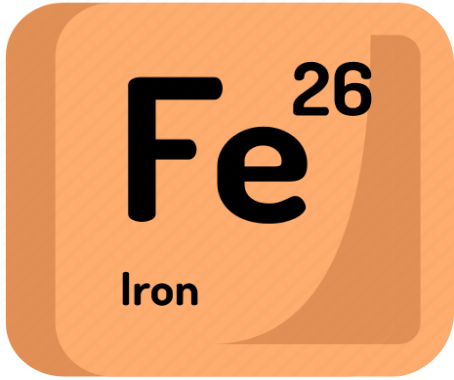

Gold nanoparticles functionalized with mercaptosuccinic acid as means for detecting Fe(III) ions

Komova N.S., Serebrennikova K.V., Berlina A.N.,
Pridvorova S.N., Zherdev A.V., Dzantiev B.B.

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Iron ions in water

Fe (II)

soluble / ferrous iron

Soluble iron, or “clear water” iron, is the type of iron found in our groundwater and oxidizes to insoluble or red iron in the presence of oxygen either in the well or in your home.

Fe (III)

insoluble / ferric iron

When insoluble iron, or “red water” iron is poured into a glass, it appears rusty or has a red or yellow color. Insoluble iron can create serious taste and appearance problems for the water user.

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Iron ions in water

IRON IN WATER

Iron is one of the earth's most plentiful resources, making up at least five percent of the earth's crust. When rainfall seeps through the soil, the iron in the earth's surface dissolves, causing it to go into almost every natural water supply, including well water.

The LOC for iron in drinking water should not exceed 0.3 mg/L for drinking water. The permissible concentration of iron in drinking water is not harmful to human health.

WHAT DOES IRON DO?

Iron, even in small quantities, can be one of the most troublesome elements found in water. As little as 0.3 ppm of iron ions can affects the tastes of foods and beverages, destroy hydro-technical equipment and even more so, an excess of iron can cause various diseases in humans.

IRON IONS DETECTION

The determination of iron ions in water requires rigorous analytical methods in order to provide high quality data. The ultra-low concentrations of iron species claim analytical techniques with appropriate detection limits. The main analytical techniques that used for the determination of iron ions in water include spectrophotometry, atomic spectrometry, voltammetry, X-ray fluorescence and chemiluminescence.

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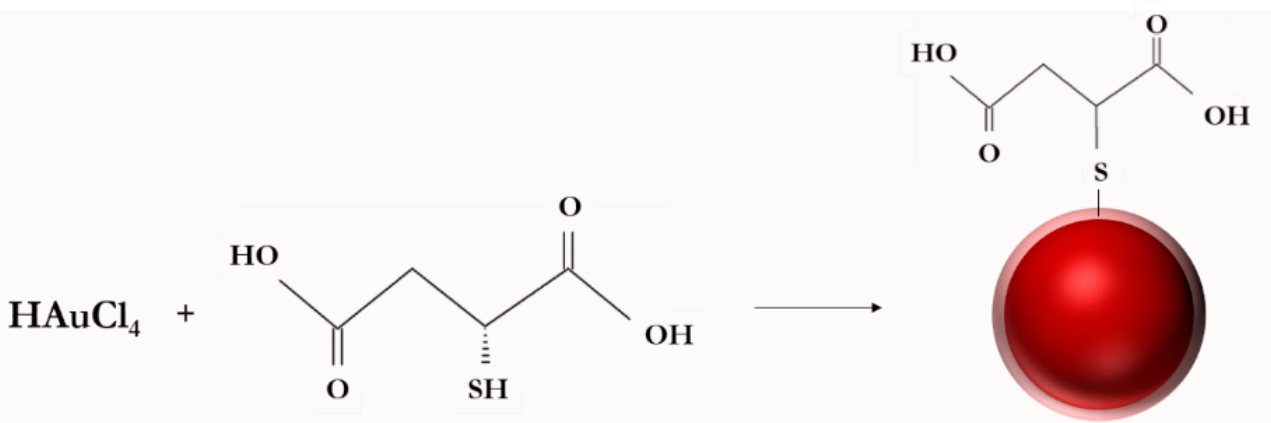
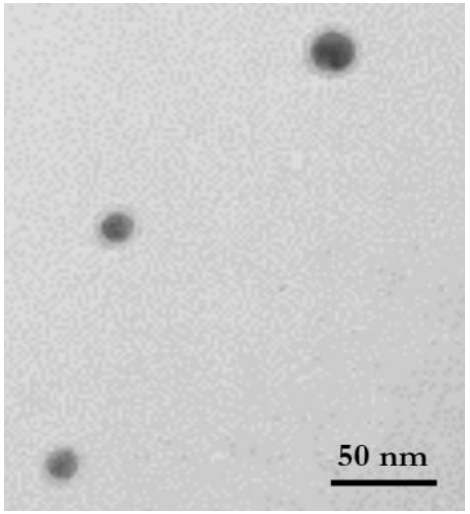
Synthesis and Characterization of MSA-capped Gold Nanoparticles

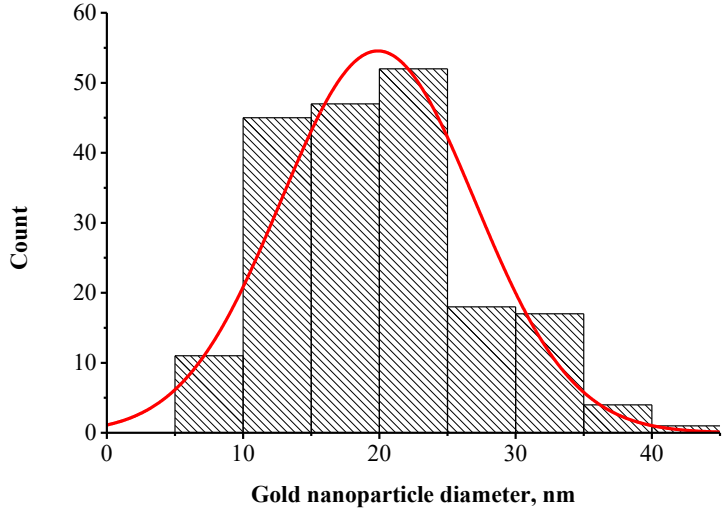


Mercaptosuccinic acid (MSA)

MSA-capped Au NP



TEM image of MSA—capped AuNPS;



Histogram of MSA-AuNPs particles diameter distribution

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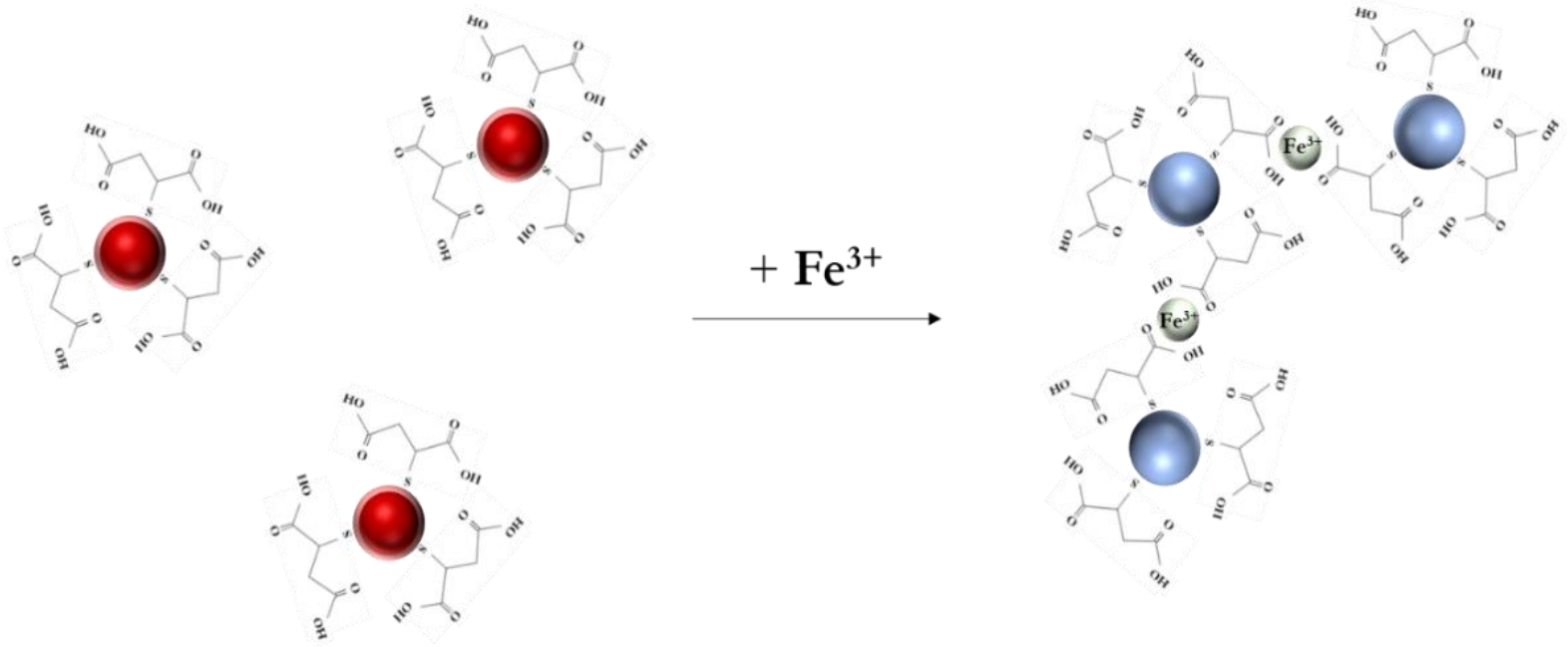
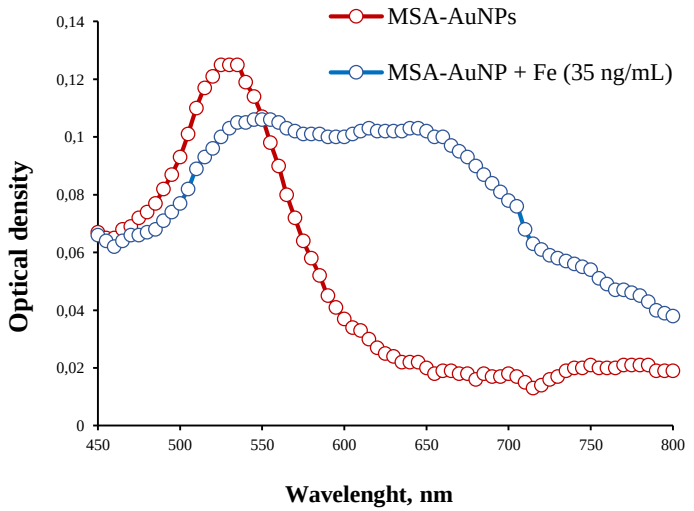
Principle of Colorimetric Determination of Fe(III) ions





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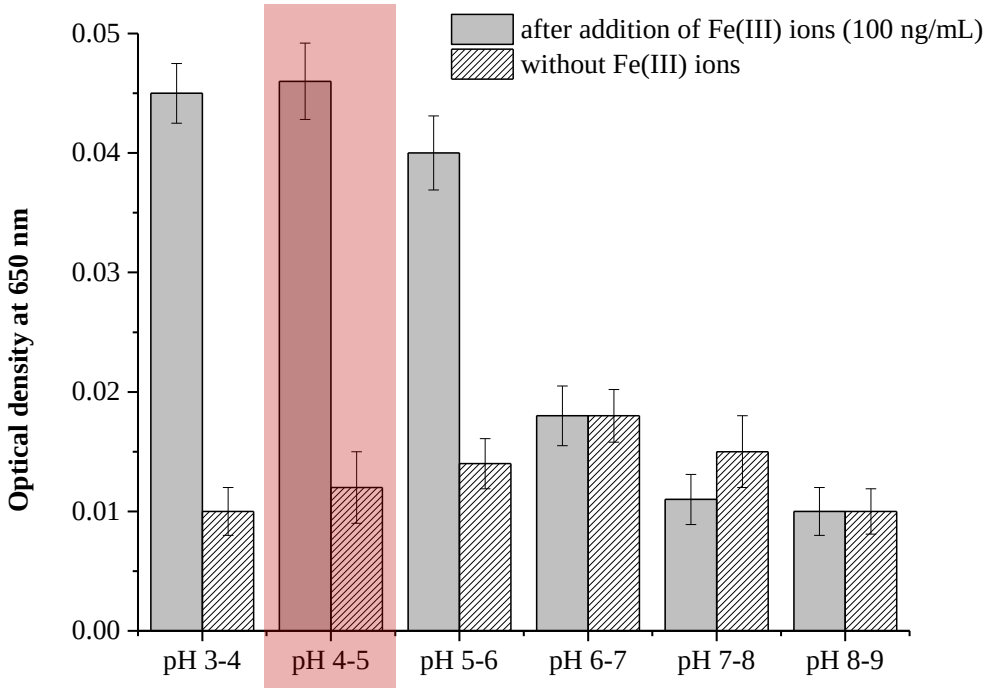
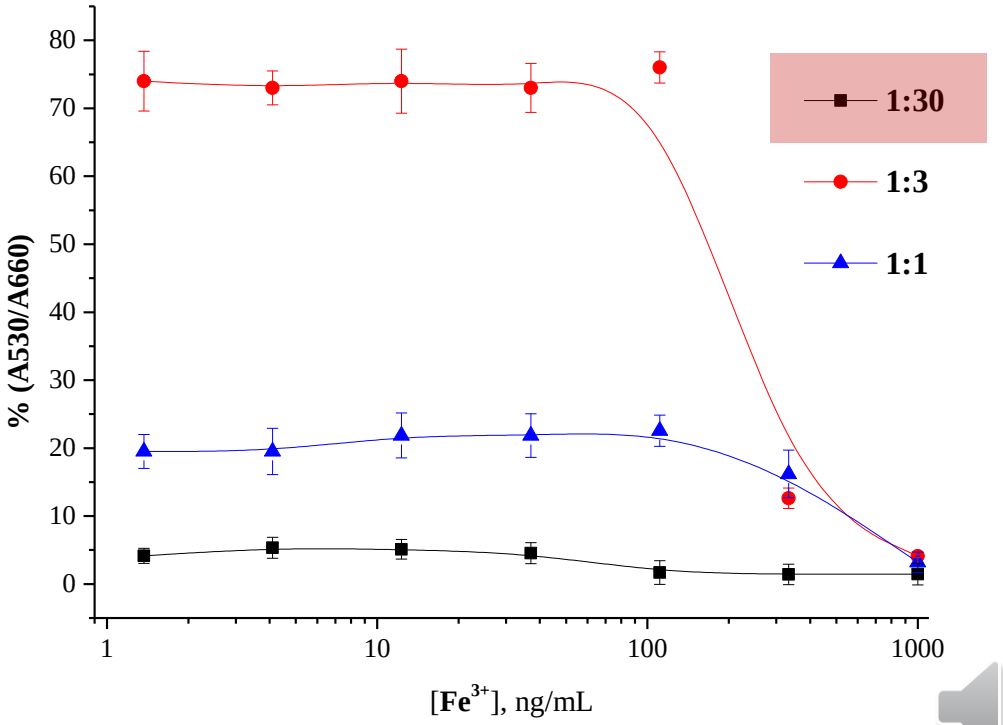
Condition Optimization for Colorimetric Detection of Fe(III) ions

The pH dependence of colorimetric reaction with and without Fe(III) ions



The dependence of volume ratio of the reacting components on analytical signal



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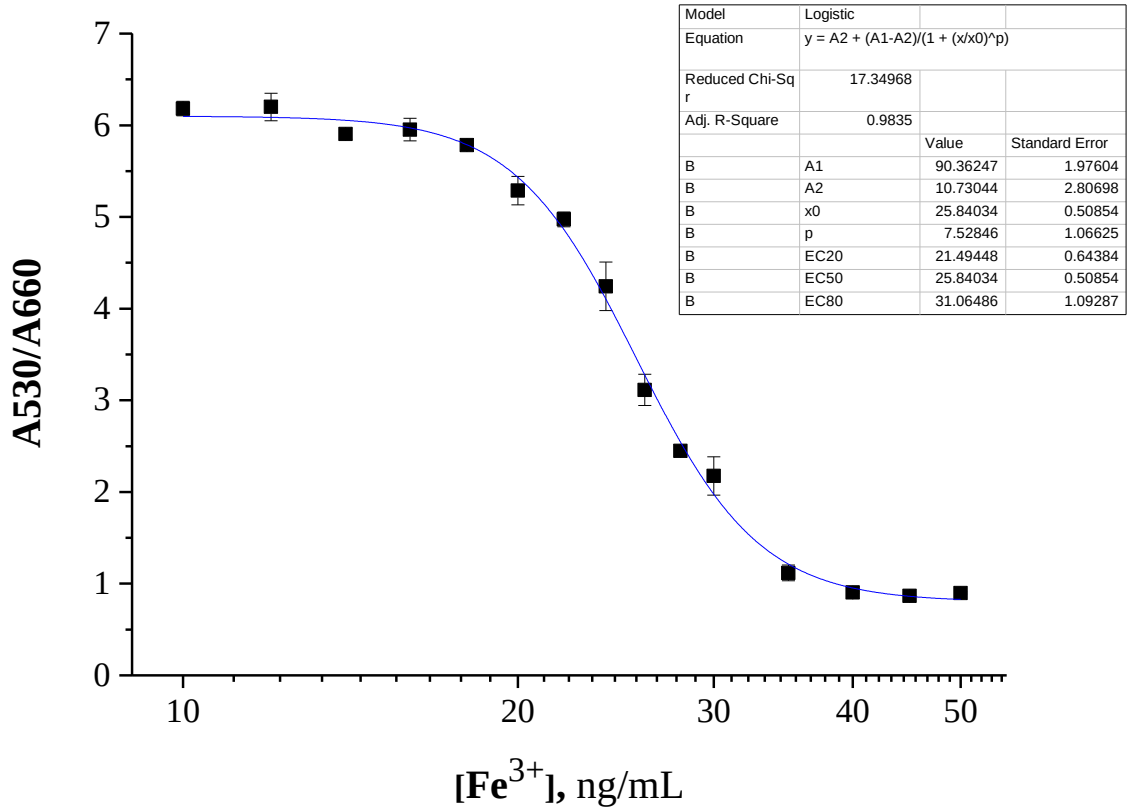
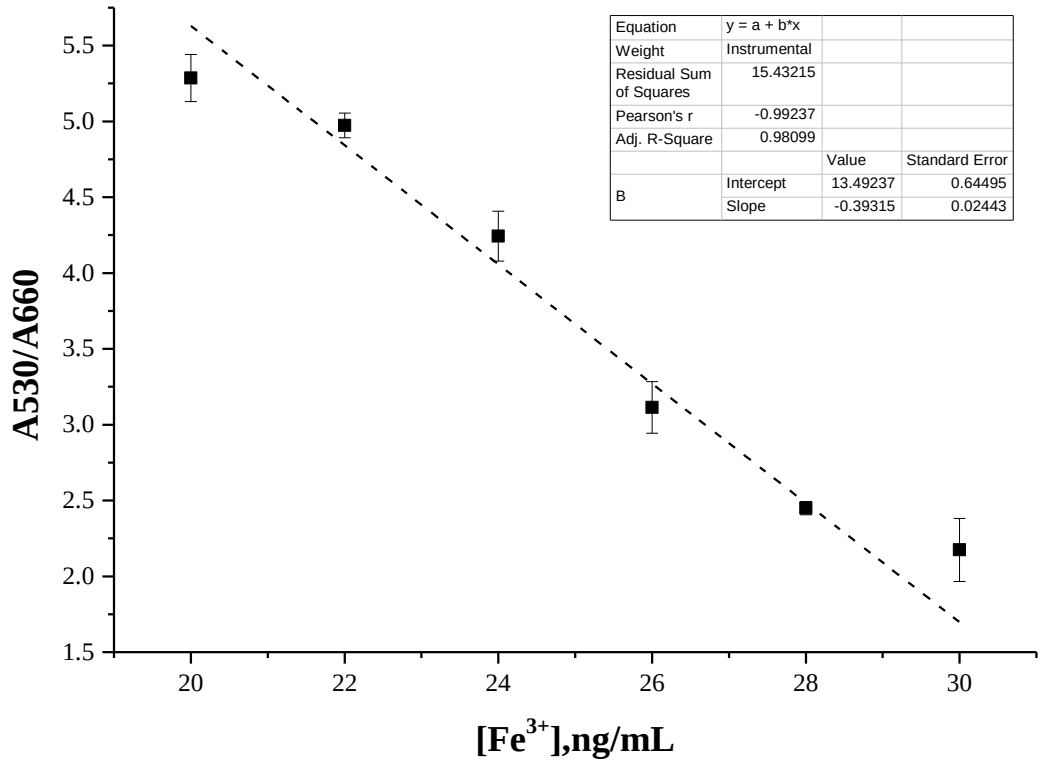
Colorimetric Determination of Fe(III) ions



Model	Logistic		
Equation	y = A2 + (A1-A2)/(1 + (x/x0)^p)		
Reduced Chi-Sqr	17.34968		
Adj. R-Square	0.9835		
		Value	Standard Error
B	A1	90.36247	1.97604
B	A2	10.73044	2.80698
B	x0	25.84034	0.50854
B	p	7.52846	1.06625
B	EC20	21.49448	0.64384
B	EC50	25.84034	0.50854
B	EC80	31.06486	1.09287



Equation	y = a + b*x		
Weight	Instrumental		
Residual Sum of Squares	15.43215		
Pearson's r	-0.99237		
Adj. R-Square	0.98099		
		Value	Standard Error
B	Intercept	13.49237	0.64495
	Slope	-0.39315	0.02443

(**a**) Calibration curve for Fe(III) ion detection using AuNP-MSA; (**b**) Linear range of the calibration curve

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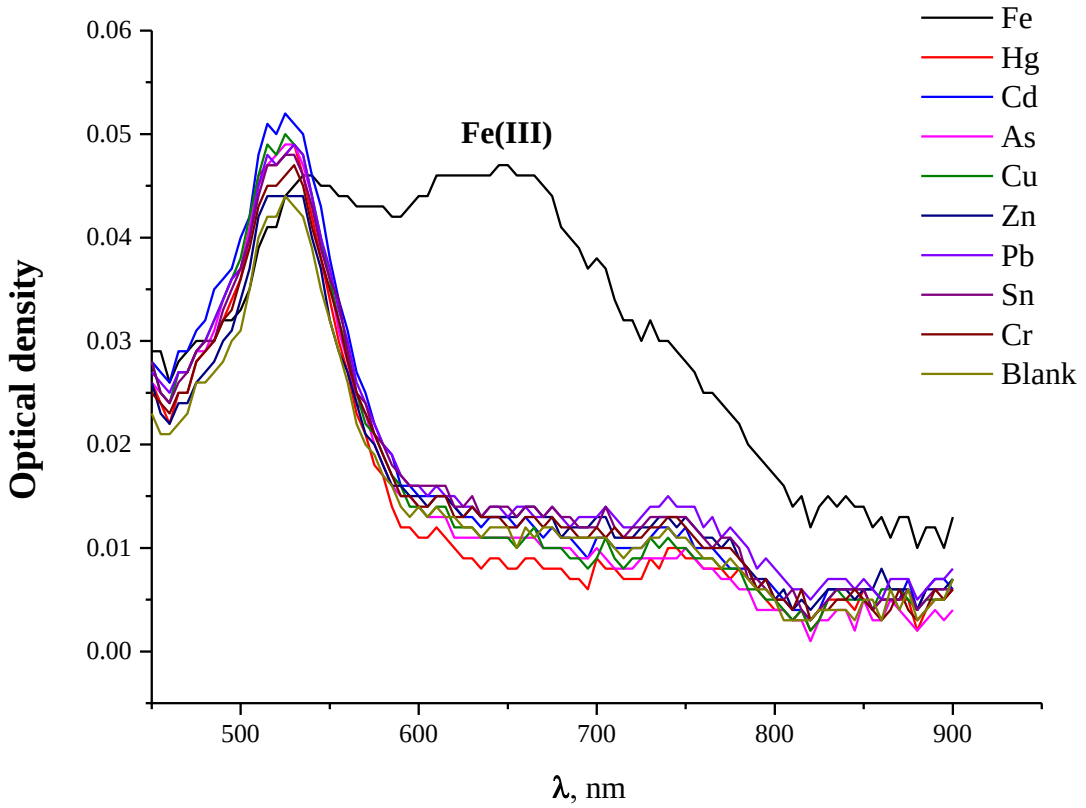
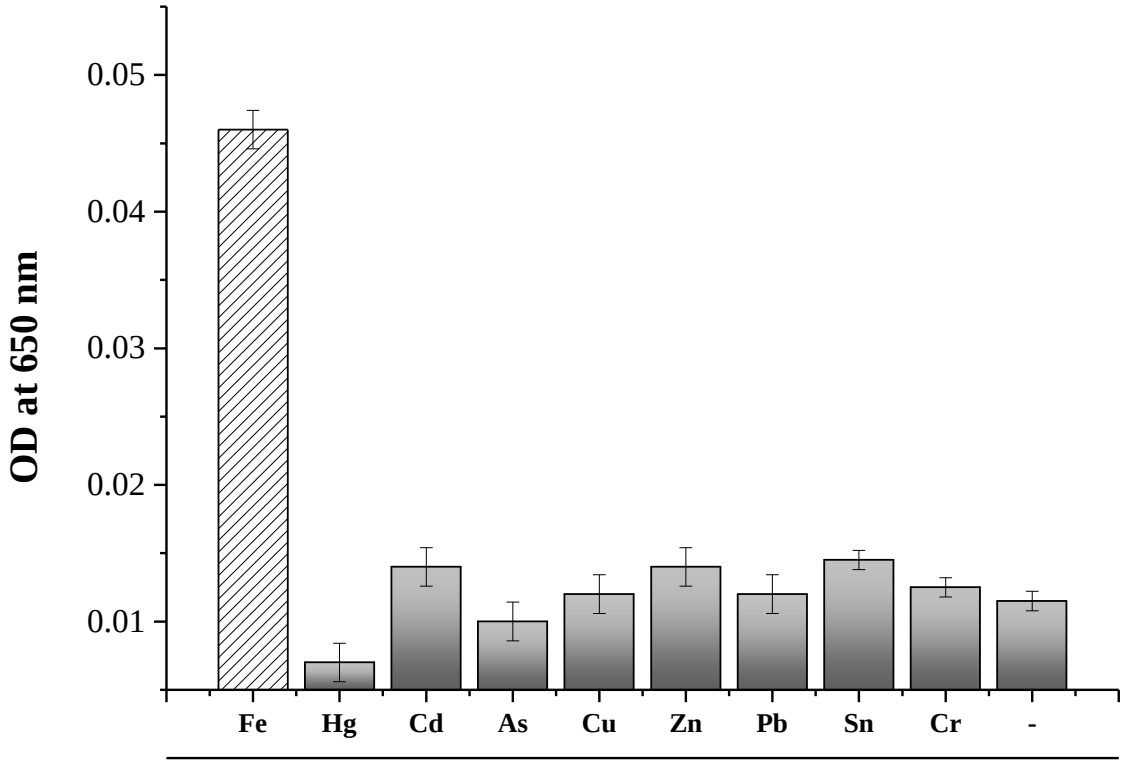
Selectivity of Fe(III) ions detection





Absorbance spectra of MSA-capped Au NPs after the addition of 100 ng/mL metal ions

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Application of developed approach for the analysis Fe^{3+} ions in water samples

Sample	Initial found, ng/mL	Added, ng/mL	Total found, ng/mL	Recovery, %	Dilution factor	Content of sample*	Maximum Permissible Concentration, ng/mL
Drinking water	10.6 ± 0.2	15	26.4 ± 0.09	105	2	21.2 ± 0.2	300
		20	29.7 ± 0.43	95.5			
Tap water	18.5 ± 0.4	30	49.8 ± 0.6	104	15	227.5 ± 0.4	
		25	40.9 ± 0.8	89.6			
Spring water	27.8 ± 0.2	30	61.05 ± 0.01	110	5	139.0 ± 0.2	
		25	54.1 ± 0.7	105			
		20	52.95 ± 0.02	126			

* - consider a dilution factor

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Conclusions

- A highly sensitive and selective colorimetric system for Fe(III) ion detection based on mercaptosuccinic acid functionalized gold nanoparticles was developed. The assay combined simple fabrication and operation with the possibility of sensitive on-site monitoring
- Optimal conditions for Fe(III) ions detection using prepared MSA-capped AuNPs was estimated
- Under optimal conditions, this system showed a good linear correlation between Fe (III) concentrations and the colorimetric signal, with visual and instrumental detection limits of 30 and 23 ng/mL, respectively.
- The developed system demonstrated high selectivity against other metal ions
- The effectiveness of the developed system was confirmed by the determination of Fe(III) ions in the water samples without a matrix influence

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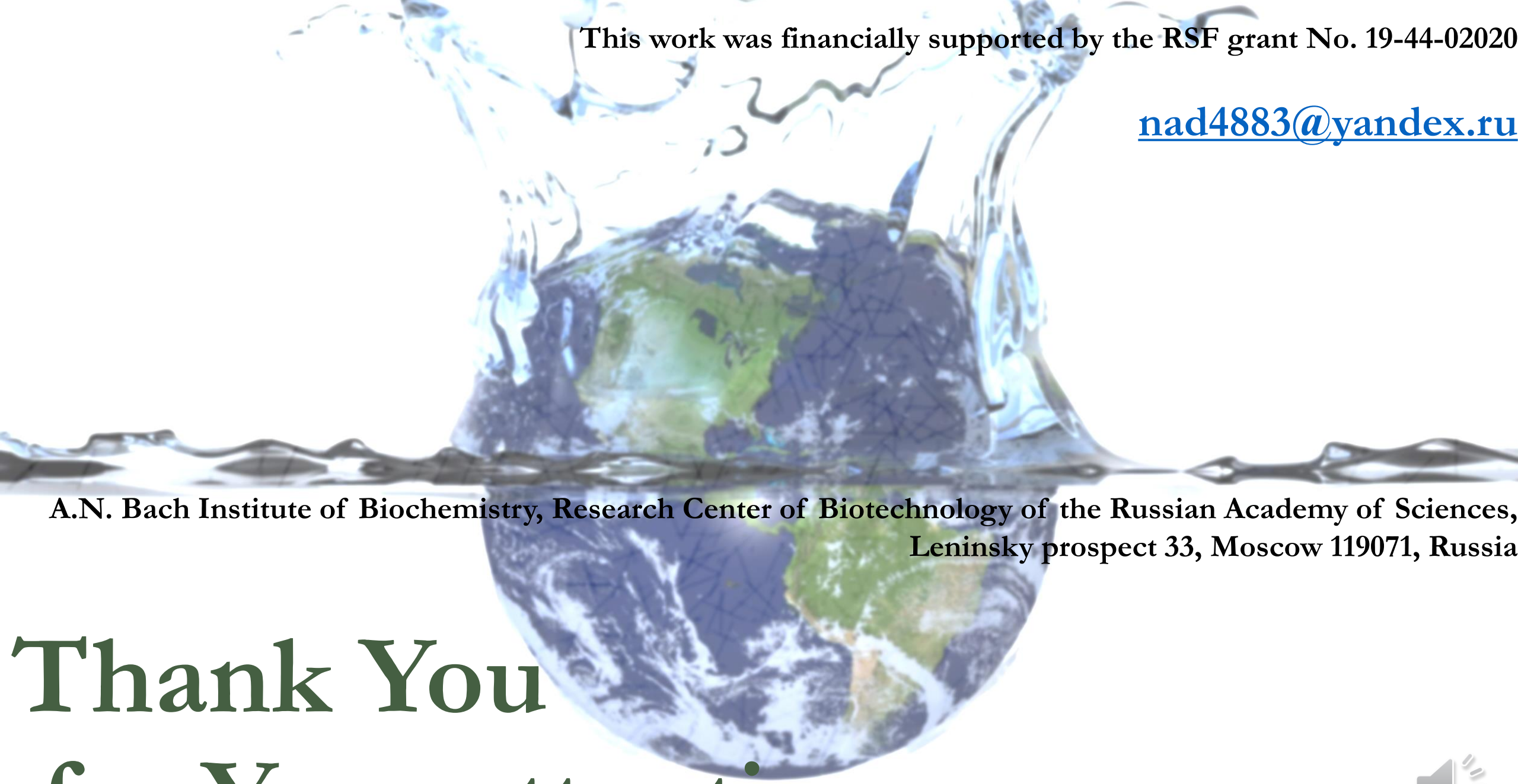

Thank You for Your attention