Nano4Green

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Agrupamento de Escolas da Maia
Viana do Castelo 13-17 July 2020

When working in partnership with the Faculty of Sciences of the University of Porto, we used the Project-based learning (PBL) methodology to develop a project to remove heavy metal ions from contaminated water, through magnetic separation.

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Introduction

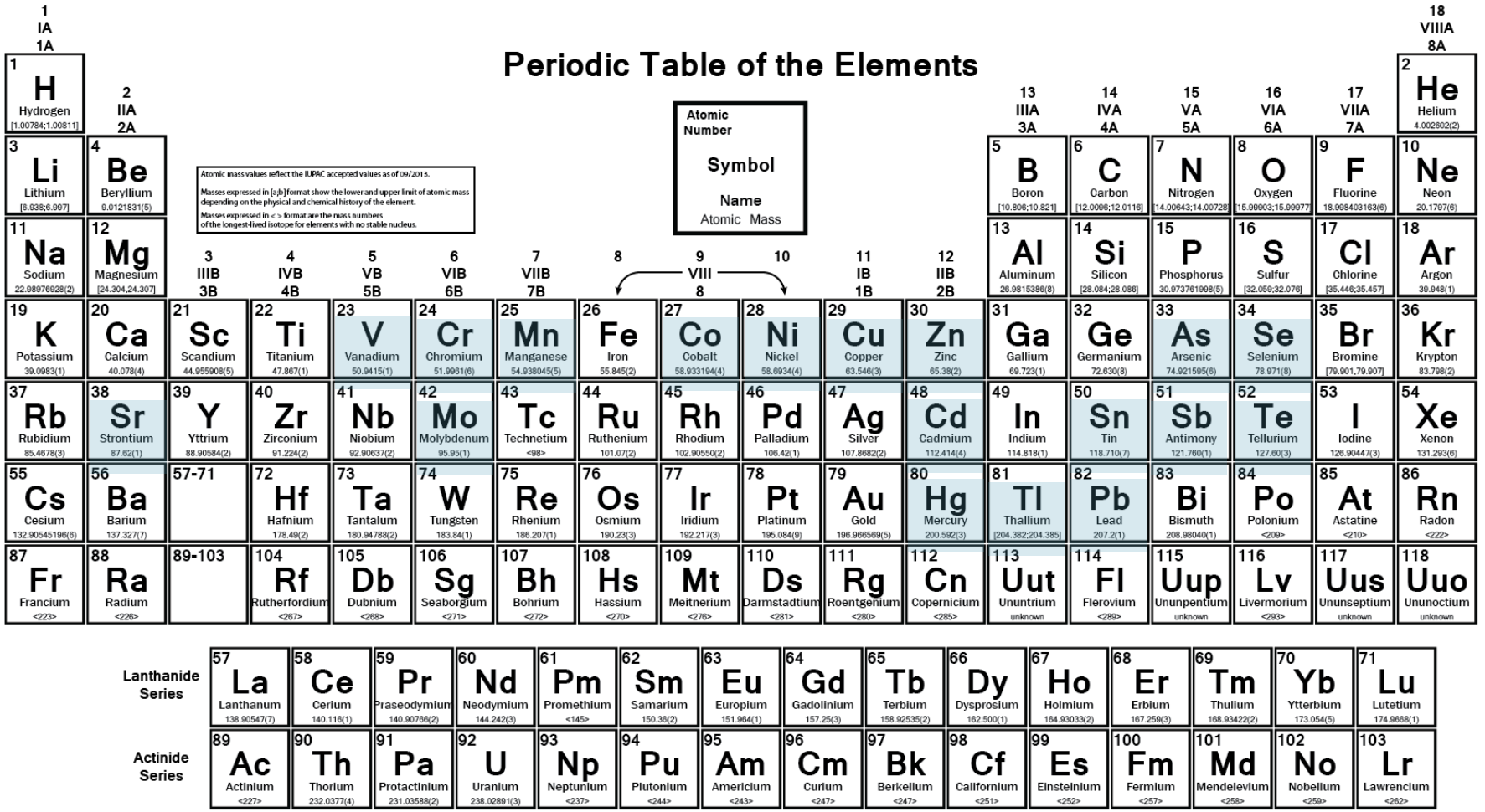


Figure 1: Heavy metals in the periodic table

Introduction

Heavy metals	Recommended Daily Intakes (adult) (per day)	
	Woman	Man
Vanadium (V)	0,010*	
Chromium (Cr)	0,025*	
Molybdenum (Mo)	0,050 - 0,4*	
Selenium (Se)	0,060**	0,075**
Zinc (Zn)	7,0 **	9,5**
Manganese (Mn)	4,6*	
Copper (Cu)	1,2**	

Heavy metals	Recommended Daily Intakes (adult) (per day)
Strontium (Sr)	-
Nickel (Ni)	-
Cobalt (Co)	-
Cadmium (Cd)	-
Mercury (Hg)	-
Thallium (Tl)	-
Lead (Pb)	-
Tin (Sn)	-
Antimony (Sb)	-
Tellurium (Te)	-
Arsenic (As)	-

* - The intake is not correctly defined

** - depends on the person's age

Table 1: Recommended daily intakes of heavy metals

Introduction

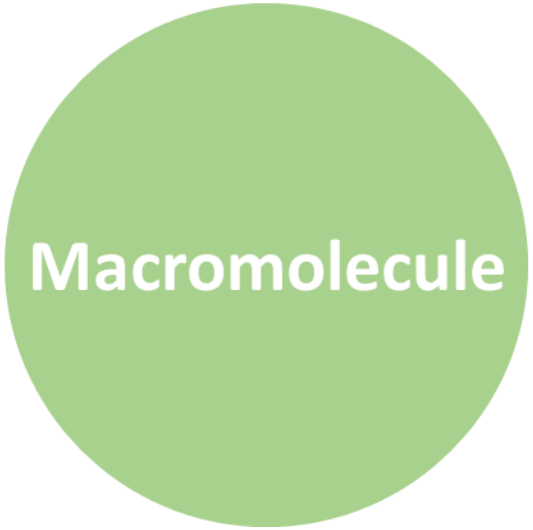
Separation by filtration membrane

Biosorption

Chemical precipitation

Adsorption

Separation by filtration membrane



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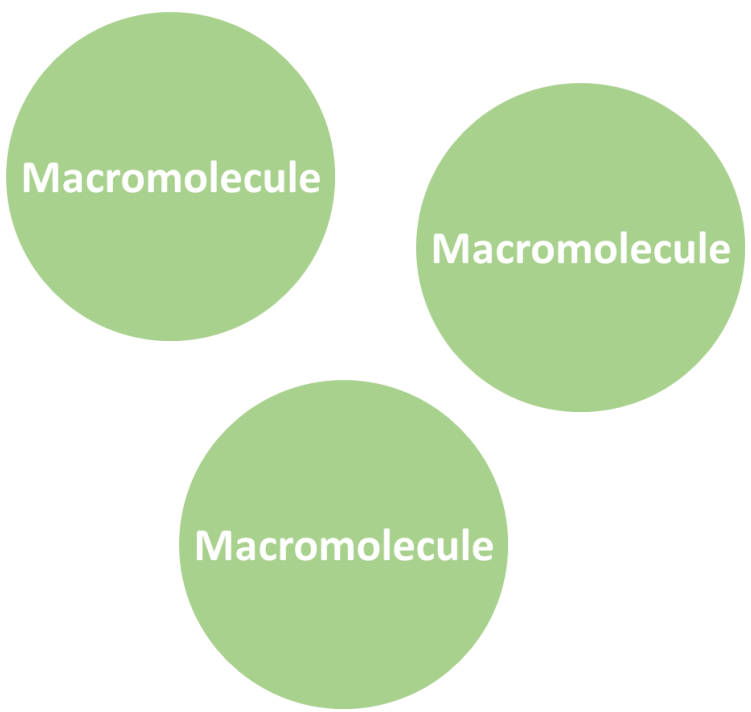

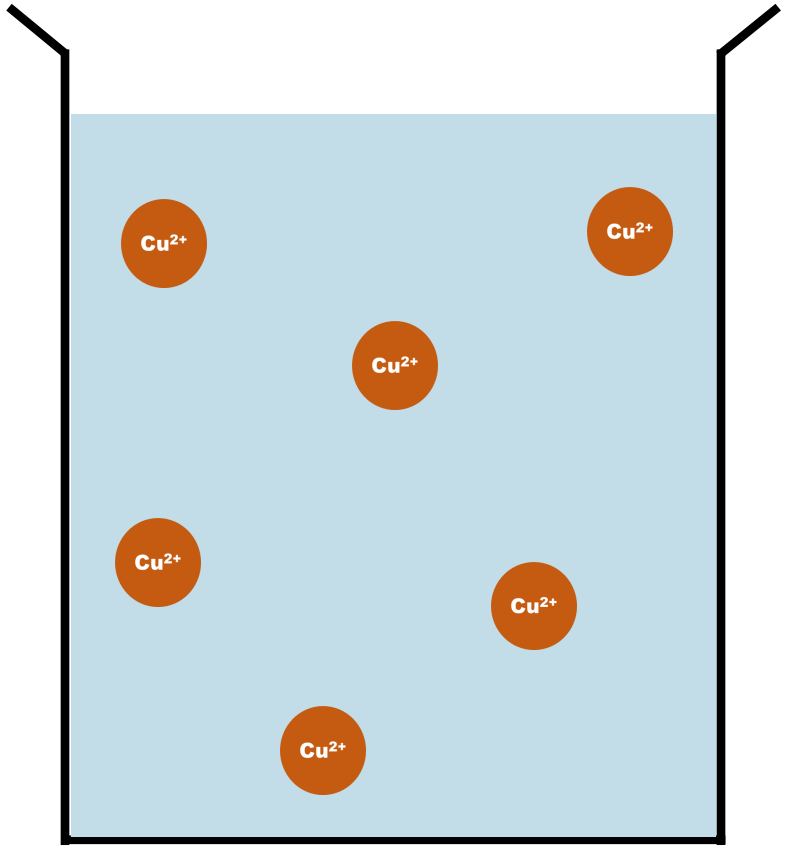

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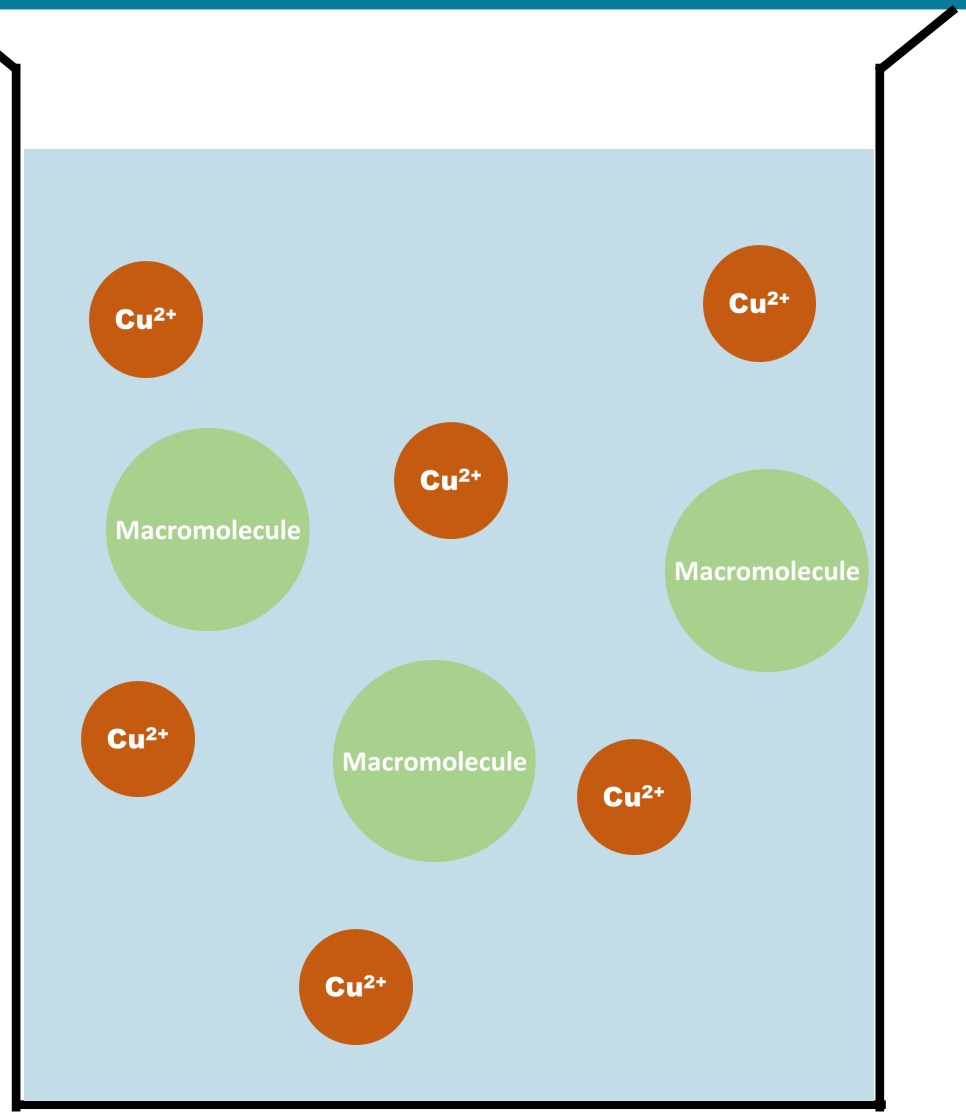

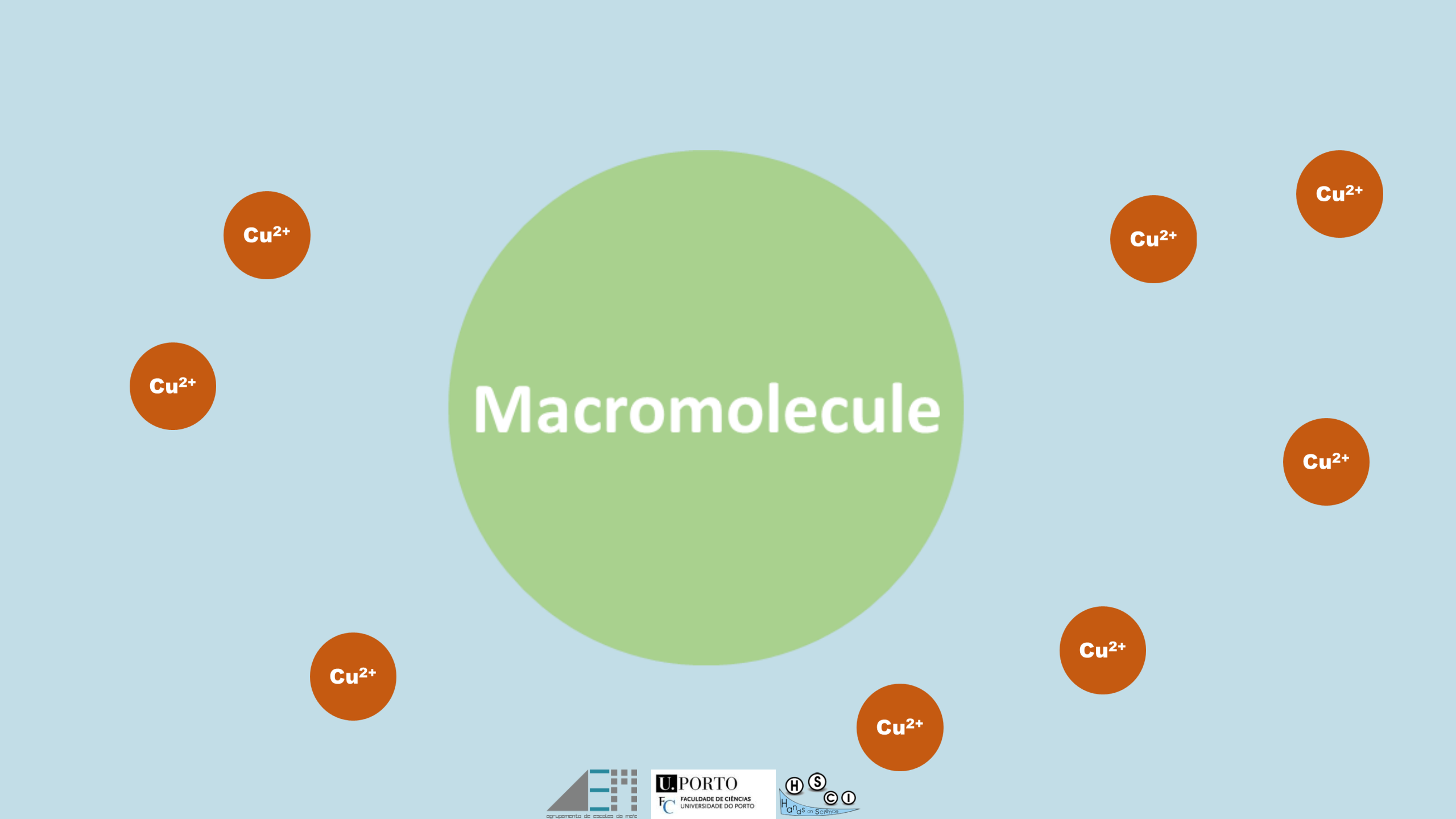
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Macromolecule
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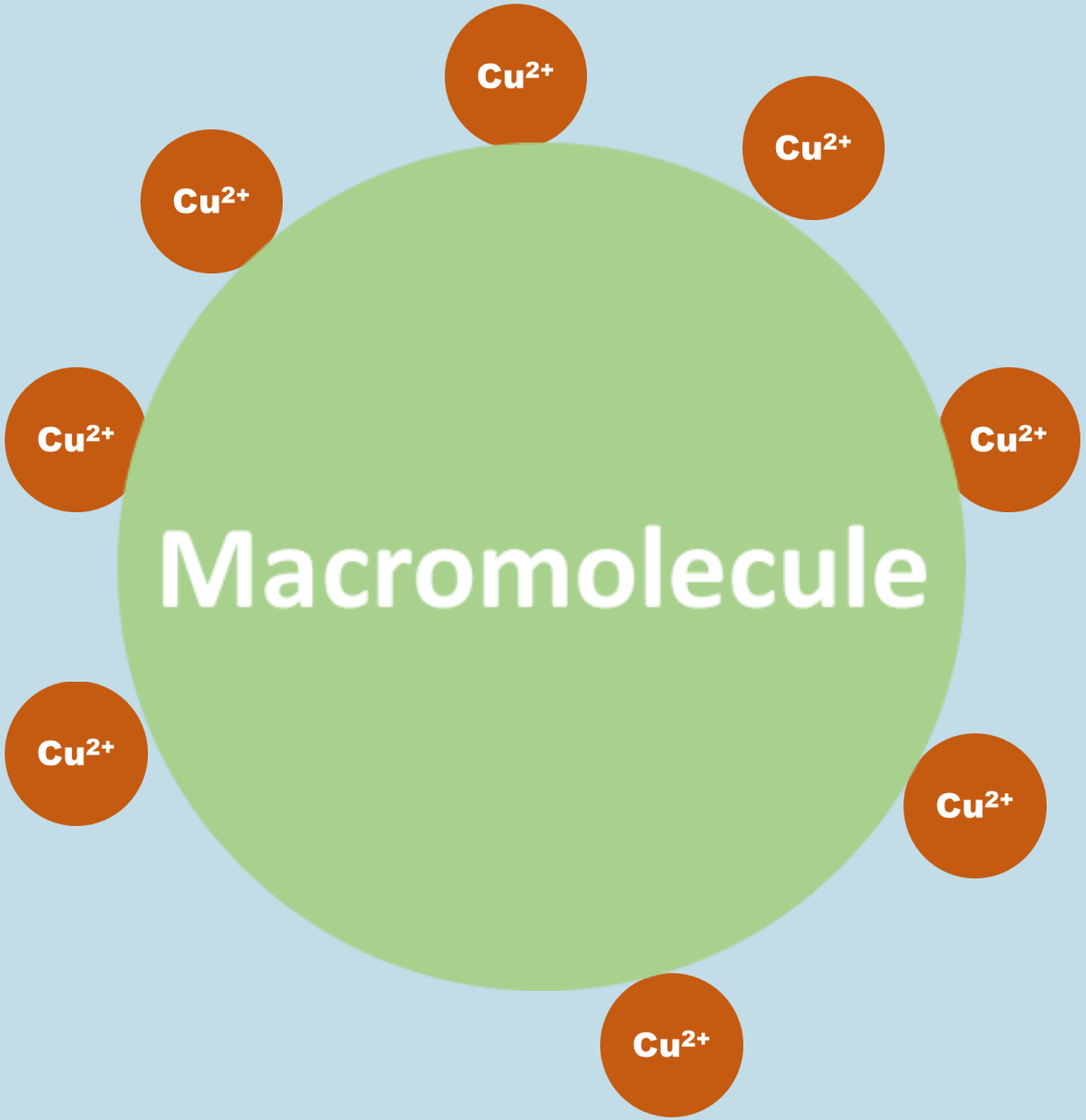
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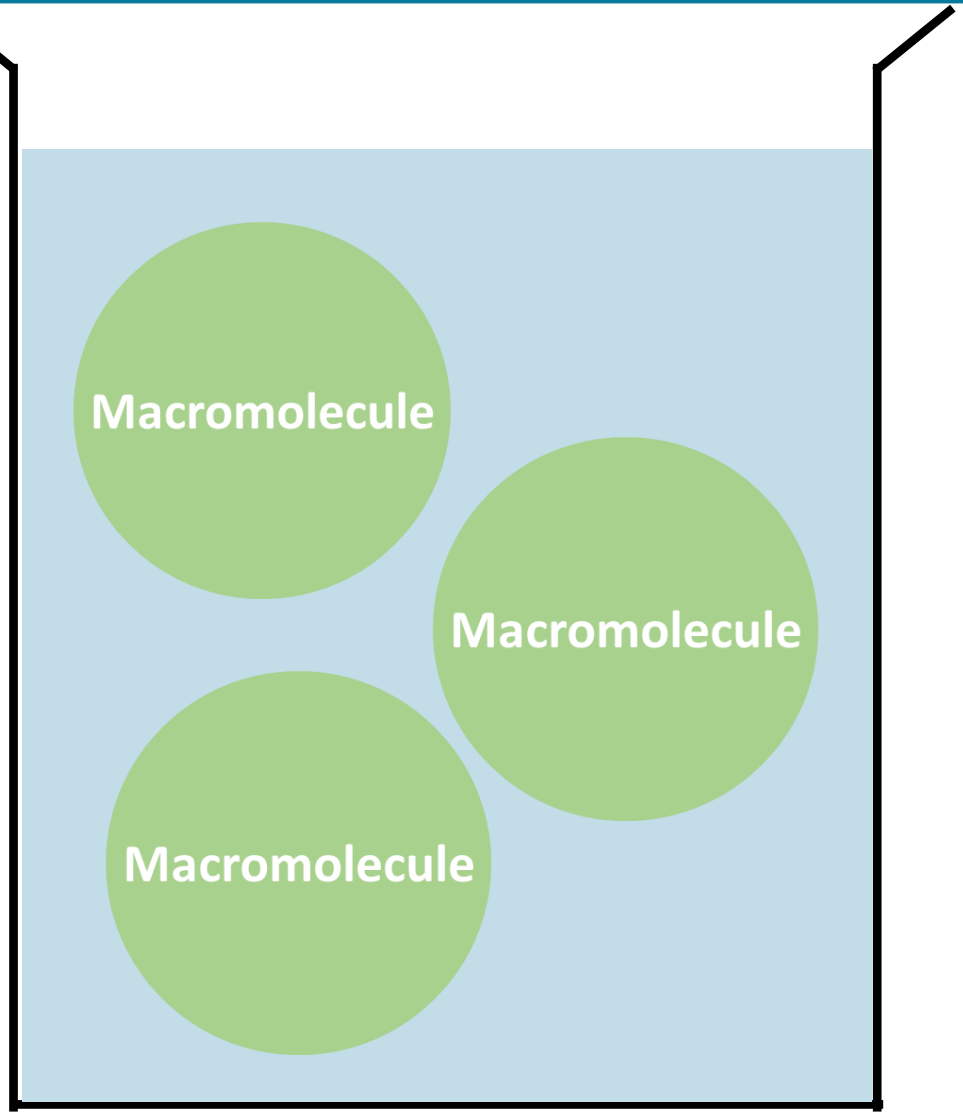
Macromolecule

Macromolecule

agrupamento de escolas de maia
U.PORTO FACULDADE DE CIÊNCIAS UNIVERSIDADE DO PORTO
HSCI Hands on Science

Separation by filtration membrane



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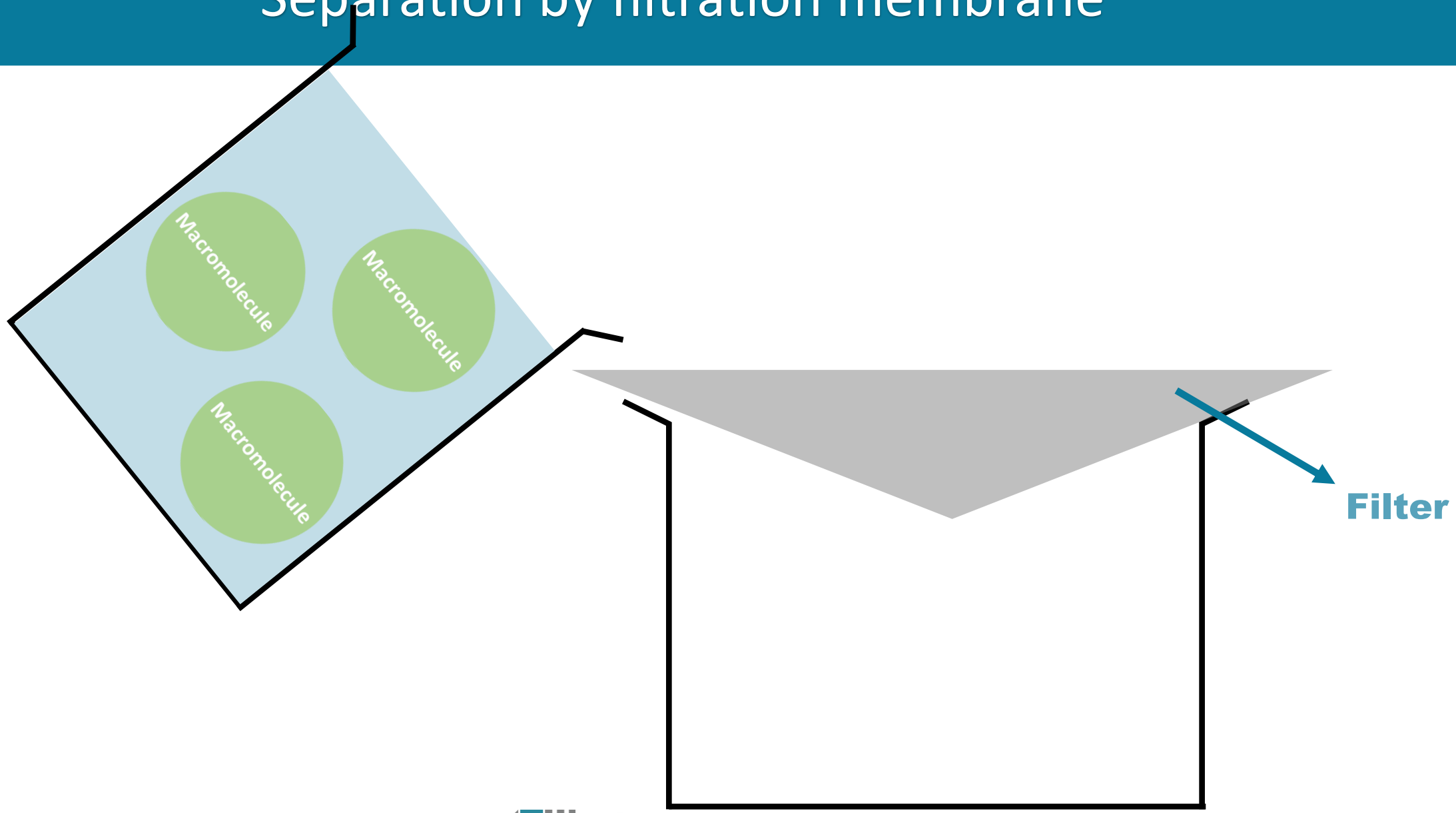

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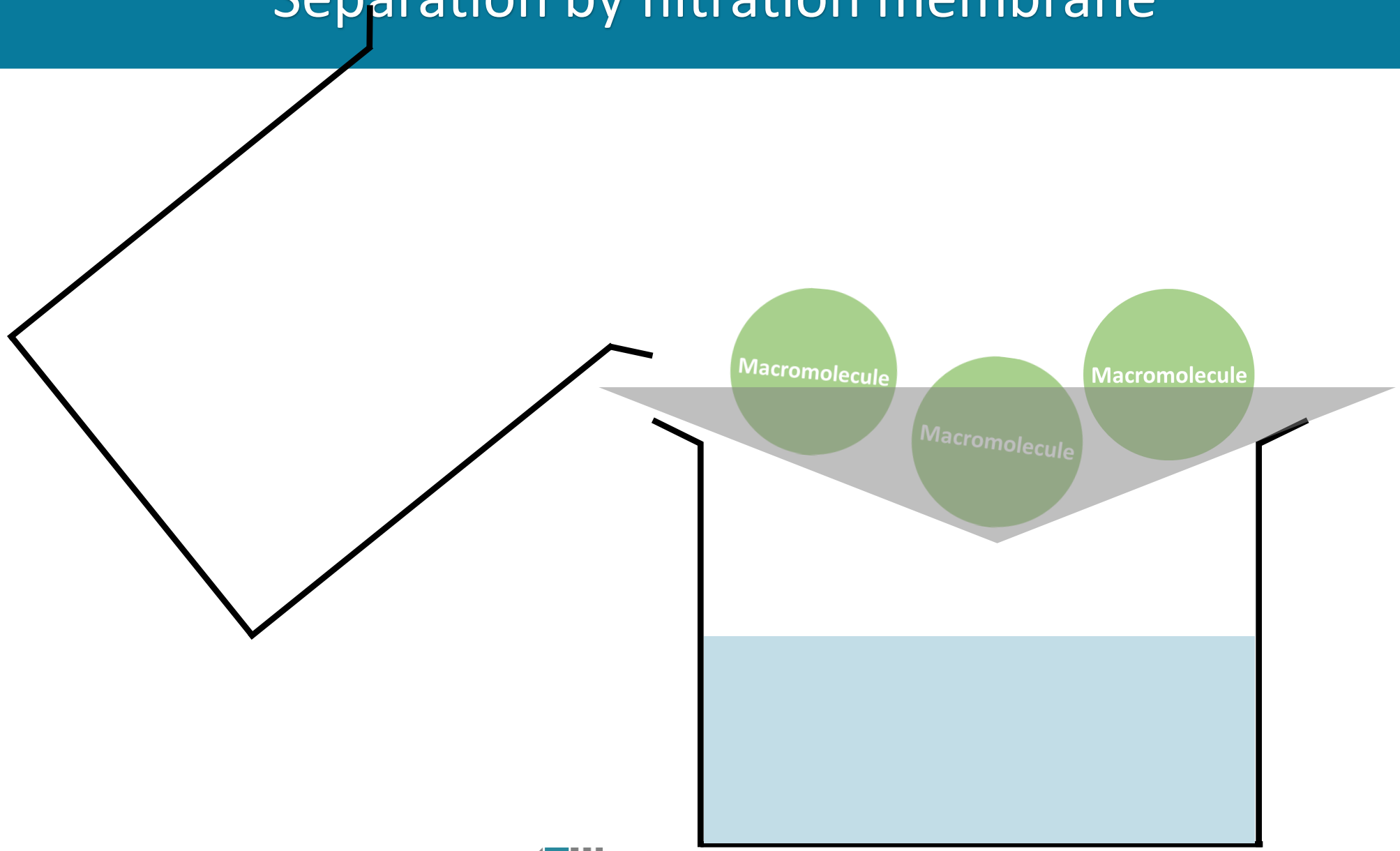

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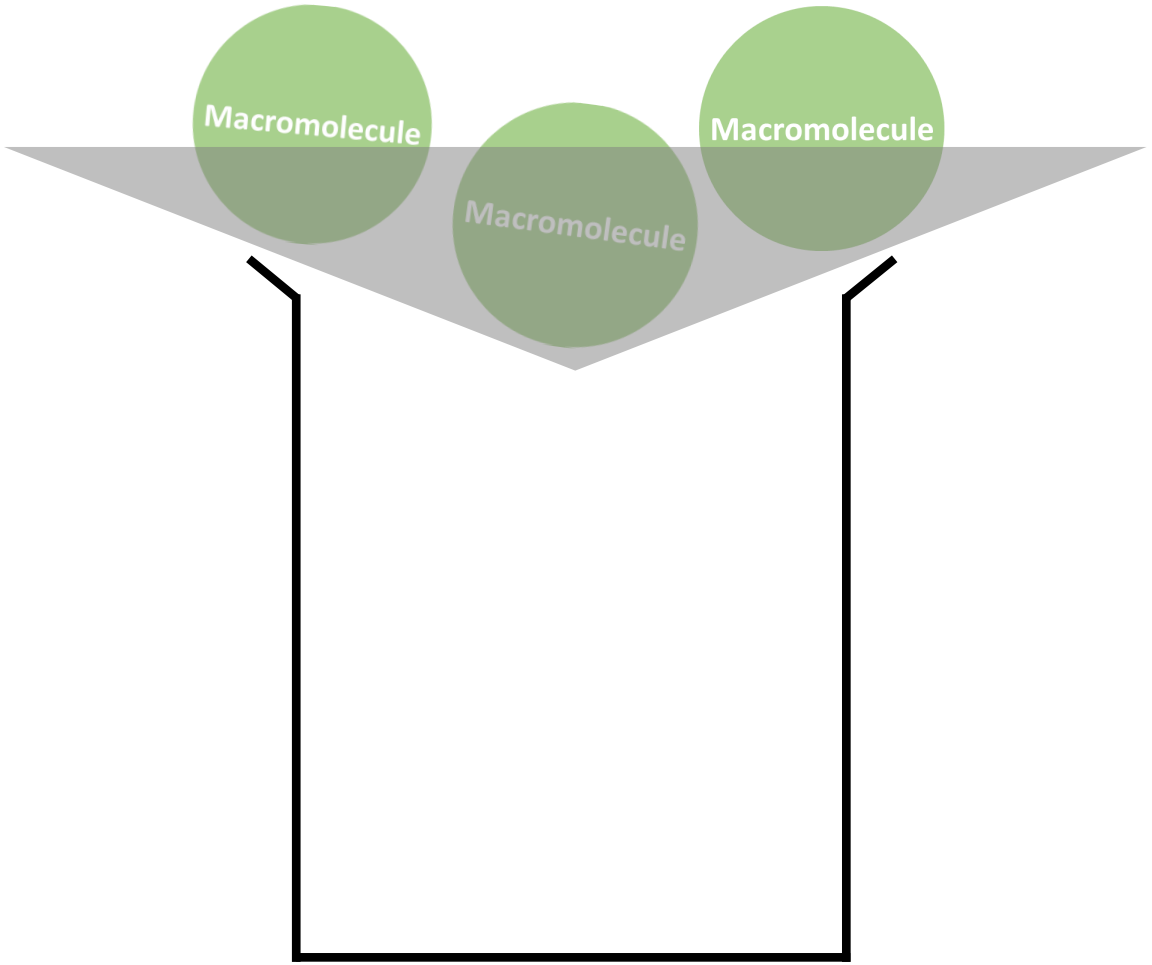
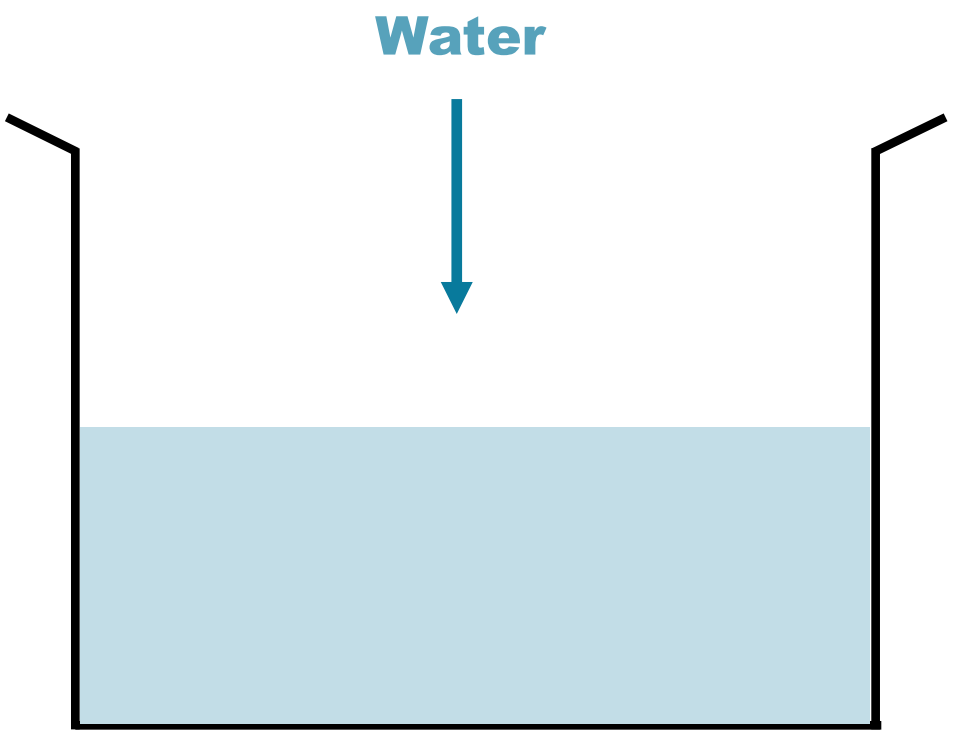




Introduction

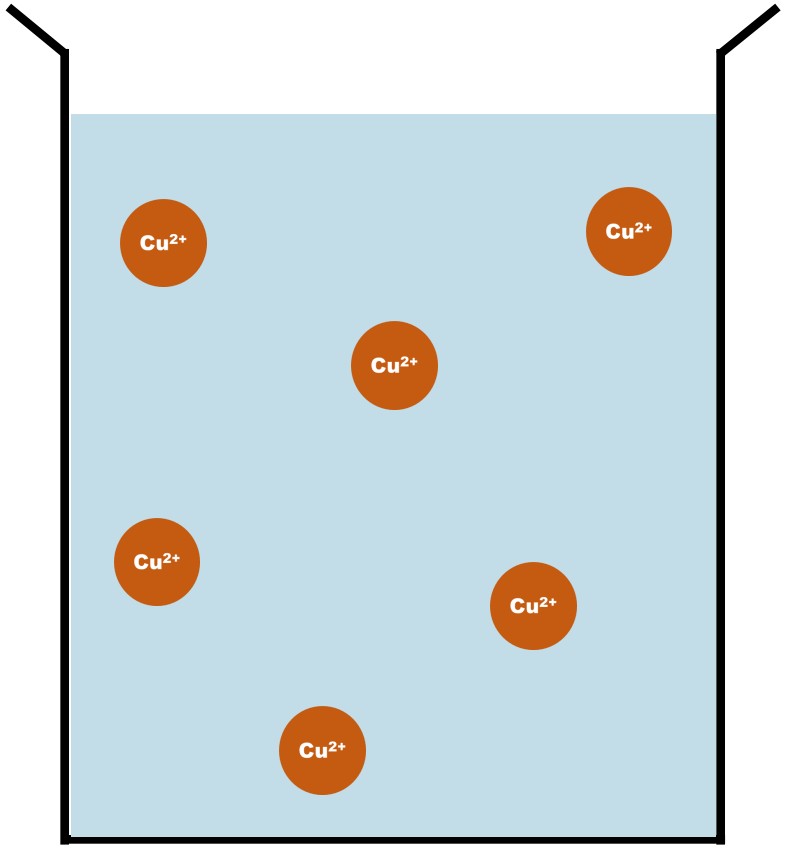
Separation by filtration membrane

Biosorption

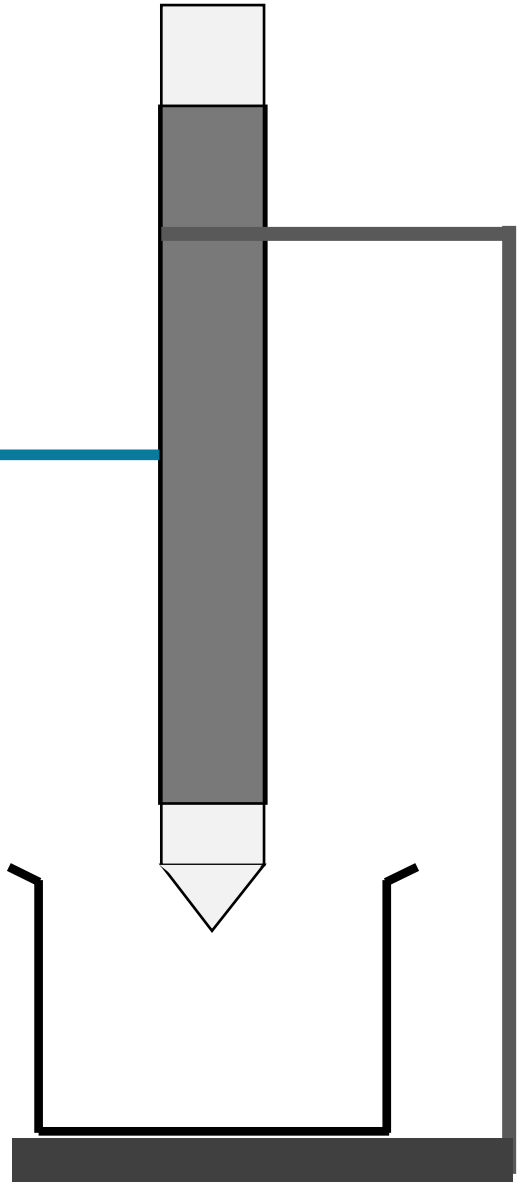
Chemical precipitation

Adsorption

Biosorption



Biomass or biomolecule



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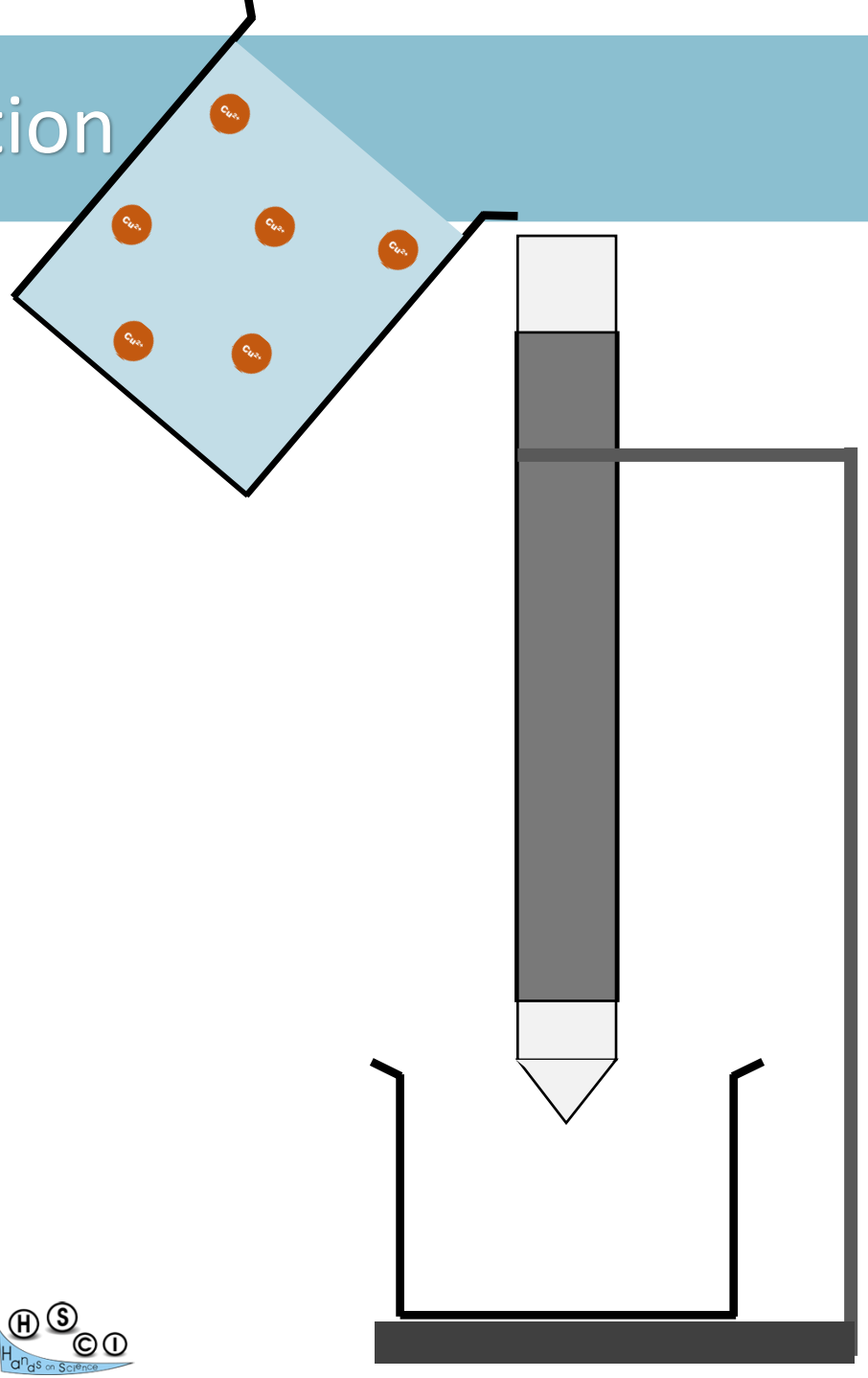

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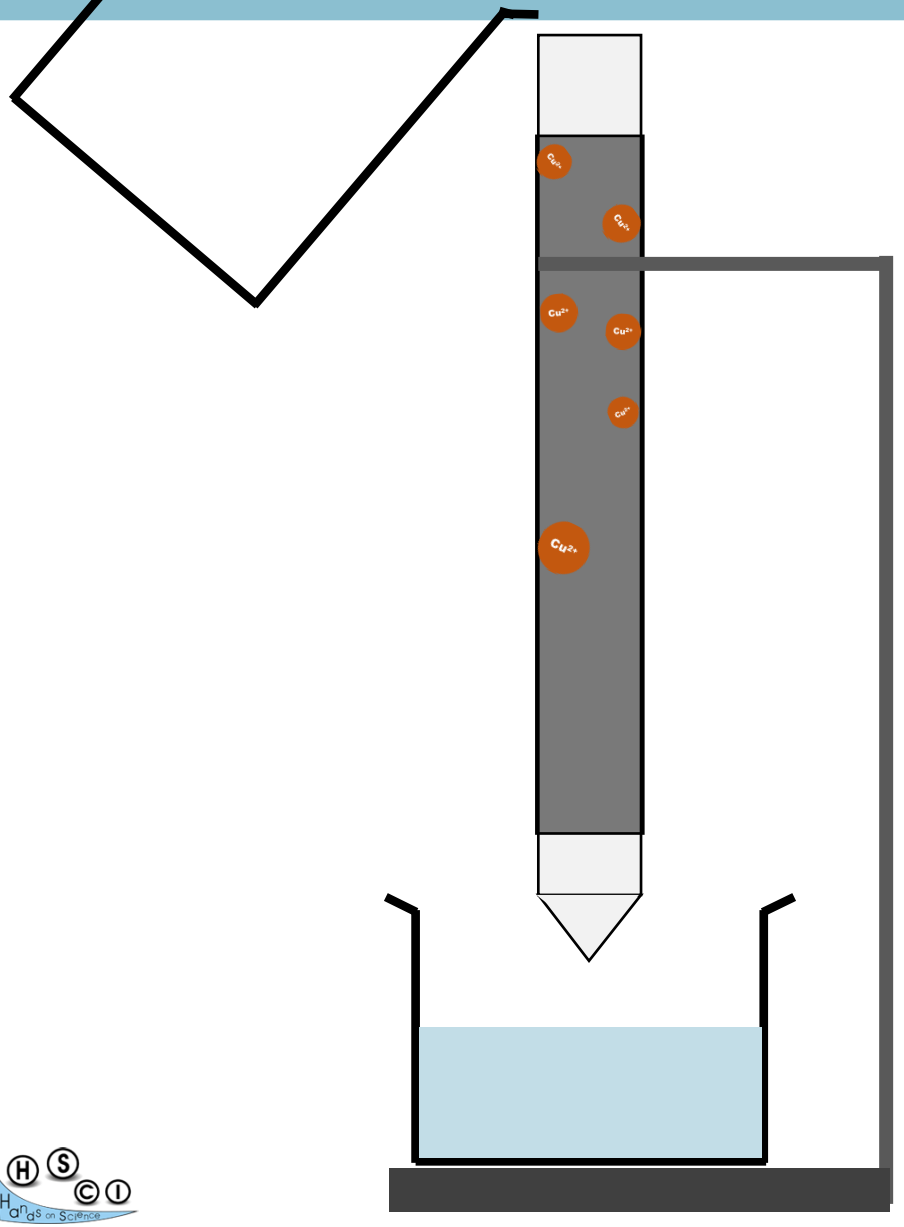

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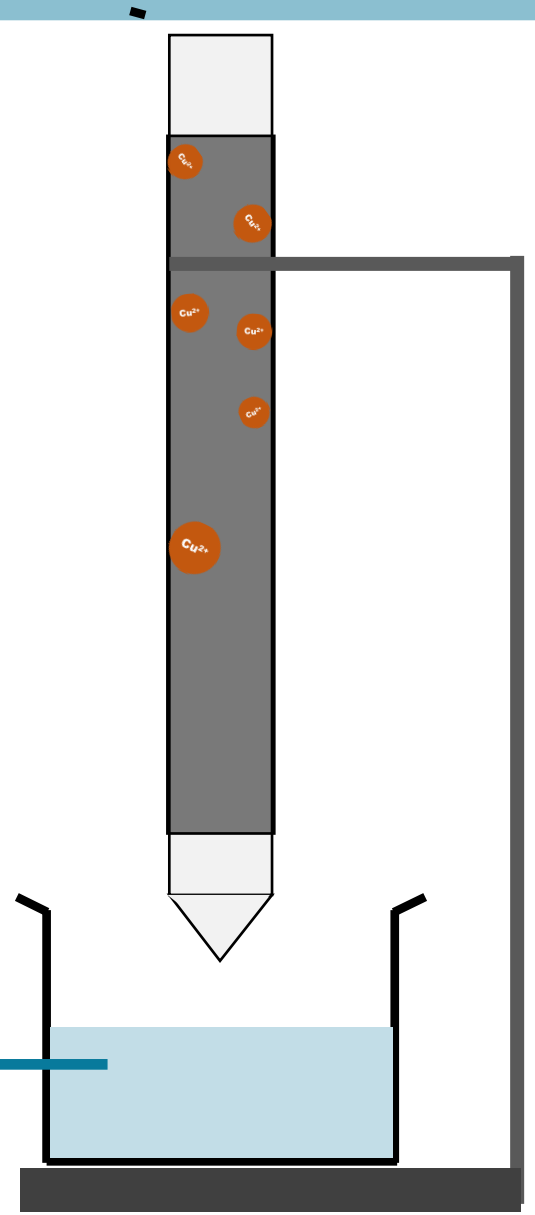

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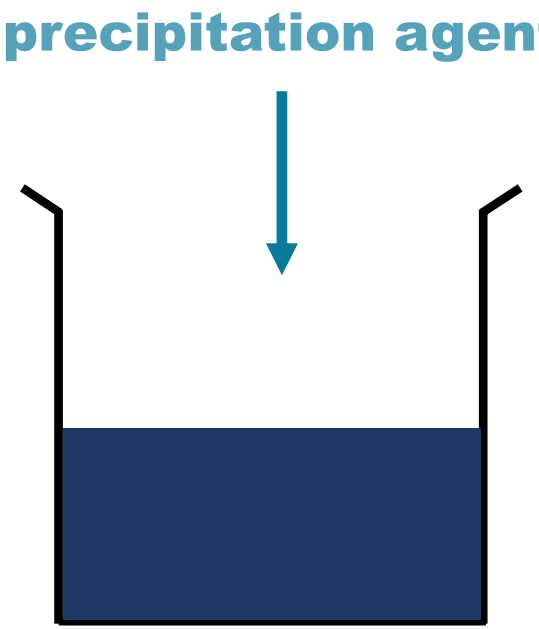
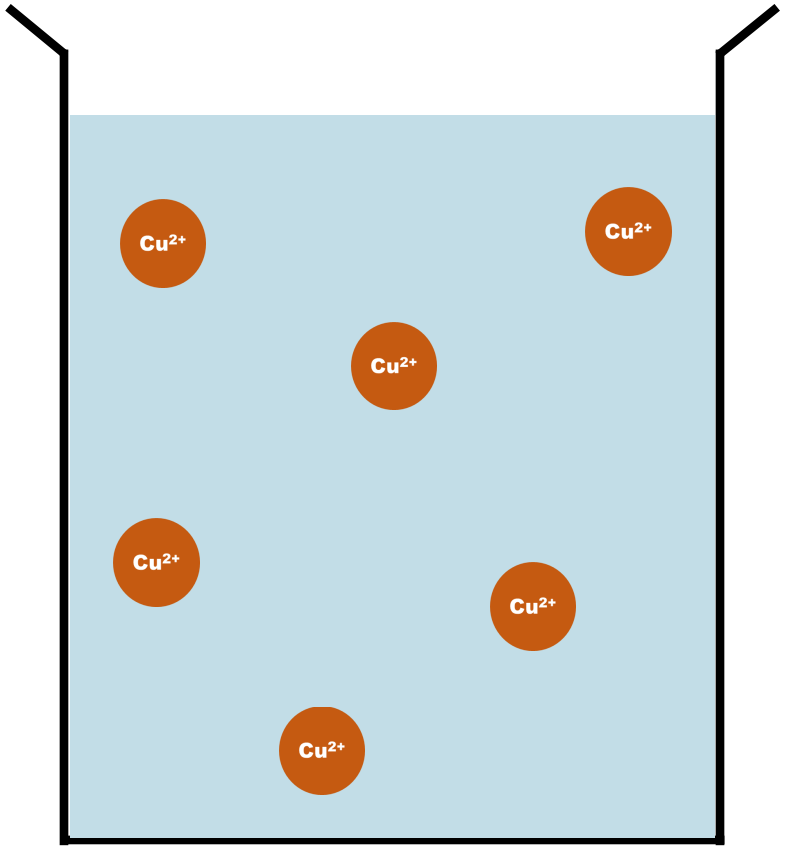
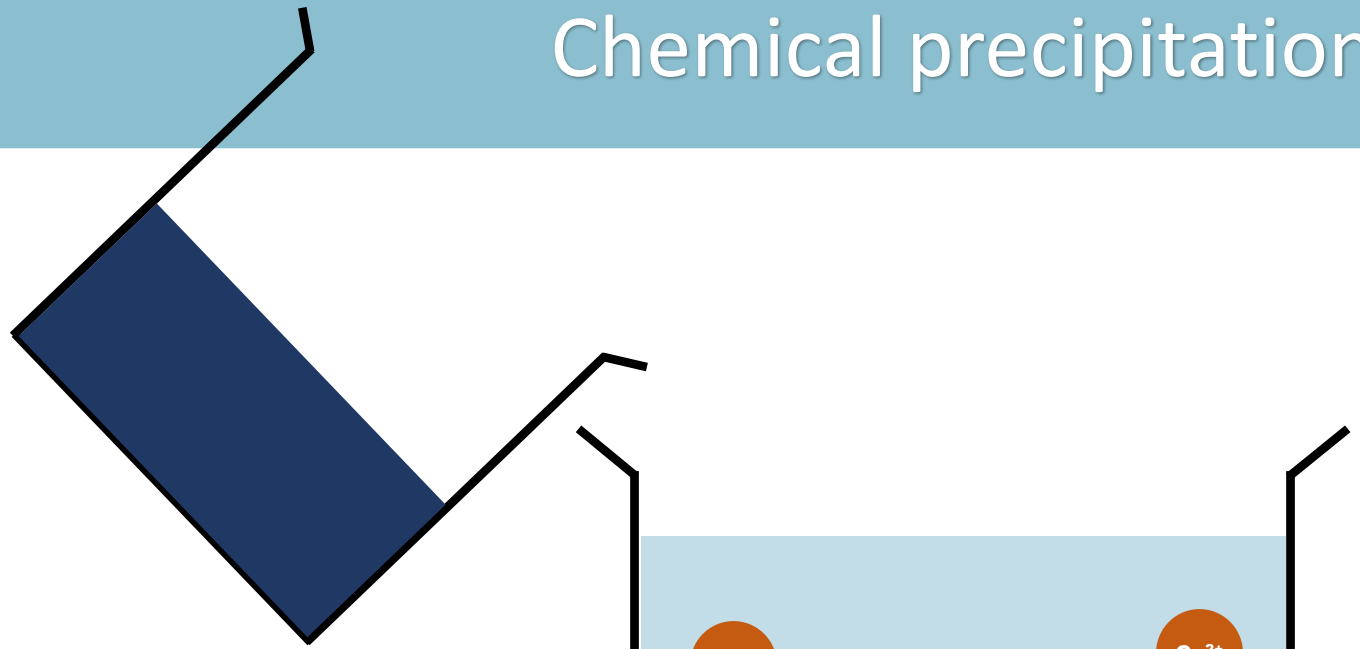
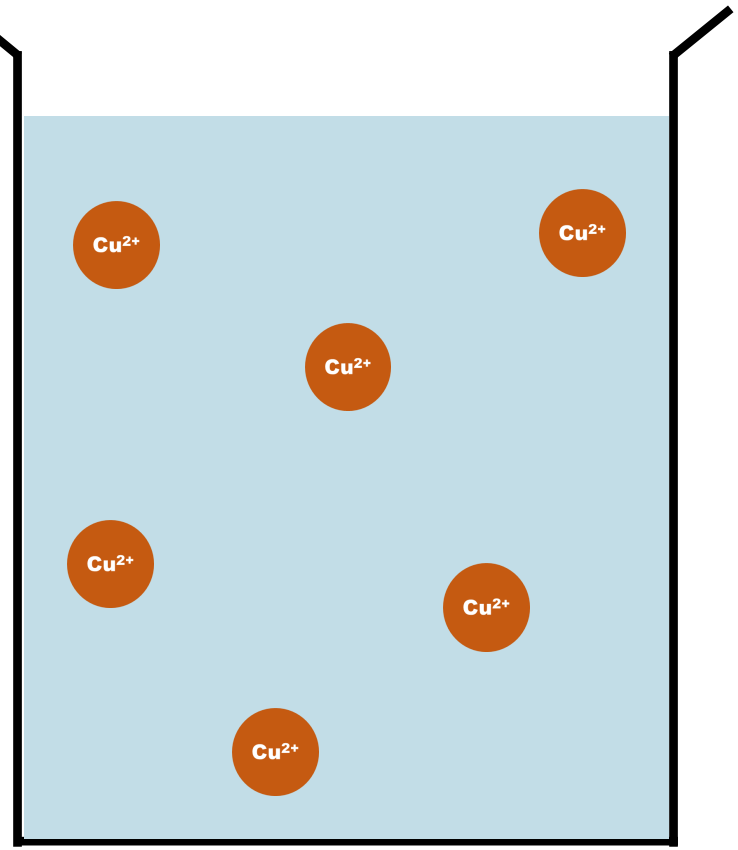


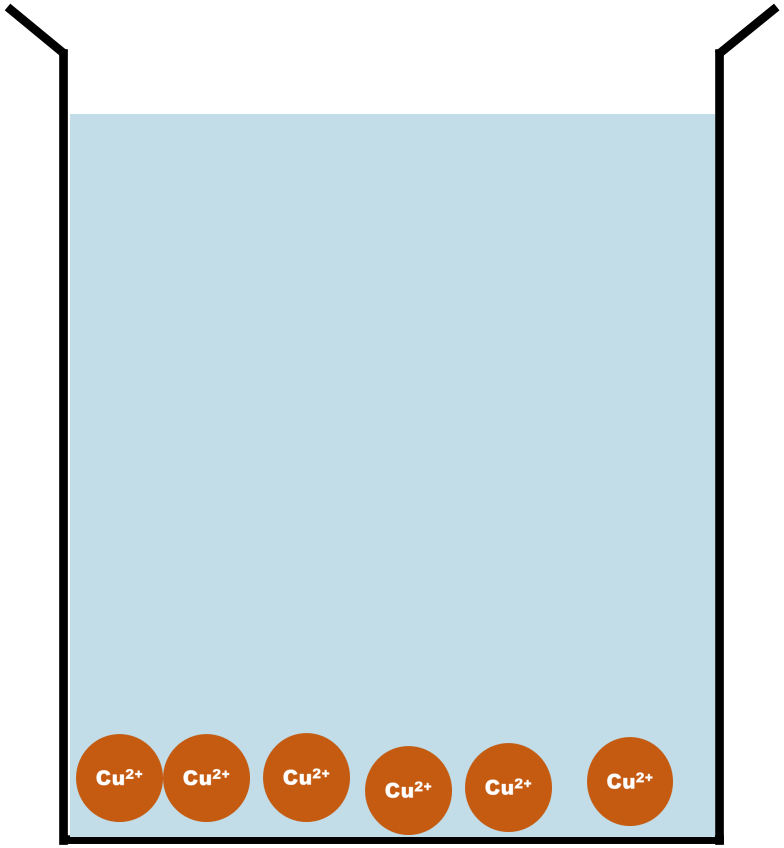


Chemical precipitation

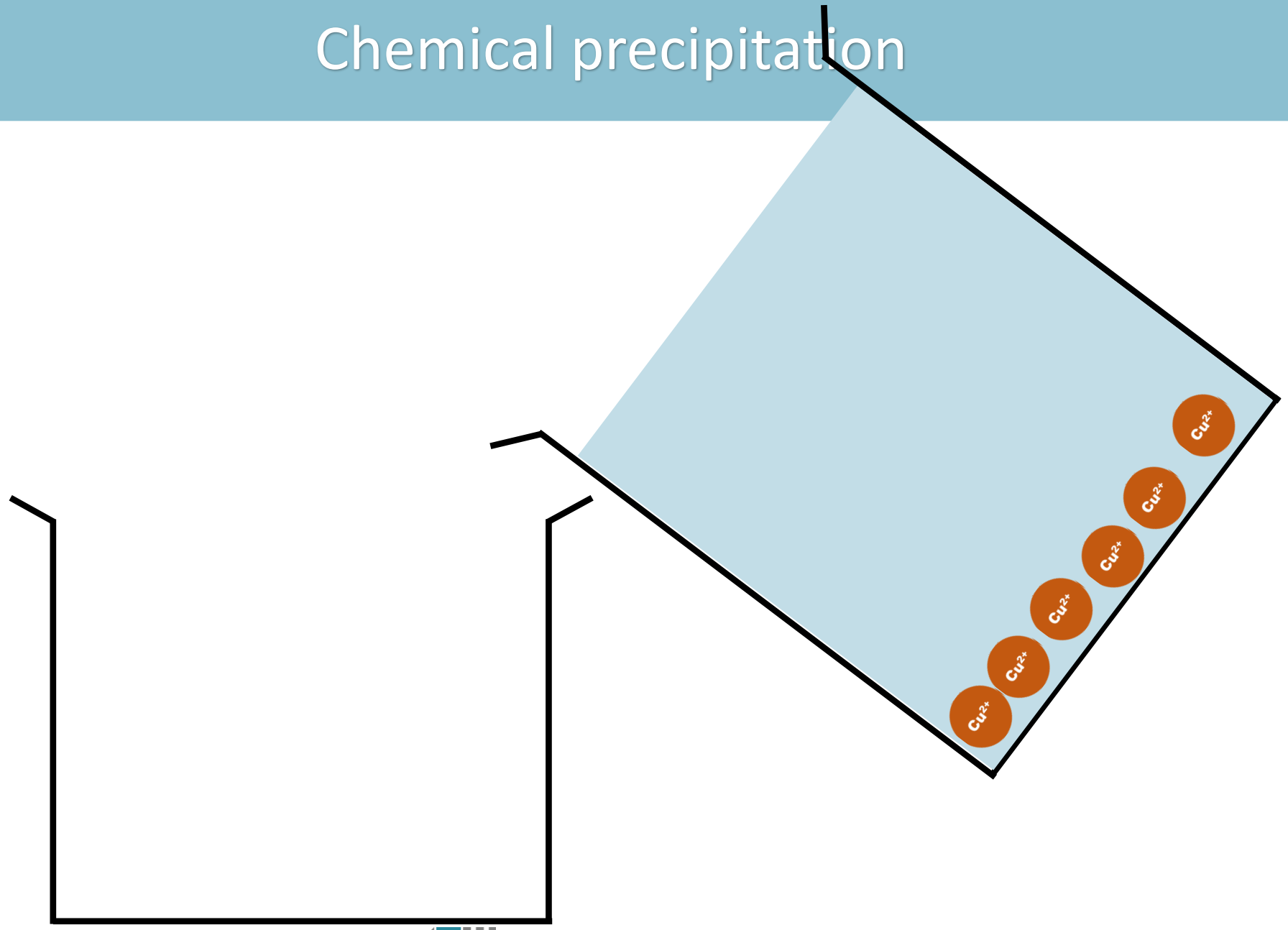




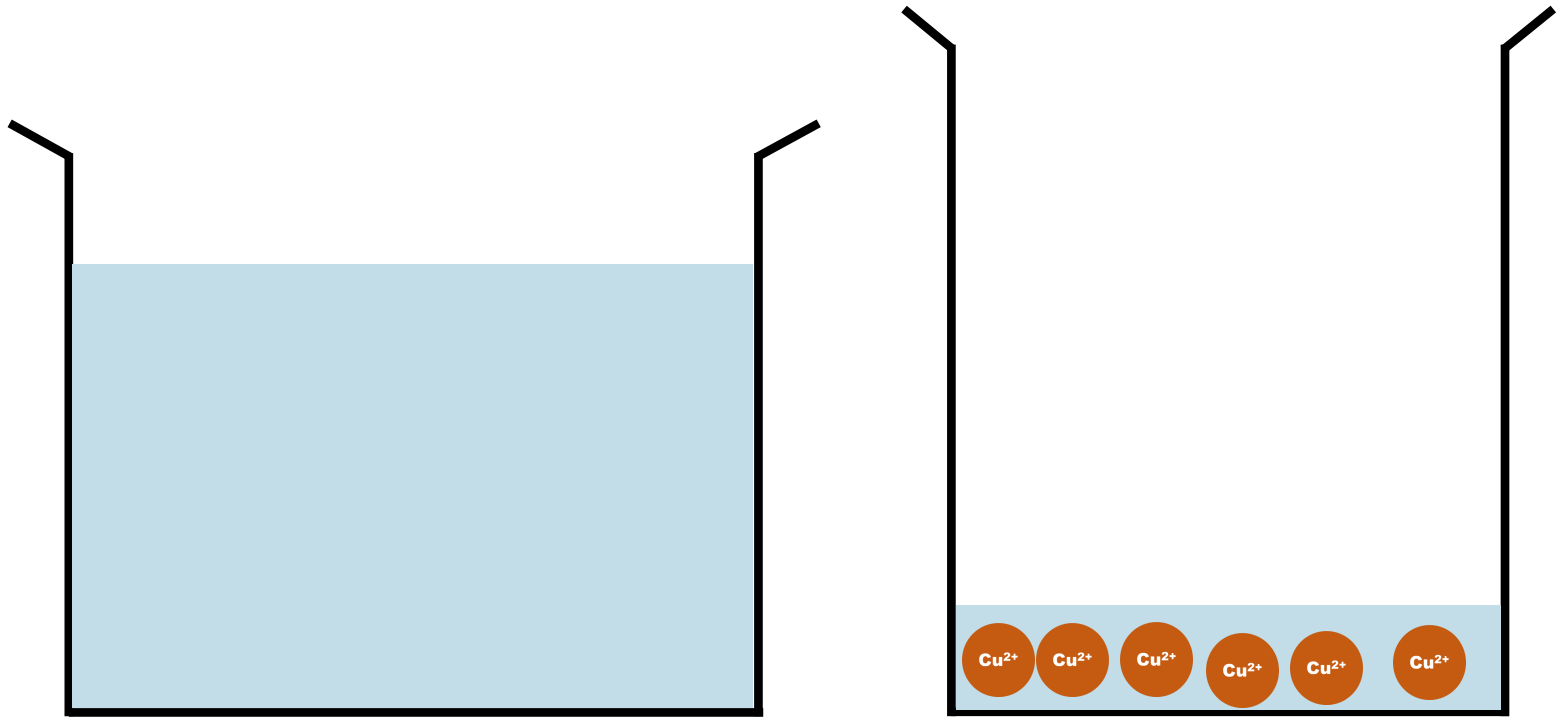
Chemical precipitation



Chemical precipitation



Chemical precipitation



Introduction

Separation by filtration membrane

Biosorption

Chemical precipitation

Adsorption

Adsorption

Absorption

Absorption is a condition in which something takes in another substance. The absorbed substance infiltrates the absorbing substance

A sponge absorbs water, increasing in size when it is full, and the water comes out easily when the sponge is squeezed

vs

Adsorption

Adsorption is a process in which a material (adsorbate) travels from a gas or liquid phase and forms a superficial monomolecular layer on a solid or liquid condensed phase (substrate). This can occur because of physical forces or by chemical bonds.

Doesn't happen in adsorption

Adsorption

Video 1: Demonstration of the adsorption process

Adsorbent - Coal

Adsorbed - Water solution with dye

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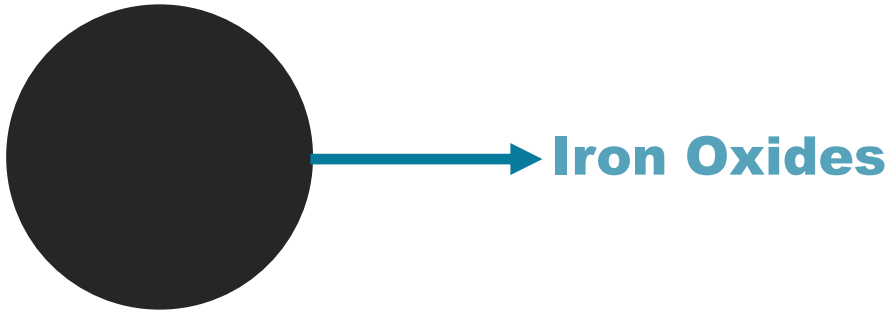
In what consists our project?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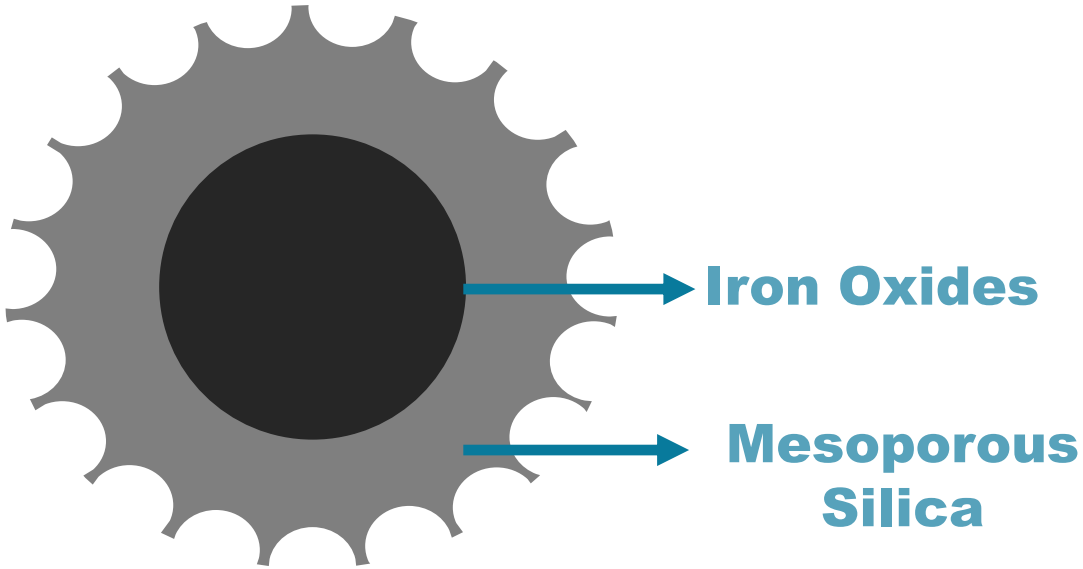
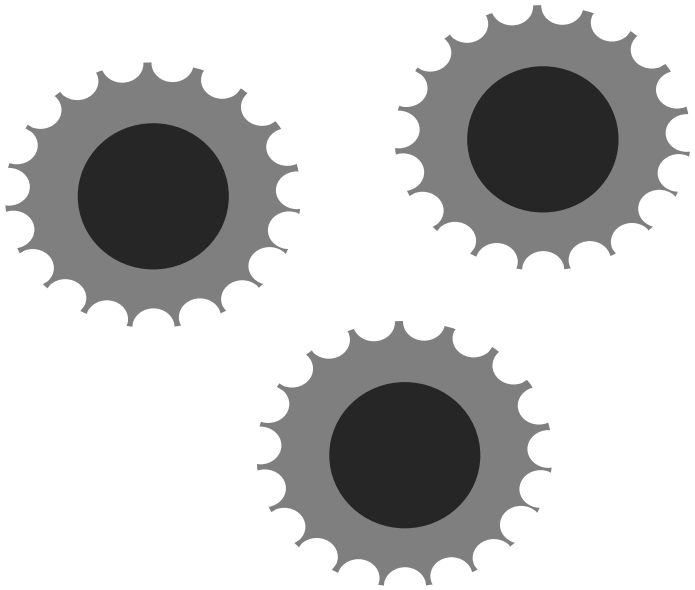
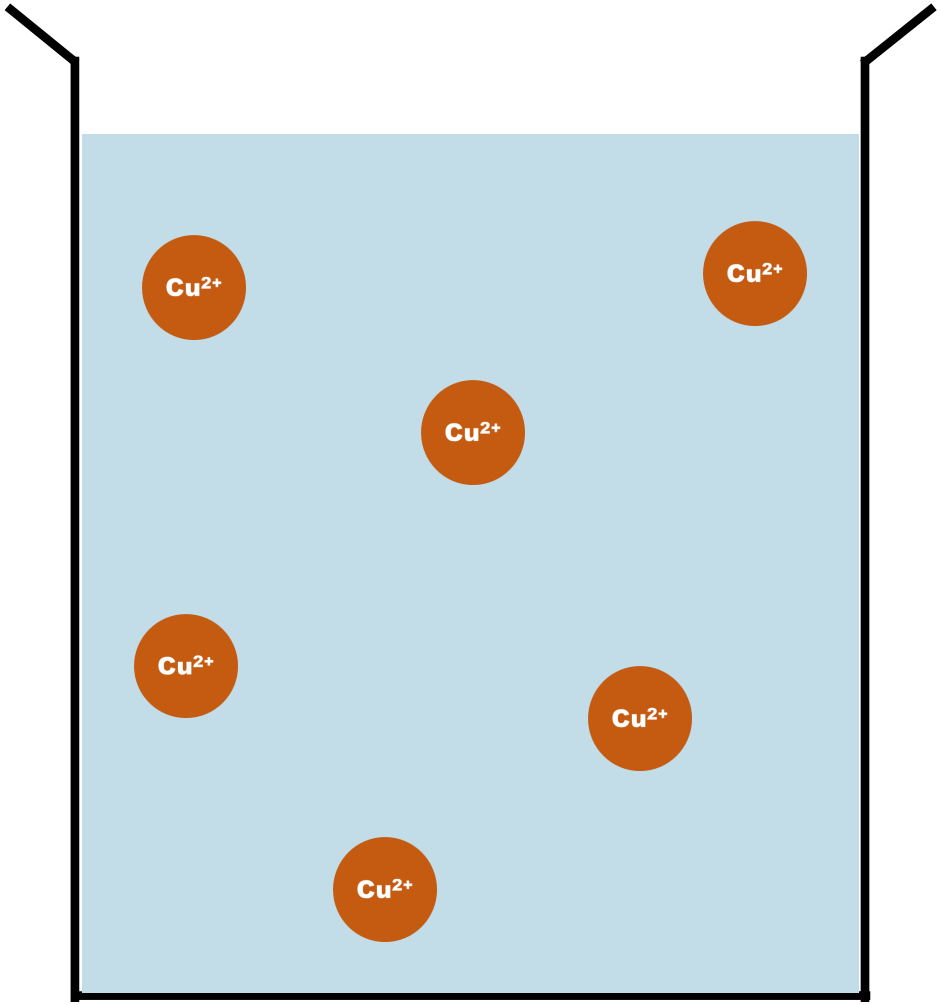

Iron Oxides
Mesoporous
Silica

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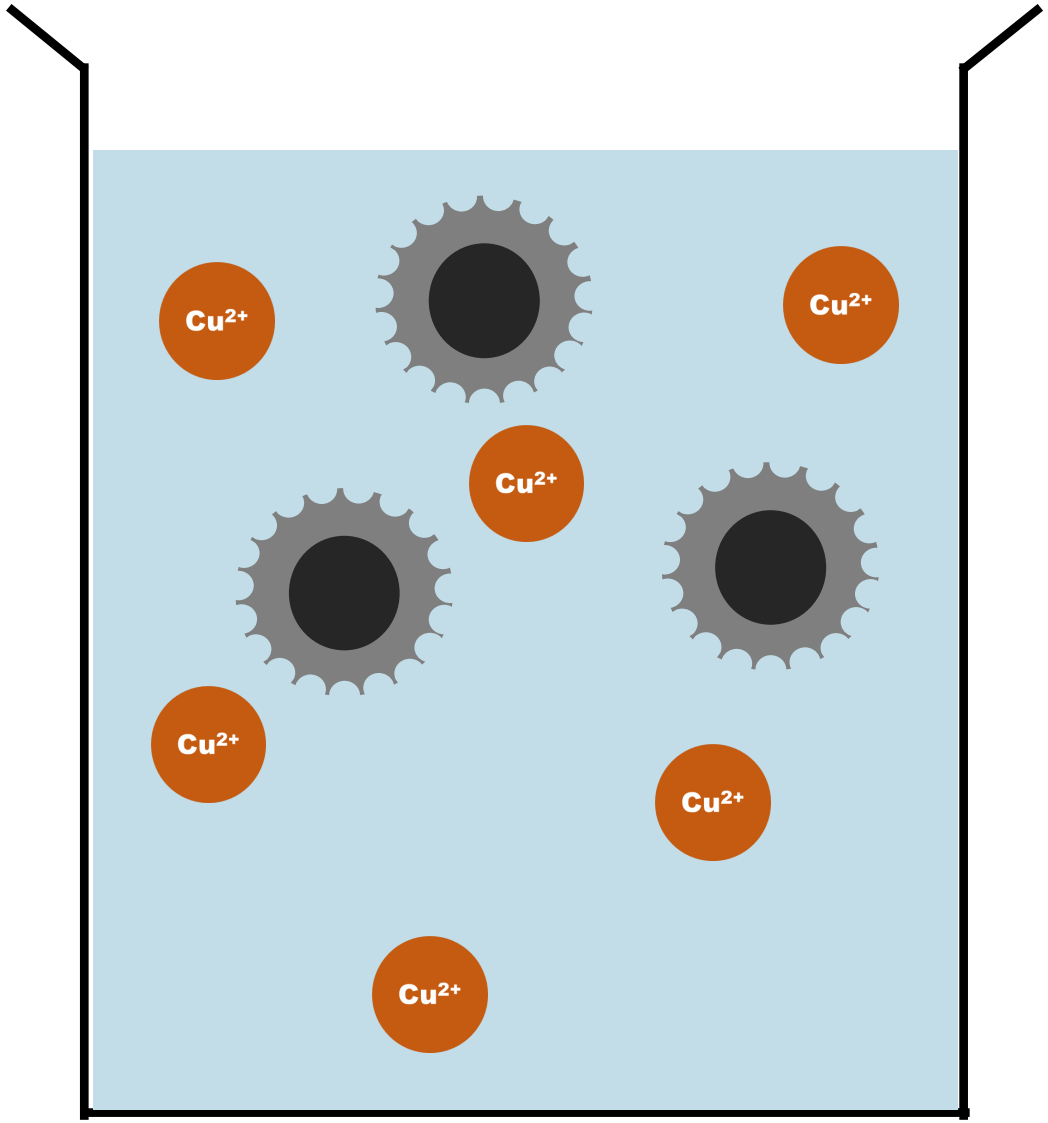
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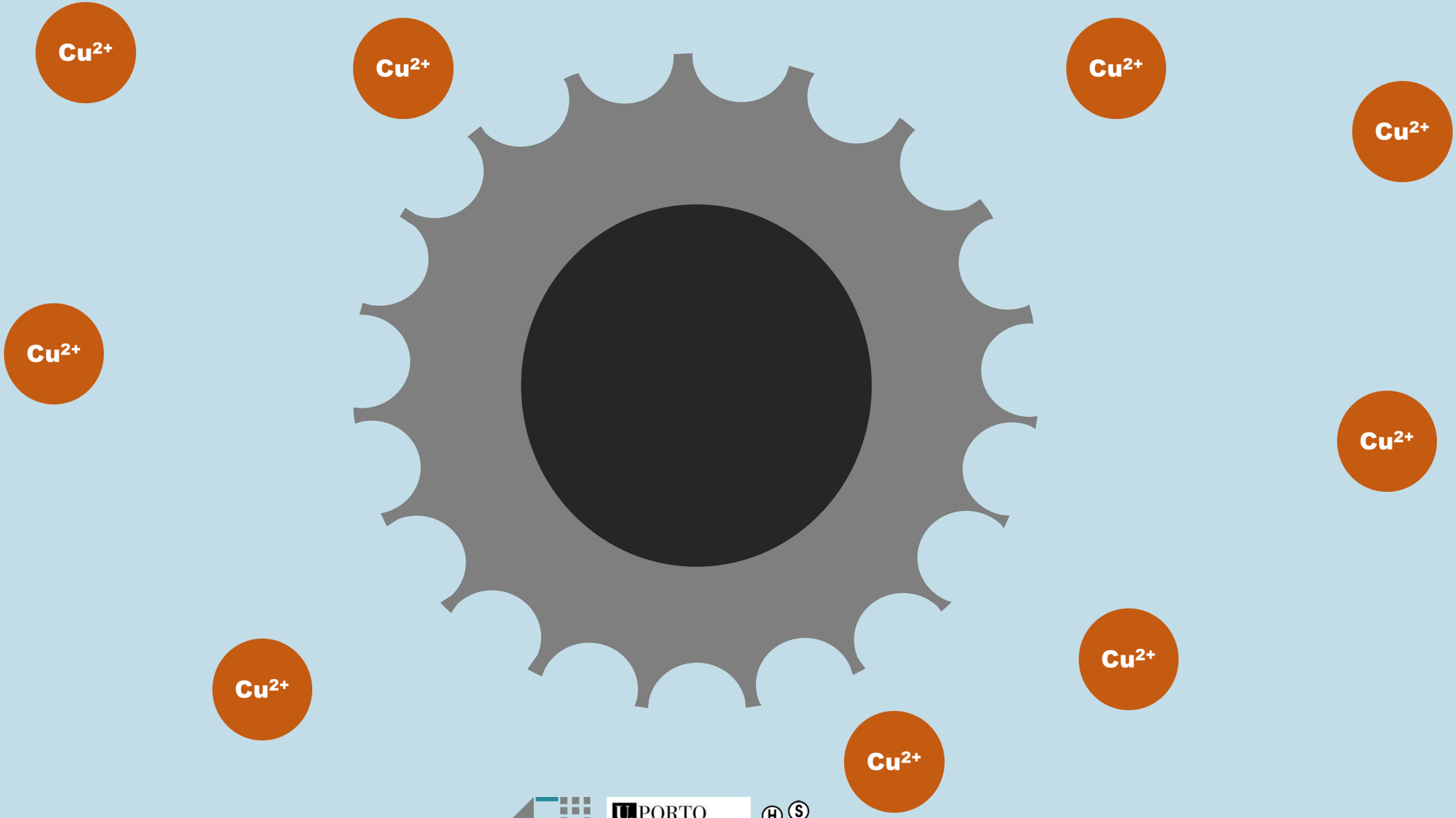
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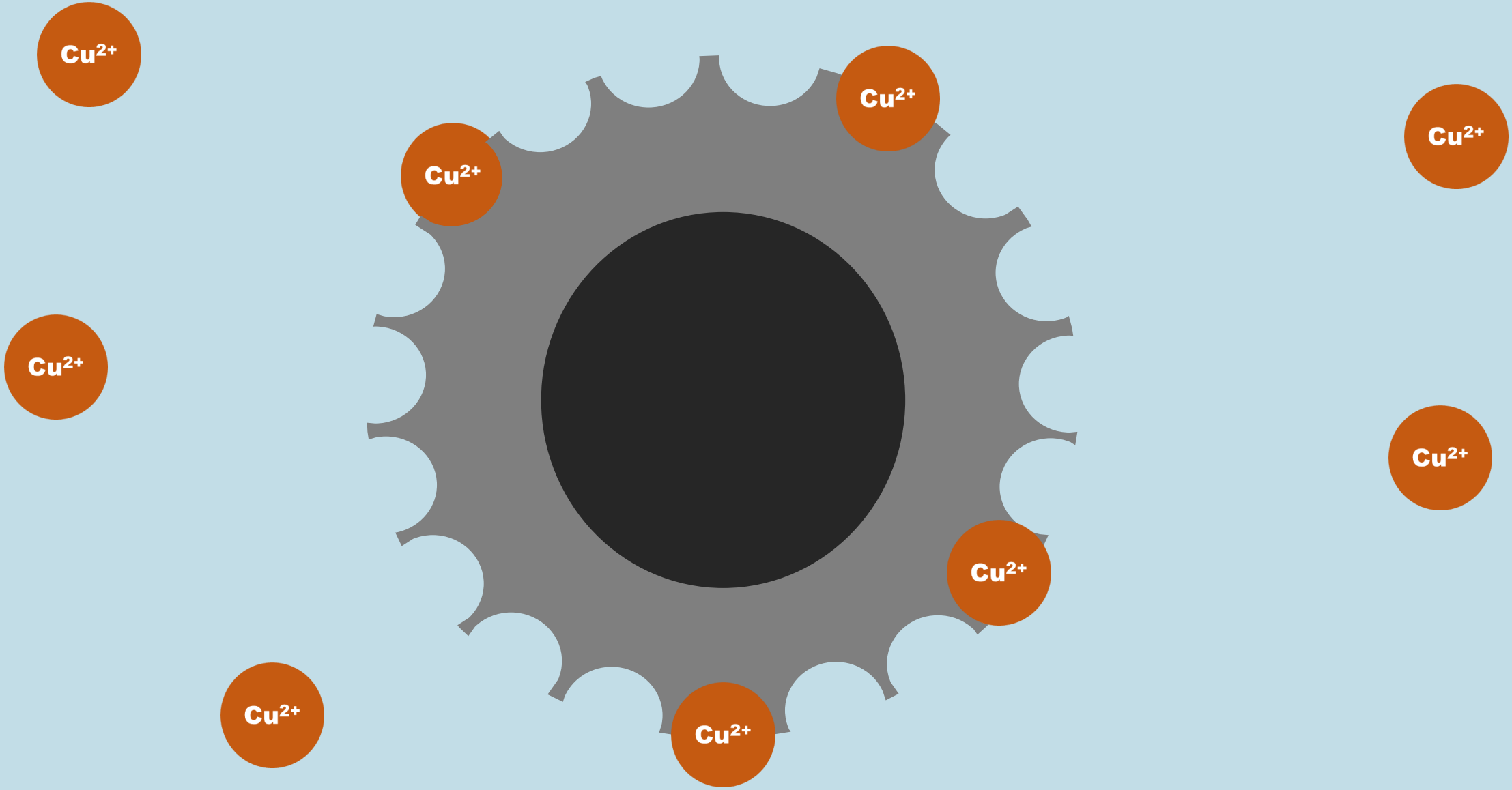
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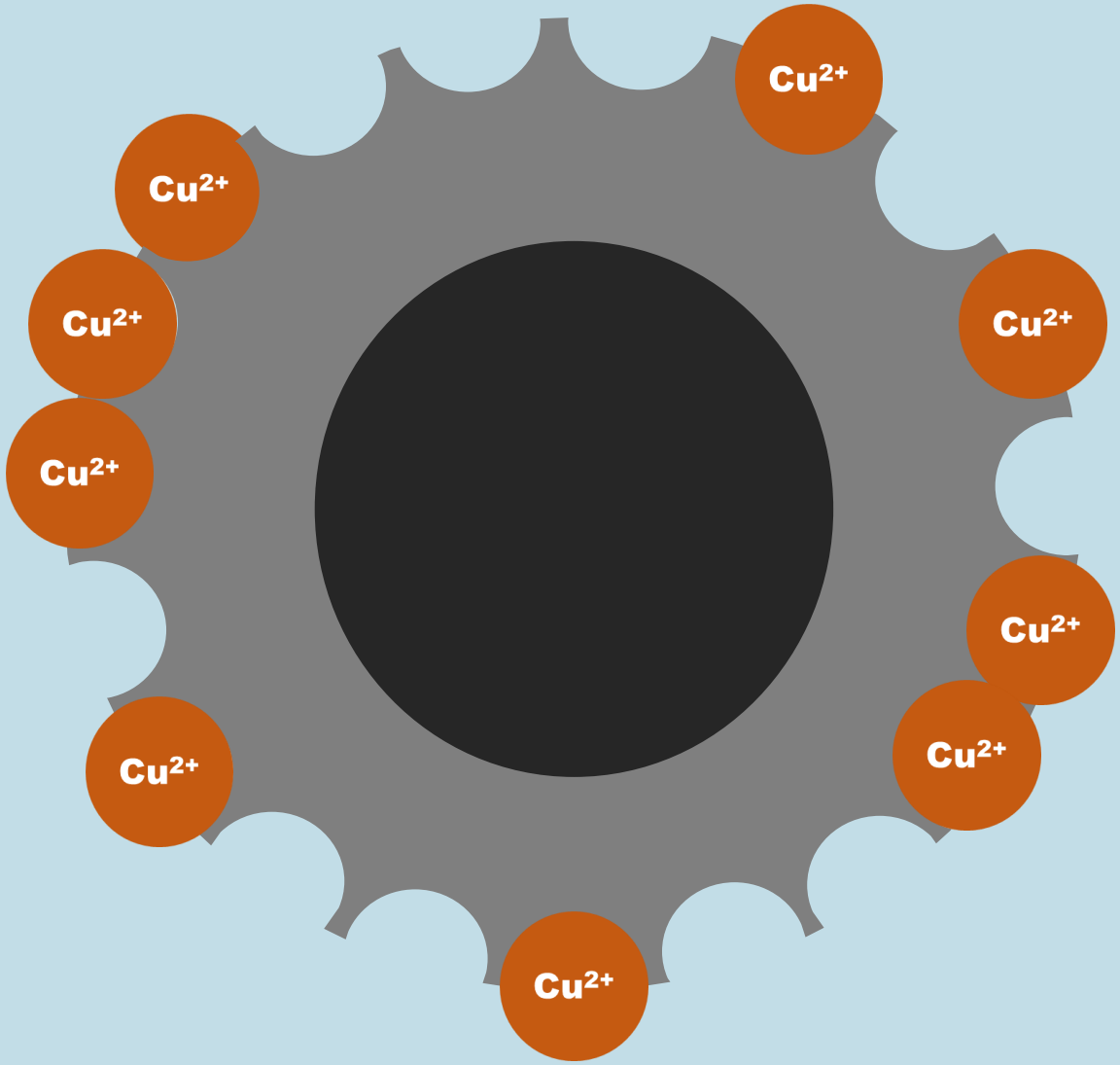
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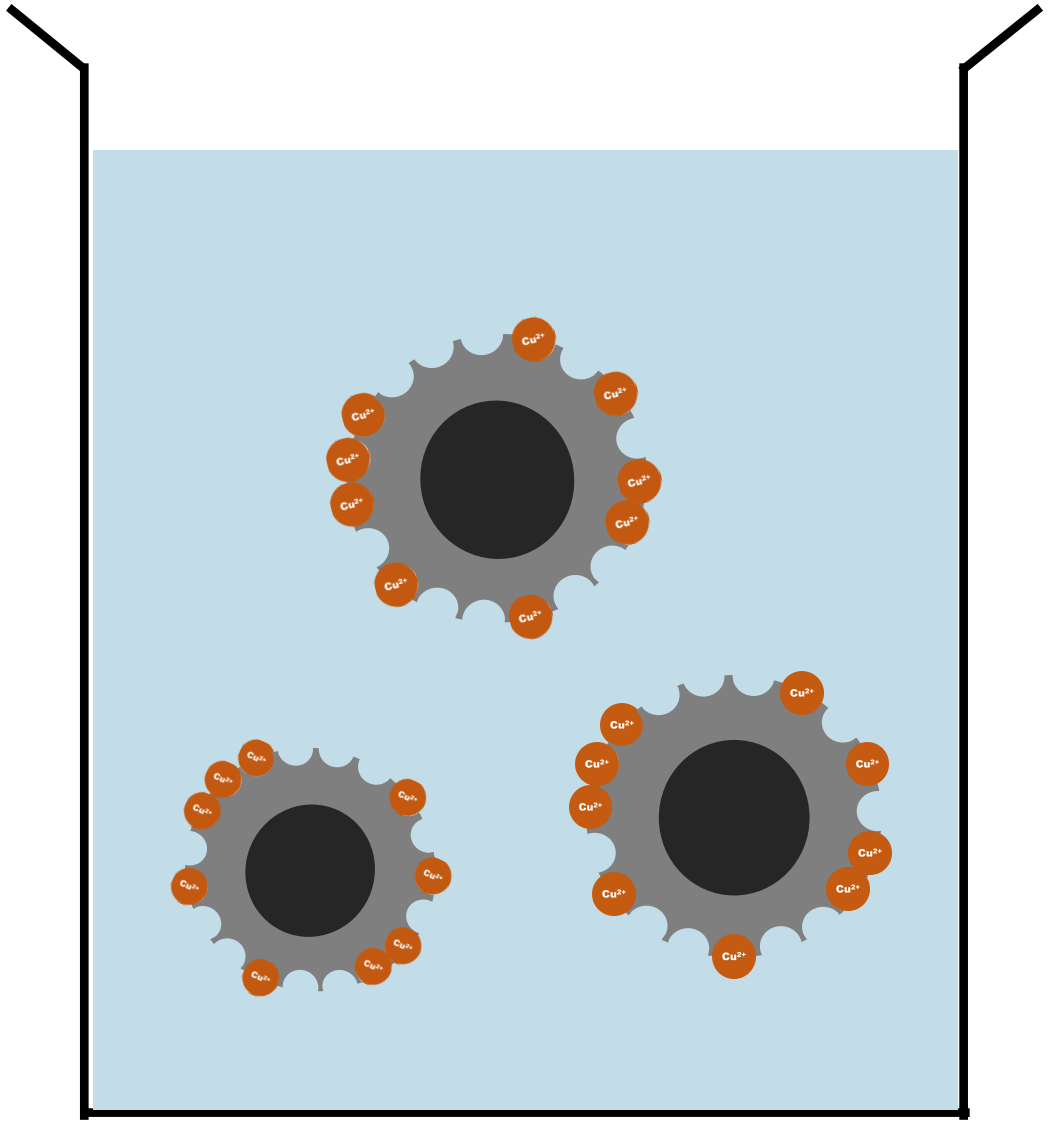
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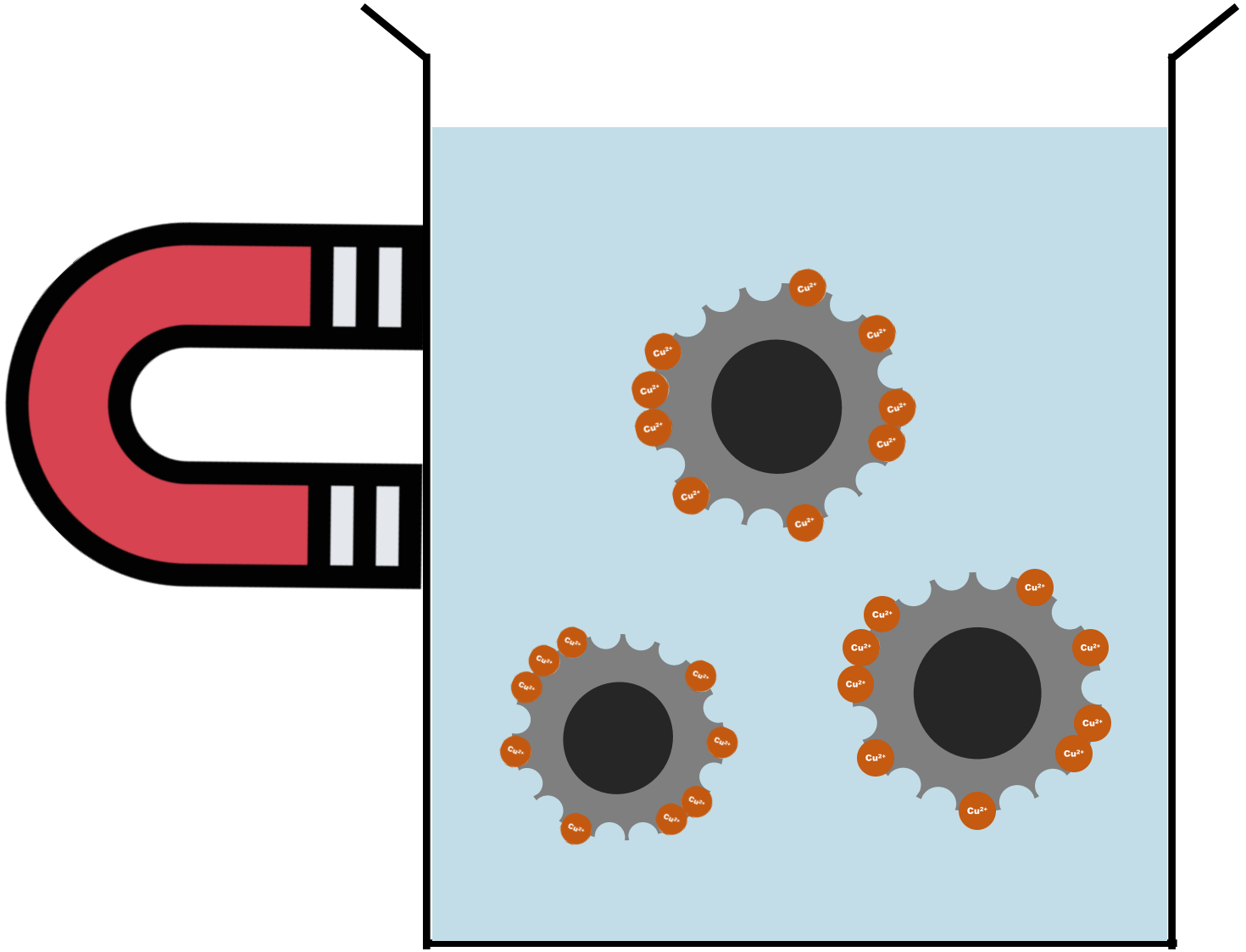
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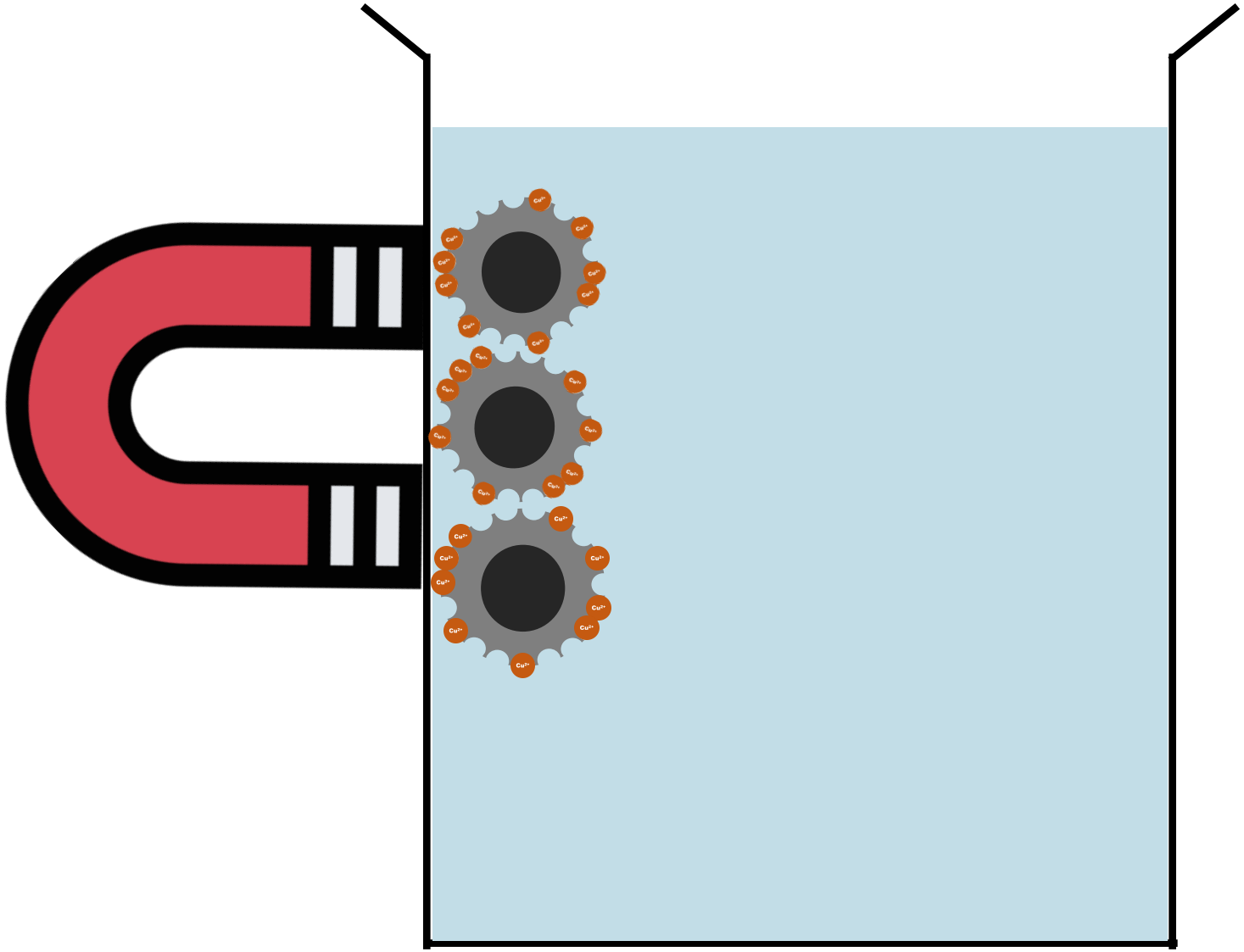
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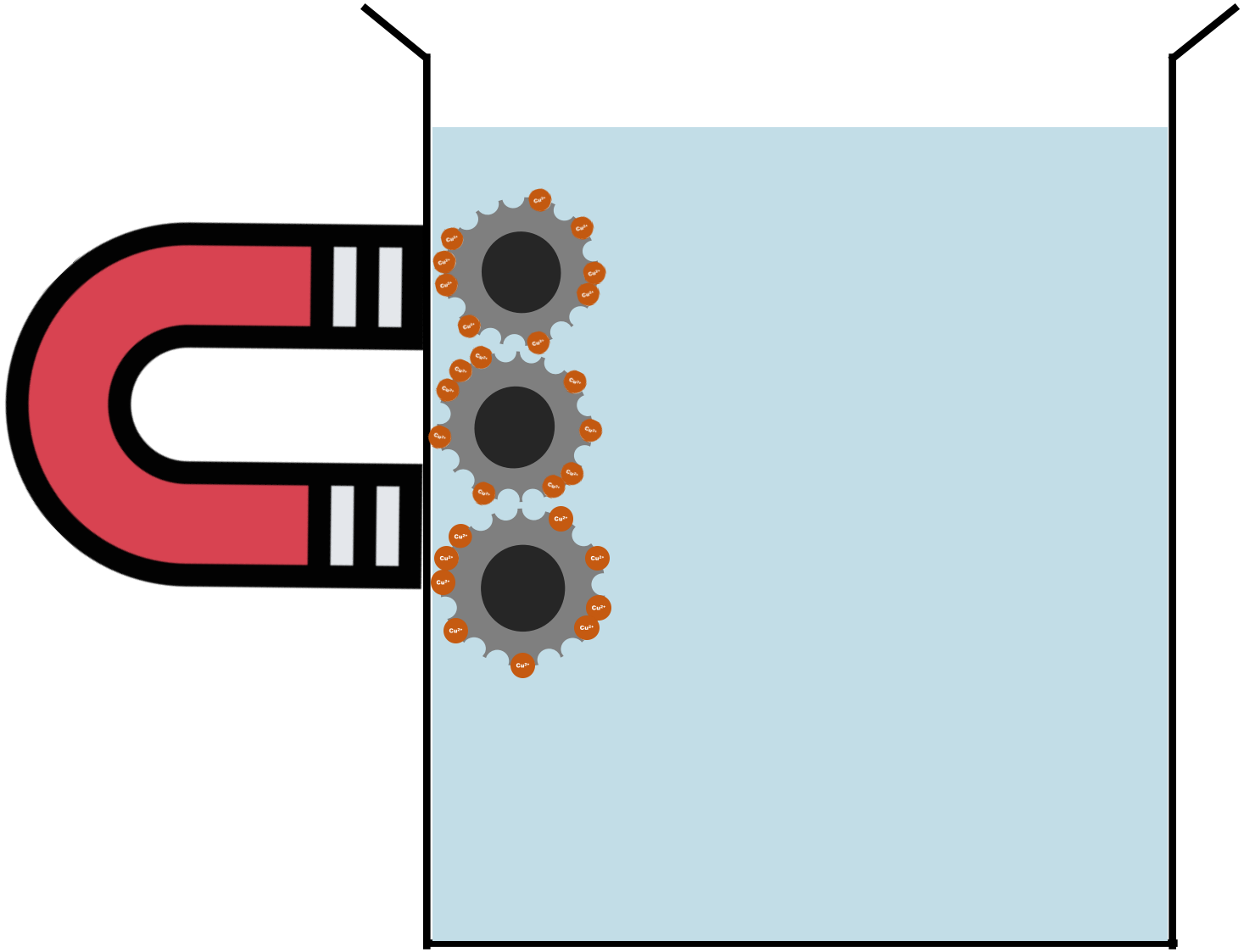
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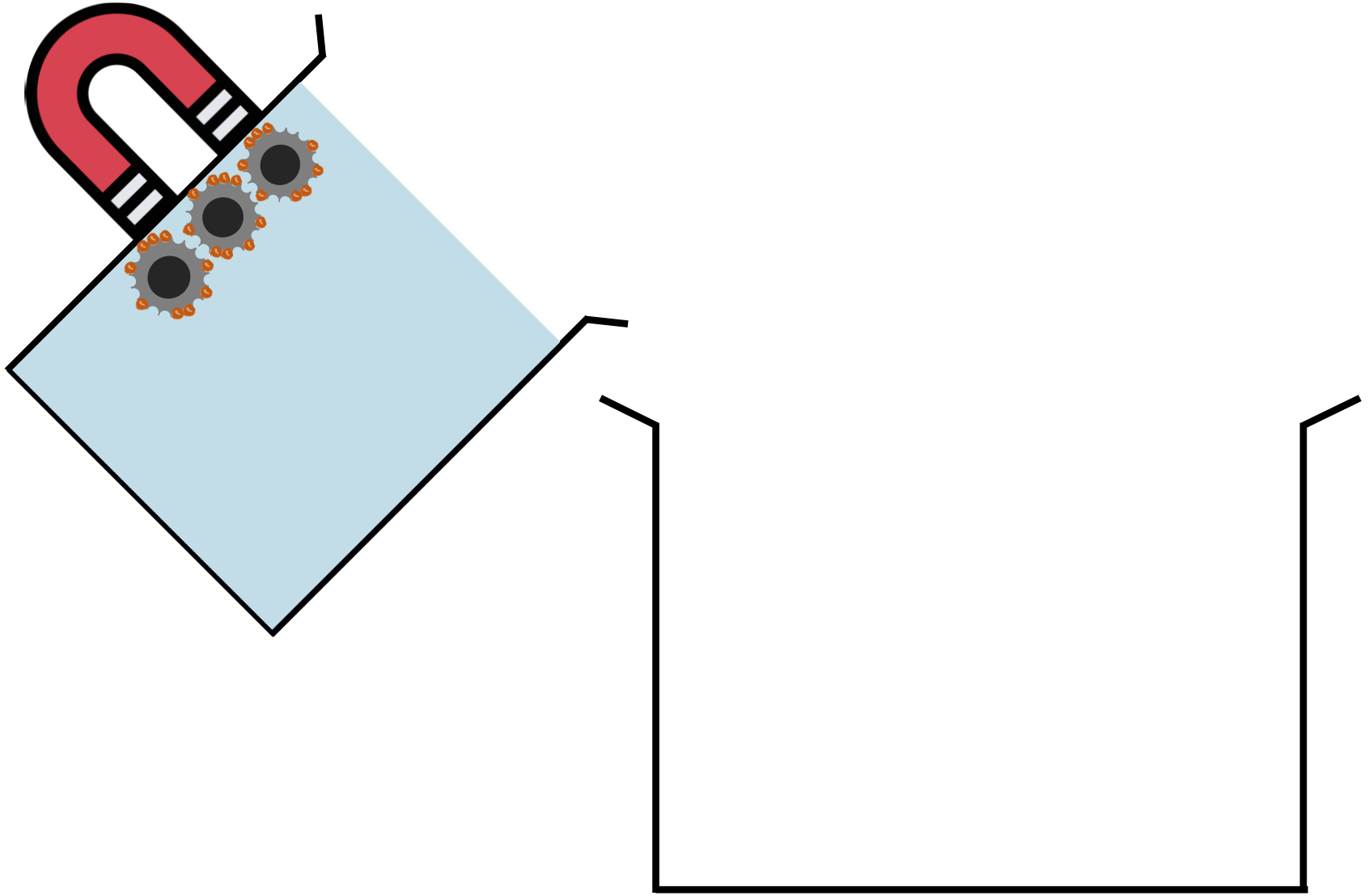

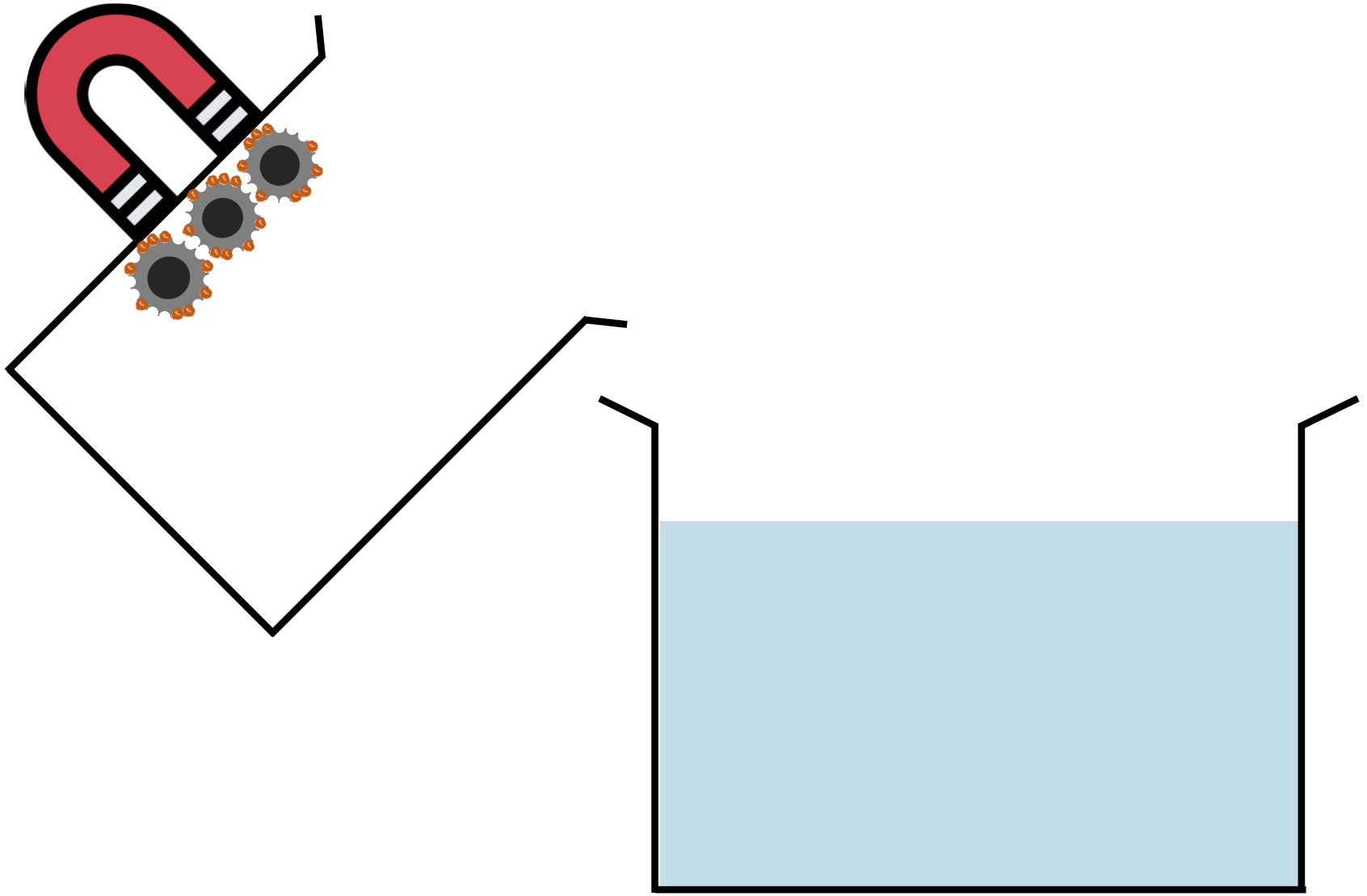

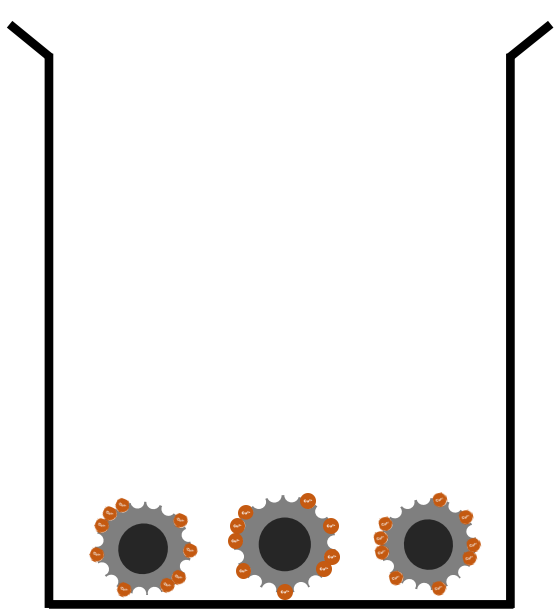

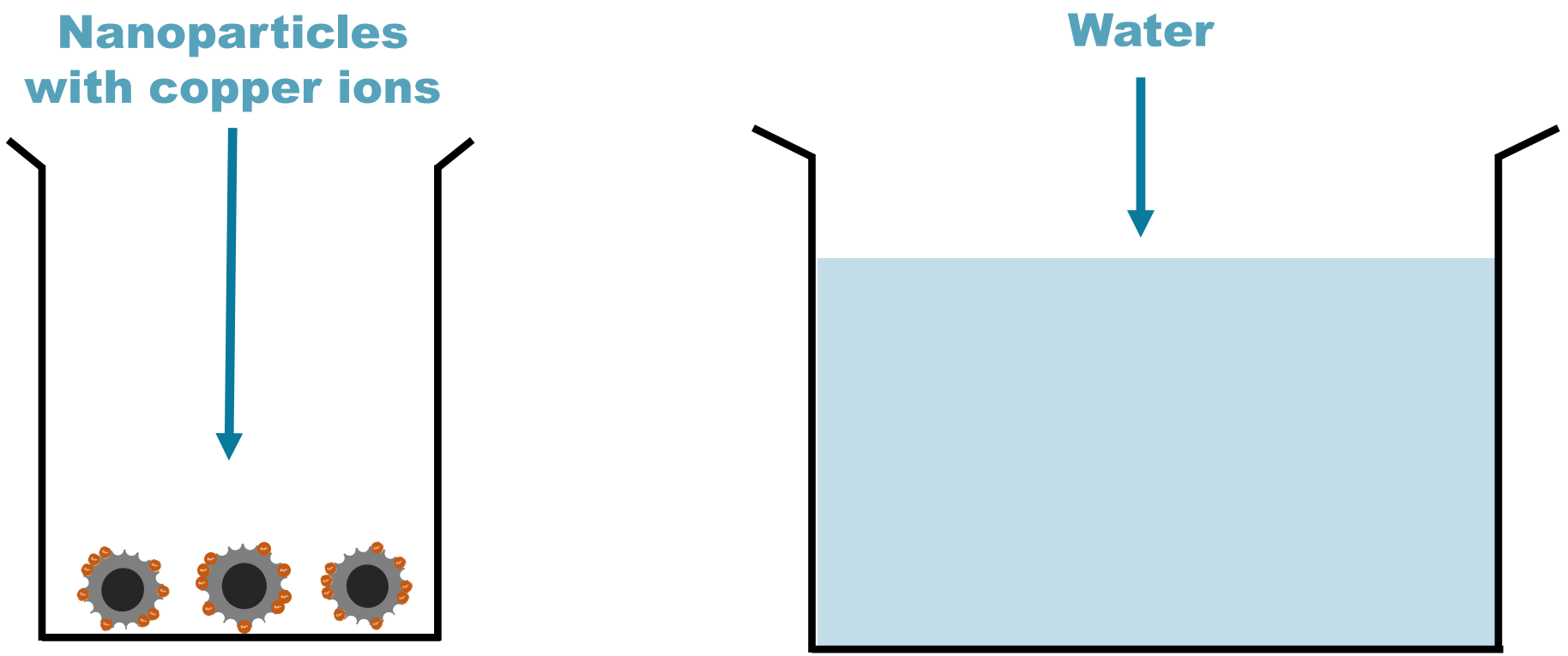
Nanoparticles
with copper ions
Water

What are the objectives of our project?

Reduce the number of cases of heavy metal ion poisoning

Removal of heavy metal ions from contaminated water

Use of an inexpensive and effective process

Reduce chemical pollution

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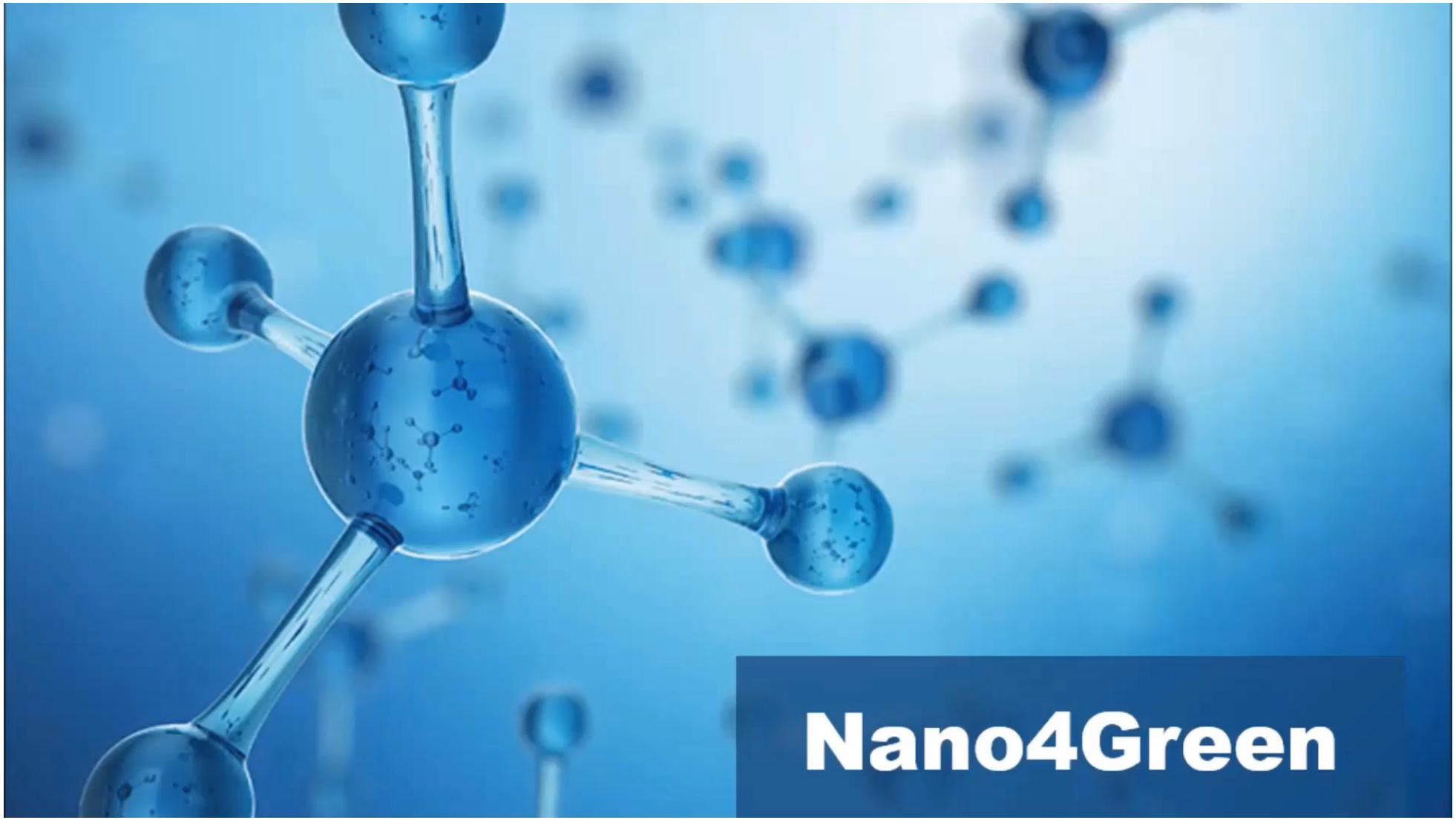
Materials and methods



Video 2: Materials and methods used

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Results and discussions

Zetasizer

Infrared Spectroscopy

Scanning Electron Microscope (SEM)

Atomic absorption spectroscopy with flame

Zetasizer

Figure 2: Zetasizer results (Fe_3O_4)

Figure 3: Zetasizer results (Fe_3O_4@SiO_2 - 1x)

Figure 4: Zetasizer results (Fe_3O_4 @ SiO_2 - 2x)

Zetasizer

	Particle size (d.nm)	PdI	Zeta potencial (mV)
1x	71.53	0.515	211.2
2x	202.9	0.267	275.9

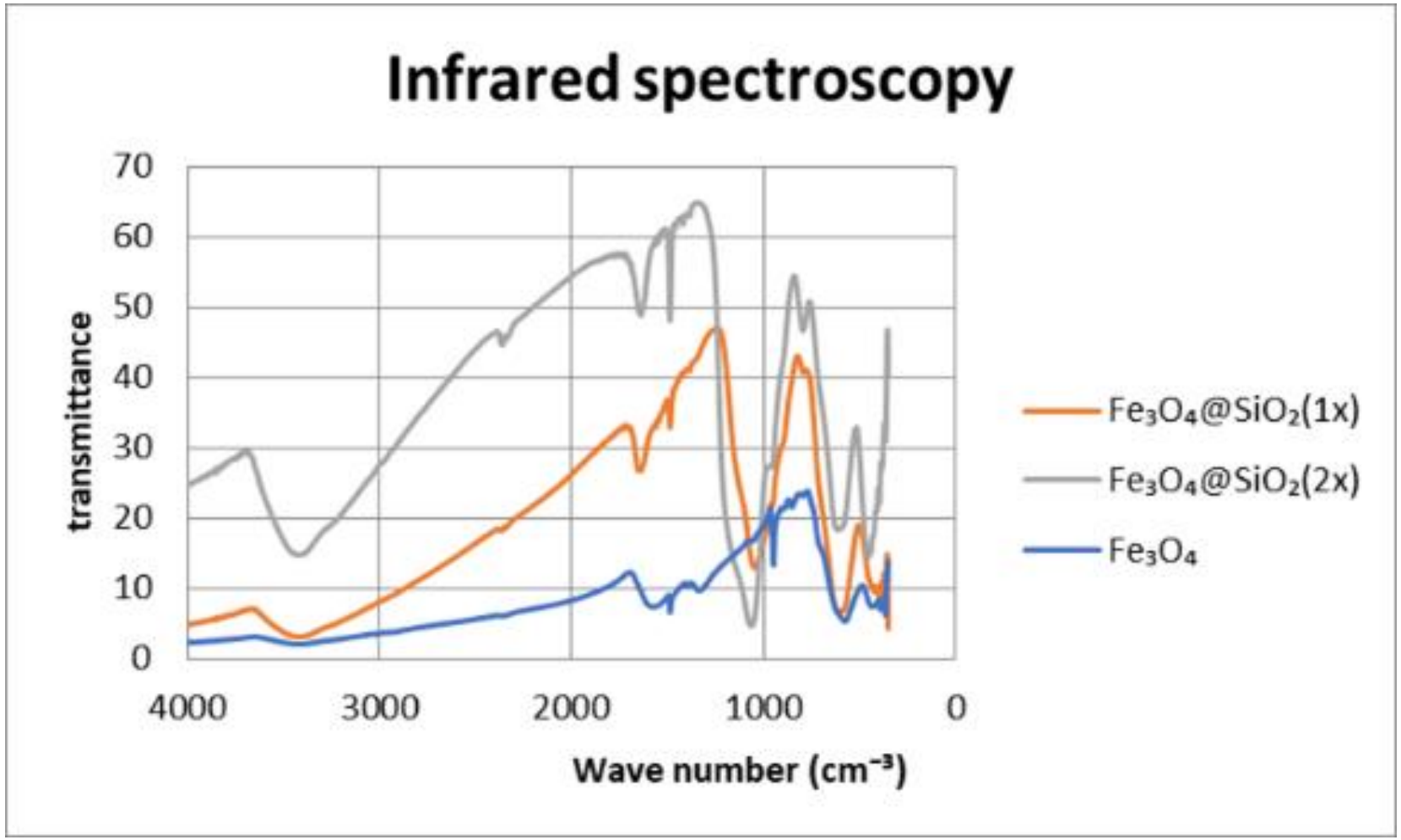
Table 2: Comparison of Zetasizer results (Fe_3O_4@SiO_2 - 1x and 2x)

d.nm – diameter value in nanometers

PdI – polydispersity index

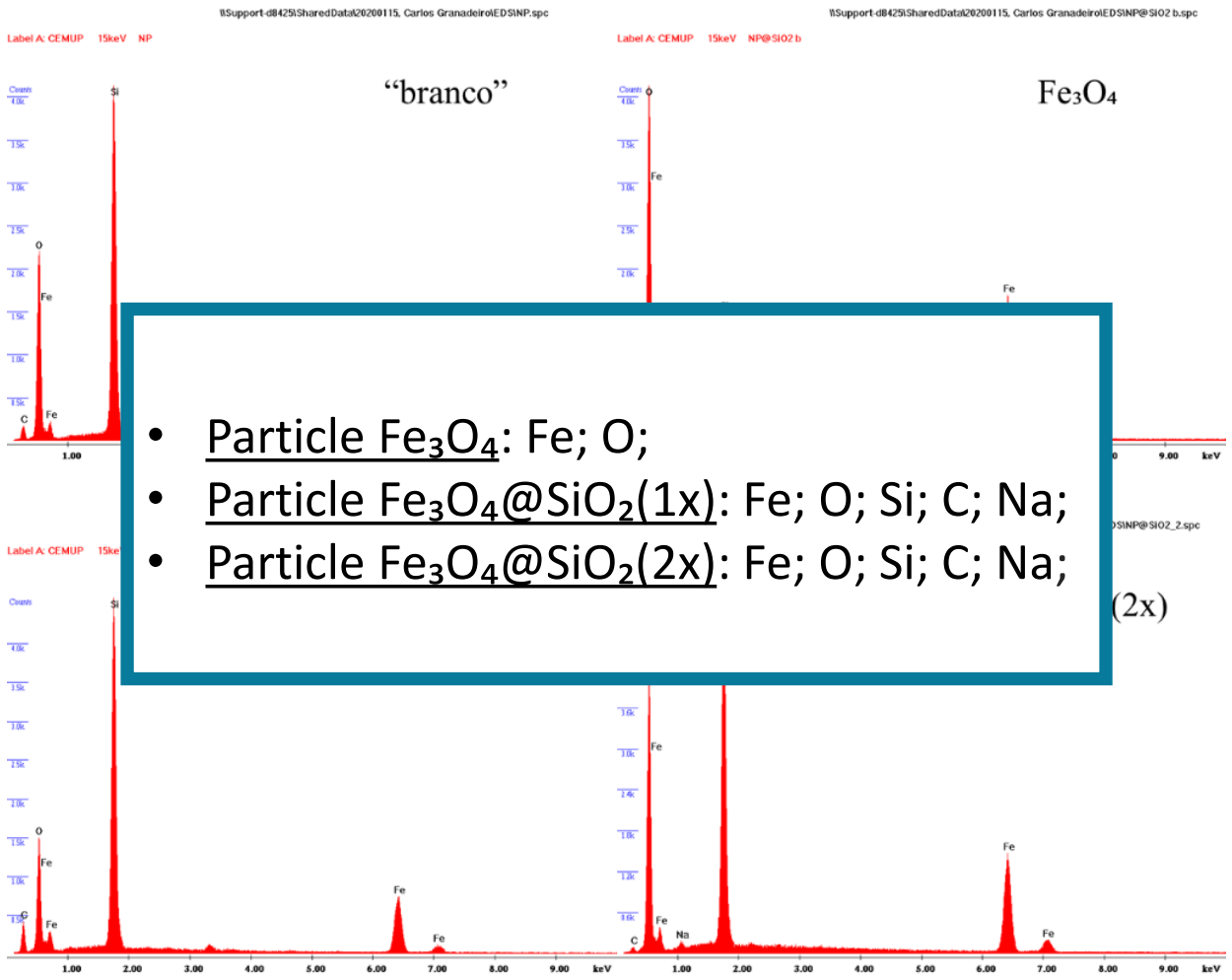
Zeta Potential - potential difference between the phase limits between solids and liquids. It is a measure of the electrical charge of particles that are suspended in liquid.

Infrared Spectroscopy



Graph 1: Results of Infrared Spectroscopy

Scanning Electron Microscope (SEM)



- Particle Fe_3O_4: Fe; O;
- Particle $Fe_3O_4@SiO_2(1x)$: Fe; O; Si; C; Na;
- Particle $Fe_3O_4@SiO_2(2x)$: Fe; O; Si; C; Na;

Figure 5: Result of Scanning Electron Microscope (SEM)

Scanning Electron Microscope (SEM)

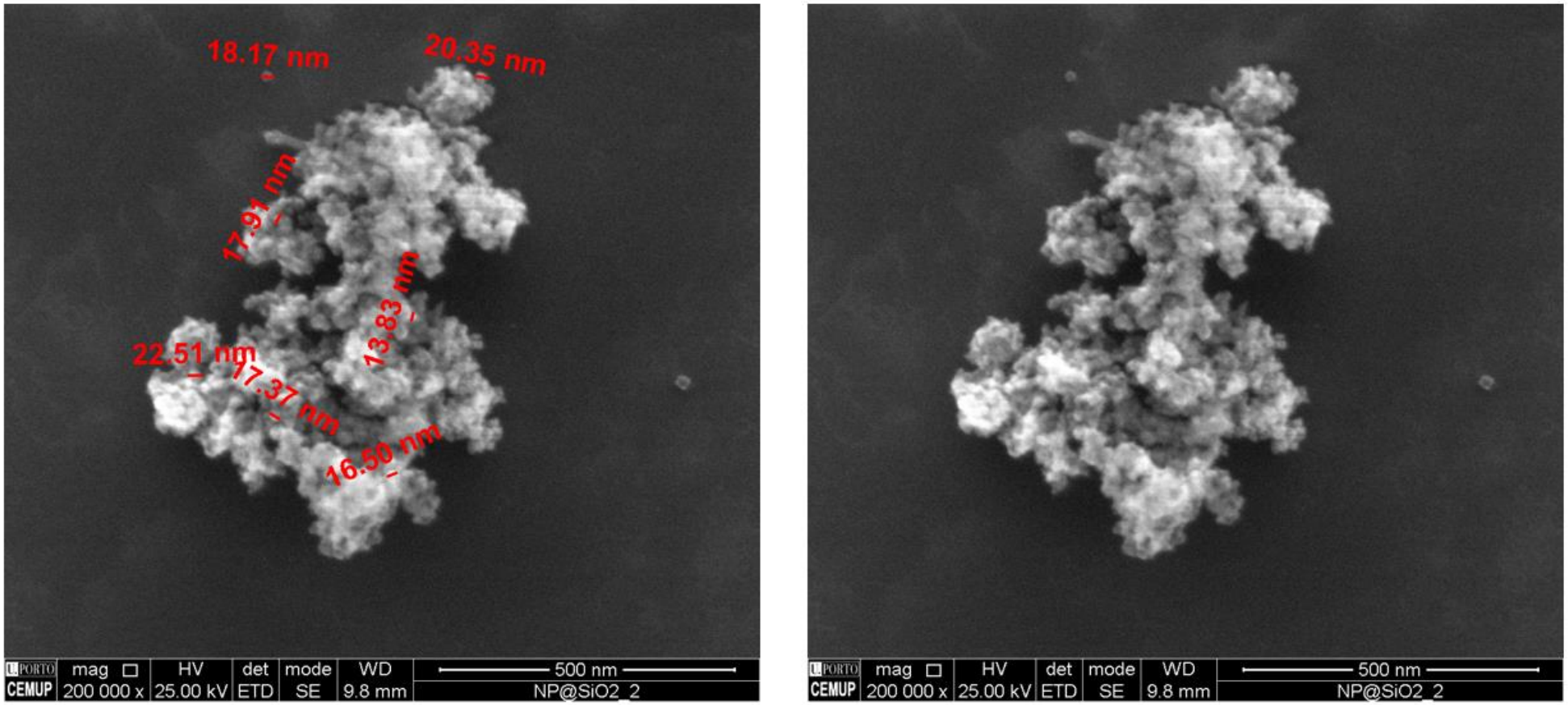
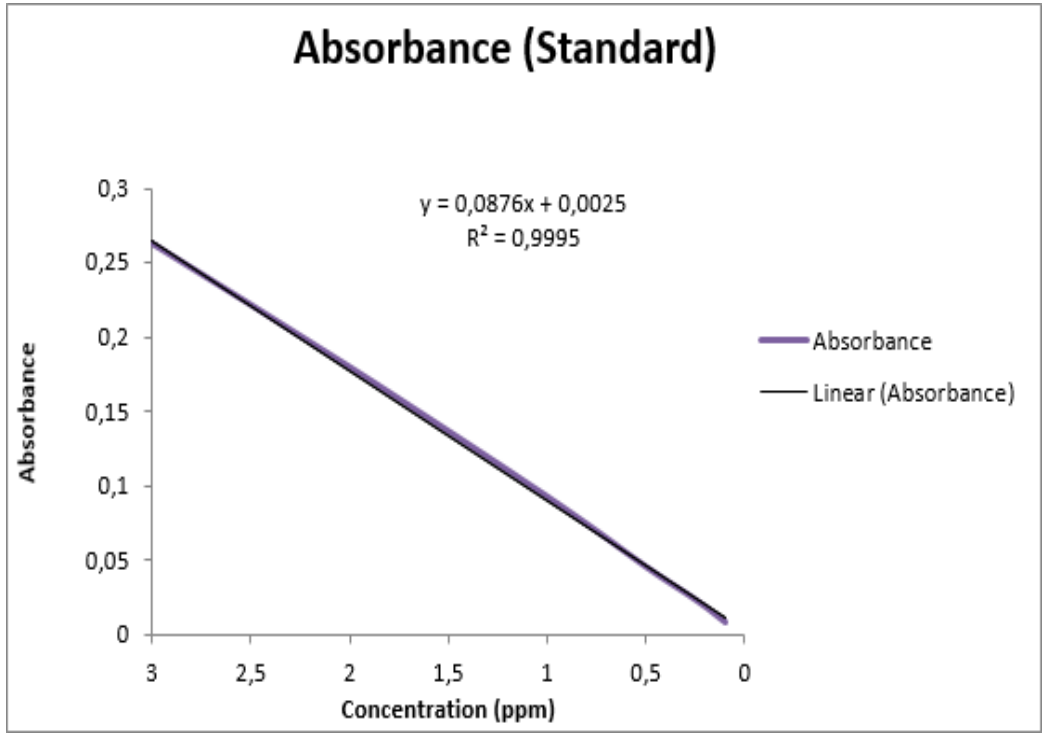
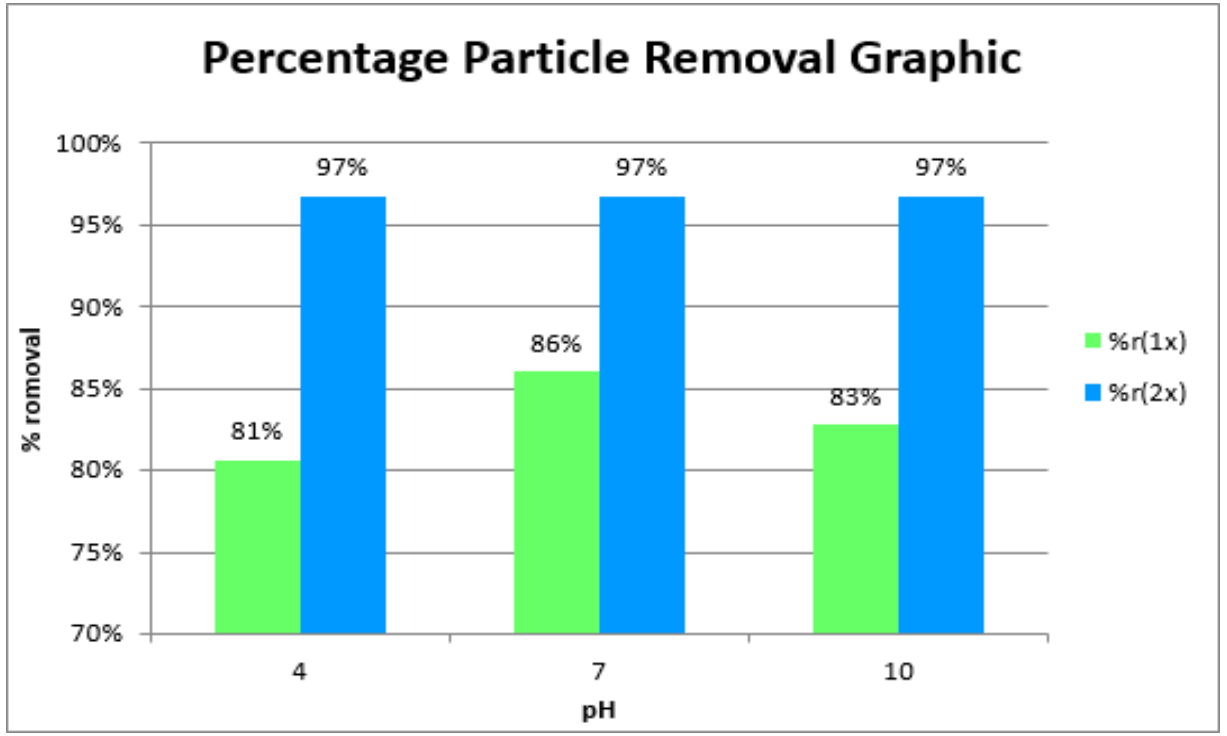


Figure 6: Result of SEM -Fe_3O_4@SiO_2(2x)

Atomic absorption spectroscopy with flame

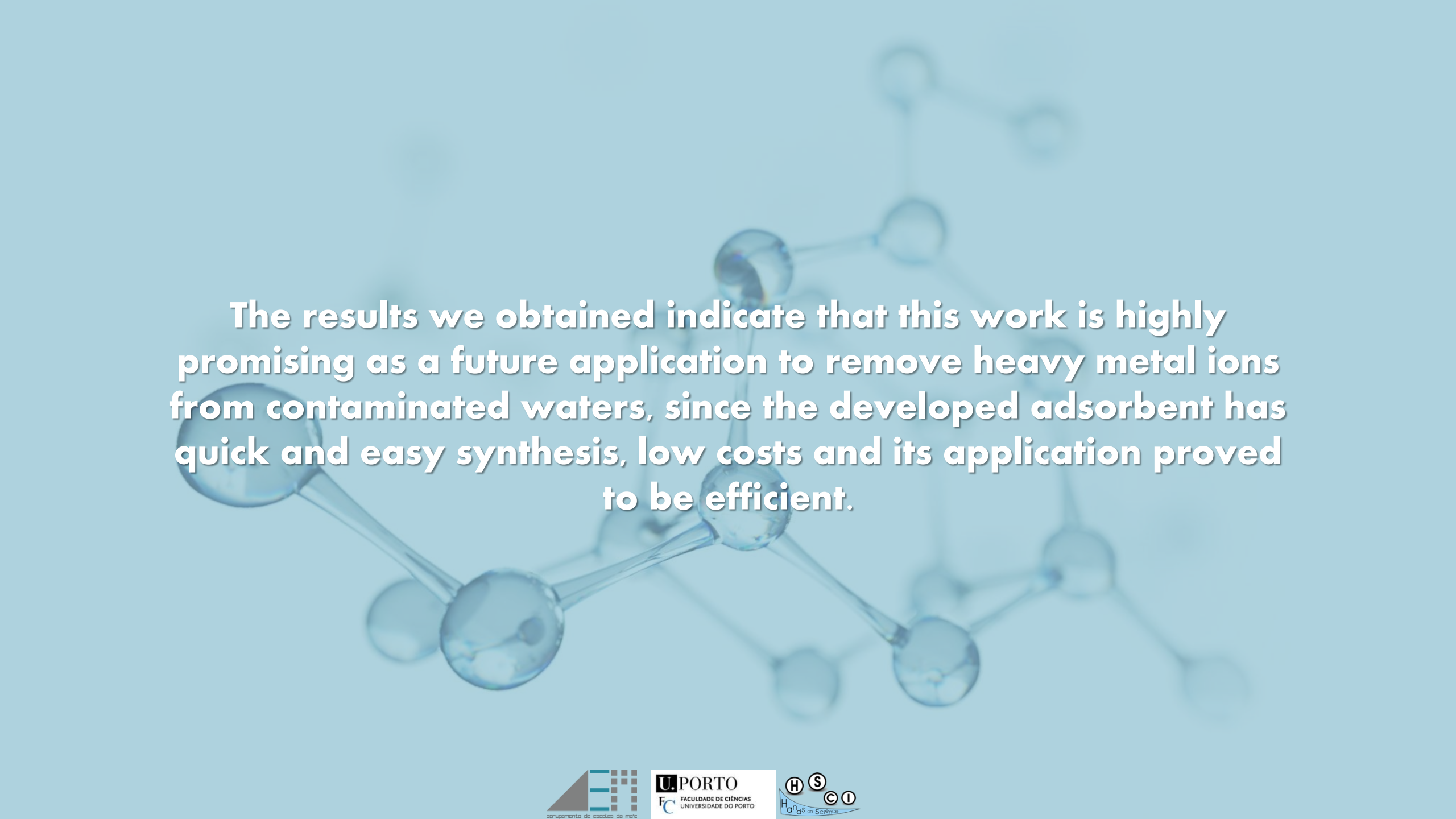


Graphic 2: Results



Graphic 3: Results

Conclusion



The results we obtained indicate that this work is highly promising as a future application to remove heavy metal ions from contaminated waters, since the developed adsorbent has quick and easy synthesis, low costs and its application proved to be efficient.

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Bibliographic references

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