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Conference & Exhibition

Characterization of SeNPs produced by *B. mycoides* SeITE01 and *S. maltophilia* SeITE02 and their biomolecular organic material

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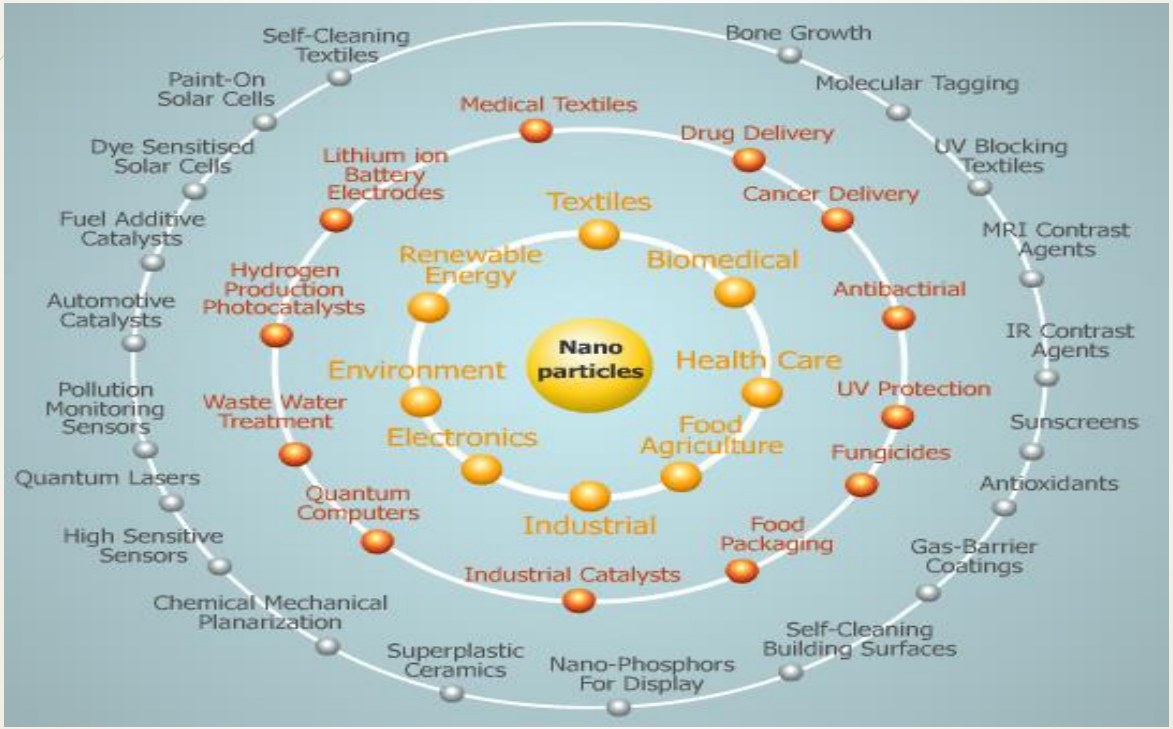
NSERC CRSNG

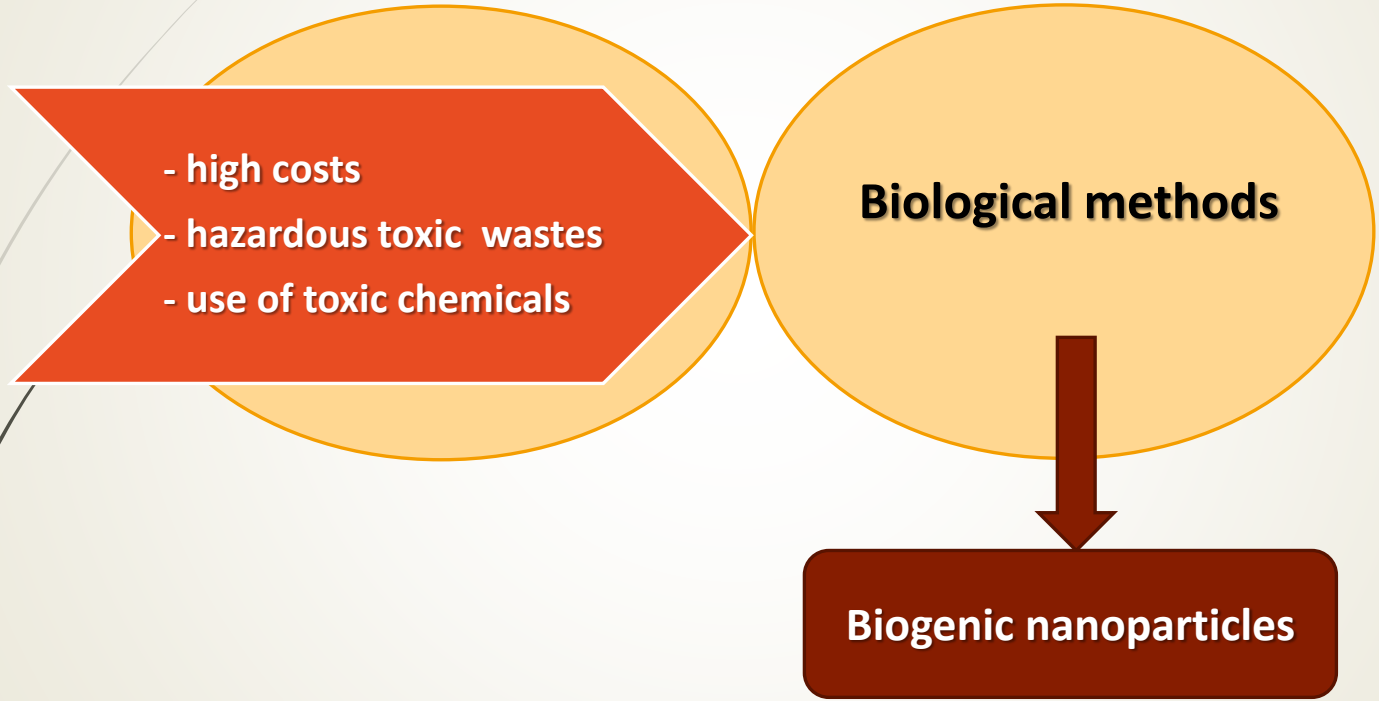
Introduction

Application fields of nanoparticles



Adapted from http: // nano.prochimia.com

Methods of nanustructures synthesis



Biogenic nanoparticles

Natural ability of microorganisms

↓

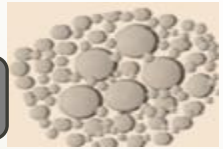
Metal/Metalloid solution

↓

Keep for stirring/Observe color change

↓

Nanoparticles recovery



Advantages

- elimination use of expensive chemicals
- green synthesis
- higher catalytic reactivity

Problems

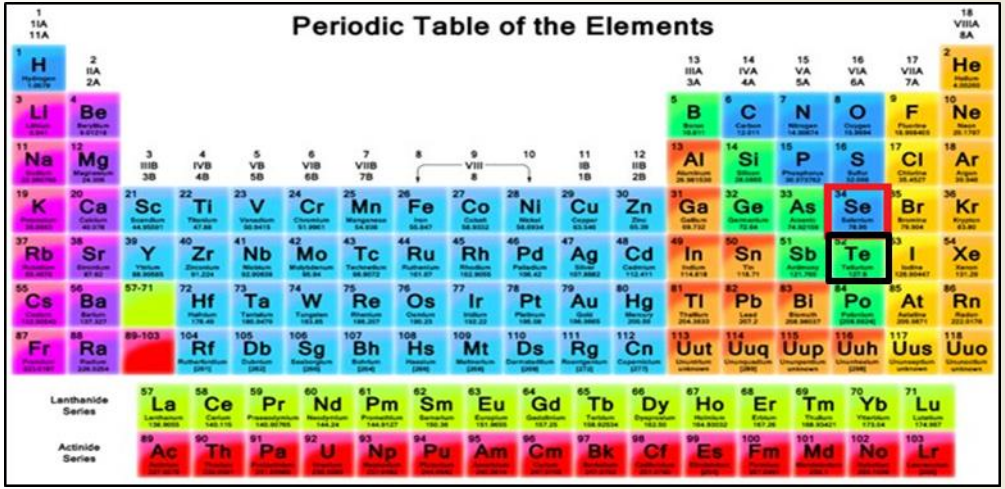
- improve purifications protocols
- longer time of synthesis

Ingale et al., Journal of Nanomedicine and Nanotechology, 2013

The Chalcogen Selenium

rare element

metalloid



Adapted from http://sciencenotes.org/periodic-table-wallpaper-2/

Selenium is an essential micronutrient for humans

present in active site of important enzymes

Uses of Se

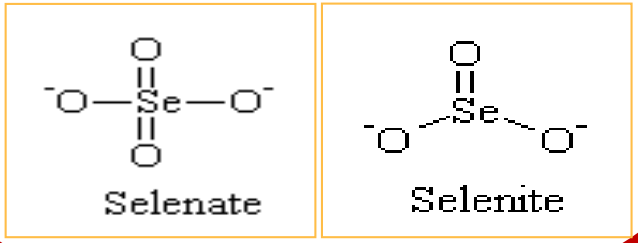
- electronics and glass industry
- animal feeds and food supplements
- photocopying
- metal alloys for batteries
- pigments and ceramics
- plastics and lubricants

Selenium in environment

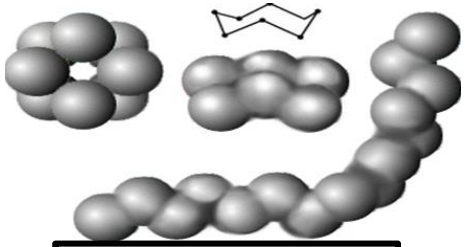
4 valence states :

- **Selenite (Se^{4+})**
- **Selenate (Se^{6+})**
- Selenide (Se^{2-})
- **Elemental selenium (Se^{0})**

Most toxic forms



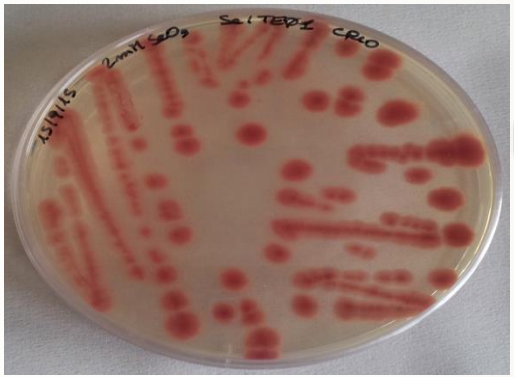
Less toxic form



Selenium nanoparticles (SeNPs)

Production of SeNPs using bacterial strains as detoxification process

Bacillus mycoides SelTE01
Stenotrophomonas maltophilia SelTE02



Minimal Inhibitory Concentration (MIC) at 25 and 50 mM of Na_2SeO_3

SeNPs production

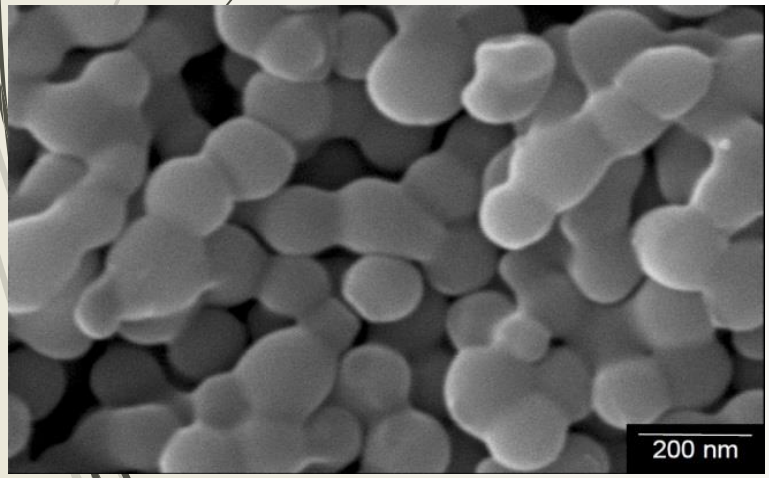
Image: http://www.flickriver.com

SeNPs produced by *B. mycoides* SelTE01 after 24 h of Na_2SeO_3 exposure

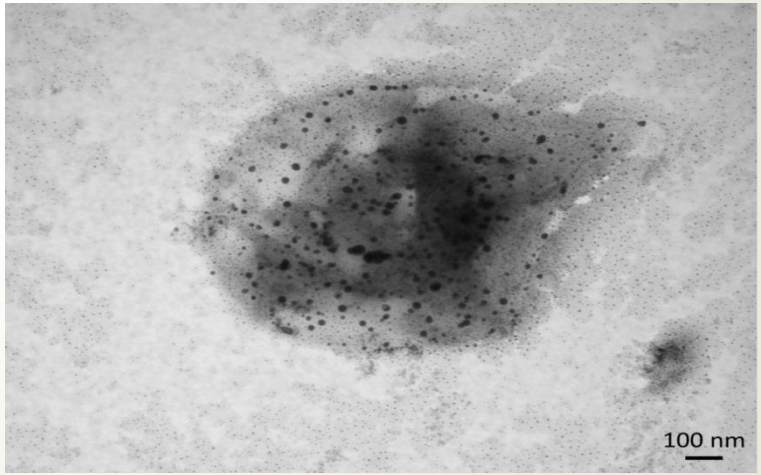
Dynamic Light Scattering (DLS) and Zeta potential measurements

Size (nm)	Intensity Distribution Data (%)	Std. Dev.	Polydispersity Index (PDI)	Zeta pot. (mV)	Std. Dev.
142	64.35	15.78	0.21	-24	0.92

Scanning Electron Microscopy (SEM)



Transmission Electron Microscopy (TEM)

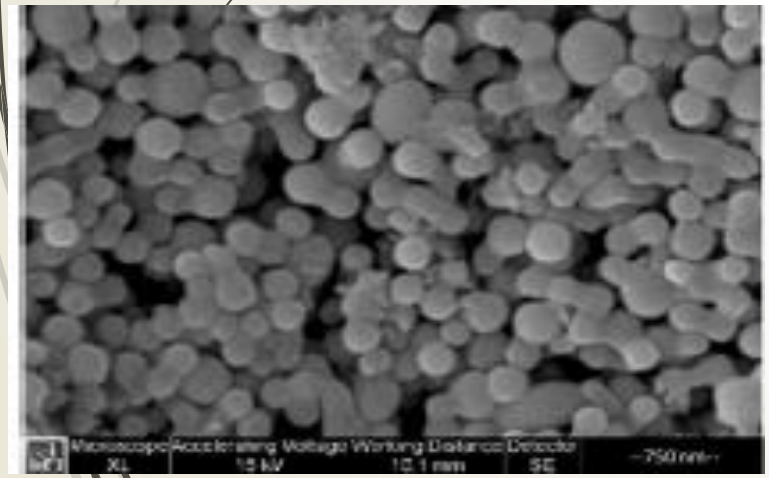


SeNPs produced by *S. maltophilia* SelTE02 after 24 h of Na_2SeO_3 exposure

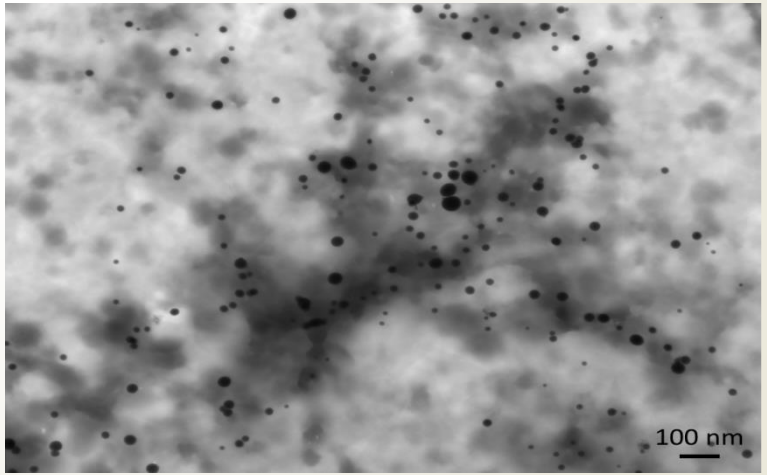
Dynamic Light Scattering (DLS) and Zeta potential measurements

Size (nm)	Intensity Distribution Data (%)	Std. Dev.	Polydispersity Index (PDI)	Zeta pot. (mV)	Std. Dev.
396	20.75	3.73	0.22	-28	1.42

Scanning Electron Microscopy (SEM)

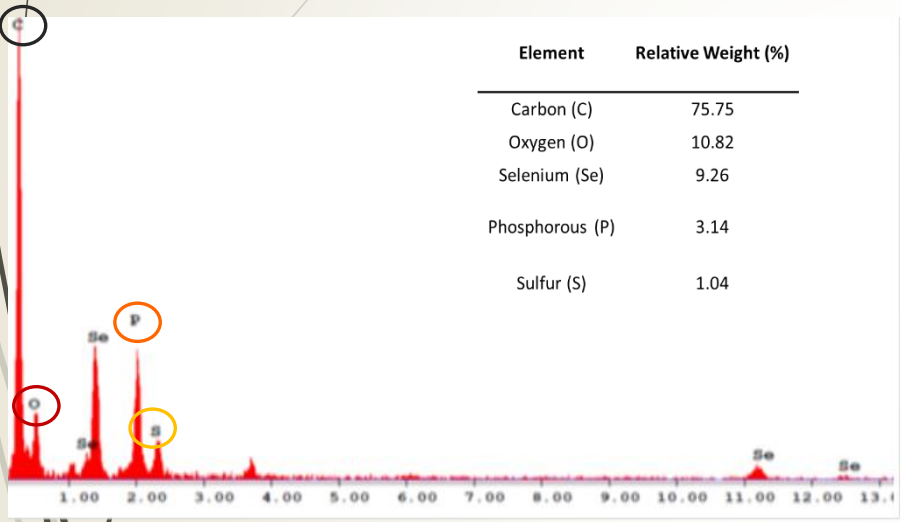


Transmission Electron Microscopy (TEM)



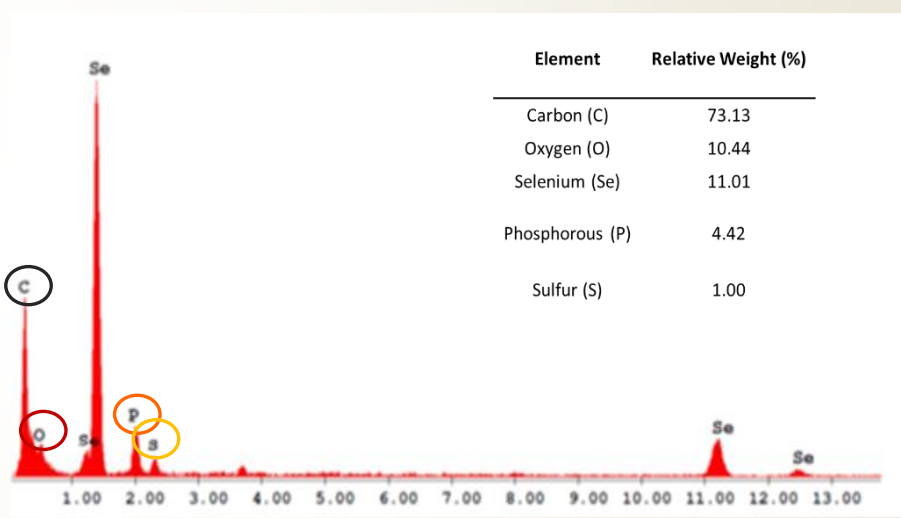
Energy Dispersed X-Ray Spectroscopy (EDX) analysis

SeNPs produced by *B. mycoides* SelTE01



Element	Relative Weight (%)
Carbon (C)	75.75
Oxygen (O)	10.82
Selenium (Se)	9.26
Phosphorous (P)	3.14
Sulfur (S)	1.04

SeNPs produced by *S. maltophilia* SelTE02



Element	Relative Weight (%)
Carbon (C)	73.13
Oxygen (O)	10.44
Selenium (Se)	11.01
Phosphorous (P)	4.42
Sulfur (S)	1.00

Presence of **Carbon**, **Oxygen**, **Phosphorous** and **Sulfur** and TEM images suggest the evidence of biomolecular organic material surrounding SeNPs

Biomolecular organic material surrounding SeNPs

Modifications of the standard extraction protocol to understand the role of the organic surrounding material

Re-exposure of the same biomass to fresh medium with new Na_2SeO_3 (conditioned cells)

Solubilization in 1.5 M Tris-HCl

Sonication

3 step of octanol fractioning non Over Night

Octanol Fractioning (Over Night)

SeNPs recove

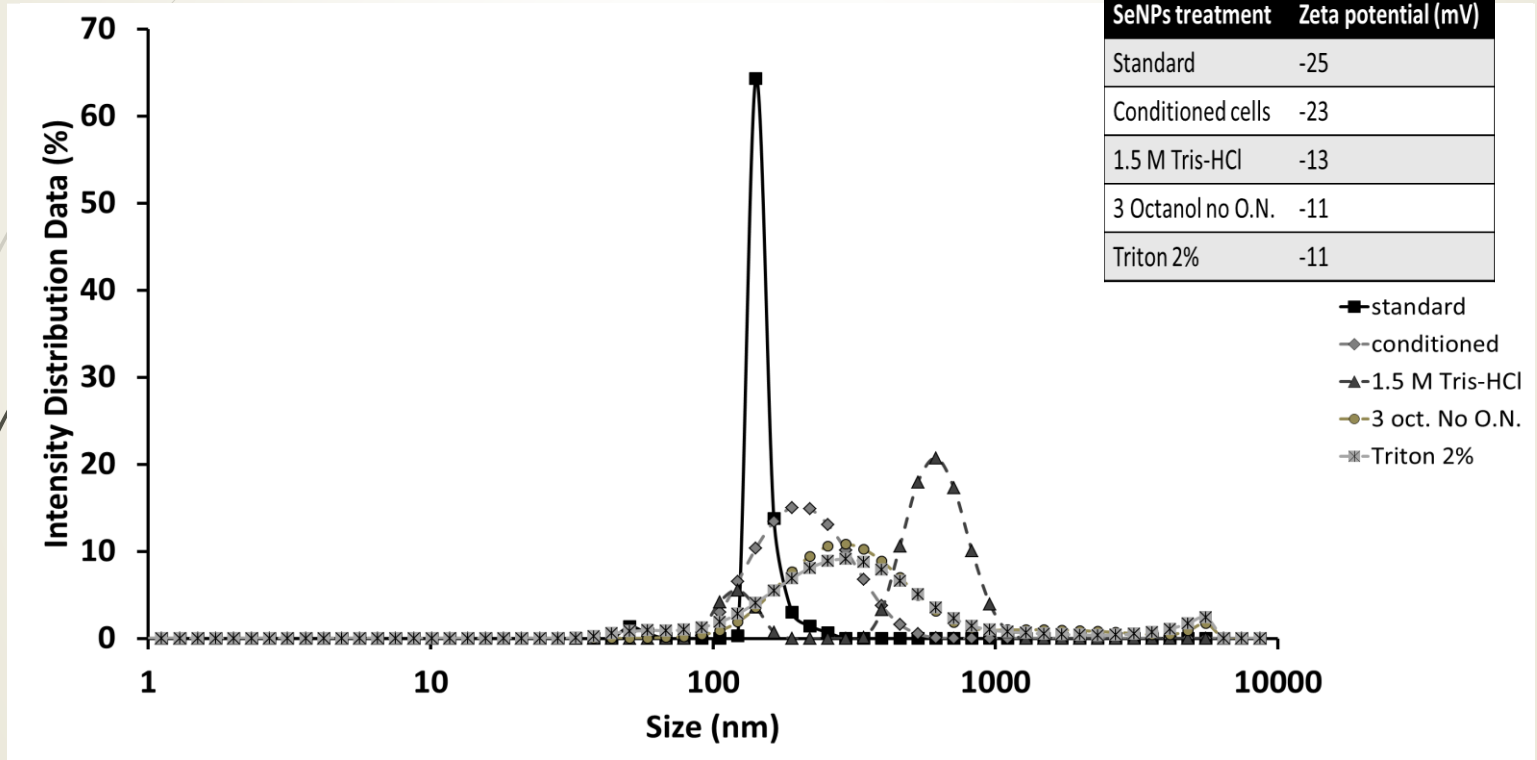
Treatment with 2% Triton X-100

Chemical-physical characterization of treated or modified biogenic SeNPs

SeNPs produced by *B. mycoides* SelTE01

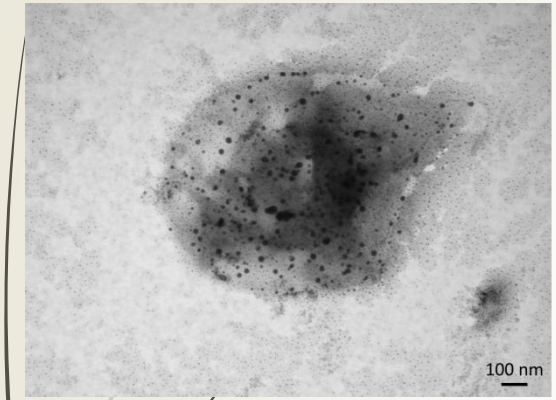
Zeta potential analysis

SeNPs treatment	Zeta potential (mV)
Standard	-25
Conditioned cells	-23
1.5 M Tris-HCl	-13
3 Octanol no O.N.	-11
Triton 2%	-11

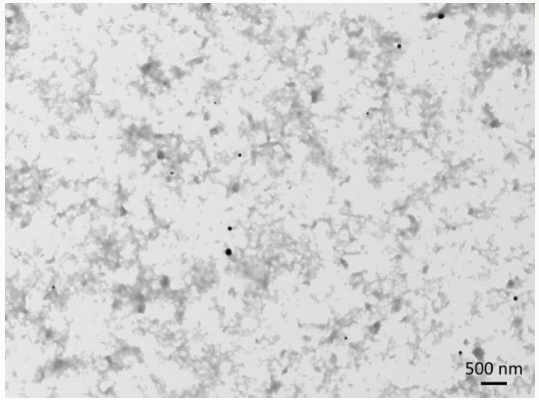


TEM imaging

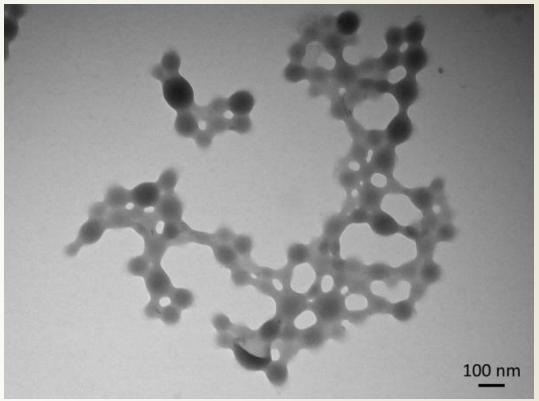
SeNPs standard



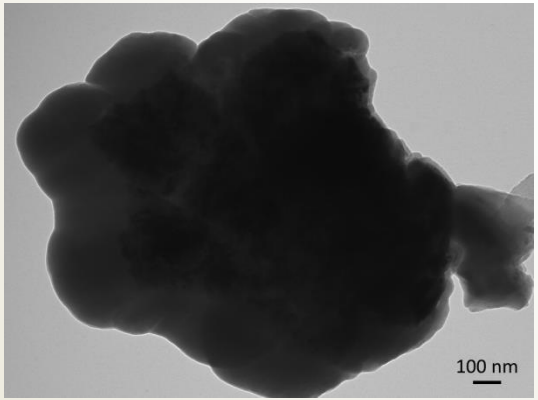
SeNPs from conditioned cells



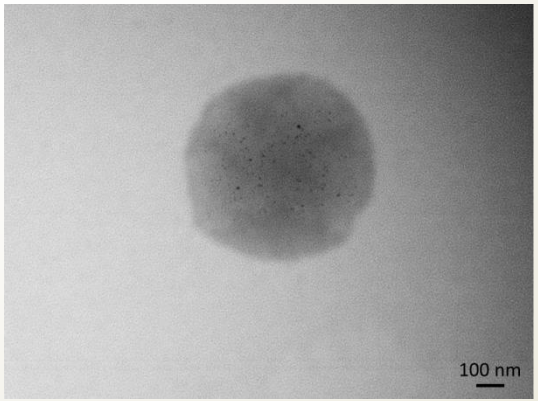
SeNPs with 1.5 M Tris-HCl



SeNPs 3 oct. no O.N.



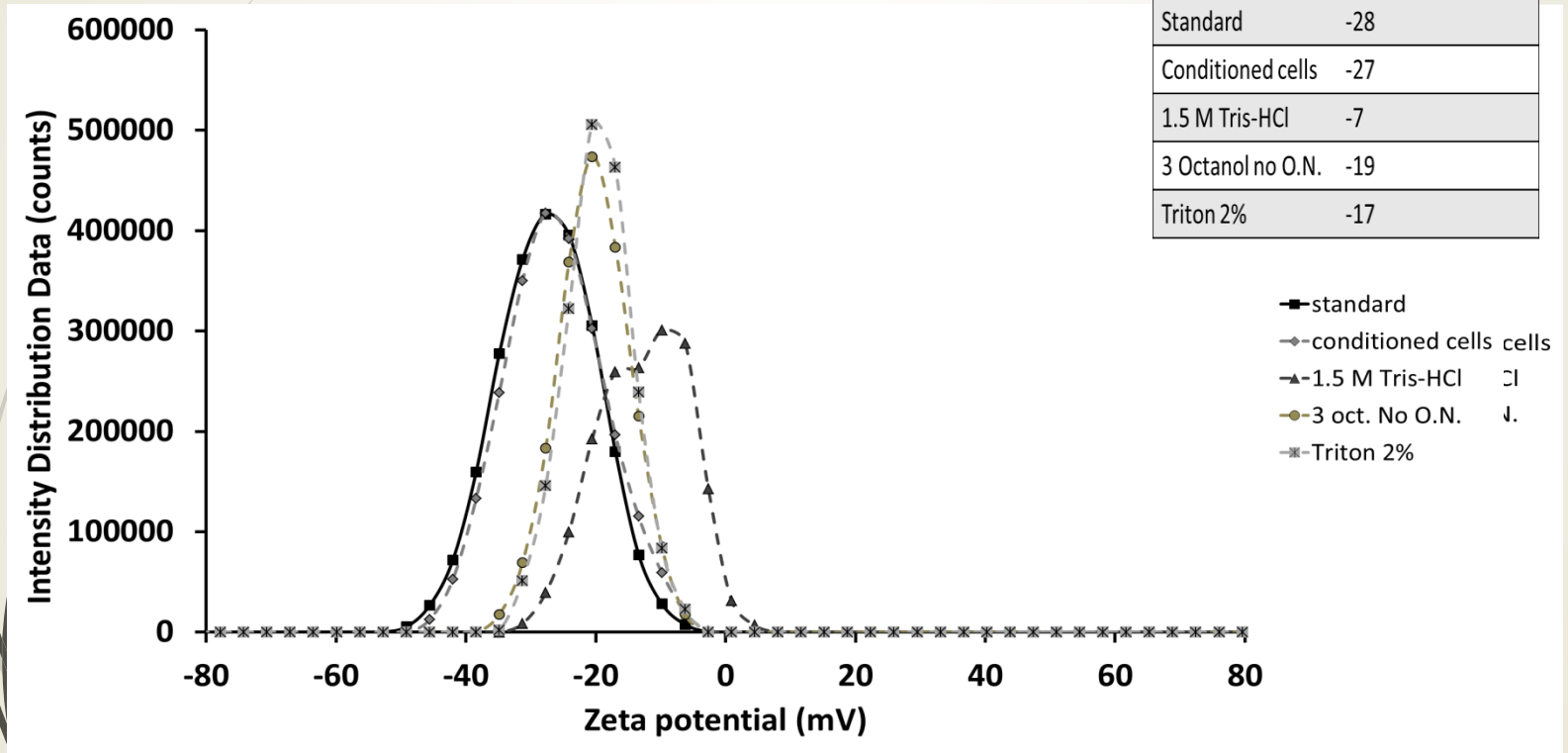
SeNPs with Triton 2%



SeNPs produced by *S. maltophilia* SelTE02

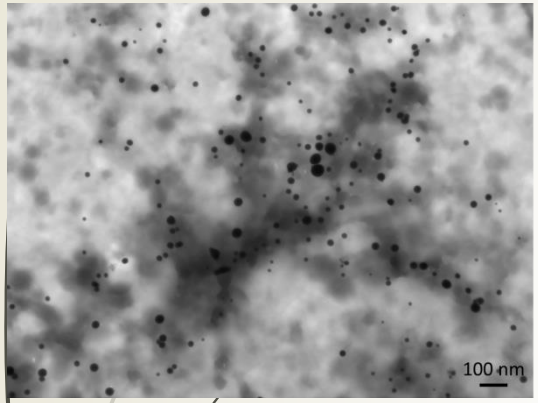
Zeta potential measurements

SeNPs treatment	Zeta potential (mV)
Standard	-28
Conditioned cells	-27
1.5 M Tris-HCl	-7
3 Octanol no O.N.	-19
Triton 2%	-17

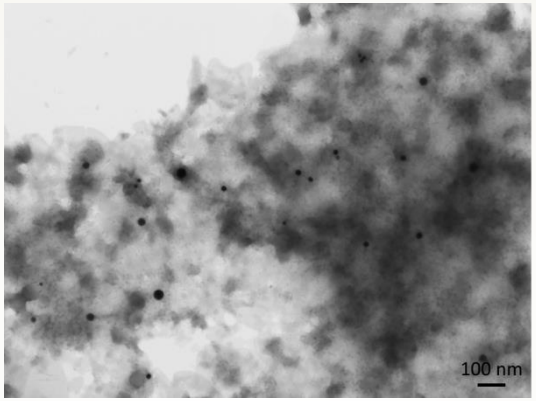


TEM imaging

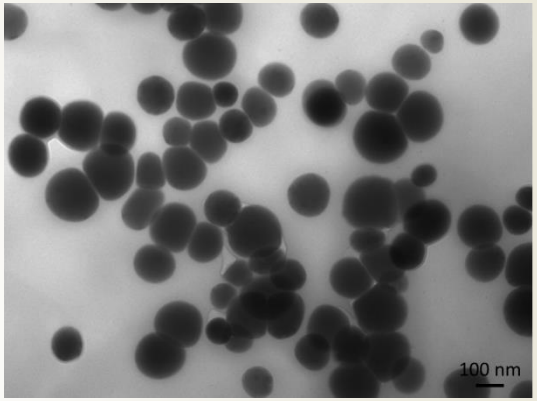
SeNPs standard



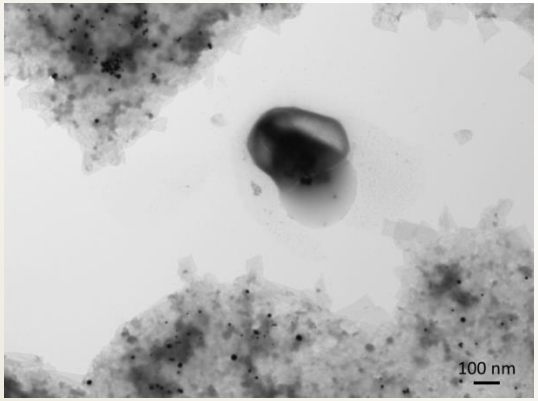
SeNPs from conditioned cells



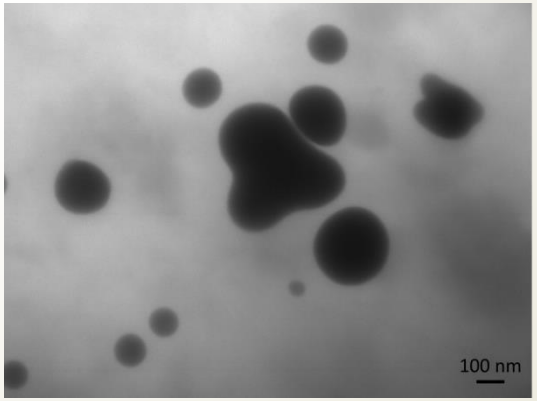
SeNPs with 1.5 M Tris-HCl



SeNPs 3 oct. no O.N.



SeNPs with Triton 2%



Summary

- **SeNPs produced by both *B. mycoides* SelTE01 and *S. maltophilia* SelTE02 were characterized by the presence of an organic surrounding material**

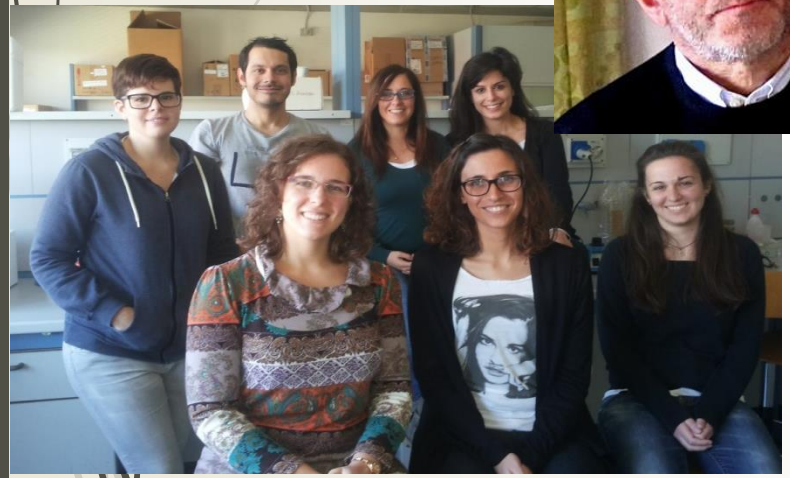
- Different modifications of the SeNPs extraction protocol acting on this organic material resulted in a strong **variation of the NPs themselves**

- Our results suggested how **the organic material in which SeNPs are embedded is not covalently bound to the NPs**, considering that the tested treatments were able to rip it off from SeNPs

- The **organic material surrounding biogenic SeNPs seems to play a key role in the stabilization of the produced NPs**, avoiding the formation of big Se-clusters or Se-aggregates

Prof. Giovanni Vallini, prof. Silvia Lampis and Enviromental Microbiology Laboratory (University of Verona)

Dr. Emanuele Zonaro
Alessandra Bulgarini



Doc. Raymond Joseph Turner and Microbial Biochemistry Laboratory (University of Calgary)

Dr. Alessandro Presentato

THANK YOU FOR YOUR ATTENTION

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