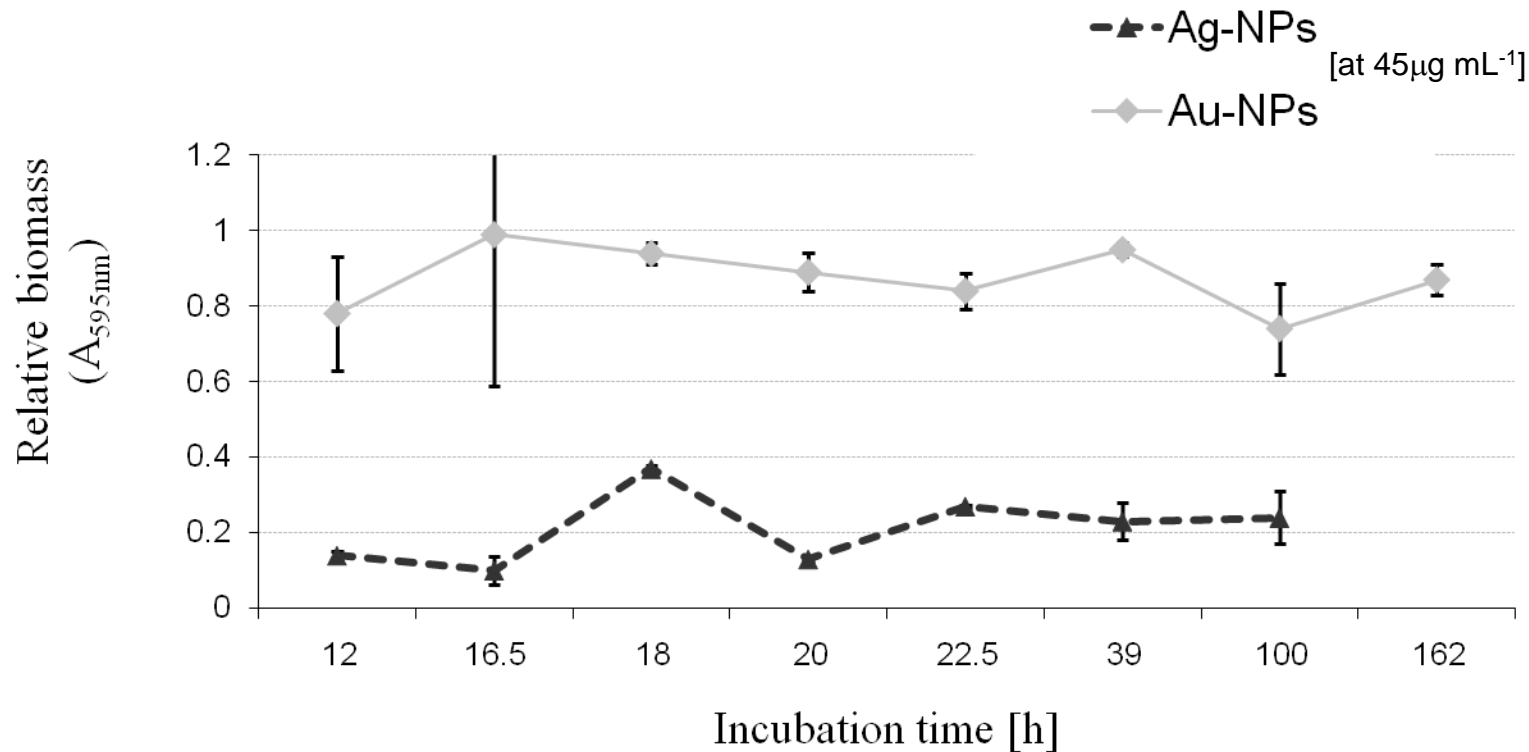
Step2:

Attached cells stained with Gentian Violet

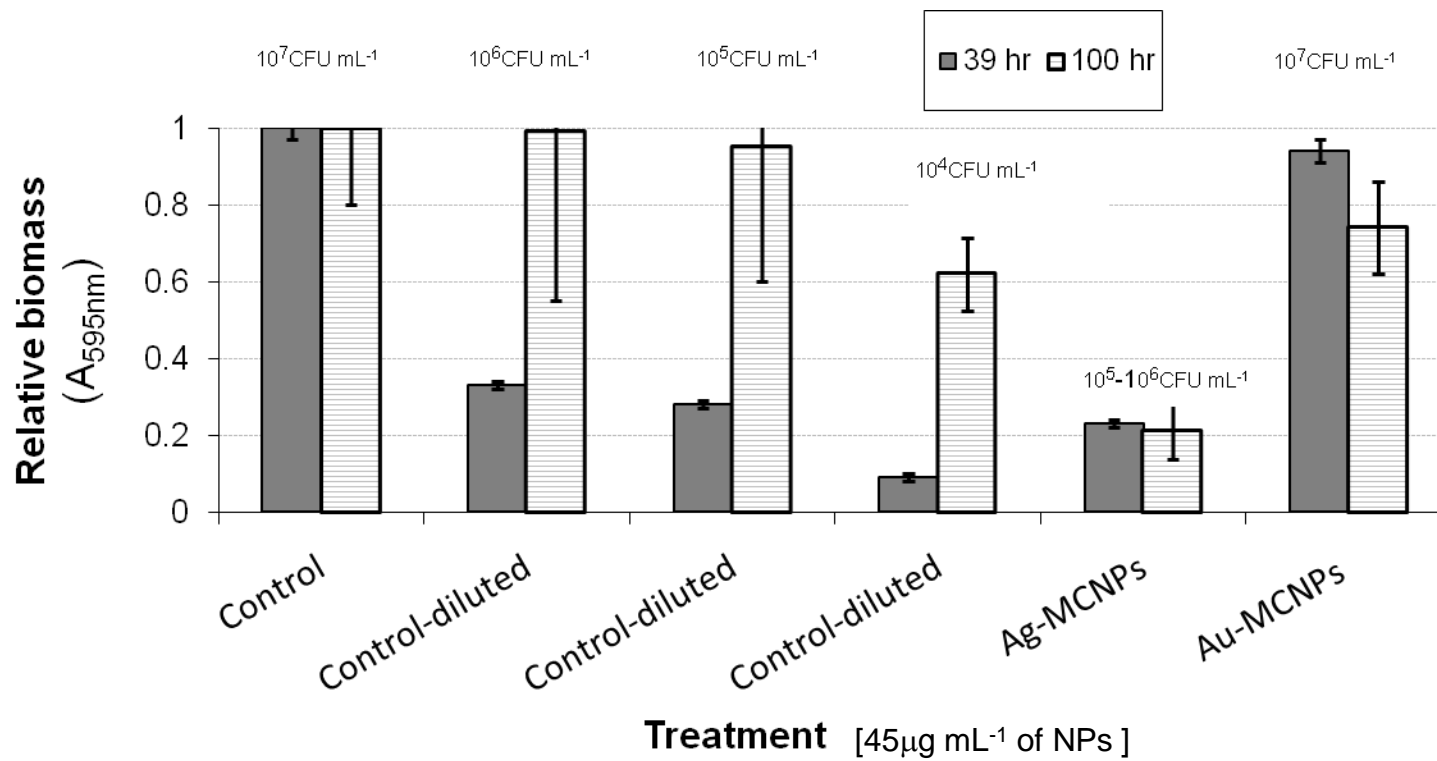


Biofilm formation

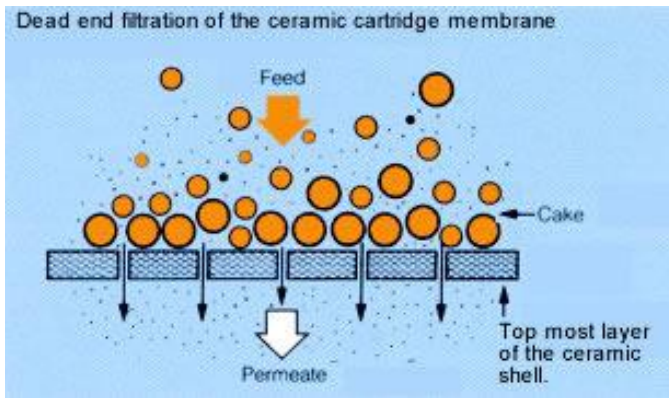
P.aeruginosa



Biofilm formation



Biofouling built up



0.78 bar

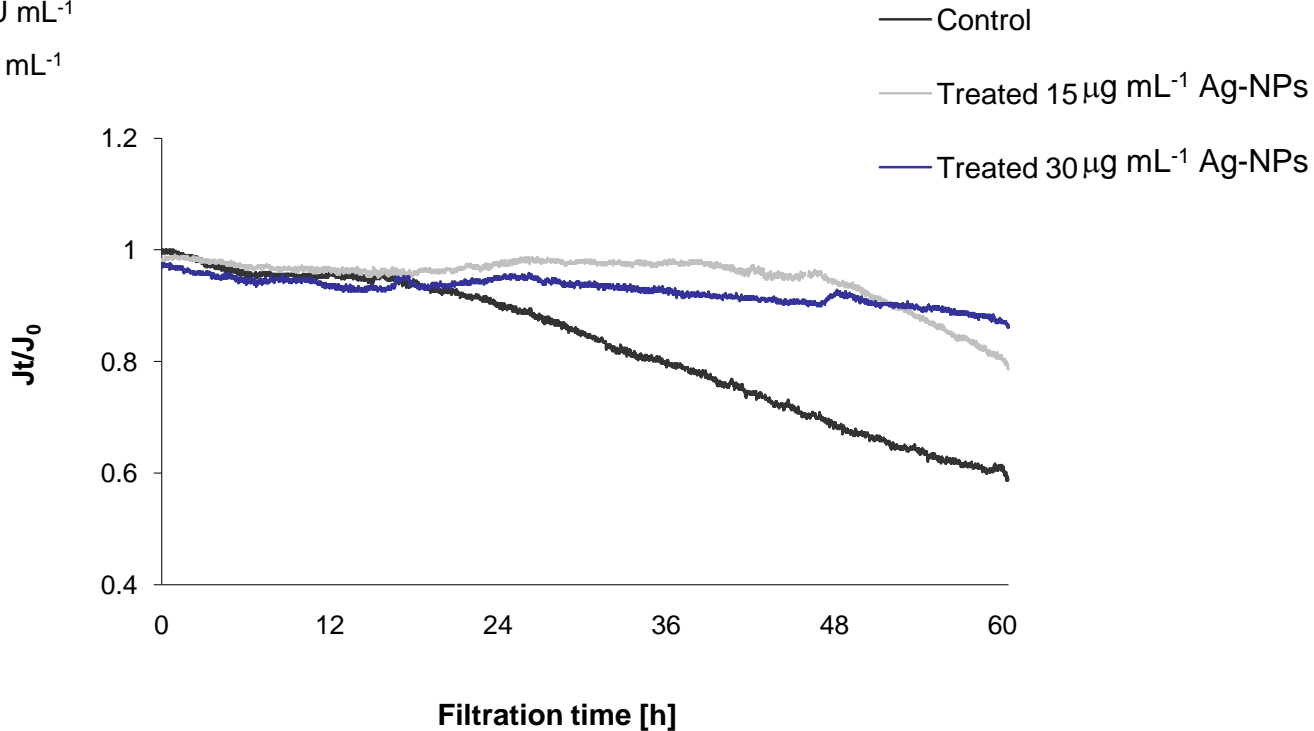
Dead-end UF stirred cell operated at constant pressure

Filtration Test

$N_c \sim 3.2 \cdot 10^8 \text{ CFU mL}^{-1}$

$N_0 t \sim 5.4 \cdot 10^8 \text{ CFU mL}^{-1}$

$N_t \sim 3.5 \cdot 10^8 \text{ CFU mL}^{-1}$



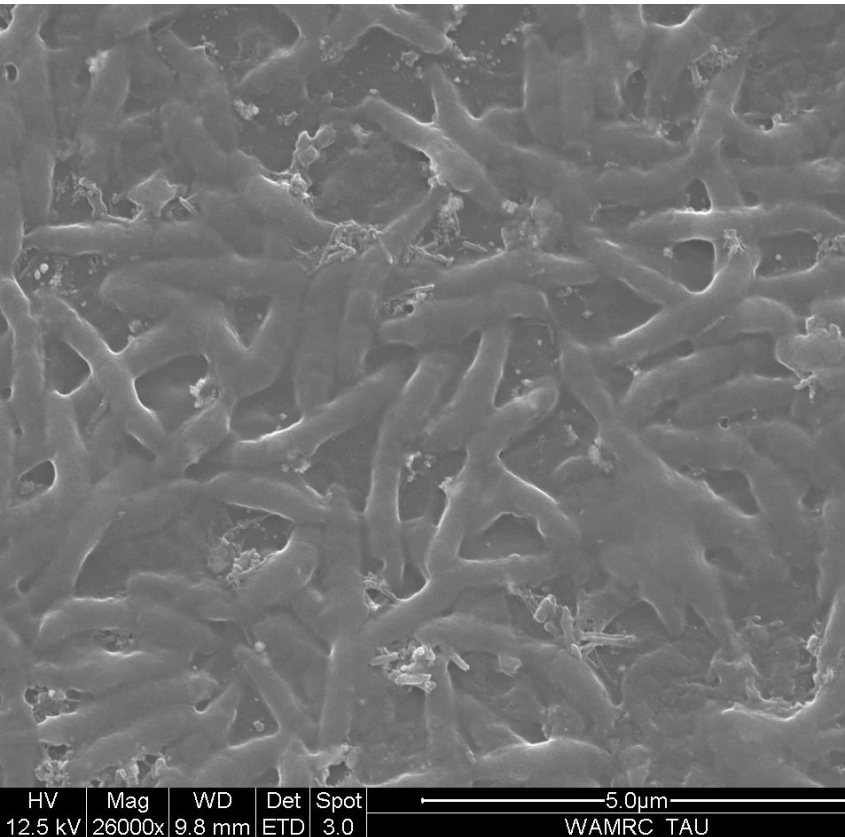
1:25

$\frac{0.013}{0.014}$
g/cm²•min

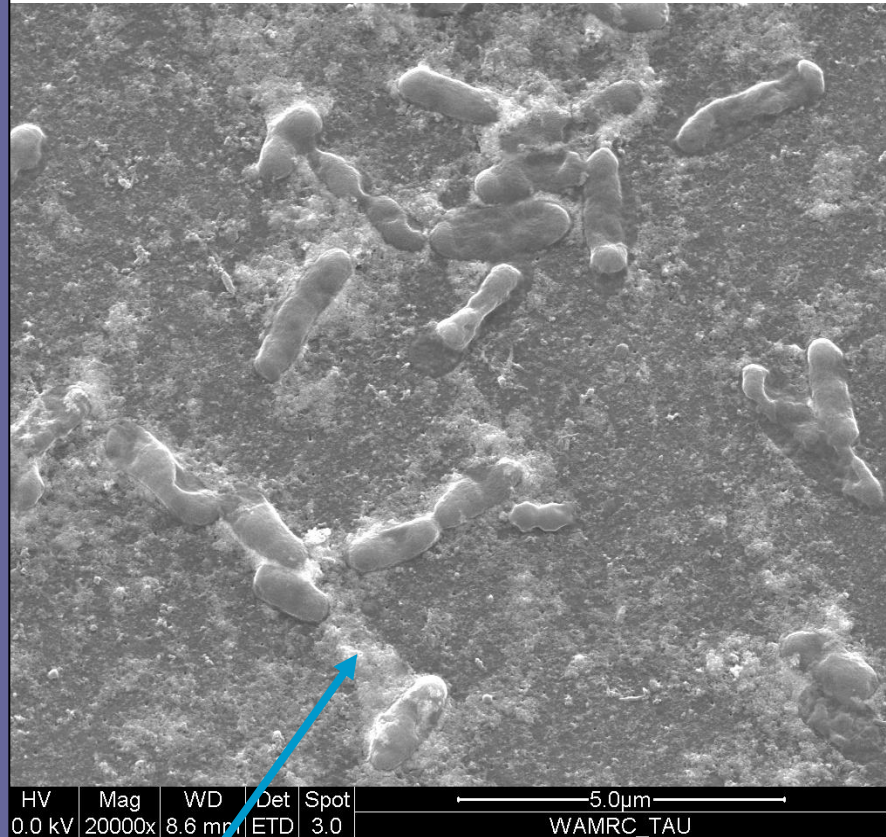
Flux equation: $J_t = J_0 e^{-kt}$

SEM micrographs of the membranes

Control

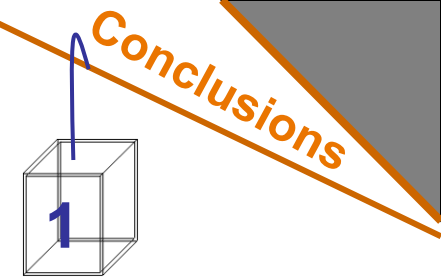


Treated



accumulation of Ag-NPs

Summary and Conclusions



- ✓ Stable molecularly capped silver nanoparticles with controlled shape, size, size distribution and charge were produced.
- ✓ Single core parameter that merges several parameters known as impacting the inactivation process, was defined.
- ✓ Under the experimental condition, exposure to silver nanoparticles resulted in retardation in formation of biofilm.
- ✓ Bacteria that survived the interaction with the nanoparticles produced less biofilm compared to control bacteria at the same microbial counts.
- ✓ Exposure to silver nanoparticles resulted in a lower flux decline in a UF membrane apparatus thus improving its performance.

Thank you for your attention

