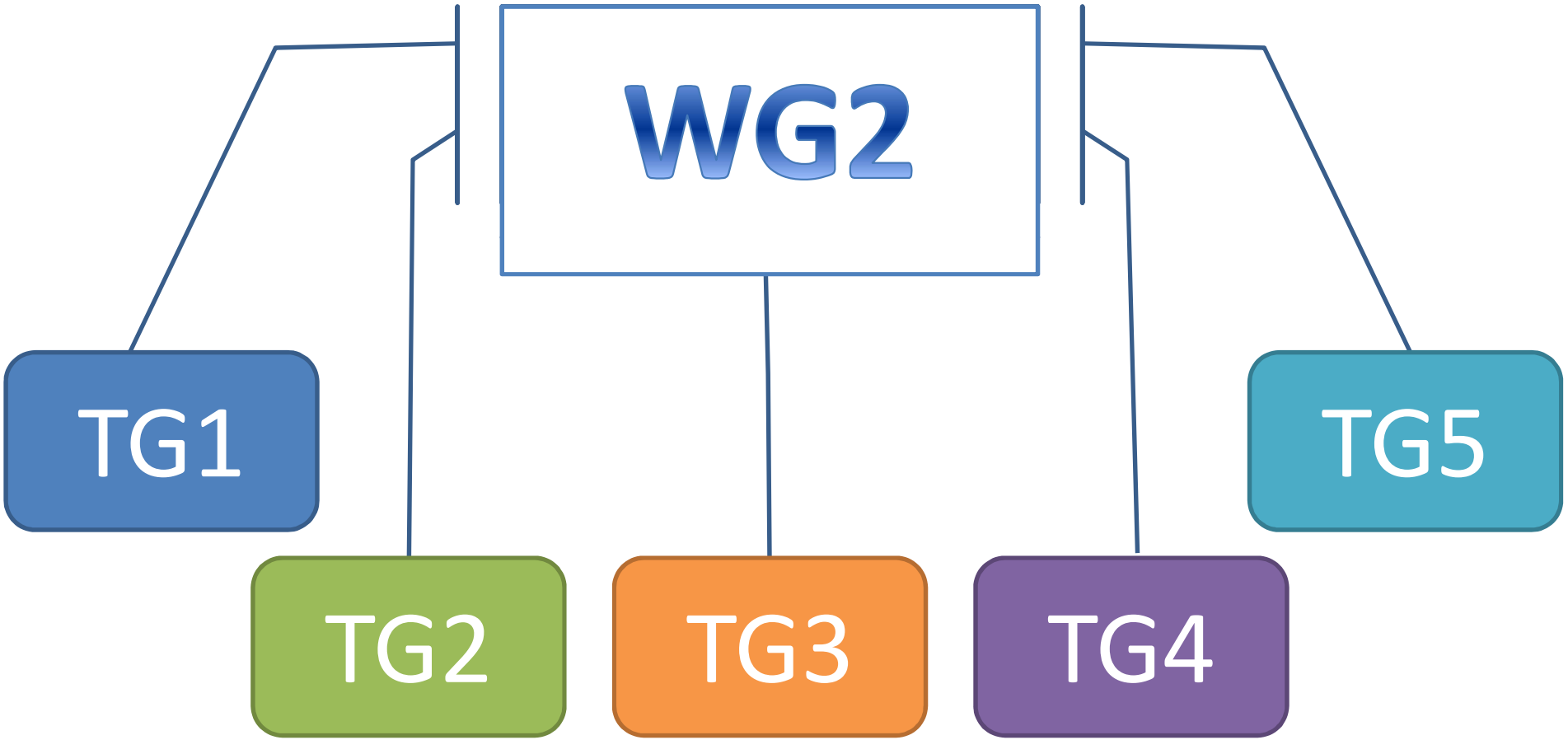
WG2

NECTAR for strong and/or multifunctional ligands, macromolecules, polyelectrolytes


WG2
TG1
TG2
TG3
TG4
TG5

TG1

Task Group 1

Complexes of polydentate ligands

Working Group 2

TASK GROUP 1

Complexes of polydentate ligands

How to deal with complexones and macrocycles ?

Potentiometric „good laboratory practice“ for titrations of polydentate ligand systems

What was taken into account

1. Materials and stock solutions:

- strong acid & base stock solutions
- ligand & metal ion purity and stock solutions
- choice of background electrolyte

2. Electrode system calibration:

- pH range of calibration titration and calibration parameters
- data at high & low pH

3. Titrations:

- detailed experimental set-up (suitable pH ranges / concentrations, M:L ratios)
- calibration-titration relations

4. Data treatment:

- data precision & titration reproducibility, a number of titration & data points
- programs for data treatment & statistical parameters
- choice of chemical model

Test systems: EDTA and EDTA-Zn^{2+}

- EDTA chosen as suitable ligand – easily available, no problems with reaction kinetics, suitable necessary titration pH range, easy to deal with …

- Chemical model with H^+/Zn^{2+} is reasonably educative => several protonations in acid solution, protonated complexes & hydroxido species

- Conditions tested: pH ranges 1.5-11.8 & 1.8-12, EDTA concentrations 0.001-0.005 M, hydroxide concentrations, 0.1 & 0.2 M, ionic strength 0.1 & 0.2 M

- Conditions chosen: pH range at least 1.7 to at least 11.5, *c*(EDTA) 0.002 & 0.003 M, *I* = 0.1 M KCl, *c*(KOH) 0.1–0.2 M, Zn:L ratio 0.95–0.98:1, *t* = 25 °C

- Other recommended conditions: in –log[H^+], four-parameter electrode calibration, calibration followed by titration, at least 3+3 titration for each EDTA concentration, 50–60 points per titration

Data obtained & evaluation

- Four labs participated – Debrecen Messina, Prague, Turin.

- Different programs used for data treatment : BSTAC, OPIUM, PSEQUAD

- Global fitting done by each group, detailed statistical analysis of all data done by Matteo Marafante (Torino).

- Reasonable agreement between data obtained by the groups.

- Results in agreement with published data & procedure can be recommended as "good laboratory practice".

- **However…** The most acidic EDTA protonation constant ($\log K_5$ ~1.2) should be determined – thus, titration should start from acidic solutions (pH 1.5–1.7). Otherwise, $\log K_4$ value is not fully correct.

- **However…** The highest attention should be paid to a correct calibration of electrode systems, four-parameter calibration is highly recommended.

Final values

From detailed statistical analysis of all data done by Matteo Marafante (Torino).

Constant	Values Interval (this work)	Average (this work)	Confidence Interval (C.I.)	NIST database	IUPAC database
$\log K_1$	10.15–10.18	10.17	± 0.08	10.19	10.12
$\log K_2$	6.12–6.23	6.17	± 0.07	6.13	6.13
$\log K_3$	2.66–2.87	2.75	± 0.14	2.69	2.77
$\log K_4$	2.02–2.25	2.11	± 0.17	2.0	2.01
$\log K_5$	(0.9–1.34)	1.15	± 0.57	1.5	(1.4)
$\log K_6$	–	–	–	–	(0.1)

- **But missing…** How to deal with systems where complexation kinetics is slow

  => “batch” / “out-of-cell” titrations.

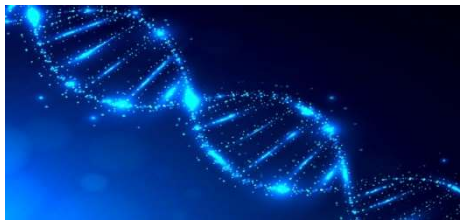
TG2

Task Group 2
BIOSUBSTRATES BINDING

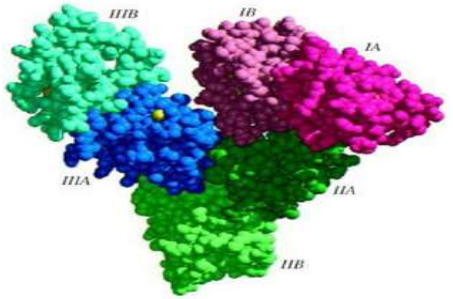
Our task

Identify target systems for studies on biosubstrates binding to be used as validation standard. Development and testing of recommended procedures.

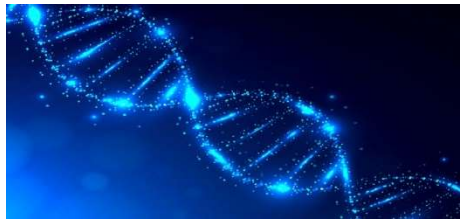
First step: dye/DNA intercalation



A target (“golden standard”) system is chosen on the basis of reactants stability and cost, availability and ease of handling. The different research groups will perform tests on the evaluation of binding constant for the target system. Results will be checked to perform intercalibration exercises between laboratories.



Paper work - Deliverables



The report was refined and split into 2 deliverables:

(i) best practices/purity issues/experimental aspects

(ii) data treatment/equations&software comparisons

Submitted on October 2022

JOB DONE

The people working on this part is quite ready to submit a paper on this part.

DREAMS…

Demetrio proposed to produce a deliverable where the different buffers are listed with pros and cons (in particular given the differences we noticed at the beginning).

CALIXARENE SYSTEM to test data fitting

NEW CALIXARENE SYSTEM to test data fitting

Everybody of us was asked to fit a simple 1:1 titration data kindly shared by Nuno Basilio. We have used whatever equation and software and compare the logK number we get.

We demonstrated what we wanted (🎉 👌): now, different people, using different data fit, obtained LogK numbers with little dispersion (+/- 0.1 Log units, ca. 1% error on Log K value, ca. 20% error on K value).

These data/thresholds can be used as a "general check" as for what is acceptable as an error on fluorescence titrations on more simple 1:1 systems. For DNA the error is (much) higher due to complexity of the system and use of simplified models.

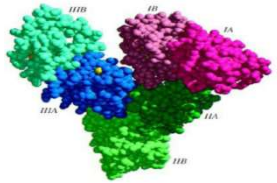
PROTEIN BINDING: INTER-LABORATORY EXERCISES

ONGOING EFFORTS

- **We have evaluated different systems and finally chosen ibuprofen/bovine serum albumin (IBU/BSA) and defined exactely the phosphate buffer to be used in our tests**

- **We have faced problems to define IBU molar extinction coefficient, but finally solved this point trough literature/measurements in different labs**

- **We have prepared a NEW PROTOCOL for BSA TITRATIONS**



- **Different groups have performed titrations**

- **We are now at the stage of fitting these titrations to compare our numbers on binding constant….**

TG3

Task Group 3
Peptides

COST Action CA18202
NECTAR
Network for Equilibria and Chemical Thermodynamics Advanced Research

4th European NECTAR Conference
and Final Action Meeting

Milazzo, February 26th-27th, 2024

University of Wroclaw, Poland
Universitat Autoǹoma de Barcelona, Spain
University of Siena, Italy
University of Balearic Islands, Spain
University of Opole, Poland
University of Ferrara, Italy
University of Sassari, Italy
University of Granada, Spain

NECTAR for strong and/or multifunctional ligands, macromolecules

Funded by the European Union

Sławomir Potocki
University of Wrocław

Histidine–rich C–terminal (HRCT) tail of GroEL1 chaperonins as a potential regulator of metal ions concentration in *Mycobacterium tuberculosis* – study on stoichiometry of metal-HRCT complexes

MSc Anna Rola
Origin Institution:
Faculty of Chemistry
University of Wroclaw

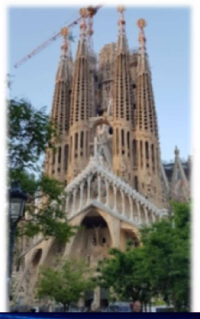
The main aim of this **STMS** was to characterize the stoichiometry and prefered metal-binding sites of model peptides Cu(II)/Ni(II)-complexes in the presence of equimolar amount, as well as an excess of metal ions. For this purpose, **high-resolution mass spectrometry** was used.

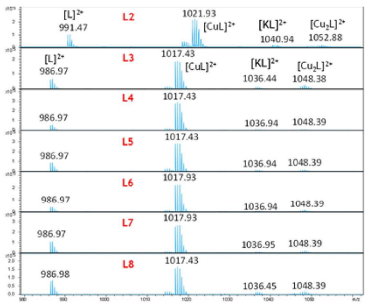
Prof. Oscar Palacios Bonilla
Host Institution:
Department of Chemistry
Universitat Autònoma de Barcelona

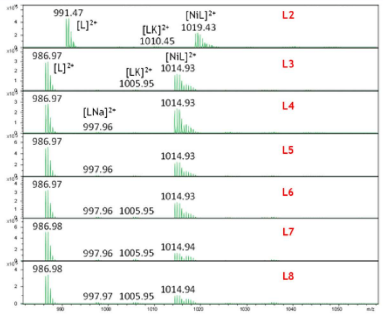
Universitat Autònoma de Barcelona

It was a great opportunity to learn new scientific skills, make international friendships and explore the catalan culture!





L2: Ac-DKPAKAEDHDHHHGHAH, L3: Ac-DKPAKAEDQDHHHGHAH, L4: Ac-DKPAKAEDHDQHHGHAH
L5: Ac-DKPAKAEDHDHQHGHAH, L6: Ac-DKPAKAEDHDHHQGHAH, L7: Ac-DKPAKAEDHDHHHGQAH
L8: Ac-DKPAKAEDHDHHHGHAQ

MILAZZO February 2024

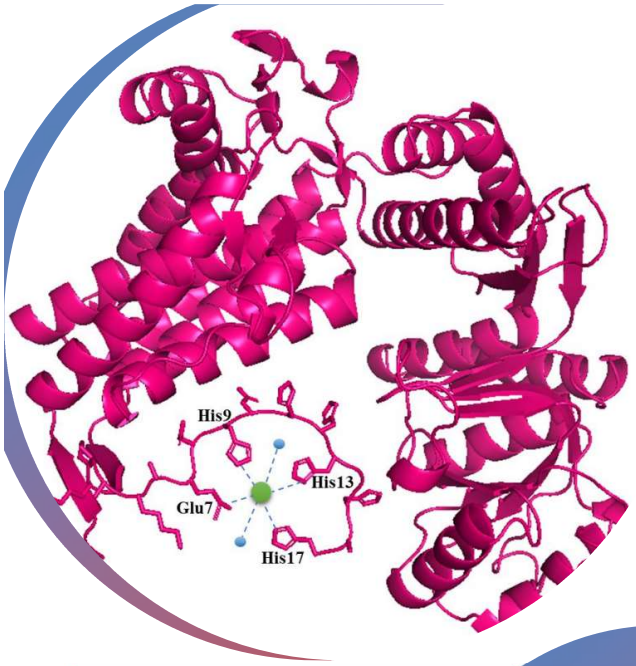
Histidine-Rich C-Terminal Tail of Mycobacterial GroEL1 and Its Copper Complex—The Impact of Point Mutations

Anna Rola*, Oscar Palacios, Merce Capdevila, Daniela Valensin, Elżbieta Gumienna-Kontecka, and Sławomir Potocki*

Cite this: *Inorg. Chem.* 2023, 62, 18, 6893–6908
Publication Date: April 24, 2023
https://doi.org/10.1021/acs.inorgchem.2c04486

PDF (3 MB) | SI Supporting Info (1) »

SUBJECTS: Bacteria, Deprotonation, Metals, Monomers, Peptides and proteins



Coordination sphere for a Ni(II)-L2 (L2: Ac- DKPAKAEDHDHHHGHAH) complex at pH around 7.1.

+

Dalton Transactions

ɐyond Copper: Examining the Significance of His-Mutations in Mycobacterial GroEL1 HRCT for Ni(II) Complex Stability and Formation

Journal:	*Dalton Transactions*
Manuscript ID	DT-ART-01-2024-000011
Article Type:	Paper
Date Submitted by the Author:	02-Jan-2024
ɔmplete List of Authors:	Rola, Anna; University of Wrocław, Faculty of Chemistry Kola, Arian; University of Siena, Department of Biotechnology, Chemistry and Pharmacy Valensin, Daniela; University of Siena, Department of Chemistry Palacios, Oscar; Universitat Autonoma de Barcelona, Chemistry Capdevila, Mercè; Universitat Aut&#65533;noma de Barcelona, Departament Química Gumienna-Kontecka, Elzbieta; University of Wroclaw, Faculty of Chemistry Potocki, Slawomir; University of Wroclaw, Department of Chem³

The presence of Lys5 residue significantly increases the stability of the system. His9 and His13 are the crucial residues for Ni(II) binding, whereas His12 has minimal relevance in complex formation.

STSM COST Nectar -
Exploiting NMR spectroscopy to determine coordination mode of the Zn(II), Ni(II), and Cu(II) complexes with metallopeptidases.

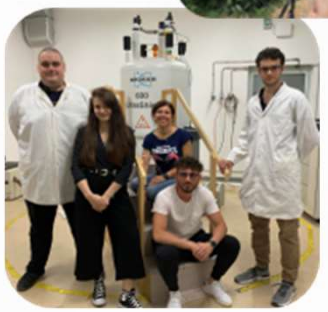
Origin Institution: University of Wrocław, Poland, Department of Chemistry
MSc Paulina Potok

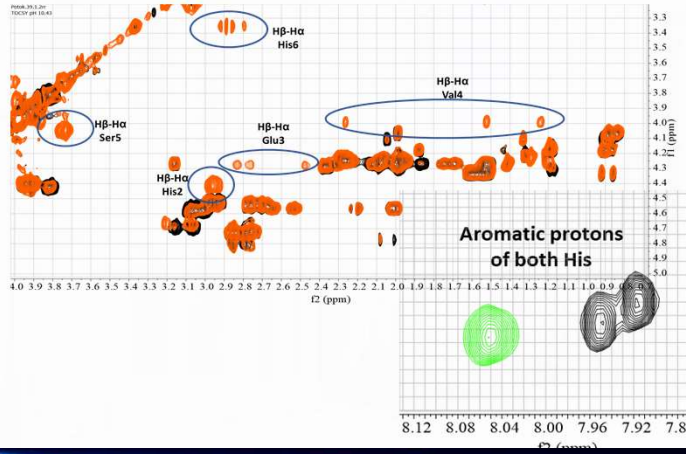
CA18202 STSM
31 days

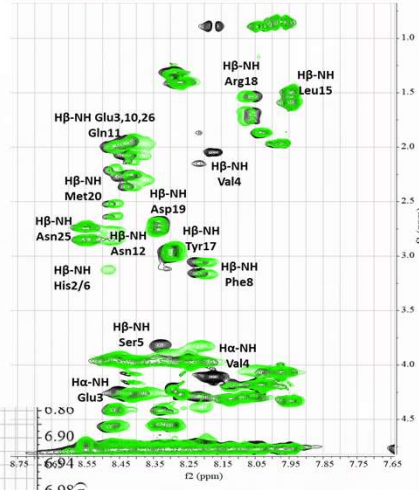
Host Institution: University of Siena, Italy Department of Biotechnology, Chemistry and Pharmacy
Prof. Daniela Valensin

DIPARTIMENTO DI BIOTECNOLOGIE, CHIMICA E FARMACIA

The main goal of the proposed **STSM project** was to characterize the coordination mode of metallopeptidases from pathogenic bacteria with transition metal ions Zn(II), Ni(II), and Cu(II) by **Nuclear Magnetic Resonance Spectroscopy.**





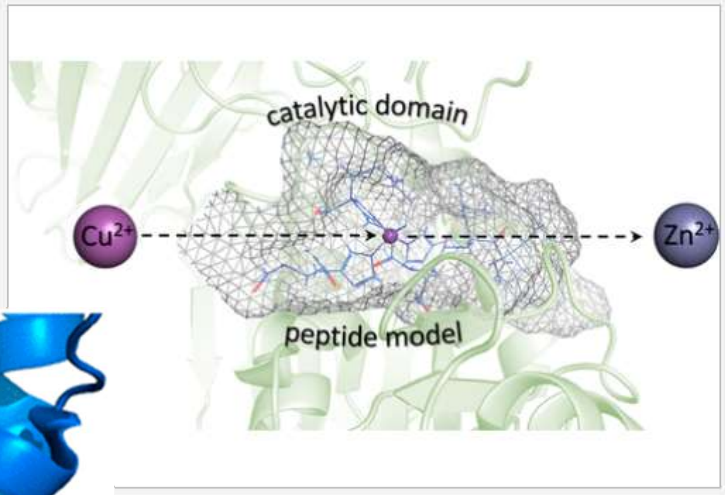


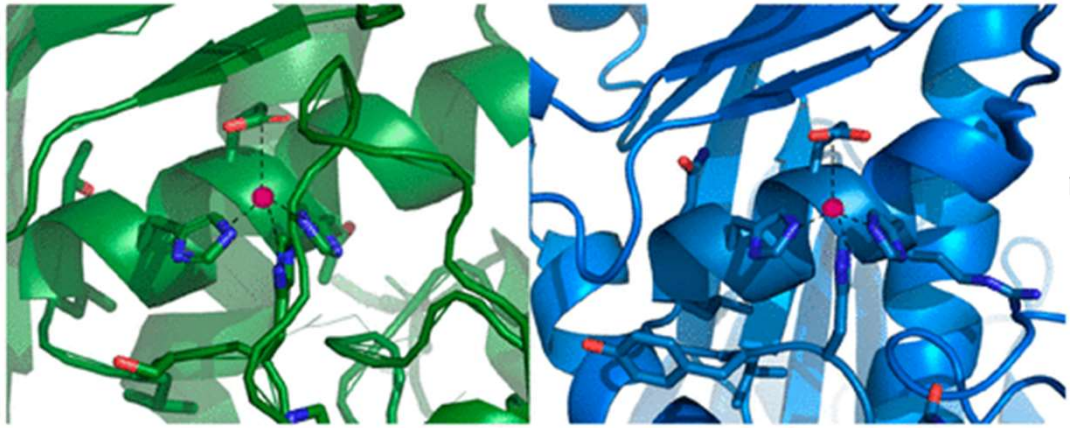
MILAZZO February 2024

Copper Forms a PPII Helix-Like Structure with the Catalytic Domains of Bacterial Zinc Metalloproteases

Paulina Potok, Arian Kola, Daniela Valensin, Merce Capdevila, and Sławomir Potocki*

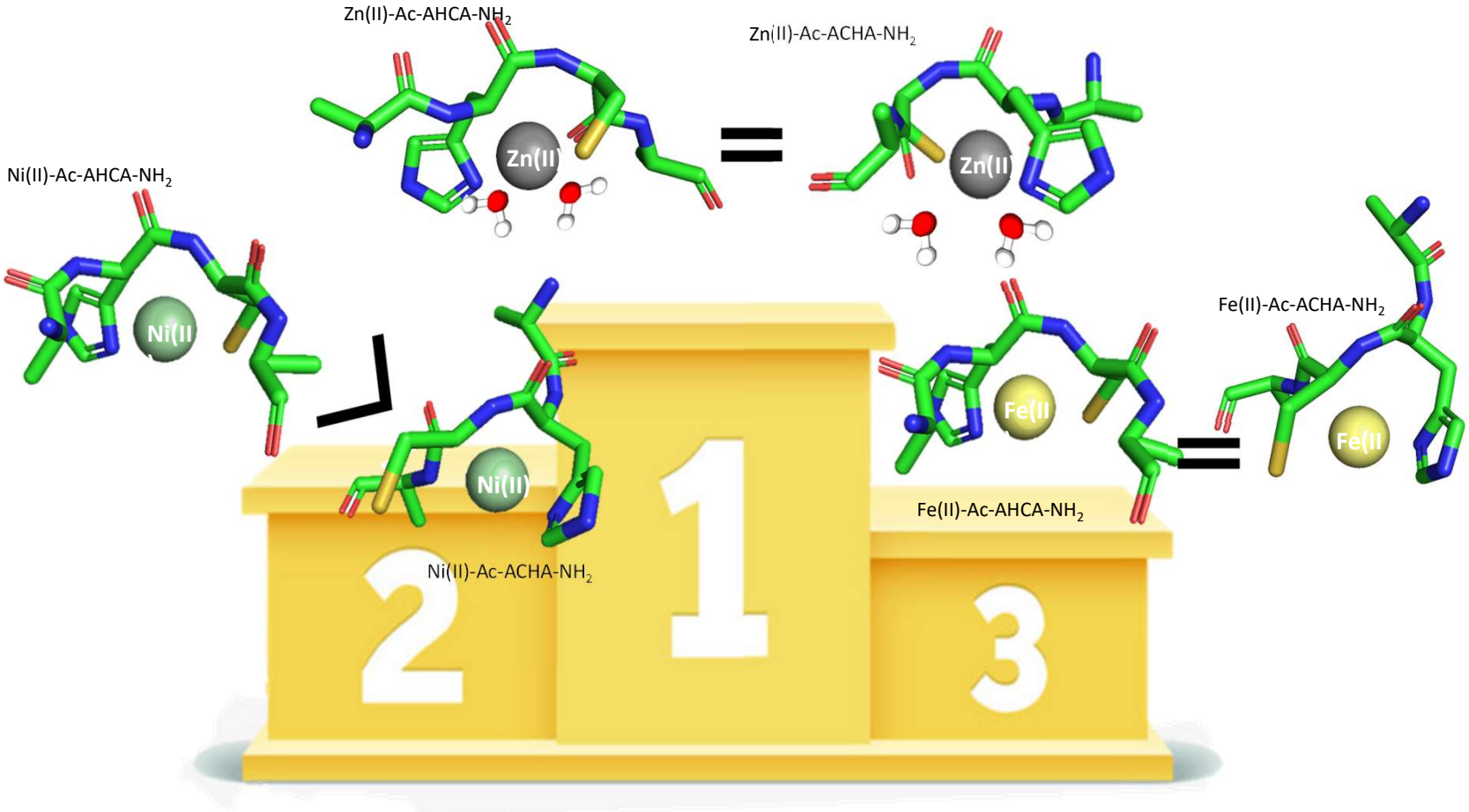
Cite this: *Inorg. Chem.* 2023, 62, 45, 18425−18439
Publication Date: November 1, 2023
https://doi.org/10.1021/acs.inorgchem.3c02391





CH vs. HC-Promiscuous Metal Sponges in Antimicrobial Peptides and Metallophores

Molecules, 2023, **28**, 3985/1-3985/14
DOI:10.3390/molecules28103985

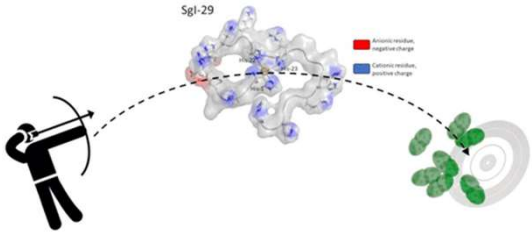


Garstka, K.; Dzyhovskyi, V.; Wątły, J.; Stokowa-Sołtys, K.; Świątek-Kozłowska, J.; Kozłowski, H.; Barceló-Oliver, M.; Bellotti, D.; Rowińska-Żyrek, M.
CH vs. HC—Promiscuous Metal Sponges in Antimicrobial Peptides and Metallophores, Molecules, 2023, **28**, 3985/1-3985/14, DOI:10.3390/molecules28103985

Semenogelins Armed in Zn(II) and Cu(II): May Bioinorganic Chemistry Help Nature to Cope with *Enterococcus faecalis*?

Dorota Dudek, Adriana Miller, Aleksandra Hecel, Arian Kola, Daniela Valensin, Aleksandra Mikołajczyk, Miquel Barcelo-Oliver, Agnieszka Matera-Witkiewicz, and Magdalena Rowińska-Żyrek*

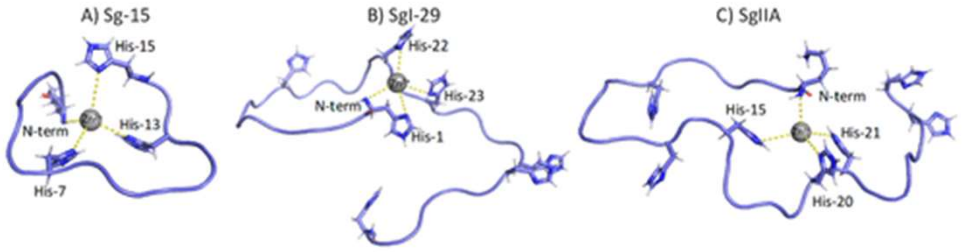
Cite this: *Inorg. Chem.* 2023, 62, 34, 14103−14115
Publication Date: August 15, 2023
https://doi.org/10.1021/acs.inorgchem.3c02390



The Cu(II)-induced antimicrobial activity of Sg-15 against *Enterococcus faecalis* is shown.

The most abundant proteins from human semen, results in the formation of 26- and 29-[illegible] respectively), which share a common 15

Sgl-29	HNKQEGRDHDKSKGHFHRVVIHHKGGKAH
SgIIA	KQEGRDHDKSKGHFHMIVIHHKGGQAHHG
Sg15 (common region)	KQEGRDHDKSKGHFH



Joint work on the characterization of Fe(II) bacterial transporters

Bartosz Orzeł MSc

Prof. Elżbieta Gumienna-Kontecka

Uniwersytet Wrocławski

Prof. Massimiliano Francesco Peana

Università degli Studi di Sassari

Inorganic Chemistry

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pubs.acs.org/IC

Article

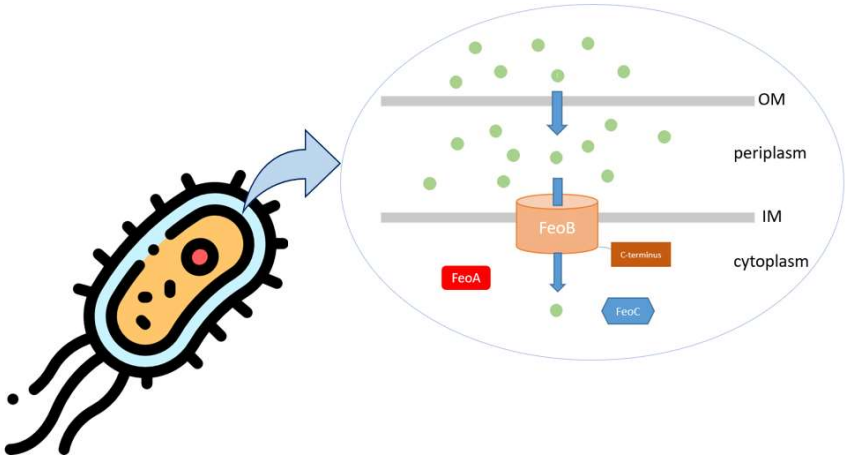
Fe(II), Mn(II), and Zn(II) Binding to the C-Terminal Region of FeoB Protein: An Insight into the Coordination Chemistry and Specificity of the *Escherichia coli* Fe(II) Transporter

Bartosz Orzel, Alessio Pelucelli, Malgorzata Ostrowska, Sławomir Potocki, Henryk Kozlowski, Massimiliano Peana, and Elzbieta Gumienna-Kontecka*

Cite This: *Inorg. Chem.* 2023, 62, 18607−18624

Read Online

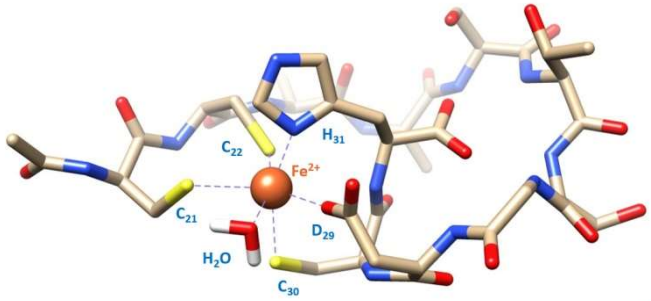
Iron(II) bacterial transporters, such as **Feo system**, are crucial for bacterial survival and pathogenicity.

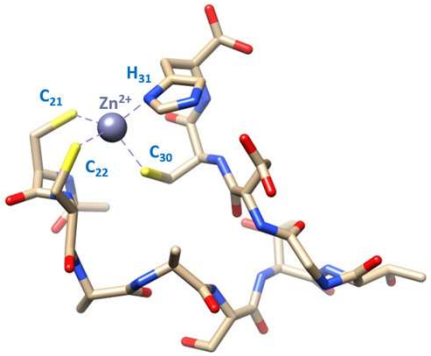


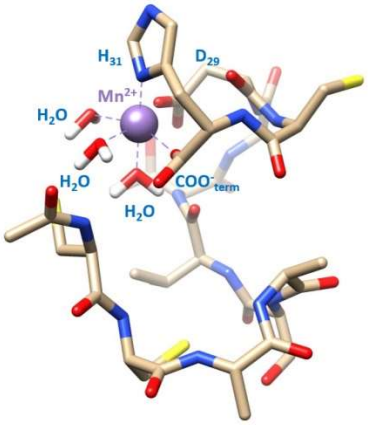
B. Orzeł, A. Pelucelli, M. Ostrowska, S. Potocki, H. Kozłowski, M. Peana, E. Gumienna-Kontecka, *Inorganic Chemistry* **2023**, 62(45), 18607–18624.

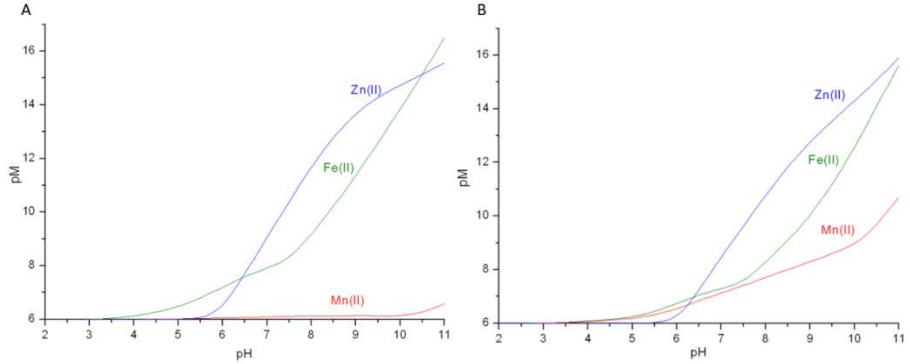
Ac- $C_{21}C_{22}A_{23}A_{24}S_{25}T_{26}T_{27}G_{28}D_{29}C_{30}H_{31}$ P1

Ac- $R_1R_2A_3R_4S_5R_6V_7D_8I_9E_{10}L_{11}L_{12}A_{13}T_{14}R_{15}K_{16}S_{17}V_{18}S_{19}S_{20}C_{21}C_{22}A_{23}A_{24}S_{25}T_{26}T_{27}G_{28}D_{29}C_{30}H_{31}$ P2









Comparison of K_d values for studied and biological ligands for Fe(II), Zn(II) and Mn(II).[a]

Ligand	Fe(II)	Mn(II)	Zn(II)	Ref.
P2	$4.75\cdot10^{-7}$	$7.02\cdot10^{-7}$	$6.31\cdot10^{-8}$	This work
E.coli Fur	$1.2\cdot10^{-6}$	$2.4\cdot10^{-5}$	$1.4\cdot10^{-10}$	78
S.pyogenes MtsA	$4.3\cdot10^{-6}$	-	-	79
B.subtilis MntR	-	$0.2\cdot10^{-6}$-$2\cdot10^{-6}$	-	80
Y.pestis YfeA	-	$1.78\cdot10^{-8}$	$6.6\cdot10^{-9}$	81
T.pallidum TroA	-	$7.1\cdot10^{-9}$	$2.25\cdot10^{-8}$	82
D.radiodurans MntH	-	$1.9\cdot10^{-4}$	-	83
Synechocystis ZnuA	-	-	$7.3\cdot10^{-9}$	84

[a] K_d values calculated for our systems as: $Kd = \frac{[M][L]}{[ML]}$ at pH=7.0.

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A. Rola, O. Palacios, M. Capdevila, D. Valensin, E. Gumienna-Kontecka & S. Potocki; *Inorganic Chemistry* (2023), **62**, 6893–6908. DOI: 10.1021/acs.inorgchem.2c04486
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DOI: 10.1021/acs.inorgchem.3c02390
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(collaboration: University of Wroclaw, Poland + University of Siena, Italy + Universitat Autònoma de Barcelona, Spain)

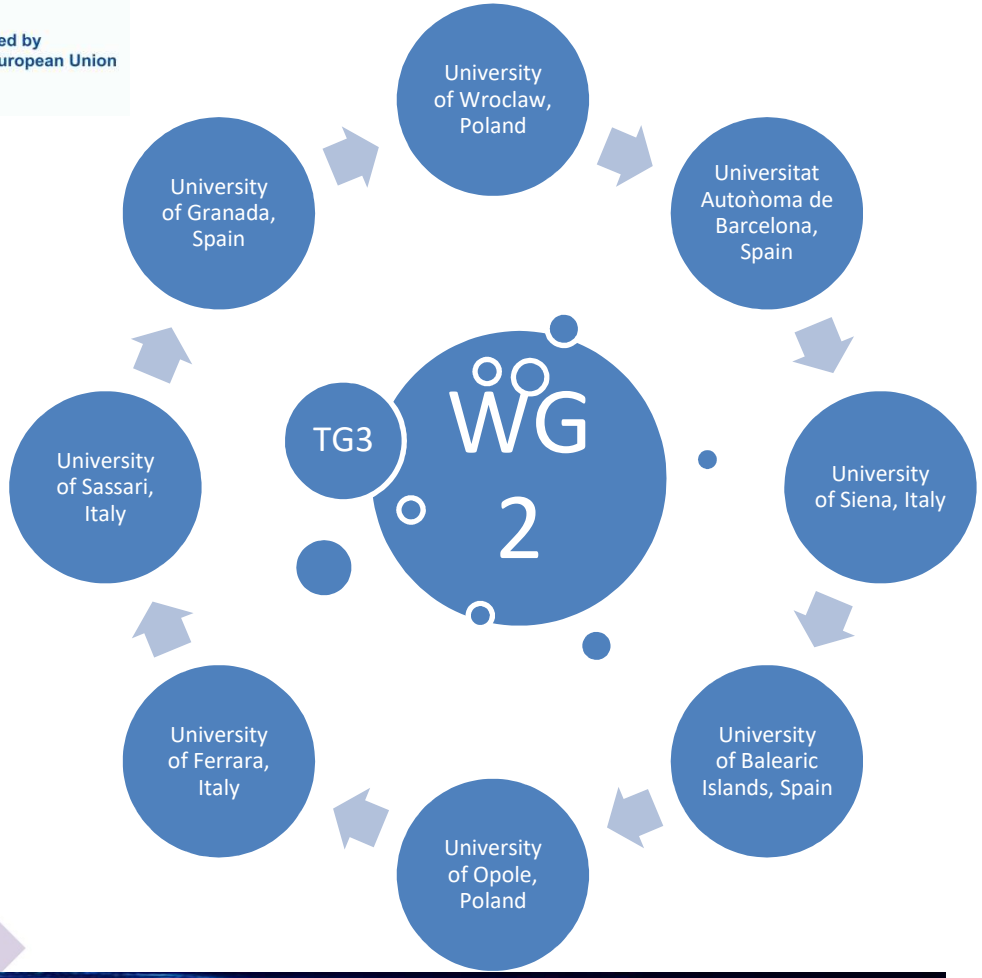
"Fe(II), Mn(II), and Zn(II) Binding to the C-Terminal Region of FeoB Protein: An Insight into the Coordination Chemistry and Specificity of the Escherichia coli Fe(II) Transporter."
B. Orzel, A. Pelucelli, M. Ostrowska, S. Potocki, H. Kozlowski, M. Peana & E. Gumienna-Kontecka; *Inorganic Chemistry* (2023), **62**, 18607−18624. DOI: 10.1021/acs.inorgchem.3c02910
(collaboration: University of Wrocław and University of Opole, Poland + University of Sassari, Italy)

"The N-terminal domain of Helicobacter Pylori's Hpn protein: the role of multiple histidine residues."
D. Bellotti, A. Sinigaglia, R. Guerrini, E. Marzola, M. Rowińska-Żyrek, M. Remelli; *J. Inorg. Biochem.* (2021), **214**, 111304. DOI: 10.1016/j.jinorgbio.2020.111304
(collaboration: University of Ferrara, Italy + University of Wroclaw, Poland)

"Novel insights into the metal binding ability of ZinT periplasmic protein from Escherichia coli and Salmonella enterica."
D. Bellotti, M. Rowińska-Żyrek, M. Remelli; *Dalton Trans.* (2020), **49**, 9393–9403. DOI: 10.1039/D0DT01626H
(collaboration: University of Ferrara, Italy + University of Wroclaw, Poland)

"Exploring the specificity of rationally designed peptides reconstituted from the cell-free extract of Deinococcus radiodurans toward Mn(II) and Cu(II)."
M. Peana, E. Gumienna-Kontecka, F. Piras, M. Ostrowska, K. Piasta, K. Krzywoszyńska, S. Medici, M. A. Zoroddu; *Inorg. Chem.* (2020), **59**, 4661–4684. DOI: 10.1021/acs.inorgchem.9b03737
(collaboration: University of Wroclaw, Poland + University of Sassari, Italy + Public Higher Medical Professional School, Poland)

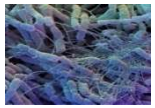
"Zinc(II) – the overlooked éminence grise of chloroquine's fight against COVID-19?"
A. Hecel, M. Ostrowska, K. Stokowa-Sołtys, J. Watły, D. Dudek, A. Miller, S. Potocki, A. Matera-Witkiewicz, A. Domínguez-Martin, H. Kozłowski, M. Rowinska-Zyrek; *Pharmaceuticals* (2020), **13**, 228.
DOI: 10.3390/ph13090228
(collaboration: University of Granada, Spain + University of Wroclaw, Poland + Public Higher Medical Professional School, Poland)


University of Wroclaw, Poland
Universitat Autònoma de Barcelona, Spain
University of Siena, Italy
University of Balearic Islands, Spain
University of Opole, Poland
University of Ferrara, Italy
University of Sassari, Italy
University of Granada, Spain
TG3
WG 2

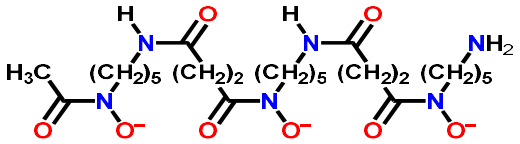
TG4

Task Group 4
Metallophores

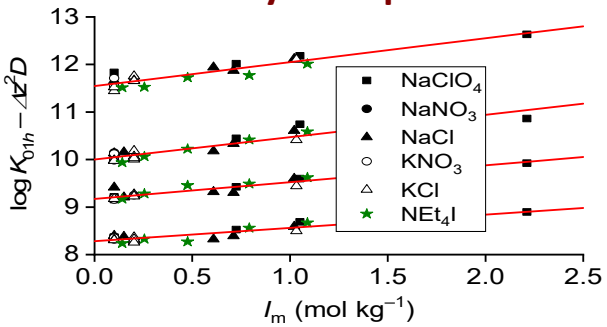
New Insights into the Acid-Base Properties of DFO



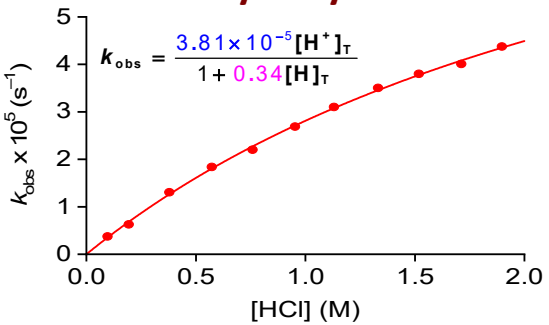
Streptomyces sp.



SIT analysis of pKa's



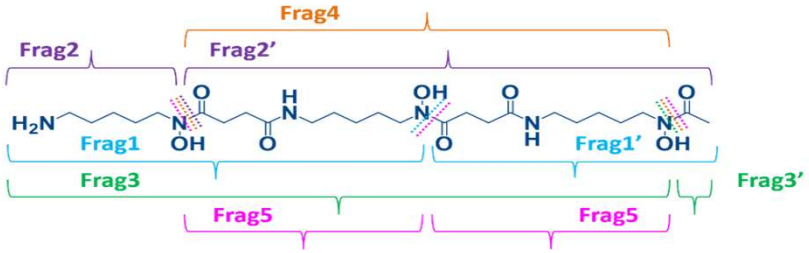
H$^+$-assisted hydrolysis kinetics



New pKa measurements in NEt$_4$I

I (M)	log $K_1 \pm 2\sigma$	log $K_2 \pm 2\sigma$	log $K_3 \pm 2\sigma$	log $K_4 \pm 2\sigma$
0.138	10.79 ± 0.03	9.46 ± 0.02	8.94 ± 0.02	8.25 ± 0.03
0.243	10.67 ± 0.02	9.50 ± 0.02	9.01 ± 0.02	8.35 ± 0.02
0.436	10.73 ± 0.02	9.57 ± 0.01	9.15 ± 0.01	8.31 ± 0.02
0.689	10.67 ± 0.03	9.70 ± 0.01	9.16 ± 0.01	8.62 ± 0.02
0.905	10.85 ± 0.04	9.84 ± 0.01	9.29 ± 0.02	8.75 ± 0.03

LCMS analysis of the fragmentation pattern



In collaboration with C. Bretti

In collaboration with S. Gama

Metal-complexes as Potential drugs

Journal of Molecular Liquids 396 (2024) 124027

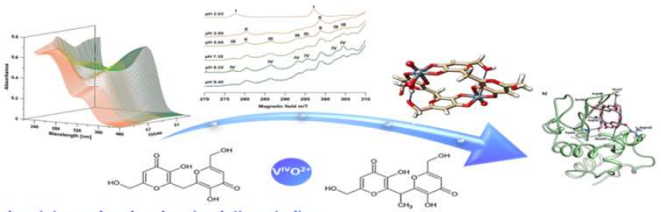
Contents lists available at ScienceDirect

Journal of Molecular Liquids

journal homepage: www.elsevier.com/locate/molliq

Solution chemistry of oxidovanadium(IV) complexes with two bis-kojic acid derivatives

Rosita Cappai [a,b,*], Alessandra Fantasia [b], Giuseppe Sciortino [c], Daniele Sanna [d], Federico Pisanu [e], Eugenio Garribba [e], M. Amélia Santos [f], Guido Crisponi [b], Valeria M. Nurchi [b]



Solution chemistry and molecular simulation studies on the oxidovanadium(IV) complexes with two bis-kojic acid derivatives

molecules

MDPI

Article

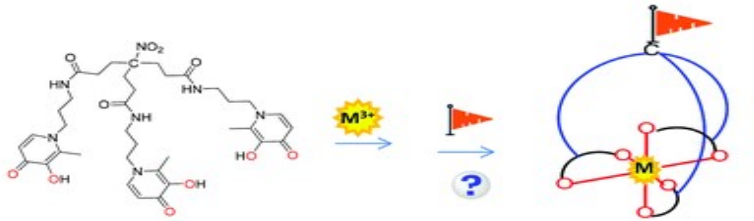
A Multi-Technique Investigation of the Complex Formation Equilibria between Bis-Deferiprone Derivatives and Oxidovanadium (IV)

Rosita Cappai [1], Alessandra Fantasia [1], Guido Crisponi [1], Eugenio Garribba [2], M. Amélia Santos [3] and Valeria Marina Nurchi [1,*]

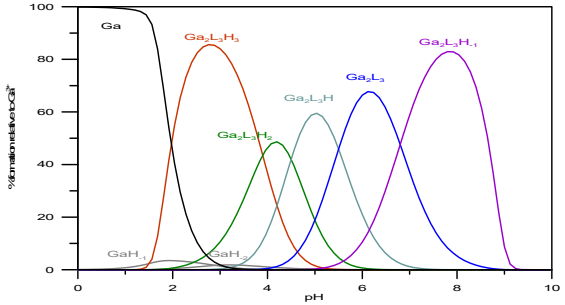
Metal-complexes as Potential drugs

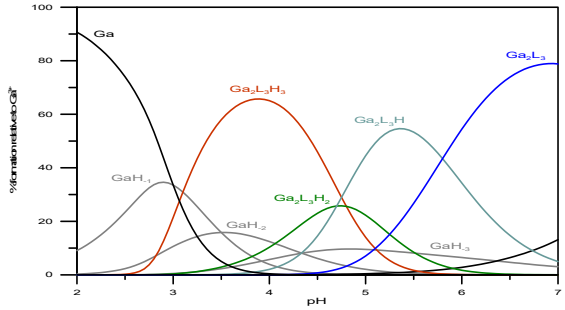
Gd(III) and Ga(III) complexes with a new tris-3,4-HOPO ligand as new imaging probes: complex stability, magnetic properties and biodistribution

S. Chaves, K. Gwizdała, K. Chand, a L.Gano, A Pallier, É. Tóth, M. A. Santos, | *Dalton Trans*., 2022, 51, 6436–6447, https://doi.org/10.1039/D2DT00066K (*coll*. **Portugal, France , Poland**)



Ga(III) complexes with biskojic acids as new metallophoress: complex stability, and biological properties. D. Griffith, R. Cappai , M.A.Santos *et al*. (work in progress) (*coll*. **Ireland , Italy , Portugal**)

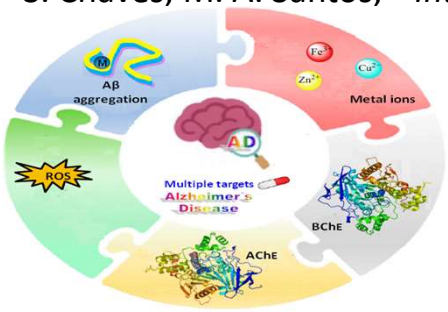


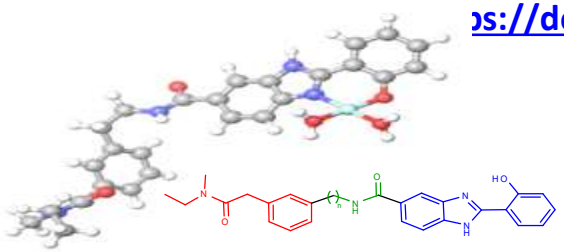


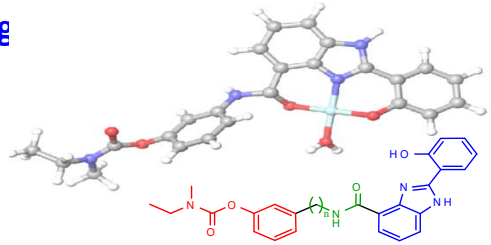
Multitarget metal chelators for potential therapy of Alzheimer´s Disease (AD)

Rivastigmine–Benzimidazole Hybrids as Promising Multitarget Metal-Modulating Compounds for Potential Treatment of Neurodegenerative Diseases" ,

D. Vicente-Zurdo, L. Brunetti, L. Piemontese, B. Guedes, S.M Cardoso, D. Chavarria, F. Borges , Y. Madrid, Y. Madrid, S. Chaves, M. A. Santos, " *Int. J.* https://doi.org

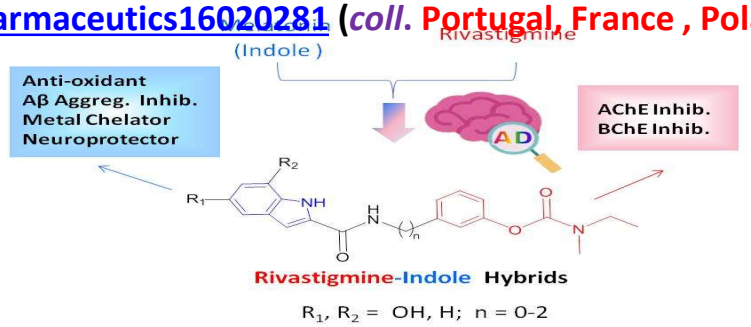






New Multitarget Rivastigmine-Indole Hybrids as Potential Drug Candidates for Alzheimer´s Disease",

L. Bon , A. Banás , I. Dias , I Melo-Marques , S. M. Cardoso, S. Chaves, M. A. Santos, *Pharmaceutics* **2024**, *16*(2), 281; https://doi.org/10.3390/pharmaceutics16020281 (*coll.* Portugal, France , Poland)



TG5

Task Group 5
Calorimetry

Milazzo, Feb
26-27 2024

WG2
Task Group n.5 on Calorimetry

ITC study of multiple host-guest complex formation: an interlaboratory exercise

Research groups from:

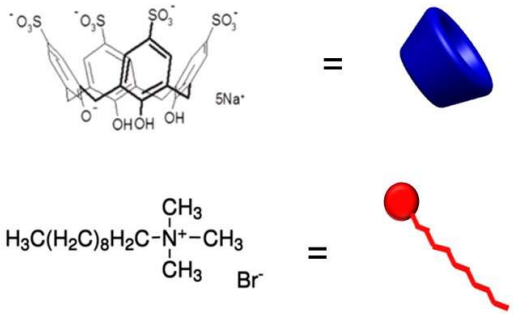
Catania, Ferrara, Firenze, Ljubljana,
Messina, Strasbourg, Udine, Wroclaw

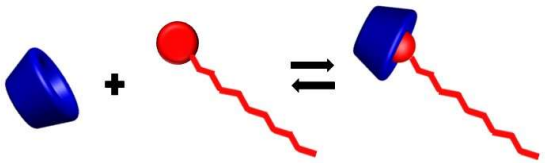
Main goals of WG2 - TG5

- Experimental design/conditions for the analysis of multiple equilibria
- Data refinement: use proper chemical models and software
- Critical comparison of data/results obtained by different labs, instruments, software
- Guidelines on the correct use of ITC data for the study of solution equilibria
- Training people: invite researchers to deal/interact with trained people, STSM

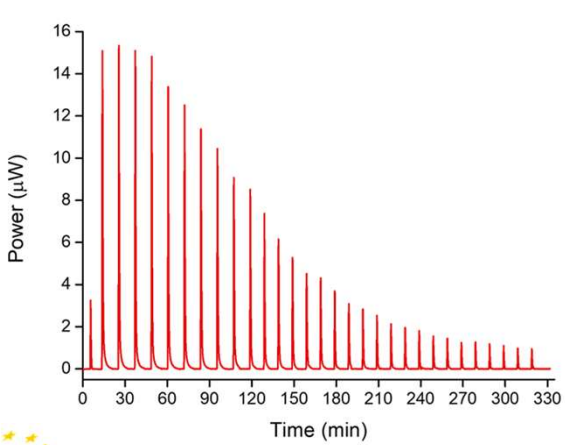
inter-laboratory exercise → «best practices» protocol

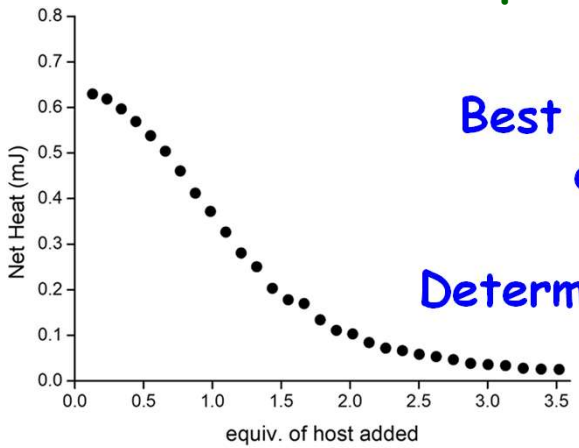
ITC titration for a host-guest 1:1 complex in buffered aqueous solution





Simple host-guest equilibrium

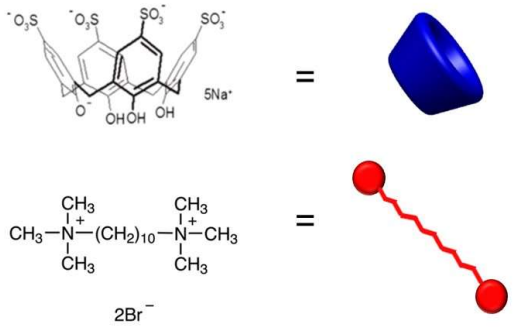


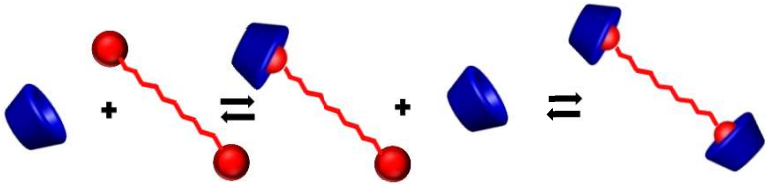


Best experimental design and data analysis model

Determination of accurate K and ΔH values

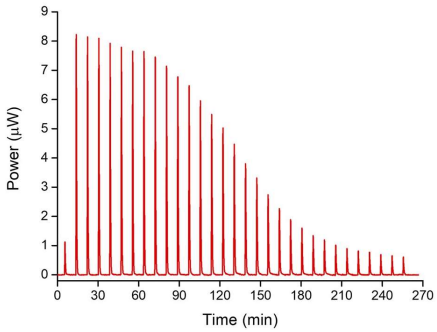
ITC titrations for host-guest 1:1 and 2:1 complexes in buffered aqueous solution

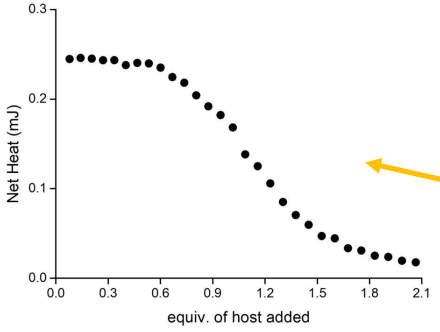


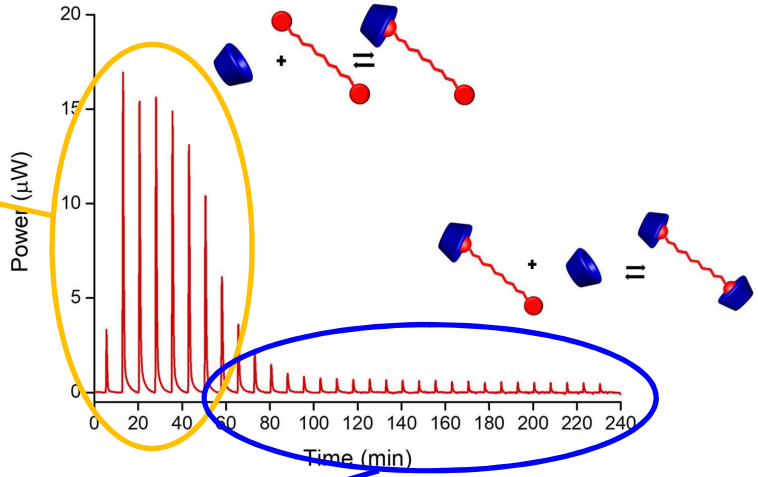


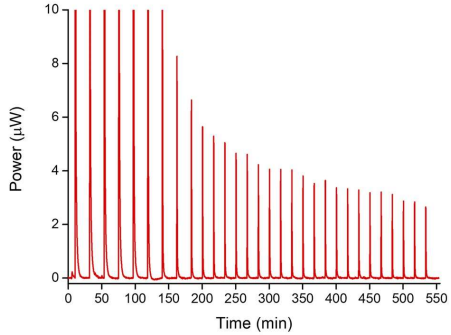
Multiple host-guest equilibria

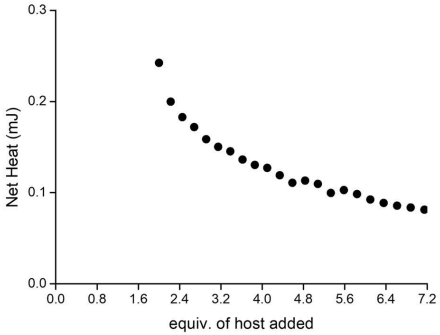
ITC titration for host-guest 1:1 and 2:1 complexes in buffered aqueous solution











Issues in the heat measurement!!

Careful experimental design needed for the determination of accurate K and ΔH values

WG2
Task Group n.5 on Calorimetry

- Proper design of ITC experiments to measure reliable heat values for the different complexation steps of multiple equilibria.

- The appropriate data refinement should include all the equilibria occurring in solution and the exact stoichiometry of the species rather than "obscure" binding models used by most software.

- The results from this excercise will contribute to prepare new guidelines on correct experimental design and data analysis in ITC titrations.

THANK YOU FOR THE GREAT TIME!!
LET'S KEEP IN TOUCH