Peptides as receptors for metal ions in potentiometric chemical sensors

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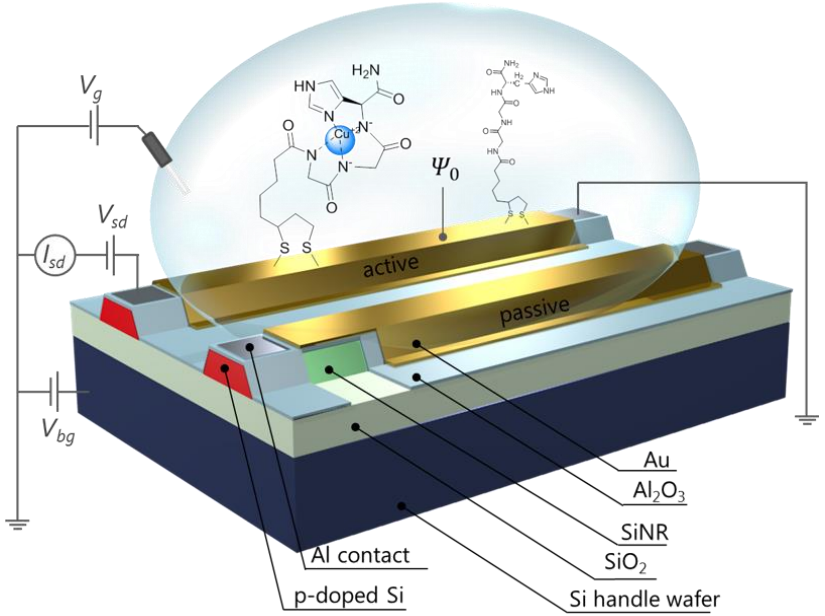
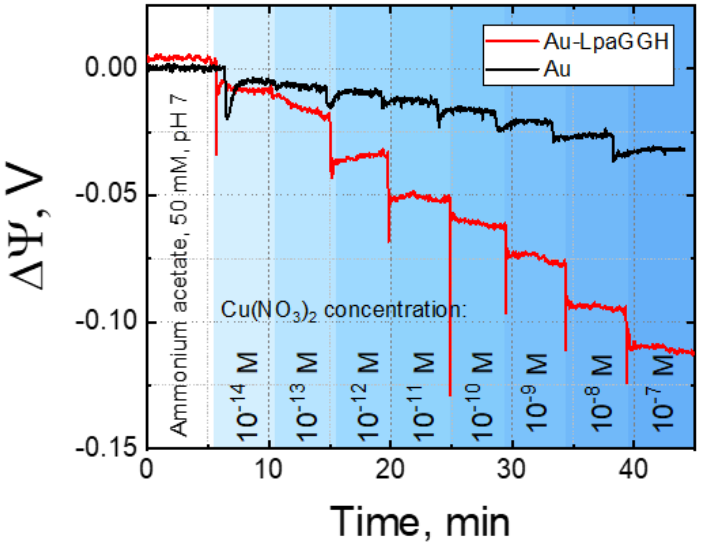
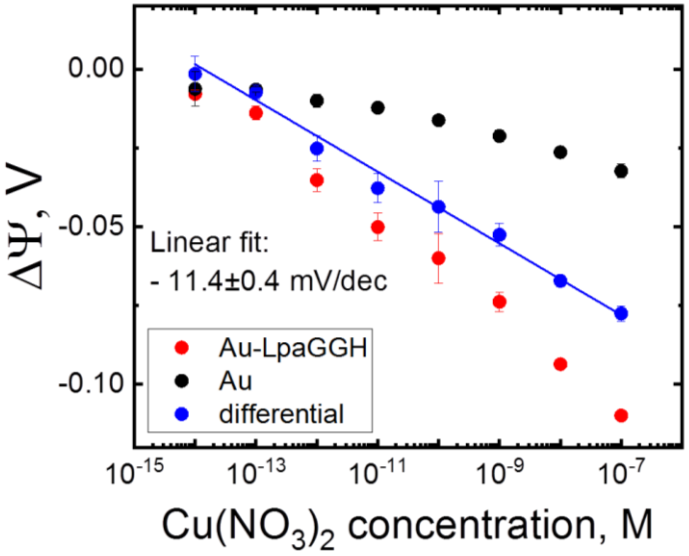


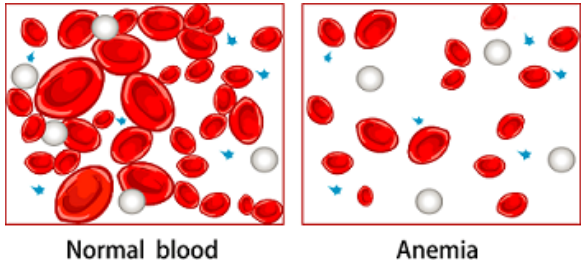




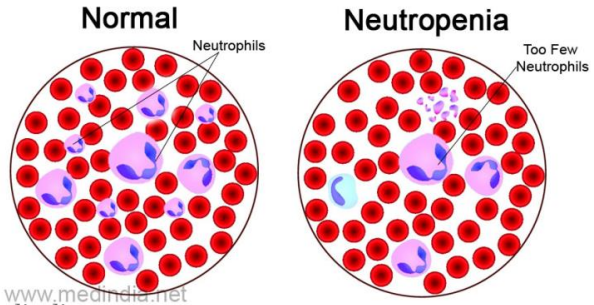
Importance of monitoring copper concentration

Copper deficiency

anemia, neutropenia, bone abnormalities



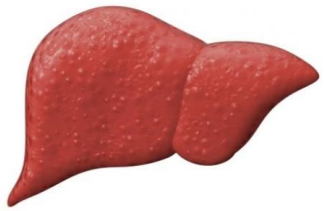
niddk.nih.gov



medindia.net

Elevated copper concentrations

damage of the liver, brain and other organs, copper poisoning



medicalnewstoday.com

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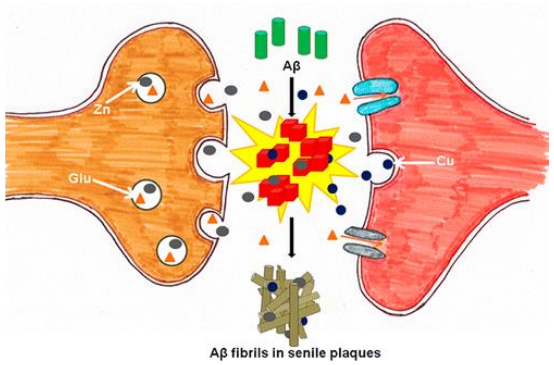
npic.orst.edu

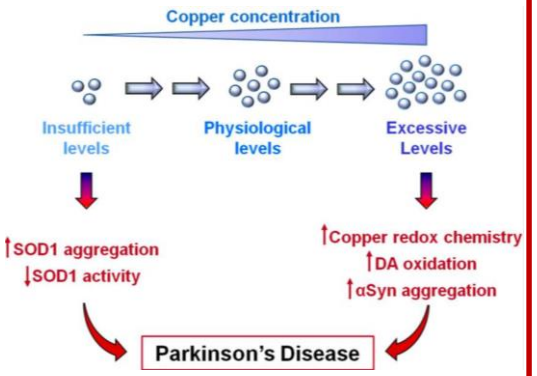
ck12.org

Neurodegenerative diseases

Copper plays an important role in the pathogenesis of Alzheimer's and Parkinson's diseases



Faller et al. Inorg. Chem. 2013



Bisaglia, et. al. Biomolecules 2020

Monitoring of copper concentration is necessary

Working principle of ISFET

State of the art

flame and electrothermal atomic absorption spectrophotometry, atomic emission spectrometry with inductively coupled plasma

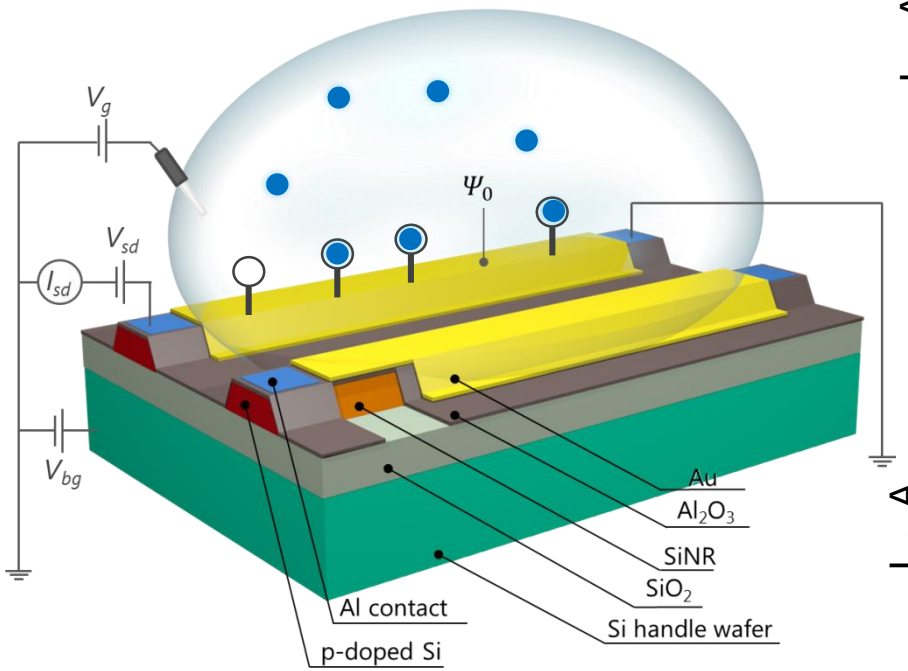
- remain expensive
- sample pre-treatment
- large sample quantities
- time-consuming

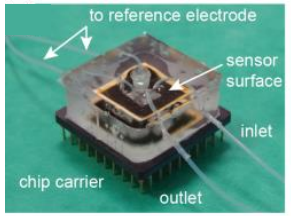
ISFET

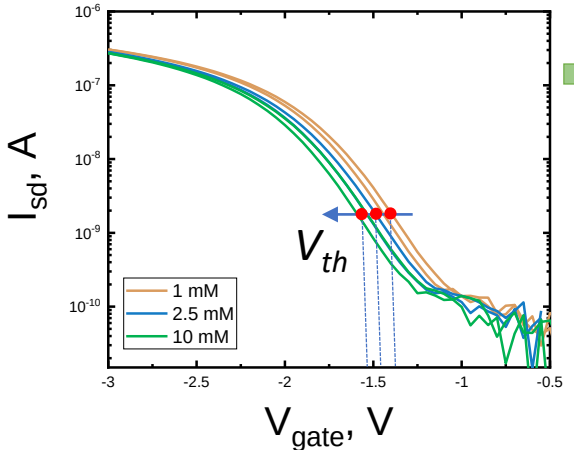
ion-sensitive field-effect transistor

- compact
- convenient in use
- low production cost perspectives
- small sample volume
- differential measurements

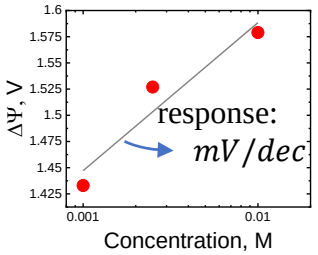
ion-sensitive field-effect transistor

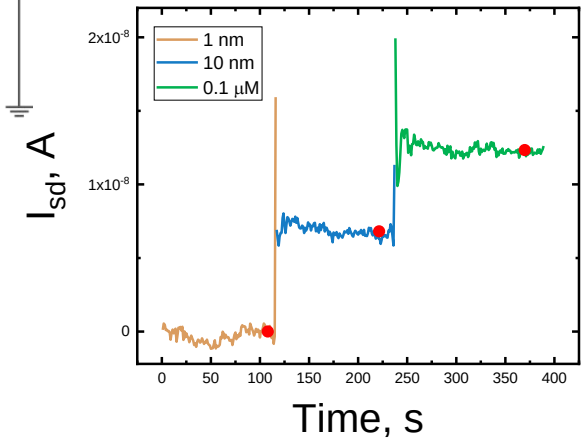




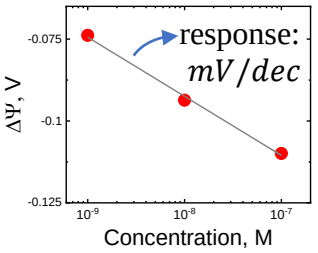


$$\Delta\Psi = -\Delta V_{th}$$





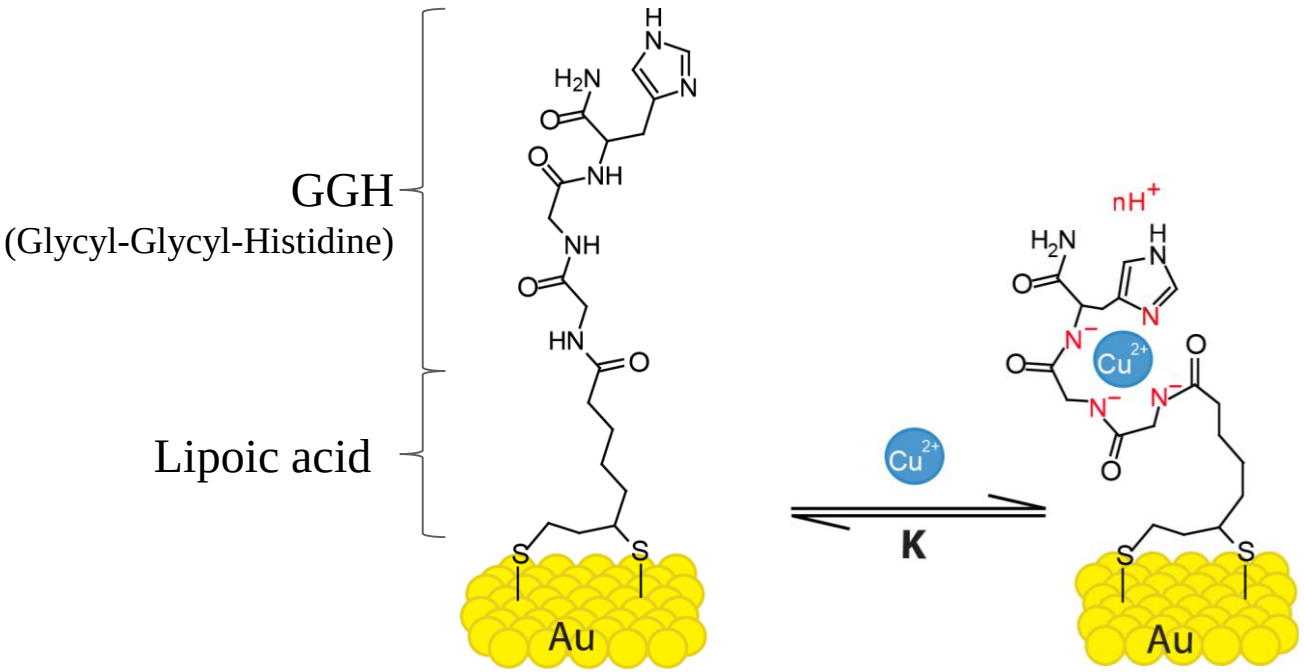
$$\Delta\Psi = -\frac{\Delta I_{sd}}{g_m}$$



ISFETs convert chemical reaction into an electric signal

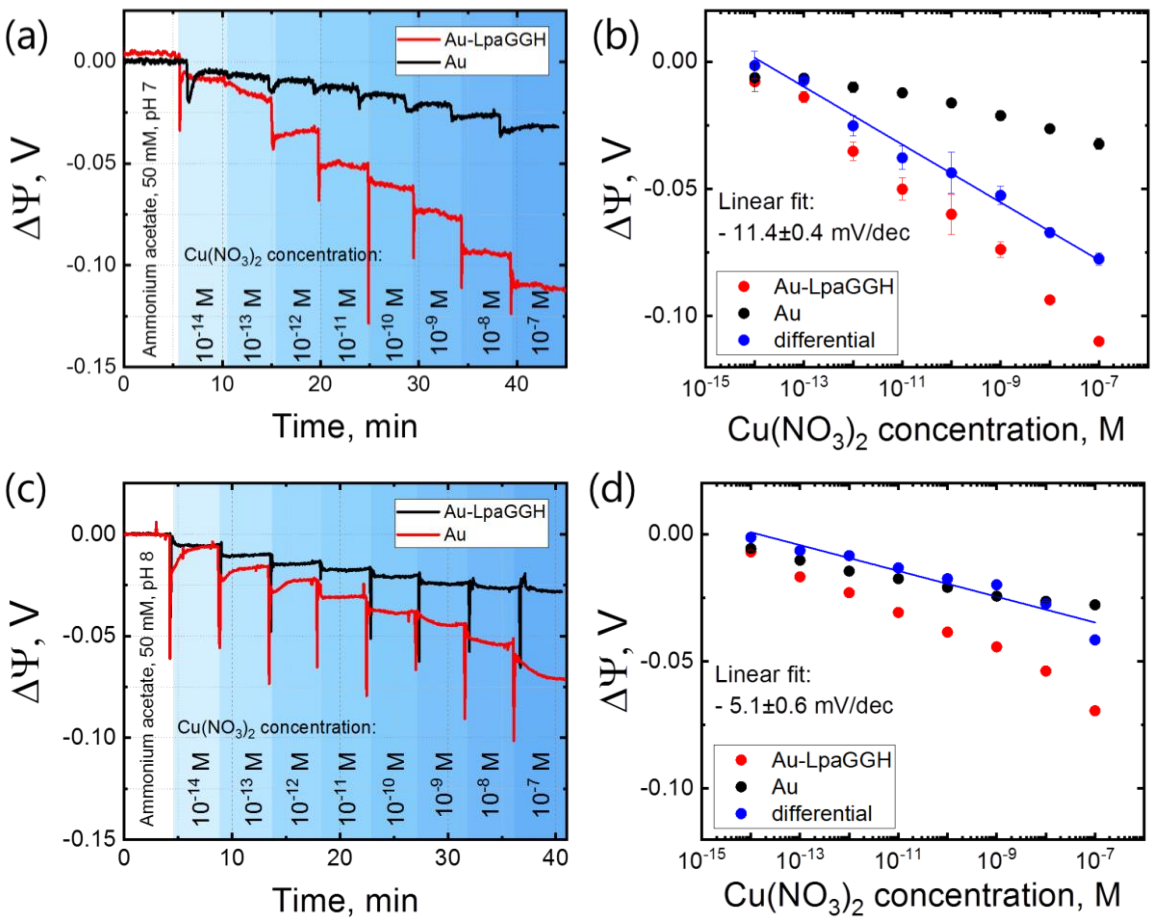
GGH peptide as a receptor for copper ions and response of the GGH ligand to $Cu(NO_3)_2$ in the low concentration range

- Peptides are present in the human body and participate in important processes
- Selective to certain metal ions



Lpa-GGH monolayer on a gold surface and the complexation of Cu^{2+} ions.

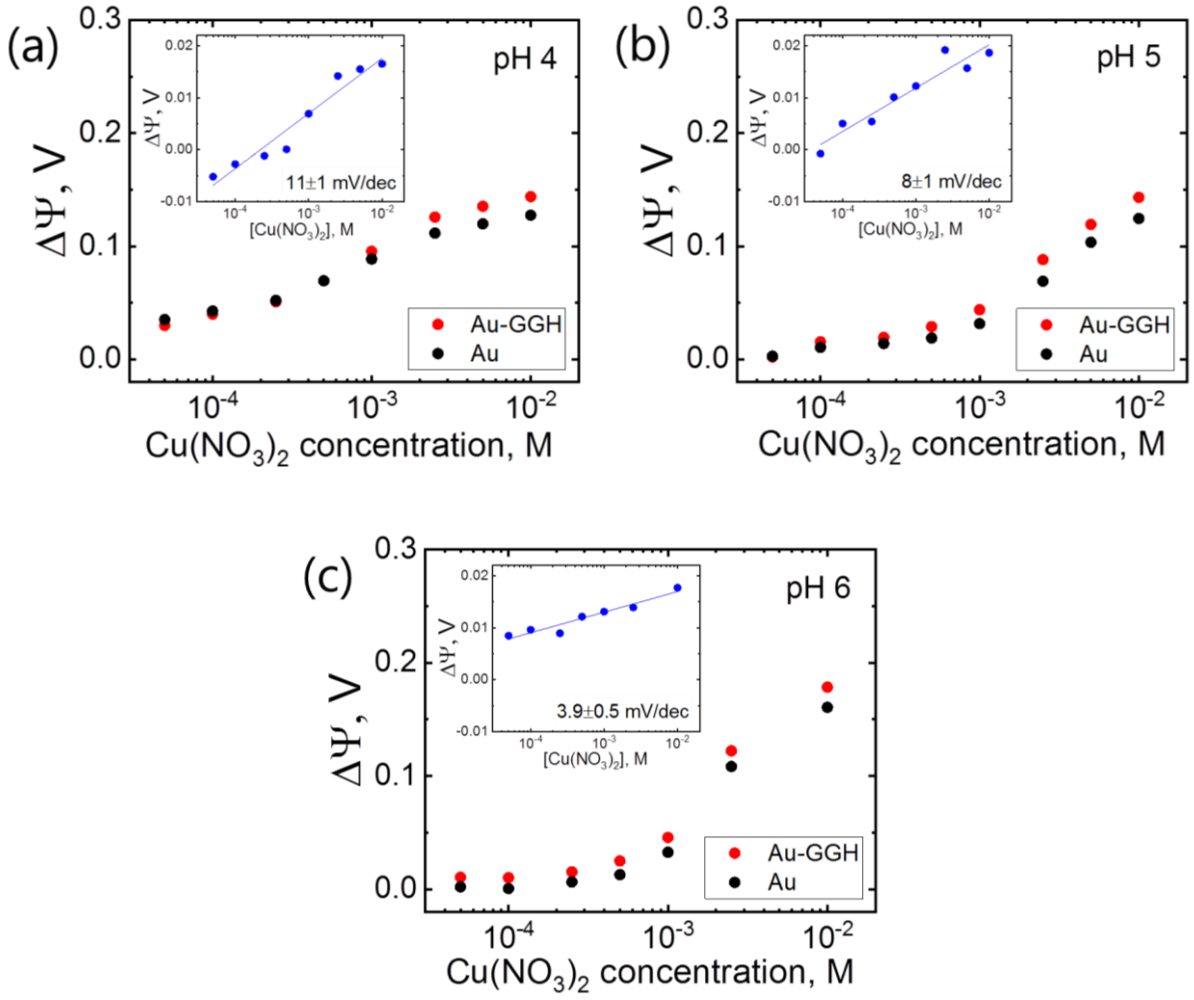
Complex chelation mechanism

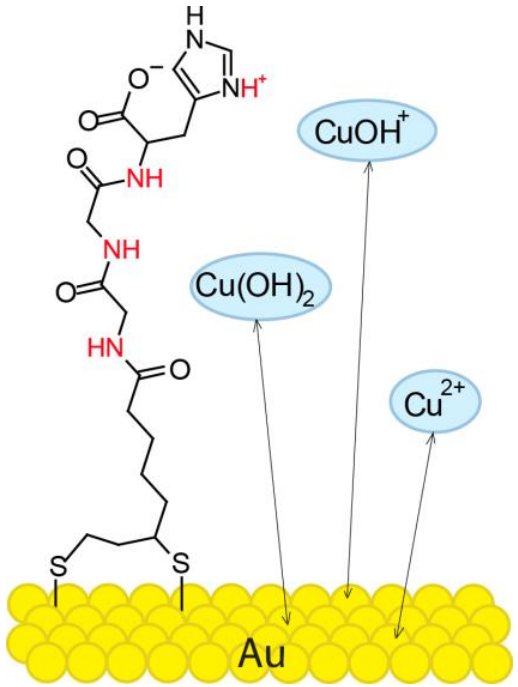


pH of the electrolyte solution significantly affects the device's response

O. Synhaivska et al., Sensors 2019

Response of the GGH ligand to $Cu(NO_3)_2$ in the high concentration range



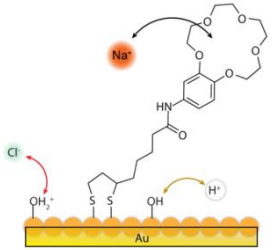


Non-specific adsorption is a dominating factor at high concentrations

O. Synhaivska et al., Sensors 2019

Conclusions & Outlook

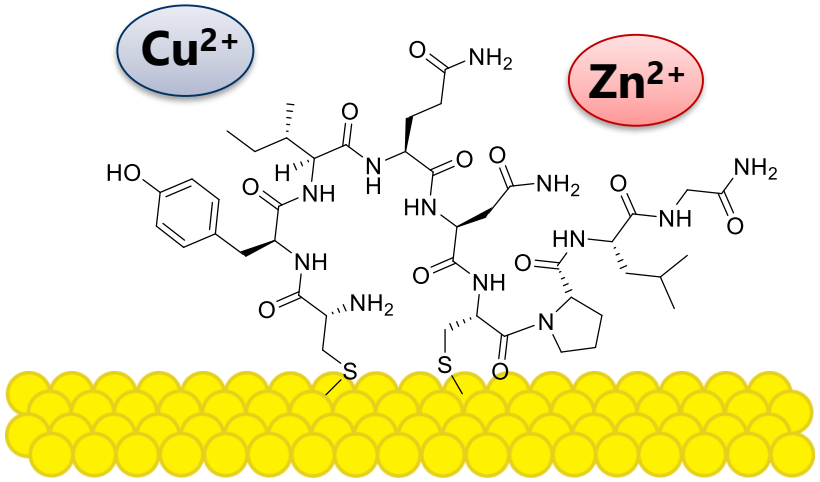
- Peptides are more sensitive to the environmental conditions compared to more simple molecules, such as crown ethers



M. Wipf et al. ACS Nano (2013)

- Non-specific adsorption dominates the devices response in the high concentration range

- We are exploring more complex systems for detection of multiple ions



Neuropeptide Oxytocin