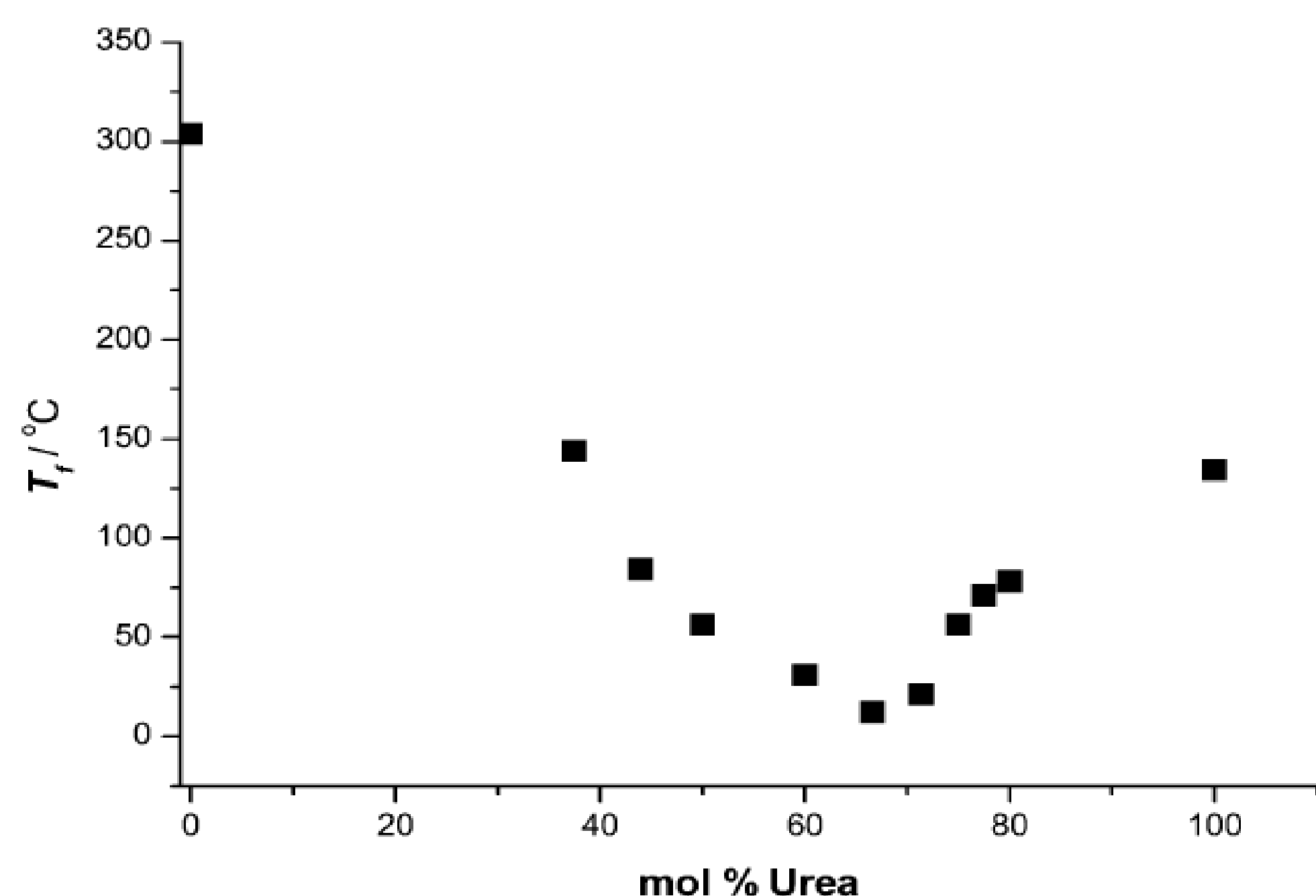


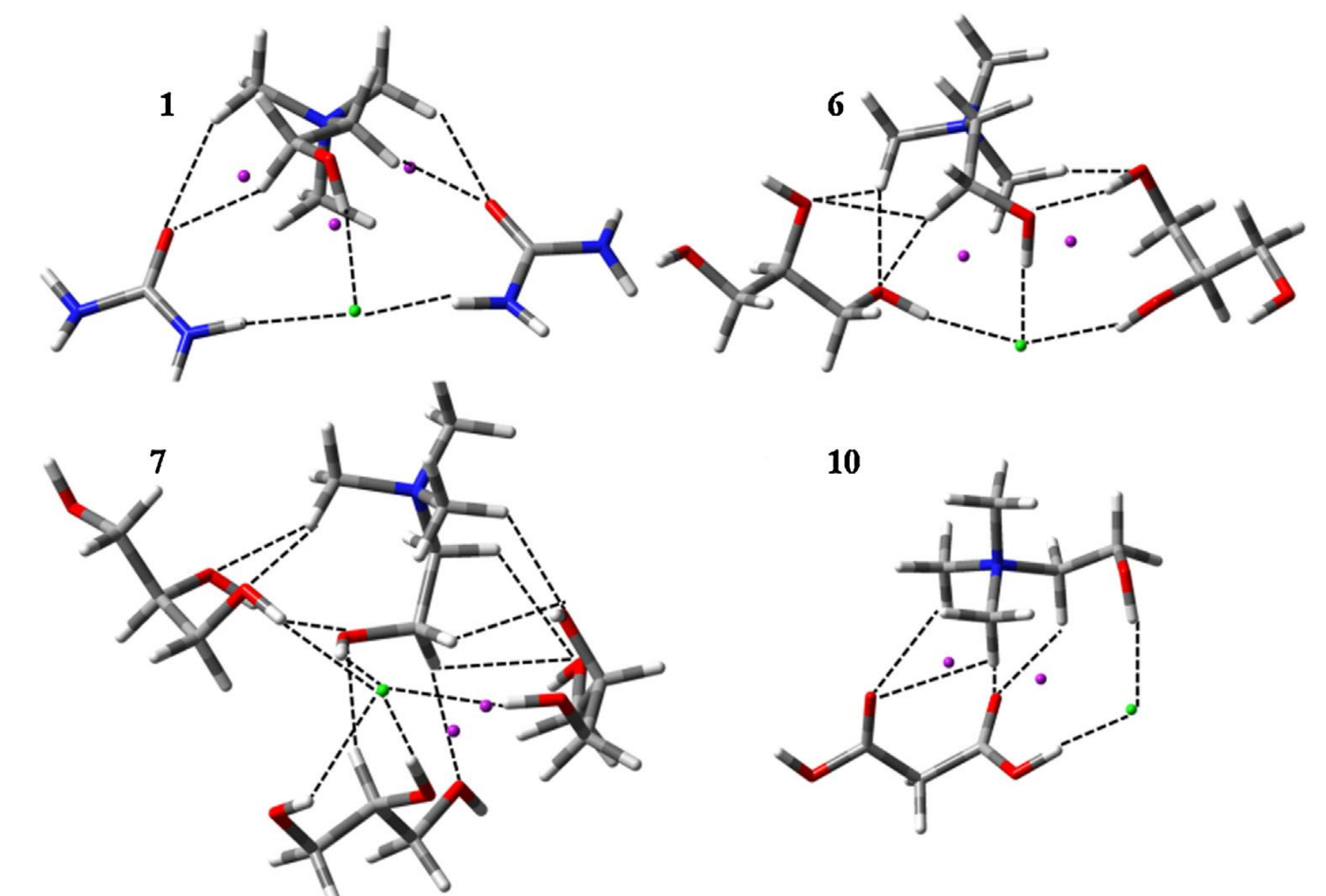
The green solvents of tomorrow: Natural deep eutectic solvents in biocatalytic reactions

Natural deep eutectic solvents (NADES) are a mixture of two or more naturally derived organic compounds with a largely decreased melting point. Their **biodegradability, low toxicity, negligible volatility, low price and tailorable properties** make them an alternative for common organic solvents as green reaction media, especially for (bio)catalytic reactions.



Melting point depression of choline chloride/urea mixtures as a function of composition (Abbot. et al., 2003)

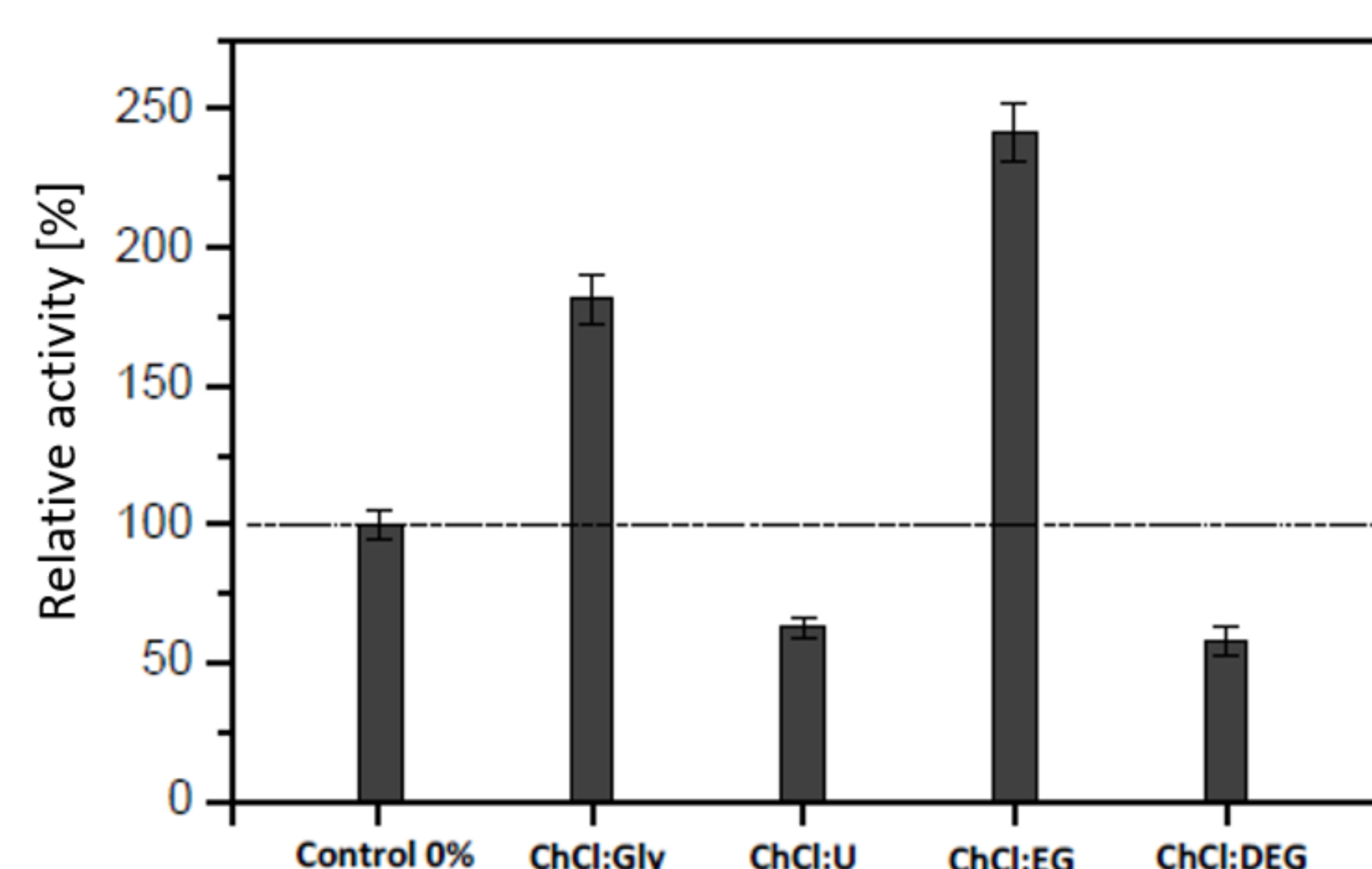
Melting point depression caused by the **intermolecular hydrogen bonding network** formed between the components.



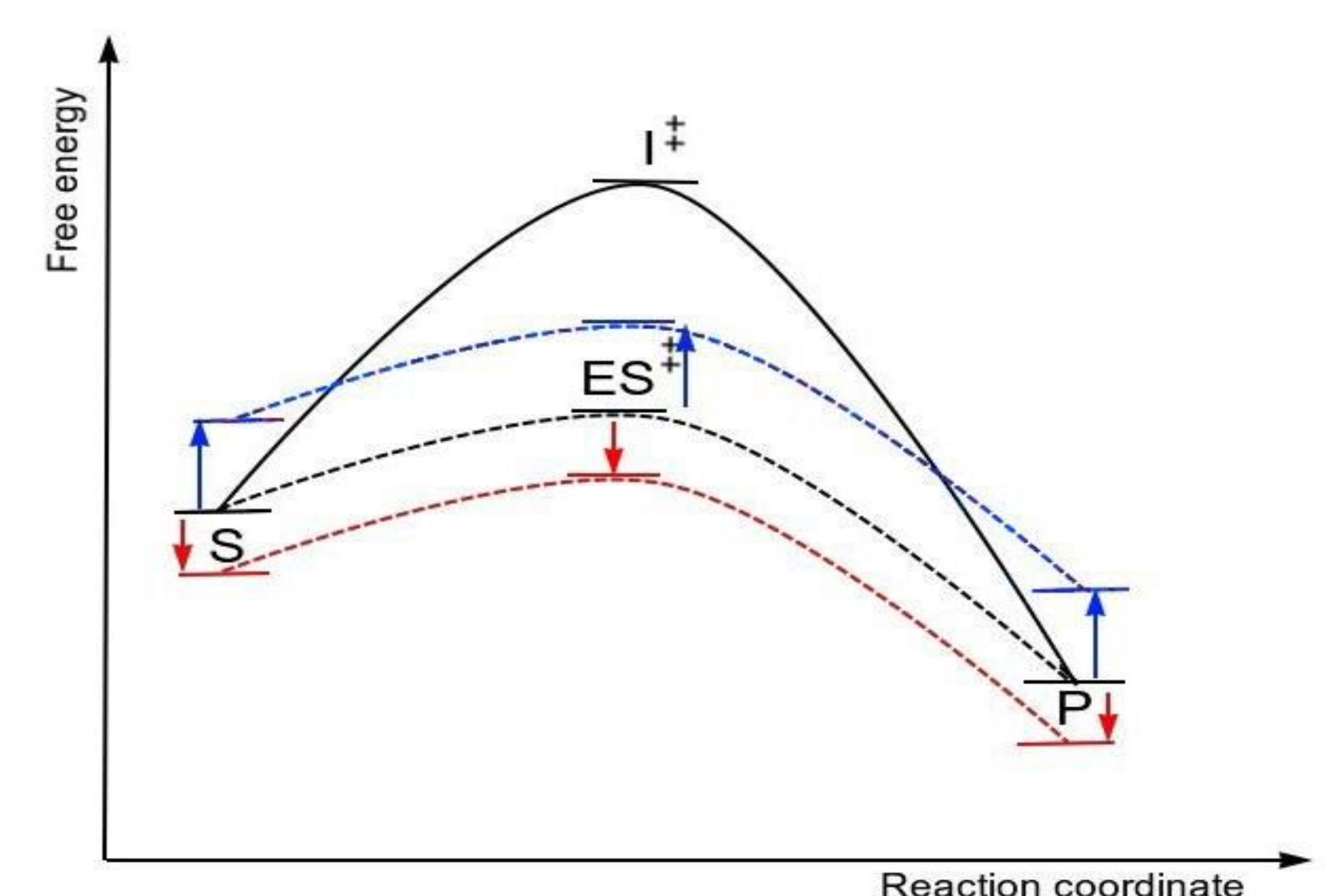
Optimal structures of the intermolecular hydrogen bonding in choline chloride/urea eutectic mixture according to density functional theory modeling (García et al., 2015)

NADES effect on biocatalysis

The **intermolecular hydrogen bonding network** also interacts with the actors in enzyme catalyzed reactions. The **influence of NADES on biocatalytic reactions** as reaction media is complex and **not described**, therefore their effective use in industrial processes is not yet feasible.



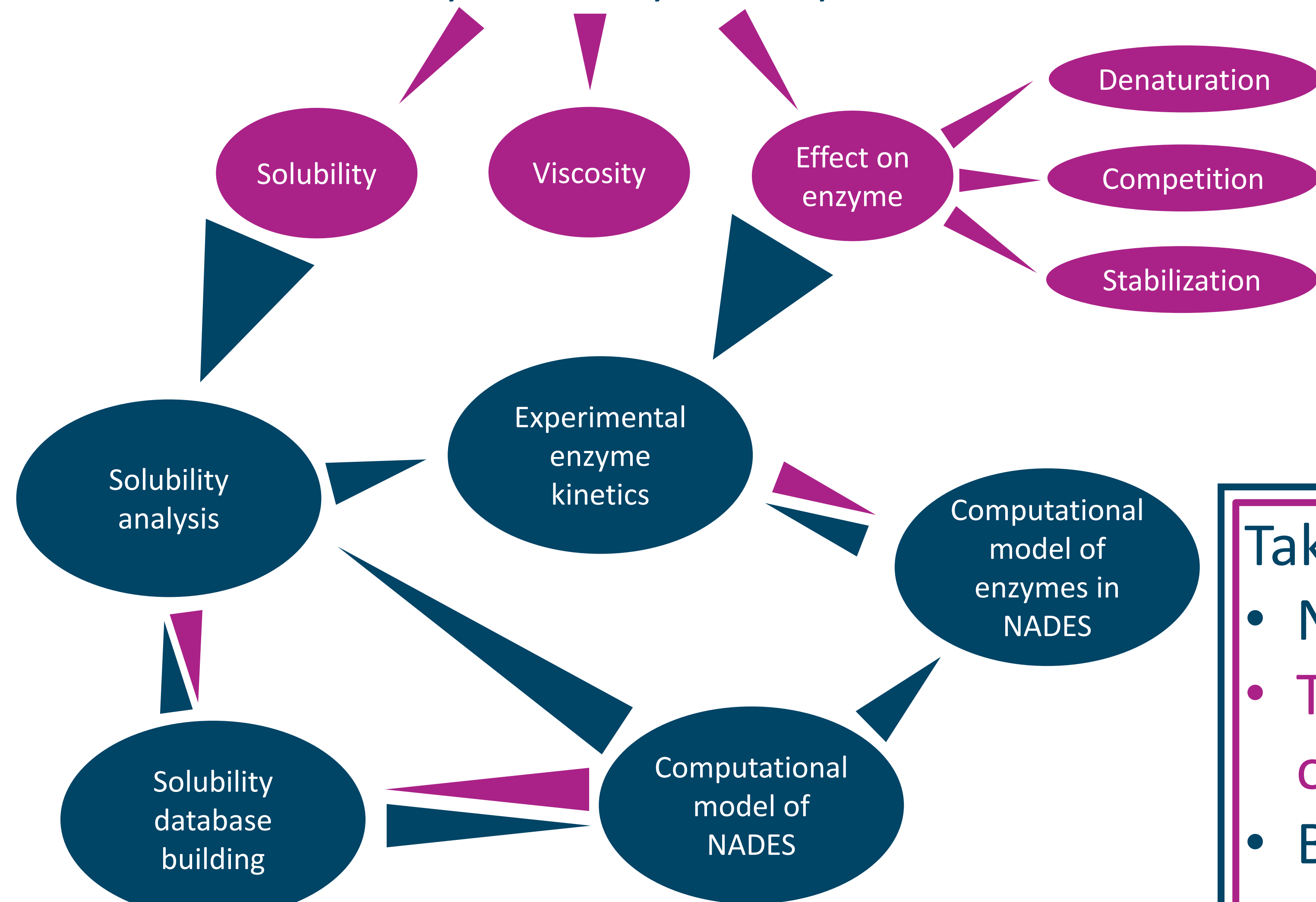
NADES effect on biocatalysis: relative maximum reaction rate of lipase-catalyzed hydrolysis in different NADES (Juneidi et al. 2017)



Solubility effect of NADES: The solute-solvent interaction changes the free energy of the substrates and product, therefore changes the thermodynamics of the reaction

Substrates $\xrightarrow[\text{Enzymatic reaction}]{\text{NADES solvent}}$ Products

Activity, selectivity, stability?



Prediction of the right NADES for the right use

Our aim is to create a **predictive model** for the interactions between the actors in enzyme-catalyzed reactions and NADES media. To achieve this we:

- develop and validate a **solubility model** of reagents and products in NADES, through experiments and molecular scale modelling
- distinguish the **effects of NADES on biocatalysis** (solvation, mass transfer limitations, effect on enzyme activity and stability) by experimental **kinetic modeling and computational modeling**

The research will deliver for the first time a **methodology to screen NADES for use in biocatalysis**, paving the way to industrial application.

Take home message

- NADES offer a green alternative to common organic solvents
- Their application in industry requires a better understanding of their structure-property interaction
- By the combined application of experimental screening, computational chemistry and data analysis, a holistic model will be obtained.

References

- García et al., Chemical Physical Letters 634 (2015) 151-155.
 Juneidi et al., Biochemical Engineering Journal 117 (2017) 129-138.
 Abbot et al., Chemical Communication 0(2003) 70-71.